COMMUNITY ASSISTANCE
PLANNING REPORT NO. 316

A RESTORATION PLAN FOR THE ROOT RIVER WATERSHED

Part One

Chapters 1-7

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Special acknowledgement is due to Dr. Joseph E. Boxhorn, SEWRPC Senior Planner; Mr. Aaron W. Owens, SEWRPC Planner; Ms. Patricia M. Kokan, SEWRPC Secretary; Ms. Laura L. Kletti, SEWRPC Principal Engineer; Dr. Thomas M. Slawski, SEWRPC Principal Specialist Biologist; Ms. Megan A. Beauchaine, SEWRPC Research Analyst; Ms. Megan R. Bender, SEWRPC Engineer; and Ms. Ann Dee Allan, SEWRPC Senior Public Involvement and Outreach Specialist, for their contributions to the conduct of this study and the preparation of this report.

COMMUNITY ASSISTANCE PLANNING REPORT
NUMBER 316

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Part One of Two
Chapters 1-7

Prepared by the

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ROOT-PIKE

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July 2014

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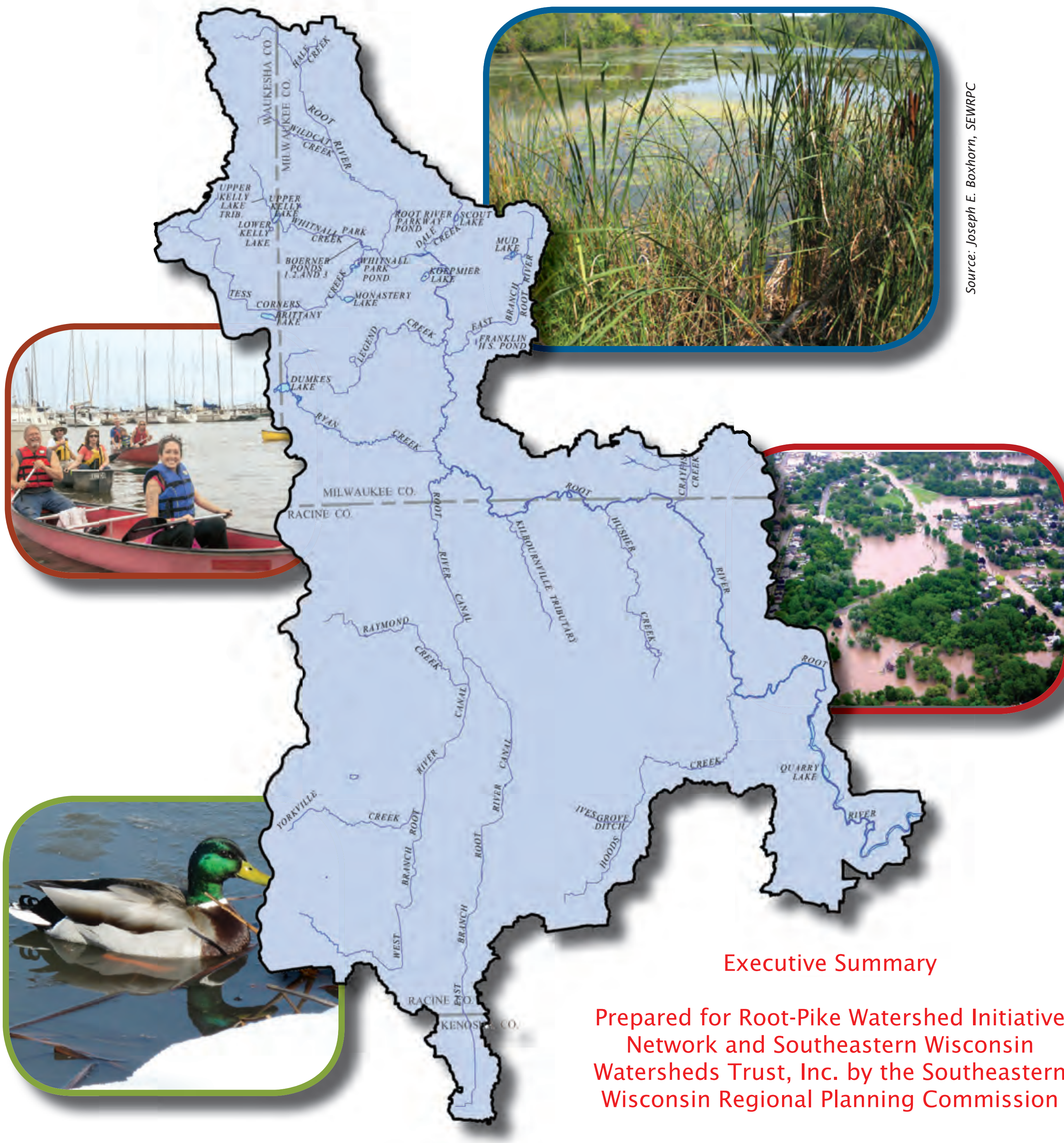
A Restoration Plan for the Root River Watershed

A Guide to Managing Water Quality, Recreational Access and Use, Habitat Conditions, and Flooding



Source: Joseph E. Boxhorn, SEWRPC

Source: Jay Warner, Warner Consulting

Source: Civil Air Patrol

Source: Joseph E. Boxhorn, SEWRPC

Executive Summary

Prepared for Root-Pike Watershed Initiative Network and Southeastern Wisconsin Watersheds Trust, Inc. by the Southeastern Wisconsin Regional Planning Commission

July 2014

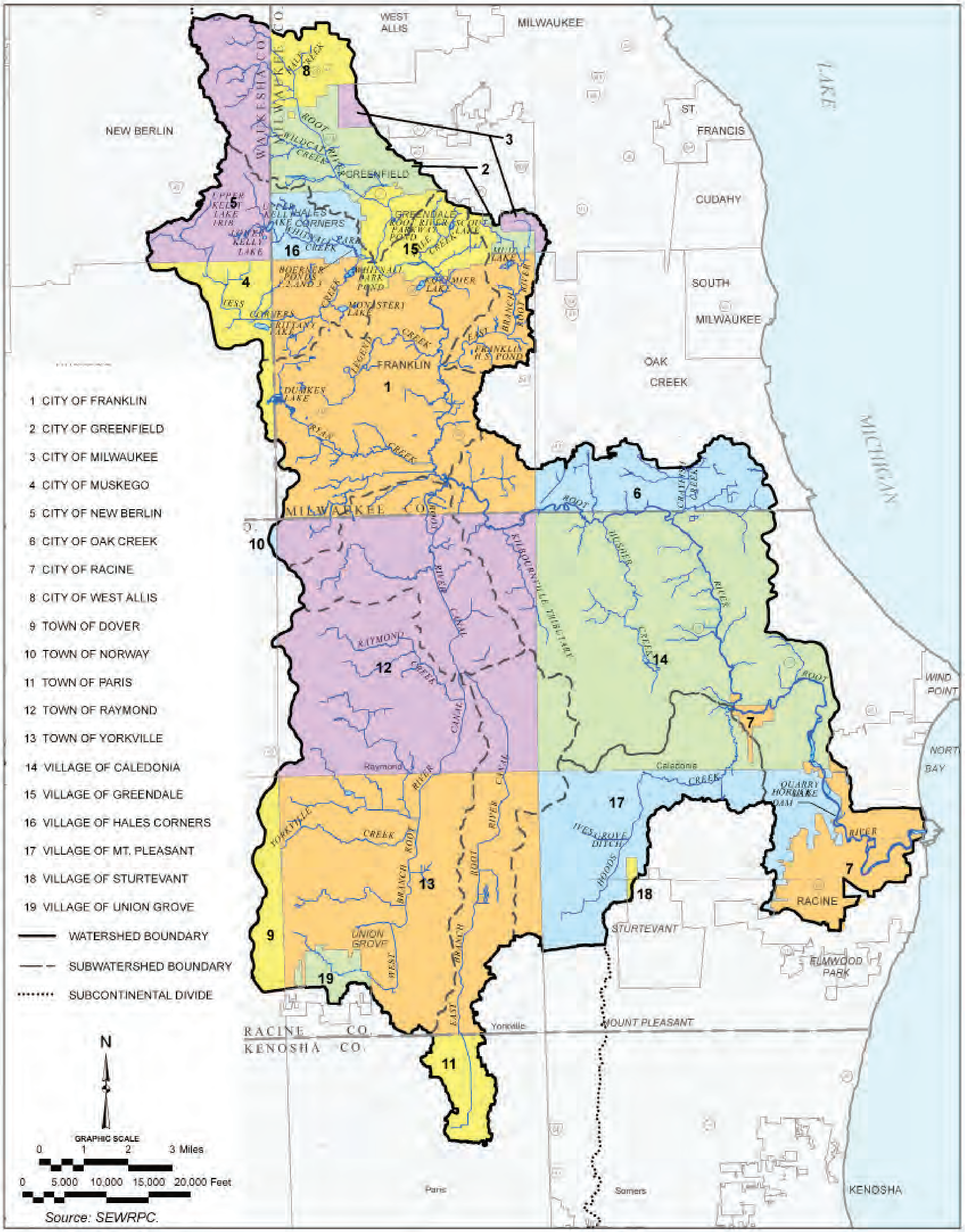
Water quality

Recreational use and access

Habitat conditions

Flooding

Civil Divisions Within the Root River Watershed: 2012



The Root River watershed is located in Kenosha, Milwaukee, Racine, and Waukesha Counties. It reaches into eight cities, six villages, and five towns in southeastern Wisconsin.

A Restoration Plan for the Root River Watershed

Source: Aaron W. Owens, SEWRPC

Erosion is evident in this portion of Hoods Creek.

The health of a river system is usually a direct reflection of the use and management of the land within its watershed. The Root River watershed in southeastern Wisconsin is not in the best of health and has shown signs of degradation over several decades. The Root River Watershed Restoration Plan is a comprehensive resource developed to provide a set of specific, targeted recommendations to improve the Root River and its tributaries. The recommendations are for focused implementation from 2014 to 2019, but the plan is comprehensive in scope and it is likely that it will be implemented well beyond 2019.

The plan is coordinated with other recent plans and recommendations. Notably, the 2007 SEWRPC regional water quality management plan update provides comprehensive recommendations related to land use, pollution abatement, and water quality management that are directly related to the Root River watershed. The 2014 Root River plan includes a detailed review of the status of implementation of these recommendations.

The Root River Watershed Restoration Plan seeks to preserve, restore, and enrich the natural environment by focusing on these four areas:

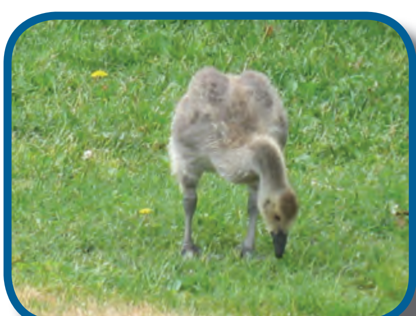
- **Water quality**
- **Recreational access and use**
- **Habitat conditions**
- **Flooding**

Root River characteristics and conditions

The Root River watershed contains a mixture of urban and rural land uses, with urban development concentrated in Milwaukee and Waukesha Counties, the City of Racine, and the southeastern portion of the watershed. The remaining two-thirds of the watershed is primarily influenced by rural land uses.

The ecological integrity of the River and its tributaries is threatened by a number of problems that restrict potential uses of those streams. Although the watershed includes environmental corridors, parks, and natural areas, and provides opportunities for outdoor recreation, it is adversely affected by:

- Areas with chronically low concentrations of dissolved oxygen that inhibit aquatic habitats,
- High concentrations of bacteria which indicate that disease-causing agents may be present,
- High concentrations of phosphorus and chloride,
- High concentrations of total suspended solids,
- Streambed and streambank erosion,
- Disconnected habitats for wildlife that rely on natural land and water corridors,
- Exotic invasive species that can displace native species and degrade habitat, and
- A lack of recreational access in some places.



Source: Joseph E. Boxhorn, SEWRPC

The Root River watershed attracts geese and other waterfowl.

Integrated watershed planning

Using existing plans and recent scientific data from established sources, Root River watershed restoration planners at SEWRPC, working with an Advisory Group of experts and interested parties, developed specific, targeted recommendations to improve water quality, recreational access and use, and habitat conditions, and to reduce flooding in Racine County. These water quality recommendations include measures to reduce the levels of phosphorus, bacteria, and pollutants.

Urban recommendations for restoring the watershed

Nonpoint source pollution contributed by urban and rural stormwater runoff is a major source of pollution in the Root River watershed. The Root River plan recognizes the watershed's sensitivity to human influences and includes strategies to reduce the pollutants from runoff.

Municipal and county governments, property owners, and resource managers can implement best management practices to reduce runoff pollution in the watershed. In urban areas, nonpoint sources of runoff can be controlled through many different independent and coordinated practices and green infrastructure.

Source: Root-Pike Watershed Initiative Network

Bioswales are one urban solution to stormwater runoff.

Source: Joseph E. Boxhorn, SEWRPC

Porous pavement can include brickwork, as show above.

Municipalities can address water quality by monitoring stormwater for illicit discharges of contaminated water; designing facilities to reduce sediment, nutrient, bacteria, and pathogens; and implementing and enforcing pet litter controls.

Green infrastructure

The Root River watershed plan is closely aligned with numerous relevant governmental and nongovernmental entities, and incorporates projects, plans, programs, and data from these entities. In 2013, the Milwaukee Metropolitan Sewerage District (MMSD) developed a green infrastructure plan for its planning area, including significant portions of the Root River watershed. The MMSD plan includes many of the strategies to reduce urban runoff that are listed on this page.

Source: Milwaukee Metropolitan Sewerage District

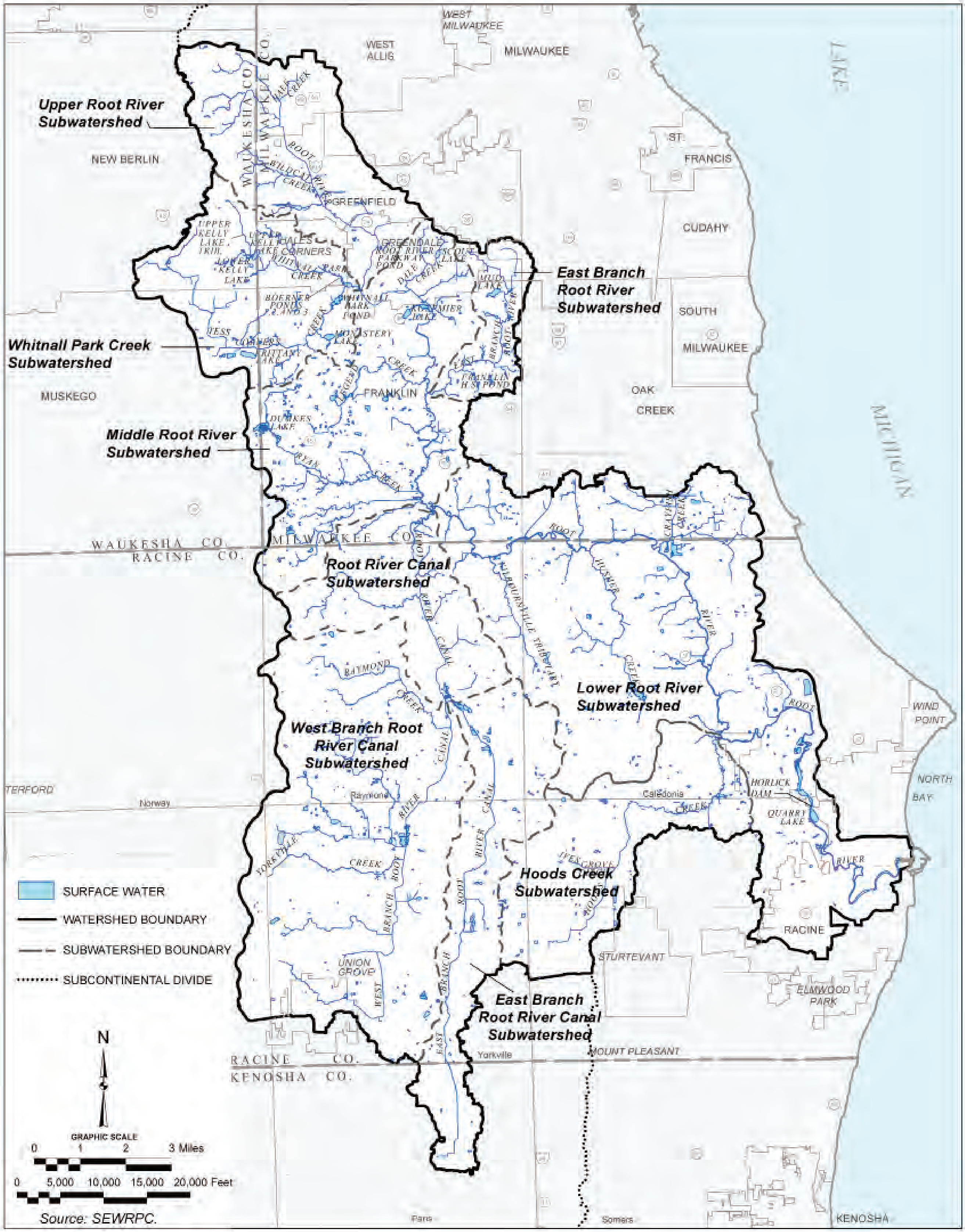
Source: Root-Pike Watershed Initiative Network

Green roofs, left, and rain barrels, above, catch stormwater runoff.

Strategies to reduce pollution from urban runoff

- Grassed swales
- Infiltration basins
- Bioretention facilities
- Rain gardens
- Green roofs
- Native landscaping
- Cisterns
- Rain barrels
- Soil amendments
- Porous pavement
- Stormwater treatment facilities
- Storm sewer systems
- Vacuum sweeping of roads and parking lots
- Non-chloride (road salt) snow and ice controls
- Fertilizer application controls
- Pet litter and debris controls
- Marine sanitation controls

Surface Water Within the Root River Watershed: 2012



The Root River watershed includes nine subwatersheds: the Upper Root River, Whitnall Park Creek, East Branch Root River, and Middle Root River upstream in Milwaukee and Waukesha Counties, and the Root River Canal, West Branch Root River Canal, East Branch Root River Canal, Lower Root River, and Hoods Creek downstream in Racine and Kenosha Counties.

Rural recommendations for restoring the watershed

Rural nonpoint source pollution control measures are also an important part of the Root River watershed plan. The plan includes erosion-control, farm management, and other recommendations for rural areas derived from the regional water quality management plan update. In addition to agricultural best management practices, both the Root River and the regional plans recommend regulatory oversight of private-property wastewater treatment systems.

Source: Chad Sampson, Racine County Land Conservation

Pollution from agriculture can be reduced through best practices such as grass swales and inlets for collecting and filtering runoff.

Strategies to reduce pollution from rural runoff

- Riparian buffers
- Conservation tillage
- Grassed waterways
- Cover crops
- Manure storage
- Nutrient management
- Barnyard runoff controls
- Livestock controls
- Wetlands and prairies
- Milking wastewater controls
- Drainage water management
- Saturated buffers
- Woodchip bioreactors (trenches)
- Drain tile controls

Groundwater recharge

Groundwater recharge in the Root River watershed supplies water to shallow aquifers which, in turn, provide water to the River and its tributaries. This supply of "baseflow" water is invaluable to maintaining the natural hydrology, instream habitat, and the overall health of the River, particularly during droughts and low water flows (which may become more frequent due to climate change). The Root River plan includes recommendations for protecting groundwater recharge and flow related to urban development and green infrastructure.

Source: Ann Dee Allen, SEWRPC

Members of the public and governmental and nongovernmental agencies provided input for the Root River plan at a series of public meetings in the watershed.

Surface water hydrology

Urbanization and agricultural development have altered the landscape with regard to the surface water drainage characteristics within the watershed, leading to increasing volumes of water and runoff. The Root River plan includes recommendations for slowing and moderating water flow in an effort to restore more natural, normal flows. Many different urban and rural solutions can be implemented to manage water fluctuations, including stream rehabilitation, erosion controls, wetlands, and natural vegetation.

The Root River Watershed Restoration Plan was developed to meet the U.S. Environmental Protection Agency's Nine Elements for a Watershed Plan. The elements specify requirements that include identifying the causes of pollutants, describing watershed management measures and timelines for implementation, estimating costs, setting milestones and criteria for plan progress, and information and education.

Source: Laura Kletti, SEWRPC

The Root River offers urban and rural opportunities for recreation.

Urban fishing and recreation

The Root River is a major draw for southeastern Wisconsin residents and visitors who enjoy fishing from the banks of public lands and from boats. The Wisconsin Department of Natural Resources and local governments manage and stock trout into several small lakes and ponds in the watershed.

The watershed is also served by Wehr Nature Center in Milwaukee County and by River Bend Nature Center and the Root River Environmental Education Community Center in Racine County. Seven additional nature centers outside the watershed are also located in the counties the River traverses. The Root River plan recommends that nature center facilities, programs, and services continue to be provided and enhanced according to each center's needs and resources.

Nature centers in the watershed offer programs and services unique to their locations. Although facilities and activities vary by nature center, the following activities are available at one or more of the nature centers within the Root River watershed, and rental of some equipment is also provided.

- **Hiking and cross-country skiing**
- **Connections to bicycle or multiuse trails**
- **River access for canoes and kayaks**
- **Sledding**
- **Equipment Rentals**
  - **Canoes**
  - **Cross-country skis**
  - **Kayaks**
  - **Snowshoes**

Recommendations for recreational use and access

One of the primary reasons for developing and implementing the Root River plan is to improve access to the outdoors and enhance the outdoor experience for people who fish, boat, picnic, hike, visit nature centers, and engage in other recreational activities in the watershed. To accomplish this, the plan includes recommendations to improve water quality by reducing bacteria and pathogens that enter the watershed and affect human, animal, plant, and aquatic life. Optimum recreational use of the watershed is dependent upon the propagation and protection of desired species of fish and the exclusion of invasive aquatic and terrestrial species and plants.

Source: Joseph E. Boxhorn, SEWRPC

Fishing is popular at Scout Lake in the northern portion of the watershed and other places.

Source: Tom Slawski, SEWRPC

Fishing appeals to all ages.

Recreational use and access

Riparian buffers

The preservation and development of riparian buffers—land zones that help protect water quality and function as core habitat and travel corridors for many wildlife species—are keys to the existing and future economic, social, and recreational well being of the Root River watershed.

Derived from the Latin word ripa, for "bank," riparian buffers refer to the natural or relatively undisturbed lands adjacent to waterbodies and to corridor lands in need of protection. As buffers, these areas lessen the adverse effects of development and urban and rural runoff, and so contribute to water quality, recreational use and access, and habitat conditions. They also reduce flooding.

Riparian buffers:

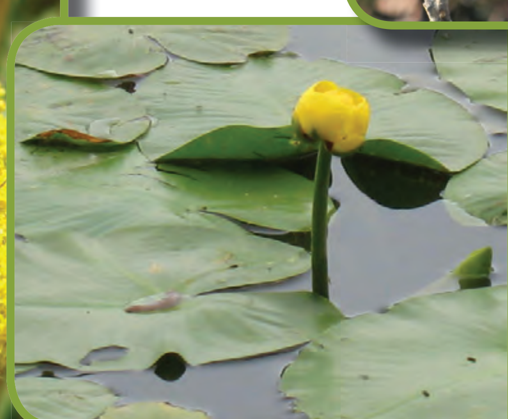
- Protect surface- and ground-water quality and recharge,
- Help protect wildlife for fishing and hunting,
- Allow native species to flourish while discouraging unwanted species, and
- Provide natural areas for rivers and streams to overflow into during floods.

Source: Joseph E. Boxhorn, SEWRPC

Riparian buffers provide environmental corridors for wildlife and also protect water quality.

Buffer design

Property owners, farmers, businesses, and developers can all benefit from learning more about environmental buffers that promote water and habitat quality and prevent or mitigate flooding. Urban and rural buffer designs vary as much as nearby areas. Landscapers and other professionals use many factors to determine the best buffer design for a specific area, including slope, soils, incoming pollution, land area dimensions, and vegetation.



Source for photos on pages 8-9: Donna Pelikan Boxhorn; Joseph E. Boxhorn, SEWRPC, and the Wisconsin Department of Natural Resources

Habitat and wildlife protection

The Root River Watershed Restoration Plan recommends that efforts be made to develop buffered areas to the extent practicable within the watershed. Several practices contribute to the effectiveness of riparian buffers, including: 1) eradicating nonnative plant species, 2) establishing and restoring native vegetation, and 3) promoting awareness and education about managing buffer zones to prevent the introduction of nonnative species of plants, fish, and animals.

Source: Joseph E. Boxhorn, SEWRPC

Muskrats can be found in the watershed, as evidenced by this lodge.

Open spaces and corridors

Riparian buffers and other natural areas cannot fully protect and nurture native species when they are disconnected from each other. Open spaces and corridors that enable water to flow, fish and other wildlife to travel and reproduce, and native trees and plants to grow, are essential to environmental health. The Root River plan recommends that open spaces be preserved and expanded through native landscaping and small wetlands, woodlands, and prairies. Nonessential roads and stream crossings are discouraged, as they interrupt natural corridors.

The Root River watershed is home to many species of plants, animals, insects, and birds.

Source: City of Racine Department of Public Works

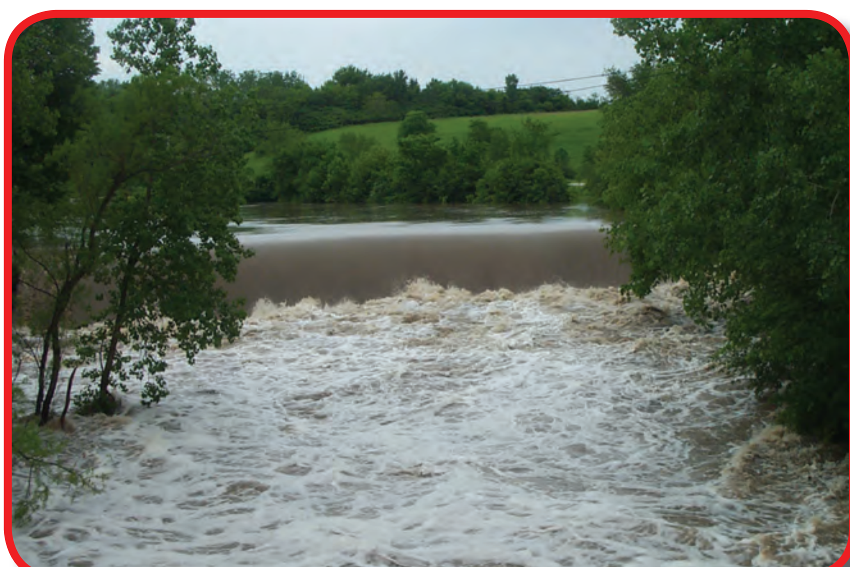
City of Racine residents experience periodic flooding from the Root River.

Flooding

At times, flooding in Racine County contributes to health, environmental, and safety hazards—including bacteria, sedimentation, and real and personal property damage. The Root River plan identified areas prone to flooding within the Racine County portion of the watershed. In areas where flooding is scattered, flood mitigation measures such as structure floodproofing or removal should be considered. In areas of the City of Racine where there is a more concentrated flood hazard, more detailed flood mitigation planning will be necessary, considering a wide range of alternatives including floodwater storage and conveyance.

The Milwaukee Metropolitan Sewerage District (MMSD) is responsible for flood mitigation in the upstream segment of the watershed. The Southeastern Wisconsin Regional Planning Commission (SEWRPC) is in the process of updating floodplain delineations in Milwaukee County

Source: Bill Miller, City of Racine Public Works



The Horlick dam must be upgraded to safely pass floodwaters.

Examples of flood mitigation

- Convey and store River floodwaters in stream overbanks
- Floodproof, elevate, or demolish flood-prone buildings
- Construct or modify bridges and culverts along roadways
- Construct or modify stormwater management systems to infiltrate, store, and/or convey runoff
- Construct emergency overflow routes for peak runoff from stormwater systems

Source: David L. Maack, Racine County Office of Emergency Management

Flooding causes property damage.

Water quality monitoring

Many governmental and nongovernmental organizations are involved in monitoring the Root River watershed for water quality, recreational use and access, habitat conditions, and flooding. More than two dozen water quality monitoring stations are in use within the watershed.

Source: SEWRPC

The Root River plan includes four alternatives for the Horlick dam, plus a recommendation to remove it, as depicted above.

Horlick dam

Horlick dam on the Root River in Racine County has become an issue of concern because it contributes to sedimentation, which increases phosphorous levels and also raises water temperatures and lowers the levels of dissolved oxygen necessary for fish and aquatic organisms to thrive. The dam also interrupts and disconnects the river system. While the dam does provide some protection from aquatic invasive species, it is not a complete barrier.

The WDNR has notified Racine County that it has until the year 2024 to increase the capacity of the Horlick Dam spillway if the County chooses to maintain the dam. Another option available to the County is to abandon and remove the dam. The Root River plan includes four alternatives for reconstructing the spillway and one to remove the dam. Based on environmental considerations—including water quality, fish community effects, and flooding—the plan recommends that the dam be removed. The plan notes that Racine County's decision on the future of the dam must also consider cost and include cultural and social implications regarding recreation, safety, and property owners' interests. It is recommended that Racine County work closely with the WDNR to determine what actions to take regarding the dam. In addition, other dams in the watershed could be evaluated for modification or removal.

Source: Laura Kletti, SEWRPC

Sports enthusiasts fish for coho salmon, chinook salmon, and other species at the Horlick dam spillway.

The Root River plan recommends comprehensive monitoring of water quality by continuing existing monitoring and adding more than 40 more monitoring stations along the River, its tributaries, and several lakes. This would allow the health of the watershed to be more accurately gauged by location.

Different types of water monitoring include analyzing indicators related to:

- Ammonia
- Cyclic organic compounds
- Chlorophyll-a
- Dissolved oxygen
- Fecal indicator bacteria
- Fish
- Phosphorous
- Metals
- Nitrate
- Nitrite
- Nitrogen
- Stream invertebrates
- Suspended solids
- Water flow
- Water temperature
- Water transparency
- Water turbidity

Root River Watershed Restoration Plan

In developing a 2014-2019 plan for watershed water quality, recreational use and access, habitat conditions, and flooding, two fundamental questions were addressed: 1) What are the conditions of the Root River watershed, and 2) What are the specific, targeted recommendations for improving the River and its tributaries?

Source: Chad Sampson, Racine County Land Conservation

Restored areas of the Root River watershed provide habitat and improve water quality.

The Root River Watershed Restoration Plan sets forth a comprehensive plan for the four areas on which it focuses. The plan includes recommendations for both general and site-specific management measures to address the physical, chemical, and biological health of the watershed. It also includes a comprehensive description of conditions in the watershed and provides lists of funding sources for implementation. The plan contains information to help people become more aware of the health and use of the watershed.

The Root River watershed is an important natural resource which, managed wisely, will continue to improve as a place for animal, plant, and aquatic life to flourish—providing decades of healthy recreation for southeastern Wisconsin residents and visitors.

The Root River Watershed Restoration Plan can be accessed online at www.sewrpc.org/SEWRPC/Environment/Root-River-Watershed-Restoration-Plan.htm. For more information, please contact the Root-Pike Watershed Initiative Network at info@rootpikewin.org, the Southeastern Wisconsin Watersheds Trust at info@swwtwater.org, or SEWRPC at mhahn@sewrpc.org.

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Chapter I

INTRODUCTION

PURPOSE OF THE PLAN

The health of a river system is usually a direct reflection of the use and management of the land within its watershed. Human activities within a watershed affect, and are also affected by, surface and groundwater quality and quantity and habitat conditions. In the Root River watershed the effects of human activities on water quality often tend to overshadow natural influences. The Root River, its tributaries, and associated wetlands are an important warmwater resource located in Kenosha, Milwaukee, Racine, and Waukesha Counties in southeastern Wisconsin that has historically shown and continues to show signs of degradation. The problems of this watershed typify those found in areas experiencing changing land use patterns and water resource-related problems and have a direct effect on the property and general welfare of the residents of the watershed. The purpose of this plan is to provide a set of specific, targeted recommendations that can be implemented over the period from 2014 through 2018 to address improvements relative to a set of focus issues related to conditions within the watershed with the overall goal of restoring and improving the water resources of the Root River watershed.

This watershed restoration plan represents a second-level plan for the management and restoration of water resources in the Root River watershed. It was prepared in the context of the Southeastern Wisconsin Regional Planning Commission's (SEWRPC) regional water quality management plan update for the greater Milwaukee watersheds (RWQMPU),[1] which was prepared in coordination with, and largely incorporates, the Milwaukee Metropolitan Sewerage District's (MMSD) 2020 facilities plan.[2] This plan builds upon the findings and recommendations of the 2007 SEWRPC RWQMPU to provide specific, targeted recommendations to address four focus issues: water quality, recreational access and use, habitat conditions, and flooding. The applicable planning, objectives, principles, and standards applied under the RWQMPU, and set forth in Chapter VII and Appendix G of SEWRPC PR No. 50,[3] are also adopted for use under this watershed restoration planning effort.

The Root River Watershed Restoration Plan is designed to assist local units of government, State and Federal agencies, nongovernmental organizations, and private landowners in identifying actions that will restore and

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[1]*SEWRPC Planning Report No. 50 (PR No. 50),* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007.*

[2]*Milwaukee Metropolitan Sewerage District,* MMSD 2020 Facilities Plan, *June 2007.*

[3]*SEWRPC Planning Report No. 50,* op. cit.

Figure 1

THE ROOT RIVER IN THE ROOT RIVER PARKWAY, VILLAGE OF GREENDALE, WISCONSIN

Photo Courtesy Donna Pelikan Boxhorn.

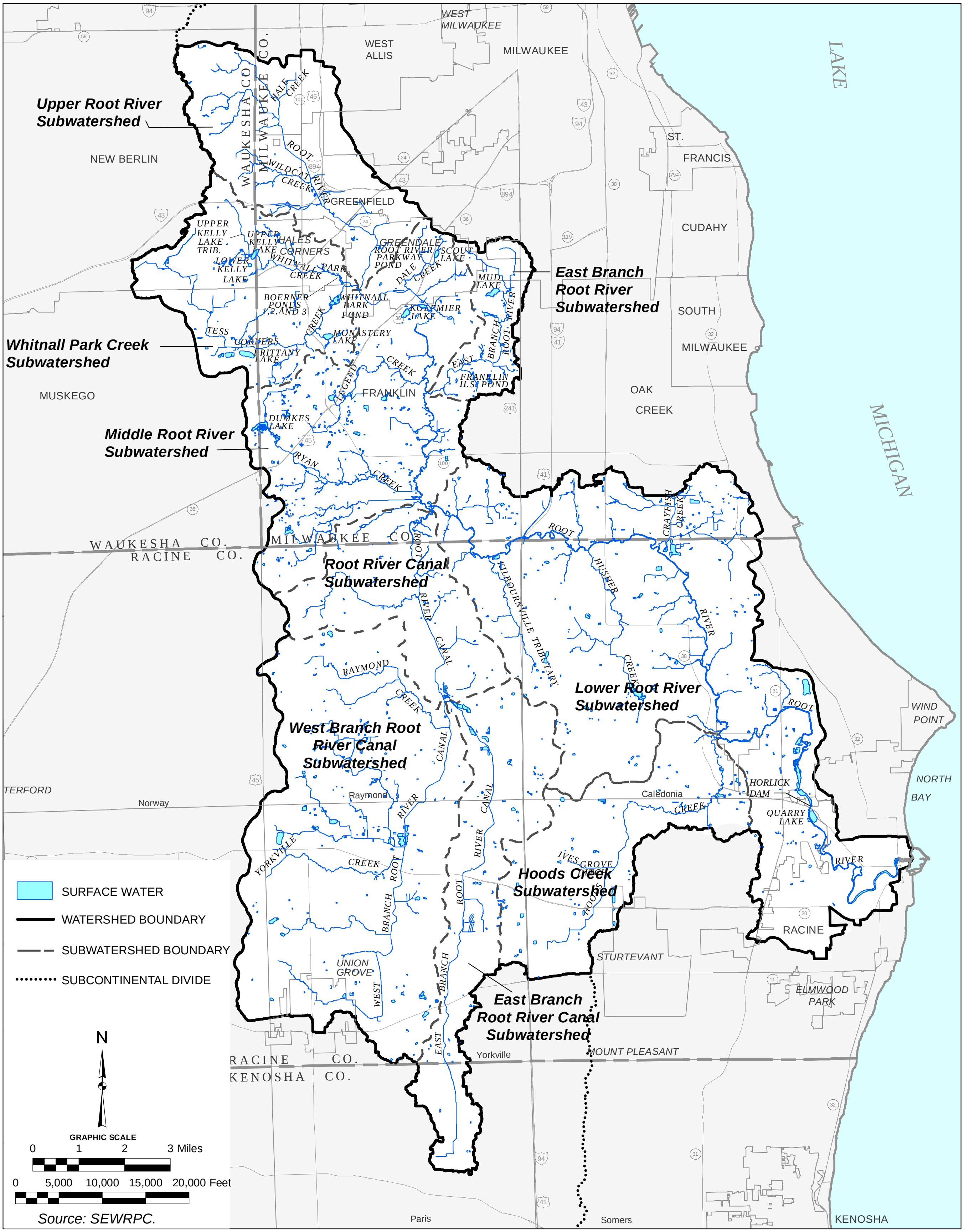
benefit the natural assets of the watershed. By implementing the actions identified in this plan, results will be achieved that preserve, restore, and enrich the natural environment. This watershed restoration plan should serve as a practical guide for the management of water resources within the Root River watershed and for the management of the land surfaces that drain directly and indirectly to this body of water over the period from 2014 through 2018.

BACKGROUND

The Root River watershed is located in the east central portion of the Southeastern Wisconsin Region and covers an area of approximately 198 square miles. The Root River is shown in Figure 1. The mainstem of the Root River originates in the City of New Berlin in eastern Waukesha County and flows approximately 44 miles in a southerly and easterly direction to its confluence with Lake Michigan in the City of Racine in Racine County. Tributaries of the Root River extend into Kenosha, Milwaukee, Racine, and Waukesha Counties. The watershed lies east of the subcontinental divide, thus its rivers and streams flow to Lake Michigan. The boundaries of the watershed, together with the locations of the main channels of the Root River and its principal tributaries, are shown on Map 1. While the Root River watershed contains no lakes with surface areas of 50 acres or more, it does contain several named lakes and ponds.

Map 1

SURFACE WATER WITHIN THE ROOT RIVER WATERSHED: 2012



Source: SEWRPC.

The watershed contains a mixture of urban and rural land uses. While urban development exists throughout much of the watershed, it is principally concentrated in the northern portion in Milwaukee and Waukesha Counties and in the southeastern portion of the watershed in and around the City of Racine. In 2000 urban development represented about one-third of the area of the watershed, with the remaining two-thirds of the watershed being in rural land uses.

Nineteen civil divisions lie wholly or partially within the Root River watershed. These are shown on Map 2. These civil divisions are an important factor that must be considered in the planning process because they form the basic foundation of the public decision-making framework within which intergovernmental, environmental, and developmental problems must be addressed. In addition to the civil divisions, the Root River watershed also contains several special-purpose units of government. Portions of the watershed are contained within three agricultural drainage districts. These districts are organized to drain lands for agricultural and other purposes. Also, four stormwater utility districts have been established for the purpose of managing stormwater runoff in the Village of Caledonia and the Towns of Dover, Raymond, and Yorkville.

The Root River watershed provides several recreational values. Much of the land adjacent to the mainstem of the Root River consists of environmental corridors that are contained within parks or natural areas. The watershed provides opportunities for fishing, hunting, boating, wading, canoeing, kayaking, wildlife watching, and scenic viewing. The section of the Root River downstream from Horlick Dam supports a rich trout and salmon fishery that is linked to Lake Michigan. This fishery is based upon stocking of these species by the Wisconsin Department of Natural Resources (WDNR). Historically, the Root River and its tributaries provided habitat for a number of fish species, including species considered threatened by the State of Wisconsin, such as longear sunfish, redfin shiner, and river redhorse, and species of special concern in the State, such as lake chubsucker, least darter, and redside dace.

A number of problems have been identified in the Root River watershed which restrict its potential uses and threaten its ecological integrity.[4] The upper section of the mainstem of the Root River and two major tributary streams, the Root River Canal and the West Branch of the Root River Canal, are considered impaired pursuant to the Federal Clean Water Act because they often exhibit concentrations of dissolved oxygen that are below the levels necessary to support fish and other aquatic organisms. Surface waters in much of the watershed exhibit high concentrations of bacteria that indicate contamination with fecal material, especially during the months of May through October when many people are actively engaged in outdoor recreation activities. Upstream from Horlick Dam, the watershed supports a poor quality fishery. This fishery contains relatively few species, is trophically unbalanced, contains few top carnivores, and is dominated by species that are tolerant of poor water quality. Streambed and streambank erosion have been found to occur in those sections of the mainstem of the Root River and those tributary streams which have been examined. Terrestrial habitat within the watershed is highly fragmented. Aquatic and terrestrial exotic invasive species are present at many locations and may be displacing native species and degrading habitat. Finally, members of the public are seeking greater access to the River and its riparian areas for recreational uses.[5]

PLANNING PROCESS

The Root River watershed restoration plan was developed in response to a request from Racine County, the MMSD, the Southeastern Wisconsin Watersheds Trust, Inc. (Sweet Water), and the Root-Pike Watershed

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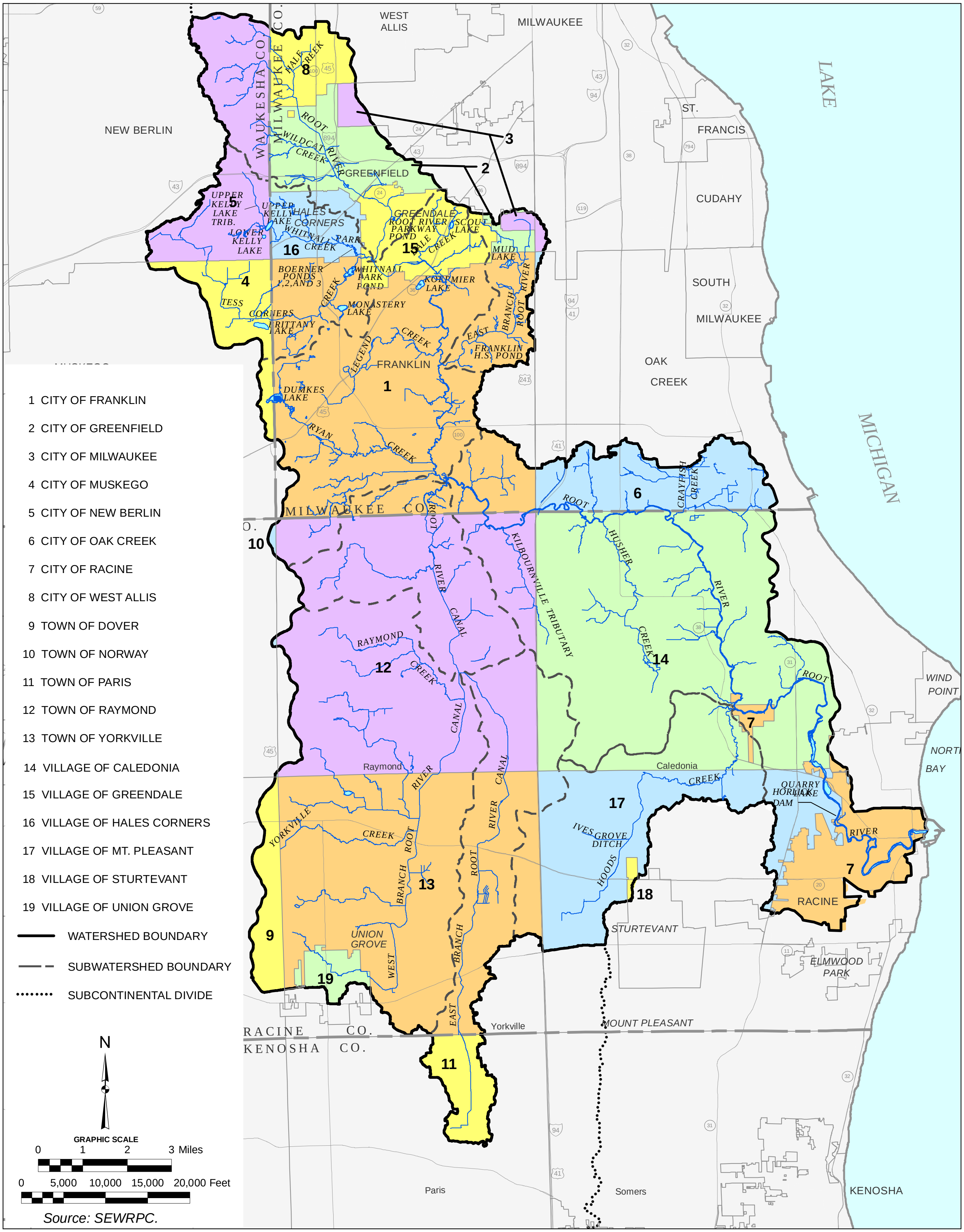
[4]*SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007.*

[5]*Root River Council and River Alliance of Wisconsin,* Back to the Root: An Urban River Revitalization Plan, *July 2008.*

Map 2

CIVIL DIVISIONS WITHIN THE ROOT RIVER WATERSHED: 2012



Initiative Network (Root-Pike WIN). Prior to making this request, these entities helped form the Root River Restoration Planning Group (RRRPG)—which includes representatives from Sweet Water, Root-Pike WIN, MMSD, Racine County, other county and municipal governments that are wholly or partially located in the watershed, the WDNR, nongovernmental organizations, and other groups and individuals representing a broad range of interests within the watershed. The RRRPG held four meetings during 2010 and early 2011 to investigate the need and potential for developing a watershed restoration plan for the Root River watershed and to initiate the planning process. The planning effort was led by Sweet Water and Root-Pike WIN through the RRRPG. Funding for the planning effort was provided by Racine County, MMSD, the Wisconsin Coastal Management Program, and the Fund for Lake Michigan.

Focus Areas

Focus areas are those general themes related to the critical concerns of the watershed. An individual focus area reflects a set of issues and problems related to one another through some desired use or state that the public has for the resource. Thus, these focus areas constitute a linkage between conditions in the watershed and the use by the public of water resources.

This watershed restoration plan is centered on four focus issues: water quality, recreational use and access, habitat conditions, and flooding. These themes are derived from three sources. First, they reflect the findings of the 2007 update of the regional water quality management plan for the greater Milwaukee watersheds.[6] As previously noted, the RWQMPU identified several problems in the Root River watershed that restrict potential uses of the resource and threaten its ecological integrity. Second, the focus issues reflect the findings of other recent planning efforts which have indicated interest in greater access to the Root River and its tributaries for recreational uses.[7] Third, they reflect general themes that emerged from the results of an online survey of, and prioritization by, interested parties including elected officials, State and local government staff, nongovernmental organizations, landowners, and residents.

Survey of Interested Parties

As part of its investigation of the need and potential for developing a Root River watershed restoration plan, the RRRPG asked staff from the University of Wisconsin-Extension to develop and conduct a survey to identify and prioritize issues to be addressed in a potential plan. This survey was designed as a two-part online survey and was implemented on the internet through an online survey service. The first part of the survey asked the respondents two types of questions. This part included initial questions to establish the relationship of the respondents to the watershed. These questions were followed by a series of open-ended questions that sought to identify major issues in the watershed related to surface water quality, natural areas, wildlife habitat, and outdoor recreation. The second part of the survey asked respondents to prioritize the issues identified in the first part and to choose from among the identified issues the five most important issues that they believed a watershed restoration plan should address.

Notice of the survey was sent by electronic mail to all persons who had previously participated in meetings of the RRRPG, representatives of all county and municipal governments in the watershed, persons working on land and water management-related issues in the watershed, and representatives and members of nongovernmental organizations working in the watershed. Separate notices were sent for each part of the survey. The notices explained the purpose of the survey and how respondents could access and complete it. Each notice also included a request that persons receiving it forward it to other persons with an interest in the watershed.

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[6]*SEWRPC Technical Report No. 39,* op. cit.

[7]*See, for example, Root River Council and River Alliance of Wisconsin,* op. cit.

The first part of the survey was conducted over the period from December 3 through 15, 2010. There were 32 respondents to this part of the poll. Of these respondents, 22 indicated that they live in the watershed; 20 indicated that they work in the watershed; and 17 indicated that they engage in outdoor recreation in the watershed. Only two respondents indicated that they fish in the watershed. The persons taking this part of the survey gave 318 separate responses to the issue-identification questions. Upon examination, similar and related responses were grouped to yield 43 issues. These are listed in Table 1. It should be noted that the issues identified in this part of the survey vary in their level of generality. In addition, it is recognized that there are interrelationships among the identified issues and that several of the issues that were identified can be considered aspects or components of other identified issues.

The second part of the survey asked respondents to rate each of the identified issues by relative importance, with a rating of 1 indicating the most important issues facing the watershed and a rating of 5 indicating the least important issues. This part of the survey also asked respondents to choose from among the identified issues the five most important issues that they believed a watershed restoration plan should address. Part two of the survey was conducted over the period from January 5 through 19, 2011. There were 61 responses to this part of the survey. The responses were used to develop three rankings of the issues. First, the issues were ranked based upon the mean rating given in response to the first question. Second, the issues were ranked based upon the number of responses to the first question rating each issue as first or second (assigned a value of 1 or 2, respectively). Third, each issue was ranked by the number of responses to the second question that placed it in the top five issues to be addressed. To examine the agreement among these ranking schemes, the issues in each scheme were assigned to five groups based upon ranks within the analysis, with the six top-ranked issues in each analysis assigned to the top group, the next six issues assigned to the next group, the next six issues assigned to the next group, the next 10 issues assigned to the next group, and the lowest-ranked 15 issues assigned to the last group. The groups are shown by color in Table 1, with the top-ranked group indicated by purple, the next group indicated by blue, the next group indicated by green, the next group indicated by orange, and the lowest-ranked group indicated by red. As shown in Table 1, the results of these three ranking schemes largely agree with one another, with the 12 most highly ranked and the 15 lowest-ranked issues being almost identical among the three analyses.

The focus areas for the watershed restoration plan were developed by examining the 15 highest ranked issues identified in the survey to determine whether there were any general themes uniting them. Four general themes emerged. The presence of water quality, stormwater runoff, nonpoint source pollution, and nutrients among the top 15 issues indicated that water quality was one general theme. The presence of habitat loss and fragmentation, access to the River, the quality of the fishery, and deterioration of parkland among the top issues indicated that recreational use was a second general theme. The presence of erosion of bed and bank, wetland loss, woodland loss, riparian buffers, habitat loss and fragmentation, and deterioration of parkland indicated that the condition of the habitat was a third general theme. Finally, the presence of flooding among the top issues, along with the expressed interest of local units of government in Racine County, indicated that flooding was a fourth general theme.

Plan Development and Review

The Root River watershed restoration plan was developed through a collective effort on the part of a number of agencies and organizations under the overall direction of the RRRPG, Sweet Water, and Root-Pike WIN. The agencies and organizations involved include the City of Racine Health Department, the WDNR, the University of Wisconsin-Extension, the counties and municipalities of the Root River watershed, and the Southeastern Wisconsin Regional Planning Commission (SEWRPC). The plan was developed under the guidance of the RRRPG and Root River Watershed Restoration Plan Advisory Committee. The Advisory Committee was created specifically for the purpose of reviewing draft plan chapters during plan development. Its membership was drawn from the participants of the RRRPG and includes elected and appointed officials, agency personnel, and citizens knowledgeable in land and water resource matters. The membership and activities of the Advisory Committee are documented in Appendix A.

Table 1

RANKING OF ISSUES IDENTIFIED IN THE ROOT RIVER ISSUE SURVEY

Issue	Question 1 Mean Rating	Question 1 Rated 1 or 2 (percent)	Question 2 Issue in Top Five
1. Water quality	1.52	90.2	29
2. Erosion of streambeds and banks	1.70	85.0	20
3. Flooding	1.70	81.7	12
4. Stormwater runoff	1.71	89.7	14
5. Wetland loss	1.72	83.3	16
6. Nonpoint source pollution	1.75	81.4	20
7. Woodland loss	1.75	80.0	8
8. Development/impervious surface	1.80	76.7	10
9. Nutrients/manure/fertilizer	1.80	80.0	12
10. Riparian buffers, the lack of or insufficiency of	1.80	81.7	16
11. Habitat loss/fragmentation	1.82	78.3	16
12. Education and public awareness, need for	1.87	78.7	14
13. Access to the river and riparian areas	1.93	69.5	12
14. Fishery quality	1.95	75.0	4
15. Deterioration of parkland	1.97	72.9	0
16. Flow issues (too much or too little)	1.98	75.0	4
17. Illicit discharges	2.00	75.0	3
18. Garbage, trash in streams and riparian areas	2.03	73.8	7
19. Groundwater recharge reductions	2.04	64.0	6
20. Farming	2.05	69.5	3
21. Invasive/nonnative species	2.05	74.6	8
22. Green infrastructure, need for	2.07	62.1	6
23. Channelization/bank modification	2.07	66.7	5
24. Brownfields	2.08	71.7	5
25. Sedimentation/siltation of channels	2.11	73.2	10
26. Pesticides	2.20	65.0	3
27. Horlick dam (removal of)	2.26	62.8	4
28. Fish passage barriers	2.26	56.1	4
29. Road salt	2.28	69.0	1
30. Prairie loss	2.34	59.3	0
31. Bridge restoration	2.45	58.9	2
32. Fish consumption advisories	2.53	44.8	3
33. Stream width	2.54	54.0	0
34. Climate change	2.71	42.4	1
35. Off-road vehicle-related damage	2.79	38.5	1
36. View loss	2.87	35.2	1
37. Navigational obstructions	2.91	38.2	2
38. Absentee landowners	3.05	32.4	0
39. Recreational instruction	3.13	27.8	0
40. Privacy for recreation	3.15	23.6	0
41. Overgrown vegetation/trees	3.15	23.7	0
42. Traffic noise	3.38	19.6	0
43. Feral pet-related damage	3.38	20.0	0

NOTE: Issues are ranked by order of importance as indicated in responses to the Root River issue survey. In each analysis issues are grouped by rank with purple indicating issues that were regarded as being the most important. The groups colored blue, green, orange, and red represent groups of issues assigned progressively less importance in the responses to the survey.

[a] *Question 1 was the first question in the second part of the survey. It asked interested persons to rate the importance of addressing each issue in the Root River watershed from 1 to 5, with 1 being the most important and 5 being the least important.*

[b] *Question 2 was the second question in the second part of the survey. It asked interested persons to identify the five issues that should be addressed by a watershed restoration plan.*

Source: University of Wisconsin-Extension and SEWRPC.

Advisory Committee meetings were held on May 2, 2012; August 1, 2012; November 7, 2012; February 6, 2013; May 1, 2013; August 7, 2013; and October 2, 2013. The Committee reviewed each chapter of the plan in draft form and provided comments and recommendations, which were addressed in the final plan. In addition, presentations were made to the RRRPG summarizing the content of draft chapters and reporting on progress. As draft chapters of the plan were completed, copies were placed in downloadable form on the SEWRPC website. This website also included a webpage on which members of the public could ask questions and submit comments on the draft plan. Copies of presentations to the RRRPG by SEWRPC staff were also placed on this website. This website could also be accessed through links on the Root-Pike WIN and Sweet Water websites.

PLAN FORMAT AND ORGANIZATION

This report documents a watershed restoration plan for the Root River watershed for the period from 2014 through 2018. It is organized into seven chapters.

Following this initial introductory chapter, the second chapter summarizes and describes the recommendations of the RWQMPU as they relate to the Root River watershed, indicates how these recommendations relate to the focus areas of this plan, and evaluates the implementation status of the recommendations.

Chapter III sets forth an inventory and review of recent and ongoing watershed management programs and initiatives in the Root River watershed that are related to the focus areas of this plan. This review describes those plans, programs, and initiatives that have recently been undertaken or are currently ongoing by State and local governments and private entities with a view toward integrating into the watershed restoration plan those efforts that are consistent with and complement the plan’s focus areas.

Chapter IV presents a characterization of the features of the Root River watershed. This characterization represents a refinement and updating of the inventories presented in the RWQMPU,[8] including analysis of water quality data collected by the City of Racine Health Department, under a project funded by the Fund for Lake Michigan, and consists of a focused inventory and analysis of those watershed characteristics most relevant to the four focus issues. This characterization includes discussion of physical conditions of the surface water system, existing surface water quality, and habitat and biological conditions in the Root River watershed. In addition it presents information on the natural and man-made features of the watershed, including a description of the natural resource base and environmentally sensitive areas, land use data, and demographics.

Chapter V provides a description of both the development of targets to be achieved by the end of the watershed restoration plan’s implementation period and alternative management actions to meet these targets. The targets developed are short-term goals or steps related to the focus issues that must be implemented to meet the long-term goals established in the RWQMPU. Establishing targets breaks the long-term goals into manageable pieces, helps determine the specific steps necessary to achieve a goal, and facilitates the development of measures to track progress. For each target developed, this chapter identifies specific actions, in the form of activities or projects that define the management measures needed to meet the target.

Chapter VI presents the watershed restoration plan recommended to guide activities over the five-year period 2014 through 2018. This chapter presents the management efforts selected to meet the targets identified in the previous chapter. For each recommended action, it also identifies the primary land uses that the action addresses and prioritizes those geographical areas and locations in the watershed where the action should be implemented. This chapter also identifies as foundation actions those actions upon which the success of other management measures depends.

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[8] *SEWRPC Technical Report No. 39*, op. cit.

Chapter VII presents implementation strategies designed to assist the implementing entities in converting the plan into actions, policies, and programs. The chapter also presents guidance on prioritizing the recommendations for implementation. In addition, the chapter identifies the agencies responsible for implementing elements of the plan, presents estimates of the resources—such as technical and financial assistance—required to implement elements of the plan, and identifies potential sources of such resources.

Chapter II

RECOMMENDATIONS OF THE REGIONAL WATER QUALITY MANAGEMENT PLAN UPDATE FOR THE ROOT RIVER WATERSHED

The 2007 regional water quality management plan update for the greater Milwaukee watersheds (RWQMPU)[1] updated the initial regional water quality management plan[2] for six watersheds, including the Root River watershed. The RWQMPU addressed three major elements of the original regional water quality management plan: the land use element, the point source pollution abatement element, and the nonpoint source pollution abatement element. In addition, the updated plan included consideration of several issues that were not considered in the initial plan, including instream and riparian habitat conditions and groundwater management. The RWQMPU planning effort was conducted in conjunction and coordination with the development of the Milwaukee Metropolitan Sewerage District's (MMSD) 2020 facility plan.

The RWQMPU made numerous recommendations that are relevant to the Root River watershed. These recommendations fall into nine broad areas:

- Land Use,
- Point Source Pollution Abatement Measures,
- Nonpoint Source Pollution Abatement—Rural Control Measures,
- Nonpoint Source Pollution Abatement—Urban Control Measures,
- Instream Water Quality Management Measures,
- Inland Lake Water Quality Management Measures,

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[1]*SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007.*

[2]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, *Volume One*, Inventory Findings, *September 1978; Volume Two,* Alternative Plans, *February 1979; Volume Three,* Recommended Plan, *June 1979.*

- Auxiliary Water Quality Management Measures,
- Groundwater Management Measures, and
- Recommended Water Use Objectives.

Table 2 summarizes the recommendations of the RWQMPU as they relate to the Root River watershed. In addition, the table indicates which recommendations relate to each of the four focus areas of the watershed restoration plan: water quality conditions, recreational use and access, habitat conditions, and flooding.

SUMMARY OF RECOMMENDATIONS OF THE REGIONAL WATER QUALITY MANAGEMENT PLAN UPDATE

Land Use Element

The land use element of the regional water quality management plan update included both an inventory of existing development in year 2000 and the identification of planned year 2020 development. In addition, projections of buildout land use conditions were developed for municipalities located within the MMSD planning area.

Year 2020 and buildout population and land use estimates were initially developed by the SEWRPC staff and the communities served by the MMSD based on future land use information provided by those communities. Those initial year 2020 populations and land development assessments were used for sizing the conveyance components of MMSD's Metropolitan Interceptor System. Planned land use data and population forecasts from the SEWRPC 2020 regional land use plan[3] were applied for communities in the study area that are not served by MMSD.

When data from the SEWRPC 2035 regional land use plan[4] became available, 2020 land use and population estimates for the MMSD communities were revised using a 2020 stage of those data and the revised data were used to develop the wastewater treatment components called for under the recommended MMSD 2020 facilities plan which is incorporated in the regional plan. Similarly refined population estimates were used for the 2020 condition evaluation of all of the public sewage treatment plants in the study area. Revised 2020 industrial and commercial land use estimates were also applied for the development of revised nonpoint source pollution loads used in modeling the instream water quality conditions under revised future year 2020 and recommended water quality plan conditions.

The RWQMPU makes several recommendations related to land use:

- That primary environmental corridors be preserved in essentially natural, open uses, forming an integrated system of open space lands. Under the RWQMPU, development within the primary environmental corridors would be limited to essential transportation and utility facilities, compatible outdoor recreation facilities, and rural-density residential development[5] in upland corridor areas not encompassing steep slopes. Several measures are in effect that help ensure the preservation of environmentally significant areas in the Root River watershed.

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[3]*SEWRPC Planning Report No. 45*, A Regional Land Use Plan for Southeastern Wisconsin: 2020, *December 1997.*

[4]*SEWRPC Planning Report No. 48*, A Regional Land Use Plan for Southeastern Wisconsin: 2035, *June 2005.*

[5]*Rural density residential development consists of a maximum of one dwelling unit per five acres.*

Table 2

RELATIONSHIP OF RECOMMENDATIONS OF THE REGIONAL WATER QUALITY MANAGEMENT PLAN UPDATE TO FOCUS AREAS OF THE ROOT RIVER WATERSHED RESTORATION PLAN

Recommendation	Focus Area			
	Water Quality	Recreation	Habitat	Flooding
Land Use				
Develop according to approved local land use plans	- -	X	X	X
Preserve primary environmental corridors in essentially open space uses	X	X	X	X
Consider preserving secondary environmental corridors and isolated natural resource areas in essentially open space uses	X	X	X	X
Preserve all identified natural areas and critical species habitat sites in public or public-interest ownership	- -	X	X	X
Preserve, to the extent practicable, all farmland covered by Class I and Class II soils	- -	- -	- -	- -
Point Source Abatement Measures				
Refine sanitary sewer service areas	X	X	- -	- -
Continue operation and maintenance of MMSD, Racine, Union Grove, and Yorkville wastewater treatment plants	X	X	- -	- -
Abandon Yorkville wastewater treatment plant at the end of its useful life	X	X	- -	- -
Construct and maintain local sanitary sewer systems	X	X	- -	- -
Evaluate the need to reduce infiltration and inflow of clearwater into sanitary sewers	X	X	- -	- -
Implement Capacity, Management, Operations, and Maintenance (CMOM) programs	X	X	- -	- -
Continue operation and maintenance of Fonk's Mobile Home Park wastewater treatment plant	X	X	- -	- -
Construct two additions to the MMSD Metropolitan Interceptor System	X	X	- -	- -
Continue to regulate wastewater treatment plant and industrial discharges under the Wisconsin Pollutant Discharge Elimination System (WPDES) program.	X	X	- -	- -
Nonpoint Source Abatement-Rural Control Measures				
Implement practices to reduce soil loss from cropland to rates below the tolerable soil loss rate, "T"	X	- -	X	- -
Require agricultural operations with 35 or more combined animal units to provide six months of manure storage	X	X	- -	- -
Apply manure and supplemental nutrient to cropland in accordance with nutrient management plans	X	X	- -	- -
Consider increasing levels of cost-share funding for barnyard runoff best management practices (BMPs)	X	X	- -	- -
Increase crop and pasture riparian buffers to minimum 75-foot widths	X	X	X	X
Limit the number of stream crossings and configure crossings to minimize fragmentation	- -	X	X	X

Table 2 (continued)

Recommendation	Focus Area			
	Water Quality	Recreation	Habitat	Flooding
Nonpoint Source Abatement-Rural Control Measures (continued)				
Convert marginally productive agricultural lands to wetland or prairie conditions	X	X	X	X
Restrict livestock access to streams	X	X	X	- -
Take measures to ensure proper handling and treatment of milking-center wastewater	X	- -	- -	- -
Implement county-enforced inspection and maintenance programs for private onsite wastewater treatment systems constructed after counties adopted private sewage system programs	X	X	- -	- -
Institute voluntary programs to inventory and inspect private onsite wastewater treatment systems constructed before counties adopted private sewage system programs	X	X	- -	- -
Nonpoint Source Abatement-Urban Control Measures				
Implement construction erosion control and urban nonpoint source pollution controls consistent with standards in NR 151	X	X	X	- -
Implement programs to detect and eliminate illicit discharges and control pathogens that are harmful to human health	X	X	- -	- -
Conduct human health and ecological risk assessments to address pathogens in stormwater runoff	X	X	- -	- -
Implement chloride reduction programs	X	- -	- -	- -
Implement fertilizer management programs	X	- -	- -	- -
Implement pet litter management programs	X	X	- -	
Implement beach and riparian litter and debris programs	X	X	X	- -
Conduct targeted research on bacteria and pathogens and research on stormwater BMP techniques and programs	X	X	- -	- -
Instream Water Quality Management Measures				
Implement projects called for under the Milwaukee County stream assessment study	X	- -	X	- -
Prepare abandonment and riverine area restoration plans for dams	X	- -	X	- -
Limit the number of culverts, bridges, drop structures, and channelized stream segments and incorporate measures to allow for passage of aquatic organisms	- -	- -	X	X
Remove abandoned bridges and culverts	- -	- -	X	X
Protect remaining stream channels, including small tributaries and shoreland wetlands	X	- -	X	- -
Restore wetlands, woodlands, and grasslands adjacent to stream channels and establish minimum buffers 75 feet in width	X	X	X	X
Restore and enhance stream channels	X	- -	X	- -
Monitor fish and macroinvertebrate populations	X	- -	X	- -
Consider more intensive fisheries manipulation measures where warranted, based upon specific goals developed in detailed local-level planning	- -	X	X	- -

Table 2 (continued)

Recommendation	Focus Area			
	Water Quality	Recreation	Habitat	Flooding
Inland Lake Water Quality Measures				
Implement recommendations of Milwaukee County park pond and lagoon management plan	X	X	X	- -
Conduct aquatic plant surveys in those lakes in which plant management activities are being conducted	- -	- -	X	- -
Establish long-term monitoring stations in inland lakes	X	X	- -	- -
Auxiliary Water Quality Management Measures				
Implement waterfowl control programs, where necessary	X	X	- -	- -
Continue, support, and institute household hazardous waste collection programs	X	- -	- -	- -
Continue, support, and institute collection programs for unused and expired medications	X	- -	- -	- -
Conduct assessments and evaluations of the significance for human health and wildlife of the presence of pharmaceuticals and personal care products in surface waters	X	- -	- -	- -
Continue and support programs to reduce the introduction and spread of exotic and invasive species	- -	- -	X	- -
Document and monitor the occurrence and spread of exotic and invasive species	- -	- -	X	- -
Continue and support current surface water quality monitoring programs	X	X	- -	- -
Extend long-term monitoring programs to areas outside of the MMSD service area	X	X	- -	- -
Establish long-term fisheries, macroinvertebrate, and habitat monitoring stations.	X	X	X	- -
Continue efforts to facilitate consolidation of data from different monitoring programs	X	X	X	- -
Continue and expand citizen-based monitoring efforts, with an emphasis on filling geographical data gaps	X	X	X	- -
Maintain and update RWQMPU/MMSD 2020 Facility Plan water quality models	X	- -	- -	X
Groundwater Management Measures				
Maintain important groundwater recharge areas	X	- -	X	X
Consider groundwater sustainability guidance from the regional water supply plan in evaluating the sustainability of proposed developments and local land use planning	X	- -	X	- -
Develop and implement utility-specific water conservation programs	X	- -	X	- -
Consider the potential impacts on groundwater quality of stormwater management facilities	X	- -	- -	- -
Recommended Water Use Objectives				
Upgrade objectives for Hoods Creek, Tess Corners Creek, and Whitnall Park Creek to Fish and Aquatic Life	X	X	- -	- -
Upgrade objective for Ives Grove Ditch to Limited Forage Fish	X	X	- -	- -

Source: SEWRPC.

- That the preservation of secondary environmental corridors and isolated natural areas be encouraged and that counties and communities consider the preservation of these areas in the preparation of county and local land use plans.

- That all of the identified natural areas and critical species habitat sites designated for acquisition under the regional natural areas and critical species habitat plan (specified sites not in existing public or public-interest ownership) be preserved,[6] and

- That, to the extent practicable, the most productive farmland, identified as farmland covered by agricultural capability Class I and Class II soils as classified by the U.S. Natural Resources Conservation Service be preserved.[7]

Point Source Pollution Abatement Plan Subelement

The RWQMPU includes recommendations related to public wastewater treatment plants (WWTPs) and associated sewer service areas, private wastewater treatment plants, and other point sources of water pollution. The RWQMPU reiterates the initial regional water quality management plan's recommendation that all sanitary sewer service areas be refined. Unrefined sewer service areas are the product of systems level planning and are normally generalized in nature. The refining process determines a precise sewer service area boundary that is consistent with local land use plans and development objectives. Reports documenting the refined sewer service area include detailed maps of environmentally significant lands within the sewer service area. The refining process is conducted by the community concerned, with the assistance of Regional Planning Commission staff. Following adoption by the designated management agency for the sewage treatment plant, local sewer service area plans are considered for adoption by the Regional Planning Commission as formal amendments to the regional water quality management plan. The Commission then forwards the plans to the WDNR for approval.

The RWQMPU recommends that the MMSD, City of Racine, Village of Union Grove, and Yorkville Sewer Utility District No. 1 maintain and operate WWTPs. It recommends that the MMSD upgrade its WWTPs according to its 2007 facilities plan. The RWQMPU evaluated facilities planning needs for WWTPs based upon a criterion that facilities planning should be initiated when average daily flow to a WWTP reaches 80 percent of the plant design capacity. Based upon the evaluations in the RWQMPU, it is not anticipated that the Village of Union Grove will need to initiate facilities planning for its plant by 2020. A June 2007 sewer service area amendment was adopted that expands the sewer service area for the City of Racine and environs to include additional areas in the Villages of Caledonia and Mt. Pleasant. The RWQMPU recommended that following adoption of this amendment, detailed facilities planning be undertaken to establish the new conveyance, pumping, and storage facilities needed to provide service to these areas. The RWQMPU recommended that, when the Yorkville Sewer Utility District No. 1 wastewater treatment plant reaches the end of its useful life, the entire Yorkville sewer service area be connected to the sewerage system tributary served by the Racine wastewater treatment plant and the Yorkville treatment plant be abandoned. Based on population and sewage flow information available at the time, the RWQMPU concluded that this would likely happen sometime after the year 2020.

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[6]*SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997; amended December 2010.*

[7]*The plan does envision that some Class I and Class II farmland that is located in the vicinity of existing urban service areas will be converted to urban use as a result of planned expansion of those urban service areas. This is a matter of balancing objectives for the preservation of productive farmland with objectives for the orderly and efficient provision of urban facilities and services. The plan also anticipates the development of lands beyond planned urban service areas that have been committed to low-density and suburban-density residential development through subdivision plats and certified surveys. This may be expected to result in the additional loss of Class I and Class II farmland.*

Within the service areas described, the RWQMPU recommends that municipalities construct and maintain local sewer systems. In Milwaukee County, this recommendation applies to all of the municipalities that are wholly or partially located in the watershed, all of which are served by MMSD. In Racine County, this recommendation applies to the City of Racine; the Villages of Mt. Pleasant, Sturtevant, and Union Grove; the Caledonia East and West Utility Districts;[8] the Mt. Pleasant Utility District No. 1; and the Yorkville Sewer Utility District No. 1. In Waukesha County, this recommendation applies to the Cities of Muskego and New Berlin, both of which are served by MMSD. Along with this recommendation, the plan calls for the municipalities operating local sewerage systems to evaluate the need to reduce clearwater infiltration and inflow into sewers and implement Capacity, Management, Operations, and Maintenance (CMOM) programs. CMOM is a program initiated by USEPA that provides a framework for municipalities to identify and incorporate widely accepted wastewater industry practices in order to better manage, operate, and maintain collections systems; investigate capacity constrained areas of the collection system; and respond to sanitary sewer overflow events. MMSD rules require that the communities within its service area implement CMOM programs. The RWQMPU also recommends eliminating discharges from all points of sewerage flow relief in sewerage systems.

Within the Root River watershed, the RWQMPU recommends continued operation of one privately owned wastewater treatment plant that serves Fonk’s Mobile Home Park in the Town of Yorkville. It also recommends that this plant be upgraded and that the level of treatment be formulated as part of the Wisconsin Pollutant Discharge Elimination System (WPDES) permitting process.

In the Root River watershed, the RWQMPU recommends constructing two additions to the MMSD Metropolitan Interceptor System: the Franklin-Muskego interceptor and the Ryan Creek interceptor.

The RWQMPU recommends continued regulation of WWTP and industrial discharges to surface waters through the WPDES program, with effluent concentrations of pollutants being controlled to acceptable levels on a case-by-case basis through the operation of the WPDES.

Nonpoint Source Pollution Abatement Subelement

Recommended Rural Nonpoint Source Pollution Control Measures

The RWQMPU includes recommendations for rural nonpoint source pollution control measures for the Root River watershed that are generally consistent with the land and water resource management plans for the counties within the watershed.[9]

The RWQMPU calls for practices to reduce soil loss from cropland to be expanded to attain erosion rates less than or equal to “T,” the maximum average annual rate of soil loss that can occur without significantly affecting crop productivity, by 2020. This could be accomplished through a combination of practices, including, but not limited to, expanded conservation tillage, grassed waterways, and riparian buffers. The applicable measures

[8]*The Caledonia West Utility District includes the Caddy Vista sewer service area, which is served by MMSD.*

[9]*SEWRPC Community Assistance Planning Report, No. 255, 2nd Edition,* A Land and Water Resource Management Plan for Kenosha County: 2008-2012*, October 2007; SEWRPC Community Assistance Planning Report No. 312,* A Land and Water Resource Management Plan for Milwaukee County: 2012-2021*, August 2011; SEWRPC Community Assistance Planning Report, No. 259, 2nd Edition,* A Land and Water Resource Management Plan for Racine County: 2008-2012*, October 2007; and Waukesha County Department of Parks and Land Use,* Waukesha County Land and Water Resource Management Plan: 2006-2010*, March 2006. (Note: the Waukesha County plan is currently being updated.)*

should be determined by the development of farm management plans which are consistent with the county land and water resource management plans.[10]

Because of the identified need to control fecal coliform bacteria from both urban and rural sources, the RWQMPU recommends that all livestock operations in the study area with 35 combined animal units or greater as defined in Chapter NR 243, "Animal Feeding Operations," of the *Wisconsin Administrative Code*, provide six months of manure storage, enabling manure to be spread on fields twice annually during periods when the ground would not be frozen prior to spring planting and after summer and fall harvest.[11] Based on a review of the technical literature presented in the plan report, it was found that storing the manure for this period of time could reduce fecal coliform bacteria and *E. coli.* concentrations by about 90 percent.[12] It also recommends that manure and any supplemental nutrients be applied to cropland in accordance with a nutrient management plan consistent with the requirements of Sections ATCP 50.04, 50.48, and 50.50 and Section NR 151.07 of the *Wisconsin Administrative Code*. Finally, it recommends that nutrient management requirements for concentrated animal feeding operations in the study area be based on the WPDES permit conditions for those operations.

Chapters NR 151, "Runoff Management," and ATCP 50, "Soil and Water Resource Management Program," of the *Wisconsin Administrative Code* have certain provisions that relate to control of barnyard runoff, including those related to manure storage facilities, manure management, and clean water diversions. However, because existing operations are excluded from the requirements if cost-share funding is not available, and because of the limited amount of such funding that is available annually, many livestock operations are not compelled to comply with the provisions related to barnyard runoff. In order to attain a greater level of control of barnyard runoff, the RWQMPU recommends that consideration be given to increasing levels of cost-share funding to enable a higher level of implementation of the best management practices needed to meet the performance standards related to barnyard runoff.

Based on a review of the literature related to the effectiveness of riparian buffers in controlling nonpoint source pollution, the RWQMPU concludes that a minimum 75-foot riparian buffer width along each side of streams flowing through current crop and pasture land is optimal for the control of nonpoint source pollution. The plan update recommends that:

- In general, where existing riparian buffers adjacent to crop and pasture lands are less than 75 feet in width, they be expanded to a minimum of 75 feet,

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[10]*The recommended rural nonpoint source pollution control measures in the RWQMPU were based upon, and incorporated, agricultural performance standards from Chapter NR 151, "Runoff Management," of the* Wisconsin Administrative Code *that were in effect from 2004 through 2007 when the RWQMPU was being developed. NR 151 was revised in 2010, with revisions taking effect January 1, 2011. The current agricultural performance standards are described in Chapter III of this report.*

[11]*Section NR 243.05 sets forth two methods for calculating animal units: one method based on "combined animal units" and one based on "individual animal units." In determining the number of animals for which the manure storage recommendation of the regional water quality management plan applies, it is recommended that the method be applied that yields the lowest number of animals for a given category. For example, based on this approach, 35 animal units are equivalent to 25 milking cows; 35 steers; 87 55-pound pigs; and 1,050 to 4,375 chickens, depending on the type and whether the manure is liquid or nonliquid.*

[12]*SEWRPC Planning Report No. 50,* op. cit.

- The procedures for targeting buffers to locations where they would be most effective as developed under the Wisconsin Buffer Initiative be considered in the implementation of the riparian buffer recommendation made herein,[13]

- Opportunities to expand riparian buffers beyond the recommended 75-foot width be pursued along high-quality stream systems, including those designated as outstanding or exceptional resource waters of the State, trout streams, or other waterways that support and sustain the life cycles of economically important species such as salmon, walleye, and northern pike, and

- The number of stream crossings be limited and configured to minimize the fragmentation of stream-bank habitat.

Consistent with this, the RWQMPU identified specific sections of stream bank in the Root River watershed do be considered for establishment or expansion of riparian buffers. These recommendations are shown on Map 3.

The RWQMPU recommends that:

- A total of 10 percent of existing farmland and pasture be converted to either wetland or prairie conditions. The focus of this effort should be on marginally productive lands, which are defined as agricultural lands other than those highly productive lands designated as Class I and Class II lands by the U.S. Natural Resources Conservation Service. Consistent with this, the RWQMPU identified candidate areas to be given first consideration when identifying marginally productive lands to be converted to wetlands and prairies.[14] Candidate areas that were identified in the Root River watershed are shown on Map 4. In the Root River watershed, the RWQMPU identified approximately 8,685 acres of candidate areas;

- Livestock access to streams be restricted through fences and other means;

- Measures be taken to ensure proper handling and treatment of milking center wastewater from dairy farms; and

- At a minimum, county-enforced inspection and maintenance programs be implemented for all new or replacement private onsite wastewater treatment systems (POWTS) constructed after the date on which the counties adopted private sewage system programs, that voluntary county programs be instituted to inventory and inspect POWTS that were constructed prior to the dates on which the counties adopted private sewage system programs, and that the WDNR and the counties in the study area work together to strengthen oversight and enforcement of regulations for disposal of septage and to increase funding to adequately staff and implement such programs.

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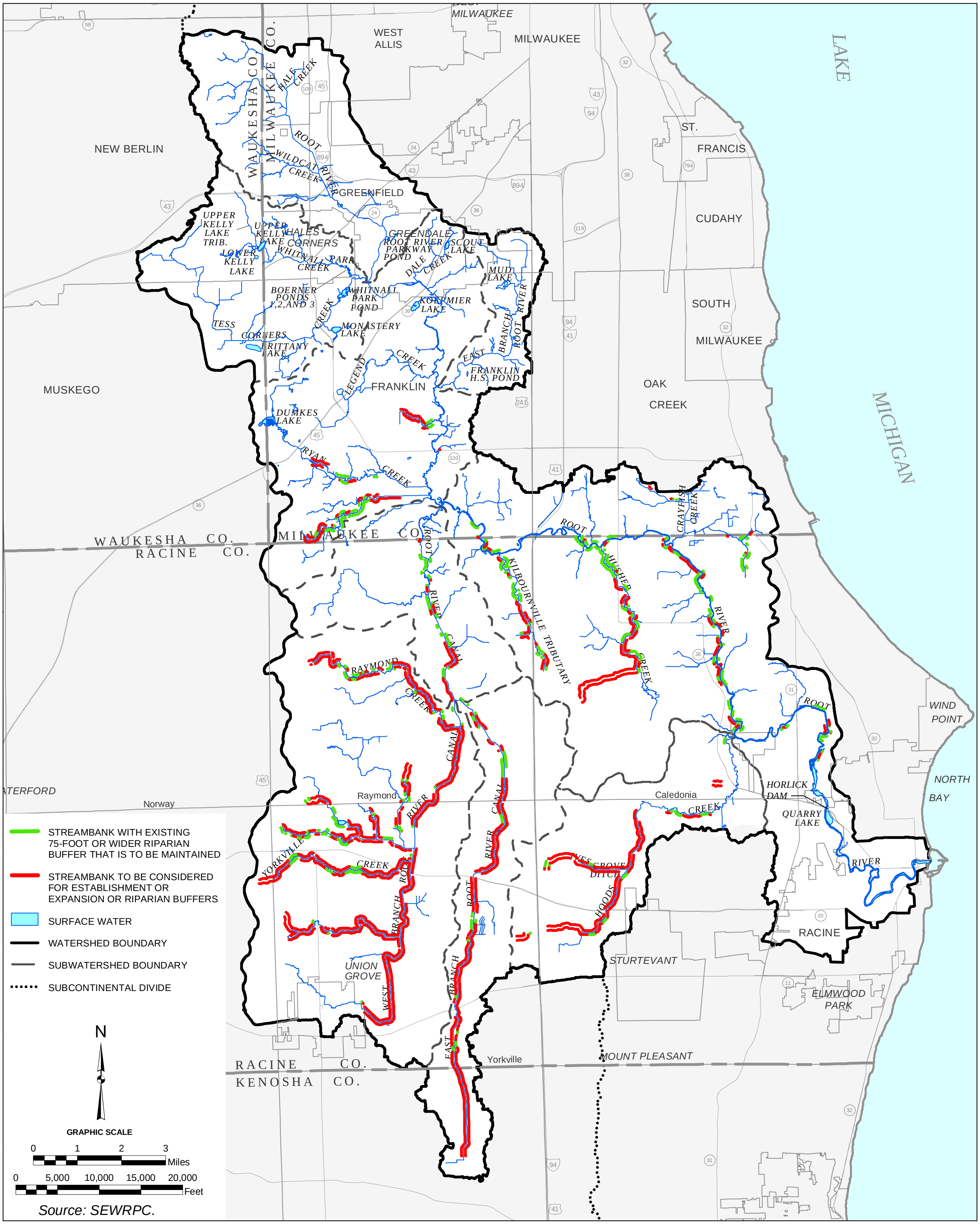
[13]*College of Agriculture & Life Sciences, University of Wisconsin-Madison,* The Wisconsin Buffer Initiative, *December 2005.*

[14]*The MMSD conservation and greenway connection plans program (Greenseams) provides for the purchase, from willing sellers, of natural wetlands to retain stormwater with the intention of reducing the risk of flooding, protecting riparian land from development, and providing increased public access. The MMSD facilities plan recommends that these programs continue and be integrated with the regional water quality management plan update recommendations regarding environmental corridors and conversion of cropland and pasture to wetland and prairie conditions.*

Within the Root River watershed, the Greenseams program only applies to areas within the MMSD service area. That area generally includes the Milwaukee and Waukesha County portions of the watershed and the Caddy Vista subdivision in the Village of Caledonia. The remainer of Racine County in the watershed and the Kenosha County portion of the watershed are not included.

Map 3

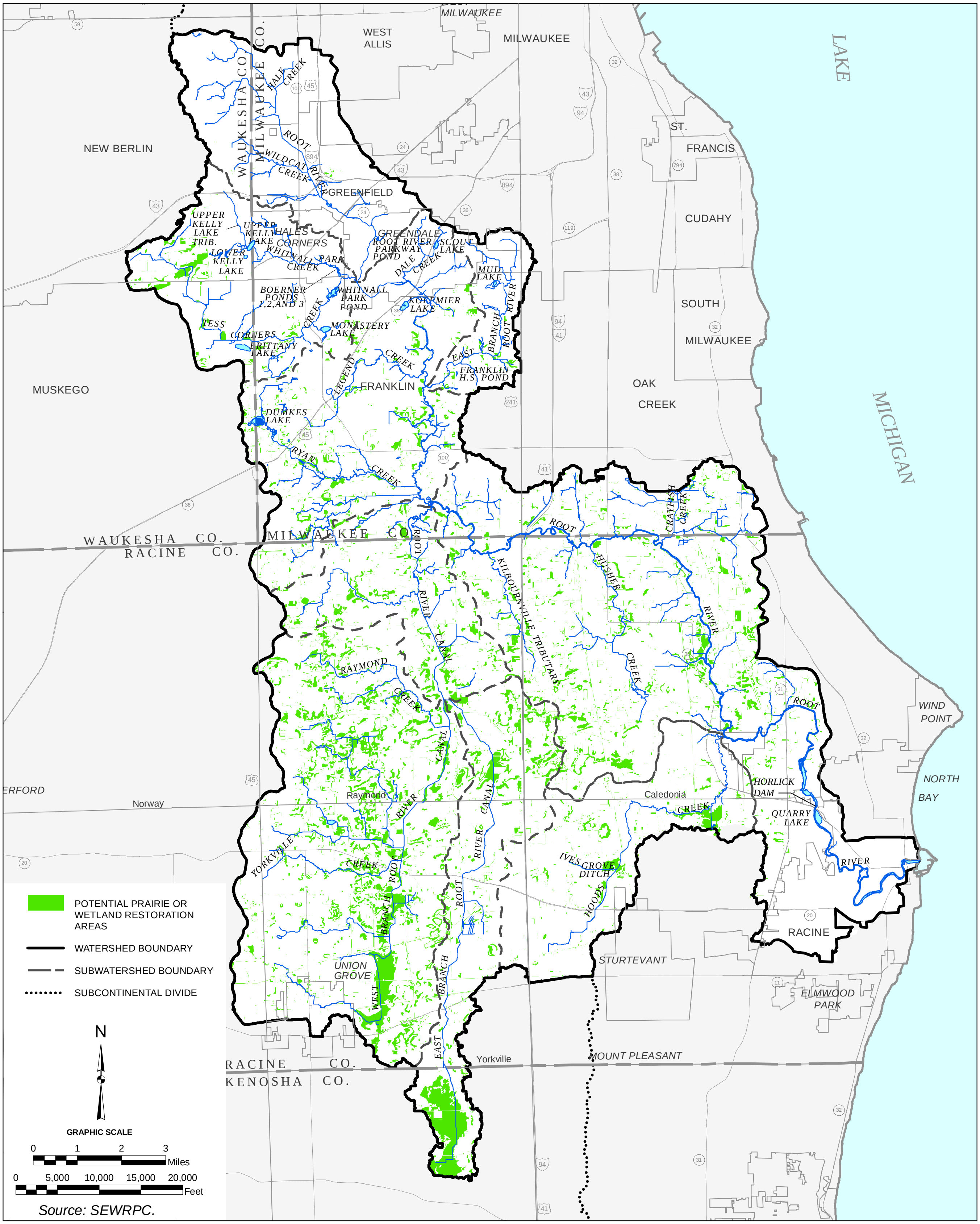
STREAM REACHES IN THE ROOT RIVER FOR WHICH ESTABLISHMENT OR EXPANSION OF RIPARIAN BUFFERS ARE TO BE CONSIDERED



Source: SEWRPC.

Map 4

POTENTIAL PRAIRIE OR WETLAND RESTORATION AREAS IDENTIFIED IN THE REGIONAL WATER QUALITY MANAGEMENT PLAN UPDATE



Source: SEWRPC.

Recommended Urban Nonpoint Source Pollution Control Measures
The RWQMPU recommends several best management practices to abate urban nonpoint source pollution. In some instances, the plan includes measures that go beyond what would be required to meet the performance standards of Chapter NR 151 of the *Wisconsin Administrative Code*.

The RWQMPU recommends that urban nonpoint source pollution controls be implemented that are consistent with the standards of Chapter NR 151.[15] By implementing controls to meet these standards, municipalities will address control of construction site erosion; control of stormwater pollution from areas of existing and planned urban development, redevelopment, and infill; and infiltration of stormwater runoff from areas of new development. Urban best management practices that could be installed to control nonpoint source pollution from existing or new development could include such measures as 1) runoff infiltration/evapotranspiration and/or pollutant filtration devices such as grassed swales, infiltration basins, bioretention facilities, rain gardens, green roofs, and porous pavement; 2) stormwater treatment facilities, such as wet detention basins, constructed wetlands, sedimentation/flotation devices; and 3) maintenance practices such as vacuum sweeping of roads and parking lots.

In order to address fecal indicator bacteria and the risks posed to human health from the pathogens whose presence can be indicated by the presence of these indicators, the RWQMPU recommends enhanced urban illicit discharge control and/or innovative methods to identify and control possible pathogen sources in stormwater runoff from all urban areas in its study area, including the Root River watershed. To address the threats to human health and degradation of water quality resulting from human-specific pathogens and viruses entering stormwater systems, the plan recommends that each municipality in the study area implement a program consisting of:

- Enhanced storm sewer outfall monitoring to test for fecal coliform bacteria in dry- and wet-weather discharges,

- Molecular tests for presence or absence of human-specific strains of *Bacteroides*, an indicator of human fecal contamination, at outfalls where high fecal coliform counts are found in the initial dry-weather screenings,

- Additional dry-weather screening upstream of outfalls where human-specific strains of *Bacteroides* are found to be present, with the goal of isolating the source of the illicit discharge, and

- Elimination of illicit discharges that were detected through the program described in the preceding three steps.

It was anticipated that the program outlined above would also identify cases where illicit connections are not the primary source of bacteria, indicating that stormwater runoff is the main source. To adequately assess the appropriate way to deal with such bacteria sources (and the potentially associated pathogens), the RWQMPU recommends that human health and ecological risk assessments be conducted to address pathogens in stormwater runoff.

Water quality monitoring data set forth in the technical report that accompanied the RWQMPU indicated that chloride concentrations in the streams of the study area are increasing over time.[16] The chloride is likely from

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[15]*The recommended urban nonpoint source pollution control measures in the RWQMPU were based upon and incorporated nonagricultural performance standards from Chapter NR 151, "Runoff Management," of the* Wisconsin Administrative Code *that were in effect from 2004 through 2007 when the RWQMPU was being developed. NR 151 was revised in 2010, with revisions taking effect January 1, 2011. The current nonagricultural performance standards are described in Chapter III of this report.*

[16]*SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007.*

multiple sources, including sodium chloride and calcium chloride applied for ice and snow control on roads and parking lots, and discharges from water softener systems to either 1) POWTS which discharge to groundwater and, ultimately, to streams and lakes as baseflow, or 2) public wastewater treatment plants which discharge to surface waters. The RWQMPU makes several recommendations to reduce the amount of chlorides introduced into the environment. It recommends that the municipalities and counties in the study area continue to evaluate their practices regarding the application of chlorides for ice and snow control and strive to obtain optimal application rates to ensure public safety without applying more chlorides than necessary for that purpose. It also recommends that municipalities consider alternatives to current ice and snow control programs, such as applying a sand/salt mix to local roads and enhanced street sweeping in the spring of the year to remove accumulated sand. It recommends that education programs be implemented to provide information about 1) alternative ice and snow control measures in public and private parking lots and 2) optimal application rates in such areas. It recommends that education programs be implemented to provide information about alternative water softening media and the use of more efficient water softeners that regenerate water based upon the amount of water used and the quality of the water.

The RWQMPU recommends that the use of low- or no-phosphorus fertilizers be encouraged in areas tributary to inland lakes and ponds and that consideration be given to adopting low- or no-phosphorus fertilizer ordinances in those areas. It also recommends that information and education programs required under municipal WPDES stormwater discharge permits promote voluntary practices that optimize urban fertilizer application consistent with the requirements of WDNR Technical Standard No 1100, “Interim Turf Nutrient Management.” One key provision of these standards calls for no application of fertilizer within 20 feet of a waterbody.

The RWQMPU recommends that:

- Existing litter and debris control programs along the urban streams of the study area be continued and that opportunities to expand such efforts be explored;
- All municipalities in the study area have pet litter control ordinance requirements and that these requirements be enforced; and
- Targeted research on bacteria and pathogens and research and implementation of stormwater BMP techniques and programs be supported. As part of this recommendation the plan also calls for support for research to develop and apply more direct methods of identifying sources of pathogens important to human health.

Instream Water Quality Measures Subelement
The RWQMPU recommends a number of instream water quality management measures that apply to the Root River watershed.

In 2004, Milwaukee County assessed the stability and fluvial geomorphic character of streams in the several watersheds within the County including the Root River watershed.[17] This study report set forth and prioritized projects for concrete lining removal, channel rehabilitation, and fish passage improvement. The RWQMPU recommends that the projects called for under the Milwaukee County stream assessment study be implemented over time in a manner consistent with the need to provide flood protection and consistent with the stream rehabilitation recommendations of the regional plan update.

The RWQMPU recommends that abandonment and associated riverine area restoration plans be prepared as part of the design of new, or reconstructed, dams and prior to abandonment of existing dams. It also recommends that

[17]*Inter-Fluve, Inc.,* Milwaukee County Stream Assessment, *prepared for Milwaukee County, September 24, 2004.*

any dam removals specifically include provisions to protect upstream reaches from erosion and downstream reaches from sedimentation by prohibiting excessive sediment transport from the impoundment during and after dam removal.

Culverts, bridges, drop structures, and channelized stream segments, fragment and limit connectivity within stream habitat and ecosystems. The RWQMPU recommends that, to the extent practicable, these stream crossings and management strategies be limited. It also recommends that where such crossings are required, they be designed to allow the passage of aquatic organisms in addition to the passage of water, especially under low flow conditions.

The RWQMPU made several recommendations regarding the protection and enhancement of fisheries. These are consistent with actions recommended by WDNR for habitat improvement of stream systems.[18]

The RWQMPU recommends that:

- To the extent practicable, protect remaining natural stream channels, including small tributaries and shoreland wetlands that provide habitat for the continued survival, growth, and reproduction of a sustainable fishery throughout the study area.

- Restore wetlands, woodlands, and grasslands adjacent to the stream channel and establish minimum buffers 75 feet in width to reduce pollutant loads entering the stream and protect water quality.

- Restore, enhance, and/or rehabilitate stream channels to provide increased quality and quantity of available fisheries habitat—through improvement of water quality, shelter/cover, food production, and spawning opportunities—using management measures that include, but are not limited to:

  - Minimizing the number of stream crossings and other obstructions to limit fragmentation of stream reaches.

  - Stabilizing stream banks to reduce erosion.

  - Limiting instream sedimentation and selectively removing excessive silt accumulations.

  - Reestablishing instream vegetation and bank cover to provide fish with shelter from predators, food, spawning areas, and protection from floods.

  - Realigning channelized reaches of streams and removing concrete lining to provide heterogeneity in depth (e.g., alternating riffle and pool habitat), velocity or flow regime, and bottom substrate composition.

  - As opportunities arise when roadways crossing streams are replaced or reconstructed, removing or retrofitting obstructions such as culverts, dams, and drop structures that limit the maintenance of healthy fish and macroinvertebrate populations.

- Monitoring fish and macroinvertebrate populations in order to evaluate the effectiveness of the water quality management program.

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[18]*Wisconsin Department of Natural Resources,* A Review of Fisheries Habitat Improvement Projects in Warmwater Streams with Recommendations for Wisconsin, *Technical Bulletin No. 169, 1990.*

- Considering more intensive fisheries manipulation measures—in terms of removal of exotic carp species and/or stocking of gamefish or other native species—where warranted based upon specific goals and objectives established for each project site, reach, or subwatershed, based on detailed local level planning, throughout the study area.

The plan also recommends that the locations for carrying out the recommended stream restoration measures be developed with the guidance and direct involvement of the WDNR, based upon site-specific field evaluations.

Inland Lake Water Quality Measures Subelement

The Milwaukee County ponds and lagoons collectively include 68 small waterbodies primarily located within the Milwaukee County Park System. Several of these ponds and lagoons are located in the Root River watershed, including three garden ponds in Boerner Botanical Gardens, Mud Lake, three ponds in Oakwood Park, the Root River Parkway Pond, Scout Lake, and Whitnall Park Pond. In response to concerns about water quality and aesthetic conditions in and around these ponds, Milwaukee County developed a park pond and lagoon management plan.[19] This study identified several problem issues related to the lakes, ponds, and lagoons, including shoreline erosion; the presence of nuisance algae and aquatic plants related to high nutrient loadings; elevated concentrations of fecal indicator bacteria, such as *E. coli*; litter; the presence of rough fish; and siltation. The plan made these three general recommendations for all park lakes, ponds, and lagoons:

- Identify and deploy alternative management strategies to mowing grass to short lengths directly adjacent to these waterbodies,

- Pursue grant funding for shoreline stabilization projects, and

- Continue water quality monitoring of these waterbodies in order to document conditions both before and after restoration projects.

The RWQMPU recommends implementation of the recommendations of the Milwaukee County park pond and lagoon management plan.

Auxiliary Water Quality Management Subelement

The RWQMPU made several auxiliary recommendations addressing several water quality issues.

The plan update recognizes that waterfowl, especially gulls, can be a significant source of fecal coliform bacteria in surface waters. It recommends that programs be implemented to discourage unacceptably high numbers of waterfowl from congregating near beaches and other water features. Measures that could be included in these programs include expanded use of informational signs regarding the negative aspects of feeding waterfowl, ordinances prohibiting the feeding of waterfowl, covered trash receptacles at beaches and water features, vegetative buffers along shorelines that discourage geese from congregating, and other, innovative measures, such as dogs trained to disperse waterfowl.

The RWQMPU makes the following recommendations related to household hazardous and pharmaceutical wastes:

- That the existing collection programs for household hazardous wastes be continued and supported and that those communities not served by such programs consider developing and instituting such programs;

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[19]*Milwaukee County Environmental Services,* Milwaukee County Pond & Lagoon Management Plan, *June 2005.*

- That assessments and evaluations be made of the significance for human health and for aquatic and terrestrial wildlife of the presence of pharmaceuticals and personal care products in surface waters; and

- That periodic collections of expired and unused prescription medications be conducted.

The RWQMPU makes two recommendations regarding exotic and invasive species:

- That programs to reduce the introduction and spread of exotic and invasive species, including programs to educate the public, be supported and continued; and

- That the occurrence and spread of exotic and invasive species be monitored and documented.

The plan evaluated existing water quality monitoring and data collection programs and characterized gaps in the available data. It found that fewer data are available for areas outside the portion of the watershed served by the MMSD than are available within MMSD's service area. It also found that relatively few data were available from tributary streams. To address monitoring needs in the watershed, the RWQMPU makes the following recommendations:

- That the surface water quality monitoring programs currently being conducted by the MMSD, WDNR, and USGS be supported and continued;

- That long-term monitoring programs be extended to areas outside of the MMSD service area (at the minimum monitoring should continue at the USGS sampling stations that were established or reinstated as part of the RWQMPU);

- That long-term fisheries, macroinvertebrate, and habitat monitoring stations be established in streams, ideally at sites where water quality is also being monitored;

- That efforts to facilitate consolidation of data from various monitoring programs be continued;

- That long-term monitoring stations in inland lakes be established or continued;

- That aquatic plant surveys be made in those lakes in which plant management activities are being conducted; and

- That citizen-based monitoring efforts be continued and expanded, with an emphasis on filling geographical gaps in existing data.

Finally, the RWQMPU recommends periodic maintenance and updating of the water quality models developed under the RWQMPU/MMSD 2020 FP.

Groundwater Management Element

The RWQMPU makes several recommendations regarding groundwater management. Three of these grew directly out of SEWRPC's regional water supply planning program which was in progress during the time that the RWQMPU was being prepared.[20] As part of the regional water supply planning program, the most important

[20]*SEWRPC Planning Report No. 52,* A Regional Water Supply Plan for Southeastern Wisconsin, *December 2010.*

groundwater areas within the Southeastern Wisconsin Region were identified.[21] The RWQMPU recommends that consideration be given to following the recommendations of the regional water supply plan regarding maintenance of these areas. Under the regional water supply planning process, groundwater sustainability analyses were made for six selected demonstration areas, representing a range of hydrogeologic conditions.[22] These areas were analyzed to provide guidance on the density of individual household wells or shared common wells that could be installed without creating significant impacts on the shallow groundwater system. The RWQMPU recommends that the groundwater sustainability guidance results developed in this study be considered by municipalities in evaluating proposed developments and in conducting local land use planning. The RWQMPU recommends that water utilities develop and implement utility-specific water conservation programs.

The RWQMPU also recommends that the design of stormwater management facilities that directly or indirectly involve infiltration of stormwater consider the potential impacts on groundwater quality, and that the provisions intended to protect groundwater quality in the WDNR’s post-construction stormwater management technical standards be applied in the design of stormwater management facilities.

Recommended Water Use Objectives

Based on the analyses conducted for the RWQMPU, the plan recommended that the WDNR consider upgrading the regulatory water use objectives of four streams in the Root River watershed. These regulatory water use objectives are part of the water quality standards promulgated by the State pursuant to the Federal Clean Water Act. They specify the appropriate water uses to be achieved by, and protected in, a waterbody. The designated water use objective of a waterbody is a factor in the determination of which water quality criteria apply to the waterbody. The RWQMPU recommends that the water use objectives for Hoods Creek, Tess Corners Creek, and Whitnall Park Creek be upgraded from limited forage fish to fish and aquatic life. It also recommends that the water use objective for Ives Grove Ditch be upgraded from limited aquatic life to limited forage fish.

STATUS OF IMPLEMENTATION OF RECOMMENDATIONS OF THE RWQMPU IN THE ROOT RIVER WATERSHED

The recommendations made in the RWQMPU identify a series of management strategies designed to improve surface water quality conditions in the Root River watershed. As indicated above, these strategies include measures related to land use, point source pollution abatement, nonpoint source pollution abatement, instream and inland lake water quality management, groundwater management, and other issues. Efforts to implement the RWQMPU have been ongoing for several years.

To formulate a restoration plan for the Root River watershed, it is important to assess the current status of implementation of the RWQMPU. There are several reasons to do this. Assessing the status of implementation enables an evaluation of how much progress toward the goals of the RWQMPU has been made since the plan was issued. Identifying areas in the watershed where projects implementing specific recommendations have been completed, are in process, or are planned can be useful for targeting locations for future projects. This identification can also indicate locations where recent efforts can be expanded or used as a basis for future actions. This can be especially important for the sorts of projects that act incrementally to produce reductions in pollutant loads to waterbodies, with resultant improvements in water quality. Alternatively, identification of areas where projects implementing specific recommendations have been completed, are in process, or are planned can

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[21]*SEWRPC Technical Report No. 47*, Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Water-Balance Model, *July 2008.*

[22]*SEWRPC Technical Report No. 48,* Shallow Groundwater Quantity Sustainability Analysis Demonstration for the Southeastern Wisconsin Region, *November 2009.*

also indicate portions of the watershed that have not received sufficient attention in the implementation of the specific recommendations. Assessing the status of plan implementation can also point out those specific recommendations that may require more attention in implementation. Finally, assessing the status of implementation at this juncture makes it possible to apply the lessons learned from recent implementation efforts to the identification and prioritization of recommendations under this watershed restoration plan.

In the assessment of the status of implementation of the RWQMPU, the recommendations are grouped into three broad categories: recommendations that reflect, in whole or in part, existing regulatory requirements; recommendations that are in various stages of implementation; and recommendations that have not yet been implemented.

Existing Regulatory Management Strategies

Table 3 shows the implementation status of recommendations of the RWQMPU that reflect existing regulatory requirements. The table also indicates the relevant regulations in the *Wisconsin Administrative Code, Wisconsin Statutes,* and local ordinances. It is important to note that some of the recommendations listed on the table are only partially addressed by existing regulations. The following descriptions will note where this is the case.

Land Use Element

Develop According to Approved Land Use Plans

The RWQMPU was developed under the assumption that local communities will develop according to the recommendations given in approved local land use plans. This is partially addressed by existing regulatory requirements. In 1999, the Wisconsin Legislature enacted legislation that greatly expanded the scope and significance of comprehensive plans within the State. The legislation, often referred to as the State's "Smart Growth" law, provides a new framework for the development, adoption, and implementation of comprehensive plans by regional planning commissions and by county, city, village, and town units of government. The law is set forth in Section 66.1001 of the *Wisconsin Statutes*. This section of the *Statutes* also defines the elements that a comprehensive plan must contain. One of the required elements is a land use element that includes "a compilation of objectives, policies, goals, maps, and programs to guide future development and redevelopment of public and private property."

The law does not require the adoption of county and local comprehensive plans; however, Section 66.1001(3) of the *Statutes* requires that county and local general zoning ordinances; county, city, and village shoreland and floodplain zoning ordinances; county and local subdivision ordinances; and local official mapping ordinances enacted or amended on or after January 1, 2010, be consistent with the comprehensive plan adopted by the unit of government enacting or amending the ordinance.

With the exception of Milwaukee County, all of the counties, cities, villages, and towns that are wholly or partially located in the Root River watershed have either adopted independent comprehensive plans, adopted multi-jurisdictional county-local comprehensive plans as their local plans, or prepared local plans as part of a multi-jurisdictional county-local process adopted by the local government. Because all of the municipalities in Milwaukee County are incorporated as cities or villages, the County has not prepared a comprehensive plan.

Point Source Pollution Abatement Measures

Refining of Sanitary Sewer Service Areas

As previously described, the RWQMPU recommends that unrefined sanitary sewer service areas in the Root River watershed be refined. This has regulatory implications because Chapter NR 110, "Sewerage Systems," of the *Wisconsin Administrative Code*, requires that sanitary sewer extensions and sewerage system facility plans be in conformance with the approved areawide water quality management plan. Most of the sanitary sewer service areas within the Root River watershed have been refined. Areas served by MMSD in the Cities of Greenfield, Milwaukee, and West Allis, the Villages of Greendale and Hales Corners, and a portion of the Yorkville Sewer Utility District's service area have not been refined.

Table 3

SUMMARY OF EXISTING REGULATORY MANAGEMENT STRATEGIES IDENTIFIED IN THE REGIONAL WATER QUALITY MANAGEMENT PLAN UPDATE

Recommendation or Management Strategy	Focus Area Primarily Addressed				Responsible and Participating Organizations	Relevant Regulations
	Water Quality	Recreational Use and Access	Habitat Condition	Flooding		
Develop according to approved land use plans	- -	X	X	X	Municipalities	66.1001 STATS[a]
Refine sanitary sewer service areas	X	X	- -	- -	Municipalities, SEWRPC, WDNR	NR 110 for public systems SPS 382 for private systems[b]
Continue operation and maintenance of MMSD, Racine, Union Grove, and Yorkville wastewater treatment plants	X	X	- -	- -	Municipalities, MMSD, WDNR	NR 208, NR 210, and WPDES permit conditions
Implement Capacity, Management, Operations, and Maintenance (CMOM) programs	X	X	- -	- -	MMSD, municipalities	Section 3.105 MMSD rules
Continue operation and maintenance of Fonk's Mobile Home Park wastewater treatment plant	X	X	- -	- -	Plant owner, WDNR	NR 208, NR 210, and WPDES permit conditions
Continue to regulate wastewater treatment plant and industrial discharges under the Wisconsin Pollutant Discharge Elimination System	X	X	- -	- -	Municipalities, MMSD, WDNR	Regulated through WPDES system (NR 200–299)
Apply manure and supplemental nutrient to cropland in accordance with nutrient management plans[c]	X	X	- -	- -	Agricultural operators, counties, DATCP, NRCS, WDNR	ATCP 50.04, ATCP 50.08, ATCP 50.48, ATCP 50.50, NR 151.07
Restrict livestock access to streams	X	X	X	- -	Agricultural operators, counties, DATCP, WDNR	NR 151.08
Implement county-enforced inspection and maintenance programs for private onsite wastewater treatment systems constructed after counties adopt private sewage system programs	X	X	- -	- -	Counties, WDNR; Wisconsin Department of Safety and Professional Services; municipalities in Milwaukee County	SPS 383.255, SPS 383.54 Chapter 15 Kenosha County Municipal Code; Section 19, Racine County Code of Ordinances; Section 14-589 Waukesha County Ordinances; Section 190-28 Franklin Municipal Code;
Implement construction erosion control and urban nonpoint source pollution controls consistent with standards in NR 151	X	X	X	- -	WDNR, counties municipalities	NR 151, NR 216

Table 3 (continued)

Recommendation or Management Strategy	Focus Area Primarily Addressed				Responsible and Participating Organizations	Relevant Regulations
	Water Quality	Recreational Use and Access	Habitat Condition	Flooding		
Implement fertilizer management programs[d]	X	- -	- -	- -	Counties, WDNR	NR 151.13, NR 151.14, 94.643 STATS
Implement pet litter management programs	X	X	- -	- -	Counties, municipalities, UWEX	County and municipal ordinances[e]
Conduct aquatic plant surveys in those lakes in which plant management activities are being conducted	- -	- -	X	- -	Counties, municipalities, lake associations	A common permit condition for aquatic plant management permits under NR 107 and NR 109
Continue and support programs to reduce the introduction and spread of exotic and invasive species	- -	- -	X	- -	WDNR	Some aspects regulated under NR 40 and ATCP 21
Water Utilities develop and implement utility-specific conservation programs	X	- -	X	- -	Water utilities	Required for withdrawals from surface water and groundwater in Great Lakes Basin under NR 852
Consider the potential impacts on groundwater quality in the design of stormwater management facilities	X	- -	- -	- -	WDNR, WisDOT, municipalities, counties	NR 151.12, NR 151.124, NR 151.24 NR 151.244, Trans 401.106

[a]*Section 66.1001(3) of the* Wisconsin Statutes *requires that county and local general zoning ordinances; county, city, and village shoreland and floodplain zoning ordinances; county and local subdivision ordinances; and local official mapping ordinances enacted or amended on or after January 1, 2010, be consistent with the comprehensive plan adopted by the unit of government enacting or amending the ordinance.*

[b]*NR 110.08(4) and SPS 382 require that sewer service areas conform with areawide water quality management plans.*

[c]*Compliance required in order to be eligible for cost-share funding.*

[d]*Includes the State ban on fertilizers containing phosphorus.*

[e]*County ordinances apply to county parks and trails and apply to dogs in all counties, except in Milwaukee and Waukesha Counties, where they apply to any animal under a person's control. Municipal ordinances vary among jurisdictions.*

Source: SEWRPC.

Since the completion of the RWQMPU, a second-generation sewer service area plan has further refined the sanitary sewer service area for the City of Franklin, including portions of the Root River watershed.[23] In addition, amendments to the regional water quality management plan since approval of the RWQMPU have resulted in further refinements to sanitary sewer service areas in the Root River watershed in the Cities of Muskego and New Berlin and the Villages of Caledonia, Mount Pleasant, and Union Grove. The existing sanitary sewer service areas in the Root River watershed are described in Chapter IV of this report.

Implement CMOM Programs
The RWQMPU recommends that the municipalities operating local sewerage systems evaluate the need to reduce clearwater infiltration and inflow into sewers and implement CMOM programs that provide a framework for municipalities to identify and incorporate widely accepted wastewater industry practices in order to better manage, operate, and maintain collections systems; investigate capacity constrained areas of the collection system; and respond to sanitary sewer overflow events. Section 3.105 of MMSD's rules requires that the communities within its service area operating sewer systems tributary to MMSD's system establish and implement CMOM programs.

Continued Regulation of WWTP and Industrial Discharges through the WPDES Permit Program
The RWQMPU recommends continued regulation of WWTP and industrial discharges to surface waters through the WPDES program, with effluent concentrations of pollutants being controlled to acceptable levels on a case-by-case basis through the operation of the WPDES program. Sections 283.31(1) and 283.33 of the *Wisconsin Statutes* require a permit for the legal discharge of any pollutant into the waters of the State, including groundwater. This State pollutant discharge permit system was established by the Wisconsin Legislature in direct response to the requirements of the Federal Clean Water Act. While the Federal law envisioned requiring a permit only for the discharge of pollutants into navigable waters, in Wisconsin permits are required for discharges from point sources of pollution to all surface waters of the State and, additionally, to land areas where pollutants may percolate, seep to, or be leached to groundwater.

Rules relating to the WPDES are set forth in Chapters NR 200 through 299 of the *Wisconsin Administrative Code*. The following types of discharges require permits under Chapter NR 200, "Application for Discharge Permits and Water Quality Standards Variances":

- The direct discharge of any pollutant to any surface water.

- The discharge of any pollutant, including cooling waters, to any surface water through any storm sewer system not discharging to publicly owned treatment works.

- The discharge of pollutants other than from agricultural uses for the purpose of disposal, treatment, or containment on land areas, including land disposal systems such as ridge and furrow, irrigation, and ponding systems.

- Discharge from an animal feeding operation where the operation causes the discharge of a significant amount of pollutants to waters of the State and the owner or operator of the operation does not implement remedial measures as required under a notice of discharge issued by the WDNR under Chapter NR 243, which deals with animal waste management.

Certain discharges are exempt from the permit system as set forth under Chapter NR 200, including discharges to publicly owned sewerage works, some discharges from vessels, discharges from properly functioning marine

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[23]*SEWRPC Community Assistance Planning Report No. 176, 2nd Edition,* Sanitary Sewer Service Area for the City of Franklin, Milwaukee County, Wisconsin, *June 2011*.

engines, and discharges of domestic sewage to septic tanks and drain fields. The latter are regulated under another chapter of the *Wisconsin Administrative Code*. Also exempted are the disposal of septic tank pumpage and other domestic waste, also regulated, under another chapter of the *Wisconsin Administrative Code*; the disposal of solid wastes, including wet or semi-liquid wastes, when disposed of at a site licensed pursuant to another chapter of the *Wisconsin Administrative Code*; and discharges from private alcohol production systems.

Discharges related to a variety of municipal and industrial activities may be permitted under the WPDES permit system. Particular facilities may be permitted either under an individual permit to the owner or operator of the facility or under a Statewide general permit.

Individual permits are issued to specific facilities that generate wastewater from unique types of activities, have complex mixtures of pollutants, or have physical-chemical treatment systems. Municipal and privately owned wastewater WWTPs are generally permitted under individual permits. Permit conditions for individual permits include effluent limitations for pollutants that are discharged and monitoring and reporting requirements. Individual permits include a compliance schedule which specifies the actions needed to be taken for the facility to remain in compliance with permit conditions and the dates by which these actions must be completed. Individual permits are issued for a five-year term. To maintain coverage beyond the end of the term, permittees must reapply at least 180 days prior to expiration of the permit.

Statewide general permits are used to cover groups of facilities that generate wastewater from relatively simple operations having similar types and amounts of pollutants. Coverage under a general permit is conferred by completing and submitting a request-for-coverage form to the appropriate WDNR regional office. Compliance with the limitations contained in a general permit must be attained at the time coverage is granted. As of March 2012, the State had issued 23 different WPDES general permits, covering a variety of activities and discharges. Examples of these include general permits for noncontact cooling water, swimming pool facilities, hydrostatic test water, and ballast water discharge. It is important to note that an individual facility may need to be covered under more than one general permit, depending on the different types of waste streams that the facility discharges. General permits contain effluent limitations for pollutants associated with the covered discharges. General permits also contain monitoring and reporting requirements. These permit conditions vary according to the category of general permit. For some general permits, the WDNR has developed standard discharge monitoring reporting forms.

Nonpoint Source Pollution Abatement—Rural Control Measures

Nutrient Management Plans and Nutrient Application

Among the rural nonpoint source pollution abatement measures in the RWQMPU was a recommendation that application of manure and supplemental nutrients to cropland be applied in accordance with approved nutrient management plans. Starting in 2005 for high-priority areas such as impaired or exceptional waters, and 2008 for all other areas, application of manure or other nutrients to croplands must be done in accordance with a nutrient management plan designed to meet State standards for limiting the entry of nutrients into groundwater or surface water resources. Requirements related to these plans are set forth in Section ATCP 50.04(3) of the *Wisconsin Administrative Code*. In general, for land that does not meet the NR 151 performance standards and that was cropped or enrolled in the U.S. Department of Agriculture Conservation Reserve or Conservation Reserve Enhancement Programs as of October 1, 2002, agricultural performance standards are only required to be met if cost-sharing funds are available. Existing cropland that met the standards as of October 1, 2002, must continue to meet the standards. New cropland must meet the standards, regardless of whether cost-share funds are available.

Restricting Livestock Access to Streams

The RWQMPU recommends that livestock access to streams be restricted the use of fences and other means. This recommendation is partially implemented through existing regulations. NR 151 prohibits allowing livestock unlimited access to the waters of the State in locations where high concentrations of animals prevent the maintenance of adequate sod or self-sustaining vegetative cover. This rule includes a provision that the prohibition does not apply to properly designed, installed, and maintained livestock or farm equipment crossings.

It should be noted that access roads and cattle crossings, fencing to exclude livestock in order to protect erodible areas, and livestock water facilities designed to replace livestock access to streams or other natural drinking water sources are eligible for cost-share funding as agricultural best management practices.

Inspection and Maintenance Programs for Private Onsite Wastewater Treatment Systems (POWTS)
As previously described, the RWQMPU recommends that, at a minimum, county-enforced inspection and maintenance programs be implemented for all new or replacement private onsite wastewater treatment systems (POWTS) constructed after the date on which the counties adopted private sewage system programs. It also recommends that voluntary county programs be instituted to inventory and inspect POWTS that were constructed prior to the dates on which the counties adopted private sewage system programs.

At the State level, the Wisconsin Department of Safety and Professional Services has established rules regulating POWTS set forth in Chapter SPS 383, "Private Onsite Wastewater Treatment Systems," of the *Wisconsin Administrative Code.* Much of the regulation is performed by counties and, in counties with population of 500,000 or more, in municipalities. SPS 383.255 requires counties with populations of less than 500,000 and municipalities located in counties with populations of 500,000 or more to develop and implement comprehensive maintenance programs for POWTS within their jurisdictions. These counties and municipalities are referred to as governmental units. These programs are to include:

- Conducting, completing, and maintaining an inventory of all POWTS located within the governmental unit's jurisdiction;

- A process that accepts and records inspection, evaluation, maintenance, and servicing reports submitted by owners of POWTS or their agents;

- A process that notifies owner of POWTS who are delinquent in meeting reporting requirements;

- A process that includes measures meant to ensure that required inspection, evaluation, maintenance, and servicing of POWTS are performed and reported; and

- Annual reporting to the Wisconsin Department of Safety and Professional Services.

The units of government are required to complete the inventory by October 1, 2013, and have the other elements of the programs in place by October 1, 2015.[24]

For POWTSs installed or constructed on or after July 1, 2000, SPS 383.54 requires submission of a management plan to the governmental unit as part of a plan for installation, construction, or replacement of or addition to a POWTS. This management plan is to include servicing and maintenance requirements, including servicing frequency requirements of the components of the system. In addition to the frequency given in the management plan, servicing is required to occur when the combined volume of sludge and scum in an anaerobic treatment tank (septic tank) equals one-third of the tank's volume. The owner or the owner's agent is required to report to the governmental unit within 30 days of required inspections, evaluations, maintenance, or servicing.

[24]*As of March 2012, Section SPS 383.255 requires that the inventories be completed within three years of October 1, 2008 and the other elements be in place within five years of October 1, 2008; however, 2009 Wisconsin Act 392 requires that these deadlines be extended to the dates given in the text above. On August 15, 2011, the Wisconsin Department of Safety and Professional Services submitted proposed revisions to SPS 383 that would further extend these dates to the State Legislature for committee review. As of March 2012, the Legislature has taken no action on the proposed revisions.*

For POWTSs existing prior to July 1, 2000, servicing is also required to occur when the combined volume of sludge and scum in an anaerobic treatment tank (septic tank) equals one-third of the tank's volume. In addition, those systems that utilize a treatment or dispersal component consisting, in part, of in situ soil are required to be visually inspected at least once every three years to determine whether wastewater or effluent is ponding on the surface of the ground. The owner or the owner's agent is required to report to the governmental unit within 30 days of required inspections, evaluations, maintenance, or servicing.

Kenosha, Racine, and Waukesha Counties and the City of Franklin in Milwaukee County have ordinances implementing POWTS management programs. With one exception, these programs require that inspection and servicing of systems be conducted on a three-year cycle. Waukesha County's program requires that inspection and servicing of systems be conducted on a two-year cycle. In each of these programs, the governmental unit provides notification to owners of POWTS that their systems are due for inspection and servicing.

Nonpoint Source Pollution Abatement—Urban Control Measures

Implementation of Construction Erosion Control and Urban Nonpoint Source Pollution Controls Consistent with the Performance Standards in NR 151

As previously discussed, the RWQMPU recommends that urban nonpoint source pollution controls be implemented consistent with the standards given in NR 151. The nonagricultural performance standards set forth in this chapter encompass two major types of land management. The first type includes standards for areas of new development and redevelopment. The second type includes standards for developed urban areas. The performance standards address the following areas:

- Construction sites for new development and redevelopment,
- Post-construction stormwater runoff for new development and redevelopment,
- Developed urban areas, and
- Nonmunicipal property fertilizing.

NR 151 requires counties and local units of government in urbanized areas, which are identified based on population density, to obtain a WPDES stormwater discharge permit as required under Chapter NR 216.02. As a result of these requirements, all four counties in which the Root River watershed is located have applied for and been issued these permits. In addition, all of the municipalities in Milwaukee and Waukesha County that are located in the Root River watershed and the City of Racine and the Villages of Caledonia, Mount Pleasant, and Sturtevant in Racine County have applied for and been issued these permits. These permit holders were required to reduce the amount of total suspended solids in stormwater runoff from areas of existing development that were in place as of October 2004 to the maximum extent practicable by 20 percent by March 10, 2008.

Permitted municipalities are also required to implement the following: 1) public information and education programs relative to specific aspects of nonpoint source pollution control; 2) municipal programs for collection and management of leaf and grass clippings; and 3) site-specific programs for application of lawn and garden fertilizers on municipally controlled properties with over five acres of pervious surface. Under the requirements of NR 151, by March 10, 2008, incorporated municipalities with average population densities of 1,000 persons or more per square mile that were not required to obtain municipal stormwater discharge permits were required to have implemented these same three programs.

In addition to the standards given in NR 151, units of government within the MMSD service area are required to comply with Chapter 13, "Surface Water and Storm Water Rules," of the MMSD rules. This Chapter requires governmental units in MMSD's service area to:

- Manage land use and activities in their jurisdictions to minimize debris and sediment from creating obstructions at outfalls or other structures in watercourses,

- Remove debris and sediment that obstructs stormwater outfalls or other drainage structures,

- Submit annual reports to the District that provide watershed, drainage, and development information,

- Establish which developments and redevelopments must comply with the peak runoff management requirements set forth in Section 13.11 of the MMSD rules, and

- Submit stormwater management plans for all eligible development and redevelopment projects.

In general, developments and redevelopments must provide stormwater management plans and comply with the runoff management requirements if they are in the District's ultimate sewer service area (except for certain riparian areas immediately adjacent to Lake Michigan), and either call for an increase of one-half acre or more of new impervious area or for demolition or construction during redevelopment that disturbs an area larger than two acres. Communities in MMSD's service area are required to have stormwater management ordinances that are consistent with Chapter 13 and to update the ordinances to include amendments to Chapter 13.

Fertilizer Management Programs
As previously discussed, the RWQMPU recommends that the use of low- or no-phosphorus fertilizers be encouraged in areas tributary to inland lakes and ponds and that consideration be given to adopting low- or no-phosphorus fertilizer ordinances in those areas. It also recommends that information and education programs required under municipal WPDES stormwater discharge permits promote voluntary practices that optimize urban fertilizer application consistent with the requirements of WDNR Technical Standard No 1100, "Interim Turf Nutrient Management."

Sections NR 151.13 and 151.14 of Chapter NR 151 of the *Wisconsin Administrative Code* set forth fertilizer performance standards for municipal and nonmunicipal properties with more than five acres of pervious surface where fertilizer is applied. These standards call for fertilizer application to be done "in accordance with site-specific nutrient application schedules based upon appropriate soil tests." These standards are required to be followed in municipalities with WPDES stormwater discharge permits.

Section 94.643 of the *Wisconsin Statutes* which became effective on April 1, 2010, after completion of the RWQMPU, places restrictions on the use, sale, and display of fertilizers containing phosphorus. This statute prohibits the application to turf of fertilizer that is labeled as containing phosphorus or available phosphate except for:

- Applying such fertilizer to establish grass, using seed or sod, during the growing season in which the person using the fertilizer began establishing the grass, or

- Applying fertilizer to an area where the soil is deficient in phosphorus as shown in a soil test performed by a laboratory no more than 36 months before the application.

The statute restricts the sale of fertilizers containing phosphorus to agricultural uses and the two uses described in the preceding paragraph. It also prohibits the display of fertilizers containing phosphorus.

Pet Litter Management
As previously discussed, the RWQMPU recommends that all municipalities, including those in the Root River watershed, have pet litter control ordinance requirements and that these requirements be enforced. All four counties that contain portions of the Root River watershed have enacted ordinances regarding control of pet litter in County parks and trails. In general, these ordinances require that the owner, caretaker, or person in control of

an animal immediately remove pet litter when it is deposited, wrap it, and properly dispose of it. With the exception of Kenosha County, these counties' ordinances also require that anyone bringing an animal into a county park or trail also bring an item or device for removing pet litter. Kenosha and Racine Counties' ordinances apply specifically to dogs. Milwaukee and Waukesha Counties' ordinances apply to animals.

Most of the municipalities in the Root River watershed have pet litter management ordinances. Only three communities—the Towns of Paris, Raymond, and Yorkville—lack such ordinances. The requirements of these ordinances vary. Most require that the owner, caretaker, or person in control of an animal immediately remove and properly dispose of pet litter deposited by an animal under their control on any public property or private property other than that belonging to owner, caretaker, or person in control of the animal. A few of these ordinances apply only to public property or parks and trails. Most, although not all, of these ordinances require that, when an animal is off its owner's or caretaker's premises, the owner or caretaker have an item or device for removing pet litter in his or her possession. Which animals are covered by these ordinances also varies by jurisdiction. Seven municipalities have ordinances that apply to animals, seven municipalities have ordinances that apply specifically to dogs, and two municipalities have ordinances that apply specifically to dogs and cats.

It should be noted that the University of Wisconsin-Extension has developed educational materials related to pet waste management.[25]

Inland Lake Water Quality Management Measures

Aquatic Plant Surveys for Lakes in Which Plant Management Activities Are Being Conducted

As previously described, the RWQMPU recommends that aquatic plant surveys be conducted in those lakes in which plant management activities are being conducted. This recommendation is partially implemented under existing regulations. Aquatic plant management activities are regulated under two chapters of the *Wisconsin Administrative Code*. Chapter NR 107, "Aquatic Plant Management," regulates the application of chemical treatment for the management of aquatic plants. Chapter NR 109, "Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations," regulates manual removal and mechanical control of aquatic plants. It also regulates the use of biological control agents. With some exceptions, a permit is required for most aquatic plant management activities.

Neither of these chapters specifically requires that an aquatic plant survey be conducted; however, they do require that the permit application include descriptive information of the plants or plant communities proposed to be managed. For chemical treatment, NR 107.04(2)(e) requires that the permit application include a description of the plant community causing the use impairment in the waterbody. Similarly, for manual removal and mechanical control of aquatic plants, NR 109.04(2)(f) requires that the permit application include a description of the aquatic plants to be controlled or removed. Under an additional provision of NR 109, the WDNR may require that an application for a permit for manual removal and mechanical control of aquatic plants include an aquatic plant management plan which describes how the aquatic plants will be introduced, controlled, removed, or disposed. The items that are required to be presented and discussed in such a plan are given in NR 109.09(2) and include a physical, chemical, and biological description of the waterbody. Under these provisions, the conduct of an aquatic plant survey has been a common permit condition for applications for permits to conduct aquatic plant management activities under NR 107 and NR 109.

Auxiliary Water Quality Management Measures

Exotic and Invasive Species Management

As described above, the RWQMPU recommends that programs to reduce the introduction and spread of aquatic and terrestrial exotic and invasive species, including programs to educate the public, be supported and continued. Several State regulations address this recommendation.

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[25]*University of Wisconsin-Extension, "Pet Waste and Water Quality," UWEX Publication GWQ006, 1999.*

At the State level, rules regarding the identification, classification, and control of invasive species are set forth in Chapter NR 40, "Invasive Species Identification, Classification and Control," of the *Wisconsin Administrative Code*. This chapter lays out several requirements.

First, NR 40 creates a comprehensive system with criteria to classify invasive species into two categories: prohibited species and restricted species. A prohibited species is one which the WDNR has determined is likely to survive and spread if introduced to the State, but which is not found in the State or that region of the State where the species is listed as prohibited, except for isolated individuals or small populations of terrestrial species or species that are isolated to a specific watershed in the State or Great Lakes. Prohibited species are those for which Statewide or regional eradication or containment may be feasible. A restricted species is one which the WDNR has determined is already established in the State or that region of the State where the species is listed as restricted and for which Statewide or regional eradication or containment may not be feasible. Both categories represent species that cause or have the potential to cause economic or environmental harm or harm to human health.[26] With some exceptions, NR 40 bans the transport, possession, transfer, and introduction of prohibited species. It also bans the transport, transfer, and introduction of restricted species. In addition, it bans the possession of restricted fish and crayfish species.

Second, NR 40 contains provisions enabling the WDNR to take action to control or eradicate invasive prohibited species that are present, but not yet established. With landowner permission or a judicial inspection warrant, the WDNR may inspect for, sample, and control prohibited species only. Persons found responsible for a prohibited species' presence on property they own, control or manage may be ordered to carry out approved control measures. If a control order is not followed, and the WDNR takes control measures, the WDNR may seek cost-recovery. Control of restricted species is encouraged under NR 40, but not required.

Third, NR 40 requires that preventive measures be taken that address common pathways that may allow invasive species to spread. In general, the preventive measures are not species-specific. Examples of preventive measures include the requirement that aquatic plants and animals be removed from, and that water be drained from, any vehicle, boat, boat trailer, or boating and fishing equipment when such vehicle or equipment is removed from a waterbody or from the waterbody's bank or shore. It should be noted that Section NR 19.055 of Chapter NR 19, "Miscellaneous Fur, Fish, Game and Outdoor Recreation," of the *Wisconsin Administrative Code*, also requires that boats, boat trailers, boating equipment, and fishing equipment be immediately drained when they are removed from an inland or outlying waterbody or the waterbody's bank or shore. This requirement extends to water in any bilge, ballast tank, bait bucket, live well, or other container.

Section NR 45.045 of Chapter NR 45, "Use of Department Properties," of the *Wisconsin Administrative Code*, requires that any firewood brought into State parks or other State-managed lands be from Wisconsin, be from within 25 miles of the State-owned property, and be from outside any quarantine areas, unless the State-owned property is also within the quarantine area. (The Root River watershed is located entirely within quarantine areas for both gypsy moth and emerald ash borer.) As an alternative, firewood that is sold by Wisconsin certified firewood dealers has been treated to eliminate pests and diseases. This firewood may be brought onto State property. The Wisconsin Department of Agriculture, Trade & Consumer Protection (DATCP) has certification procedures for firewood dealers.

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[26]*In addition to the categories of invasive species regulated under NR 40, the WDNR maintains two lists of unregulated invasive species. The first consists of a caution list of species which are not found in the State that may have shown evidence of invasiveness in similar environments in other states and could potentially spread in Wisconsin. Additional information is needed to determine whether species on the caution list belong in another category. The second list consists of nonrestricted species which may have beneficial uses, but also may have adverse environmental, recreational, or economic impacts or cause harm to human health. Most of the nonrestricted species have already integrated into Wisconsin's ecosystems and Statewide control or eradication is not practical or feasible.*

Management of several invasive species which are considered agricultural pests may also be addressed under the DATCP's authority to control pests on agricultural lands and agricultural business premises. These controls are set forth in Chapter ATCP 21, "Plant Inspection and Pest Control," of the *Wisconsin Administrative Code*. Under the rules in this chapter, DATCP may issue a quarantine order prohibiting the movement of any pest or any plant, pest host, or pest-harboring material which may transmit or harbor a pest. In addition, DATCP may issue a pest abatement order requiring the destruction or removal or pests, plants, pest hosts, or pest-harboring material within 10 days or the issuance of the order, if in DATCP's judgment such an order is necessary to prevent or control a hazard to plant or animal life in the State.

ATCP also contains measures specifically addressing particular pest species, most of which are considered either prohibited species or restricted species under NR 40. Examples of invasive species addressed under this authority include both Asian and European gypsy moth; pine shoot beetle; African and Africanized honeybees; hemlock woolly adelgid; emerald ash borer; Asian longhorned beetle; and *Phytophthora ramorum*, the fungus which causes sudden oak death. The details of measures set forth in ATCP 21 vary by pest species. In general, these rules prohibit anyone from:

- Importing the pest organism or materials that may harbor or transmit the pest organisms into the State from regulated, quarantined, or infested areas designated by the State or the U.S. Department of Agriculture, or

- Moving the pest organisms or materials that may harbor or transmit the pest organism from any from regulated, quarantined, or infested areas designated by the State or the U.S. Department of Agriculture, unless the material has been inspected and certified in written certification by a pest control officer from the State of origin as either

  - Originating from noninfested premises and having not been exposed to the pest organism,

  - Being free of the pest organism,

  - Having been effectively treated to destroy the pest organism, or

  - Having been produced, processed, stored, handled, or used under conditions which preclude effective transmission of the pest organism.

The materials subject to these prohibitions differ with the particular pest species.

At the local level, management of invasive species may be addressed through municipal ordinances. A few municipalities in the watershed have ordinances that specifically address invasive species. The Cities of Franklin and Greenfield have ordinances that define certain invasive plant species as noxious weeds and require that these species be controlled with other noxious weeds. Most of the municipalities in the watershed have noxious weed ordinances. While the content of these ordinances vary among the communities, they generally define certain plant species as noxious weeds and require their destruction or control. Some of these ordinances, such as those of the Cities of Milwaukee and Oak Creek, specifically relate to plant species that cause hay fever or skin rashes.

Groundwater Management Measures

Utility-Specific Water Conservation Programs

As previously noted, the RWQMPU recommends that water utilities develop and implement utility-specific water conservation programs. For water utilities withdrawing water from surface water or groundwater sources in the Great Lakes basin, including the Root River watershed, this recommendation is partially implemented through the requirements of Chapter NR 852, "Water Conservation and Water Use Efficiency," of the *Wisconsin Administrative Code*. This chapter requires mandatory water conservation programs for all new and increased withdrawals and diversions of water from sources in the Great Lakes basin after December 8, 2008. It does not require water conservation for existing facilities at their current level of water withdrawal.

The rule classifies new withdrawals and diversions into three tiers, based upon the daily average amount of water withdrawn, whether the new or increased withdrawal constitutes a diversion of water from the Great Lakes basin, and whether the new or increased withdrawal would result in an average water loss through consumptive use or diversion of more than 2,000,000 gallons per day. The measures that are required to be implemented vary by tier. For all new or increased withdrawals by utilities withdrawing an average of 100,000 gallons per day or more, the utility is required to develop a water conservation plan, conduct a water use audit, develop a leak detection and repair program, measure their sources of water, and educate their staff and customers about their water conservation activities. Utilities withdrawing more than an average of 1,000,000 gallons per day, seeking a new or increased diversion of Great Lakes water, or making withdrawals that result in an average water loss of more than 2,000,000 gallons per day are required to implement additional conservation and efficiency measures. Under the rule, conservation and efficiency measures that require retrofitting are optional.

Consider the Potential Impact on Groundwater Quality in the Design of Stormwater Management Facilities
As previously noted, the RWQMPU recommends that the design of stormwater management facilities that directly or indirectly involve infiltration of stormwater consider the potential impacts on groundwater quality, and that the provisions in the WDNR's post-construction stormwater management technical standards that are intended to protect groundwater quality be applied in the design of stormwater management facilities. These recommendations are addressed by regulations contained in Chapters NR 151, "Runoff Management," and Trans 401, "Construction Site Erosion Control and Storm Water Management Procedures for Department Actions," of the *Wisconsin Administrative Code*. Chapter NR 151 sets forth post-construction performance standards for new development and redevelopment and infiltration performance standards for both nonagricultural (urban) areas and transportation facilities.[27] Trans 401 sets forth post-construction performance standards for those transportation facilities that are regulated by the Wisconsin Department of Transportation. These performance standards include several elements that are intended to protect groundwater quality:

- They prohibit the infiltration of runoff that originates from certain types of source areas that can be expected to contribute contaminants that could degrade groundwater quality. Examples of these source areas include fueling and vehicle maintenance areas, storage and loading areas from certain types of industrial facilities, and rooftops and parking areas of certain types of industrial facilities.

- They prohibit infiltration of runoff that originates from certain types of source areas in close proximity of features of the landscape or improvements to the landscape that can cause groundwater to be susceptible to contamination. Examples of these include prohibitions against infiltrating any runoff within 1,000 feet upgradient or 100 feet downgradient of karst features and infiltrating runoff from commercial, industrial, and institutional land uses or regional devices for residential development within 400 feet of a community water system well or 100 feet of a private well.

- They specify required soil characteristics and separation distances between the bottom of an infiltration system and the elevation of seasonal high groundwater or the top of bedrock. These specified soil characteristic and separation distances depend upon the source of the runoff.

- They prohibit infiltration of runoff in areas where contaminants of concern are present in the soil through which infiltration will occur.

[27]*The post-construction performance standard for new development and redevelopment in nonagricultural (urban) areas is set forth in NR 151.12. The infiltration performance standard for nonagricultural (urban) areas is set forth in NR 151.124. The post-construction performance standard for transportation facilities is set forth in NR 151.24. The infiltration performance standard for transportation facilities is set forth in NR 151.244.*

- They require pretreatment prior to infiltration of runoff from parking lots and new road construction in commercial, industrial, and institutional areas.

- They require that infiltration systems shall, to the extent technically and economically feasible, minimize the level of pollutants infiltrating to groundwater and to maintain compliance with the preventive action limits for groundwater pollutants promulgated by the WDNR.[28]

Other Management Strategies that Are in Various Stages of Implementation

Table 4 summarizes the recommendations of the RWQMPU that have been or are being implemented to some degree in the Root River Watershed.

Land Use Element

Preserve Primary Environmental Corridors in Essentially Natural Open Space Uses

As previously noted the RWQMPU recommends preserving primary environmental corridors in essentially open space uses. The current protection status of primary environmental corridors in the watershed is shown on Map 5. About 5,951 acres, or 94.7 percent, of the primary environmental corridors in the Root River watershed are protected, or substantially protected, through one or more of the following means:

- Public interest ownership, including publicly owned lands, privately held lands owned by conservancy organizations and other privately held lands that were in compatible outdoor recreational use, and surface water;

- Joint State-local floodplain and shoreland-wetland zoning;

- State administrative rules governing sanitary sewer extensions within planned sanitary sewer service areas; and

- Local land use regulations, including protection through local conservancy zoning and, in the case of Waukesha County, through its review of proposed land divisions.[29]

Consider Preserving Secondary Environmental Corridors and Isolated Natural Resource Areas Essentially Natural Open Space Uses

The RWQMPU encourages the preservation of secondary environmental corridors and isolated natural areas and recommends that counties and communities consider the preservation of these areas in the preparation of county and local land use plans. Some secondary environmental corridor sites and isolated natural resource areas in the Root River watershed are in protective ownership. Example of these sites include the Caledonia Wildlife Area and Ives Grove Woods in Racine County.

Preserve All Identified Natural Areas and Critical Species Habitat Sites in Public or Public Interest Ownership

The RWQMPU recommends the preservation of all of the identified natural areas and critical species habitat sites. As called for under the regional natural areas and critical species habitat protection and management plan,[30] the

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[28]*Preventive action limits are groundwater quality criteria. They are set forth in Chapter NR 140, "Groundwater Quality, of the* Wisconsin Administrative Code.

[29]*Waukesha County utilizes its land division approval-objection authority to help ensure the preservation of environmental corridors. Waukesha County reviews all proposed subdivision plats and some, but not all, proposed certified survey maps in Waukesha County.*

[30]*SEWRPC Planning Report No. 42,* op. cit.

Table 4

MANAGEMENT STRATEGIES RECOMMENDED IN THE REGIONAL WATER QUALITY MANAGEMENT PLAN UPDATE THAT ARE IN VARIOUS STAGES OF IMPLEMENTATION

Recommendation or Management Strategy	Focus Area Primarily Addressed				Responsible and Participating Organizations[a]
	Water Quality	Recreational Use and Access	Habitat Condition	Flooding	
Land Use					
Preserve primary environmental corridors in essentially natural open space uses	X	X	X	X	Counties, municipalities
Consider preserving secondary environmental corridor and isolated natural areas in essentially natural open space uses	X	X	X	X	Counties, municipalities
Preserve all identified natural areas and critical species habitat sites in public or public interest ownership	X	X	X	X	Counties, municipalities
Preserve, to the extent practicable, all farmland covered by Class I and II soils	- -	- -	- -	- -	Counties, municipalities, DATCP
Develop according to approved land use plans	X	X	X	X	Counties, municipalities
Point Source Abatement Measures					
Refine sanitary sewer service areas	X	X	- -	- -	MMSD, municipalities
Construct and maintain local sanitary sewer systems	X	X	- -	- -	Municipalities
Construct two additions to the MMSD Metropolitan Interceptor System	X	X	- -	- -	MMSD
Nonpoint Source Abatement Measures-Rural Control Measures					
Implement practices to reduce soil loss from cropland to rates below the tolerable soil loss rate, "T"	X	- -	X	- -	Counties, DATCP, WDNR, NRCS
Require agricultural operations with 35 or more combined animal units to provide six months manure storage	X	X	- -	- -	Counties, DATCP, WDNR, USDA
Increase crop and pasture riparian buffers to a minimum width of 75 feet	X	X	X	X	Counties, Drainage districts, MMSD, DATCP, WDNR, USFSA, NRCS, Land trusts
Limit the number of stream crossings and configure crossings to minimize fragmentation	- -	X	X	X	Counties, DATCP, WDNR, USDA
Convert marginally productive agricultural lands to wetland and prairie conditions	X	X	X	X	Counties, MMSD, WDNR, Land trusts
Take measures to ensure proper handling and treatment of milking-center wastewater	X	- -	- -	- -	Counties, DATCP
Implement county-enforced inspection and maintenance programs for onsite wastewater treatment systems constructed after counties adopted private sewage system programs	X	X	- -	- -	Counties
Institute voluntary programs to inventory and inspect private onsite wastewater treatment systems constructed before counties adopted private sewage system programs	X	X	- -	- -	Counties, municipalities, WDSPS

Table 4 (continued)

Recommendation or Management Strategy	Focus Area Primarily Addressed: Water Quality	Recreational Use and Access	Habitat Condition	Flooding	Responsible and Participating Organizations[a]
Nonpoint Source Abatement-Urban Control Measures					
Implement programs to detect and eliminate discharges and control pathogens that are harmful to human health	X	X	- -	- -	Municipalities and WDNR
Implement chloride reduction programs	X	- -	- -	- -	Counties, municipalities, WDNR, WisDOT
Implement fertilizer management programs	X	- -	- -	- -	Counties, municipalities, WDNR, UWEX
Implement beach and riparian litter and debris control programs	X	X	X	- -	Counties, municipalities, MMSD, UWEX
Instream Water Quality Management Measures					
Implement projects called for under the Milwaukee County stream assessment study	X	- -	X	- -	Milwaukee County
Limit the number of culverts, bridges, drop structures, and channelized stream segments and incorporate design measures to allow for passage of aquatic organism	- -	X	X	X	Counties, municipalities, MMSD, WDNR, WisDOT
Remove abandoned bridges and culverts	- -	- -	X	X	Counties, municipalities, MMSD, WDNR, WisDOT
Protect remaining stream channels, including small tributaries and shoreland wetlands	X	- -	X	- -	Counties, municipalities, MMSD, WDNR, WisDOT
Restore wetlands, woodlands, and grasslands adjacent to stream channels and establish minimum buffers 75 feet in width	X	X	X	X	Counties, municipalities, MMSD, WDNR, WisDOT
Restore and enhance stream channels	X	- -	X	- -	Counties, municipalities, MMSD, WDNR, WisDOT
Monitor fish and macroinvertebrate populations	X	- -	X	- -	WDNR, MMSD
Consider more intensive fisheries manipulation measures where warranted based upon specific goals developed in detailed local level planning	- -	X	X	- -	WDNR
Inland Lake Water Quality Measures					
Implement recommendations of Milwaukee County park pond and lagoon management plan	X	X	X	- -	Milwaukee County
Establish long-term monitoring stations in inland lakes	X	X	- -	- -	WDNR, UWEX
Auxiliary Water Quality Management Measures					
Continue, support, and institute household hazardous waste collection programs	X	- -	- -	- -	Counties, MMSD, DATCP
Continue, support, and institute collection programs for unused and expired medications	X	- -	- -	- -	Counties, MMSD
Continue and support programs to reduce the introduction and spread of exotic and invasive species	- -	- -	X	- -	WDNR, UWEX

Table 4 (continued)

Recommendation or Management Strategy	Focus Area Primarily Addressed: Water Quality	Recreational Use and Access	Habitat Condition	Flooding	Responsible and Participating Organizations[a]
Auxiliary Water Quality Management Measures (continued)					
Document and monitor the occurrence and spread of exotic and invasive species	- -	- -	X	- -	WDNR
Continue and support current surface water quality monitoring programs	X	X	- -	- -	MMSD, USGS, RHD, WDNR
Extend long-term monitoring programs to areas outside of the MMSD service area	X	X	- -	- -	USGS, RHD, WDNR
Establish long-term fisheries, macroinvertebrate, and habitat monitoring stations	X	X	X	- -	WDNR, MMSD, USGS
Maintain and update RWQMPU/MMSD 2020 FP water quality models	X	- -	- -	X	MMSD, SEWRPC
Groundwater Management Measures					
Maintain important groundwater recharge areas	X	- -	X	X	Counties, municipalities

[a]*Abbreviations for organizations are:*

DATCP = Wisconsin Department of Agriculture, Trade and Consumer Protection
MMSD = Milwaukee Metropolitan Sewerage District
NRCS = Natural Resources Conservation Service
RHD = City of Racine Health Department
SEWRPC = Southeastern Wisconsin Regional Planning Commission
USDA = U.S. Department of Agriculture
USFSA = U.S. Farm Services Agency
USGS = U.S. Geological Survey
UWEX = University of Wisconsin-Extension
WDSPS = Wisconsin Department of Safety and Professional Services
WDNR = Wisconsin Department of Natural Resources
WisDOT = Wisconsin Department of Transportation

Source: SEWRPC.

RWQMPU recommends acquisition of those sites not in existing public or public-interest ownership. The identified natural areas and critical species habitat sites in the Root River watershed and their current and recommended protection status are shown on Map 6. The status of implementation of the RWQMPU recommendations for placing these sites in protective ownership is shown in Table 5. There are 43 natural areas and 28 critical species habitat sites that are wholly or partially located within the Root River watershed. The total area of these sites is 3,845 acres, with 3,686 acres located within the watershed. As of 2010, 2,213 acres were in protective ownership. The regional natural areas and critical species habitat protection and management plan, as amended, recommends that an additional 1,337 acres be acquired and placed in protective ownership.

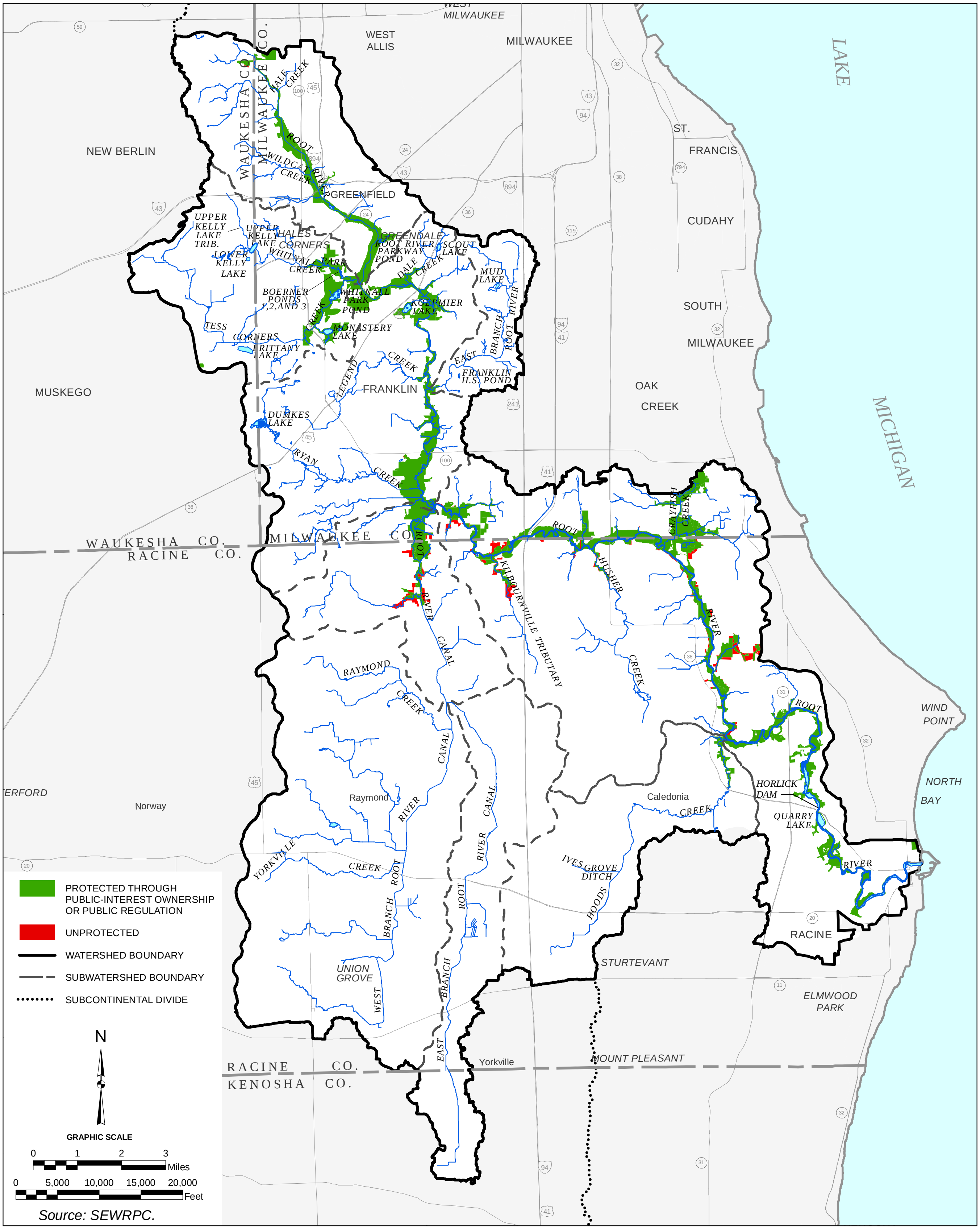
Point Source Pollution Abatement Measures

Construct and Maintain Local Sanitary Sewer Systems

As discussed previously, the RWQMPU recommends that all of the municipalities in Milwaukee County that are wholly or partially located in the watershed; the City of Racine, the Villages of Mt. Pleasant, Sturtevant, and Union Grove, the Caledonia East and West Utility Districts, the Mt. Pleasant Utility District No. 1, and the Yorkville Sewer Utility District No. 1 in Racine County; and the Cities of Muskego and New Berlin in Waukesha County, construct and maintain local sanitary sewer systems. These jurisdictions have all constructed such systems and perform maintenance on an ongoing basis.

Map 5

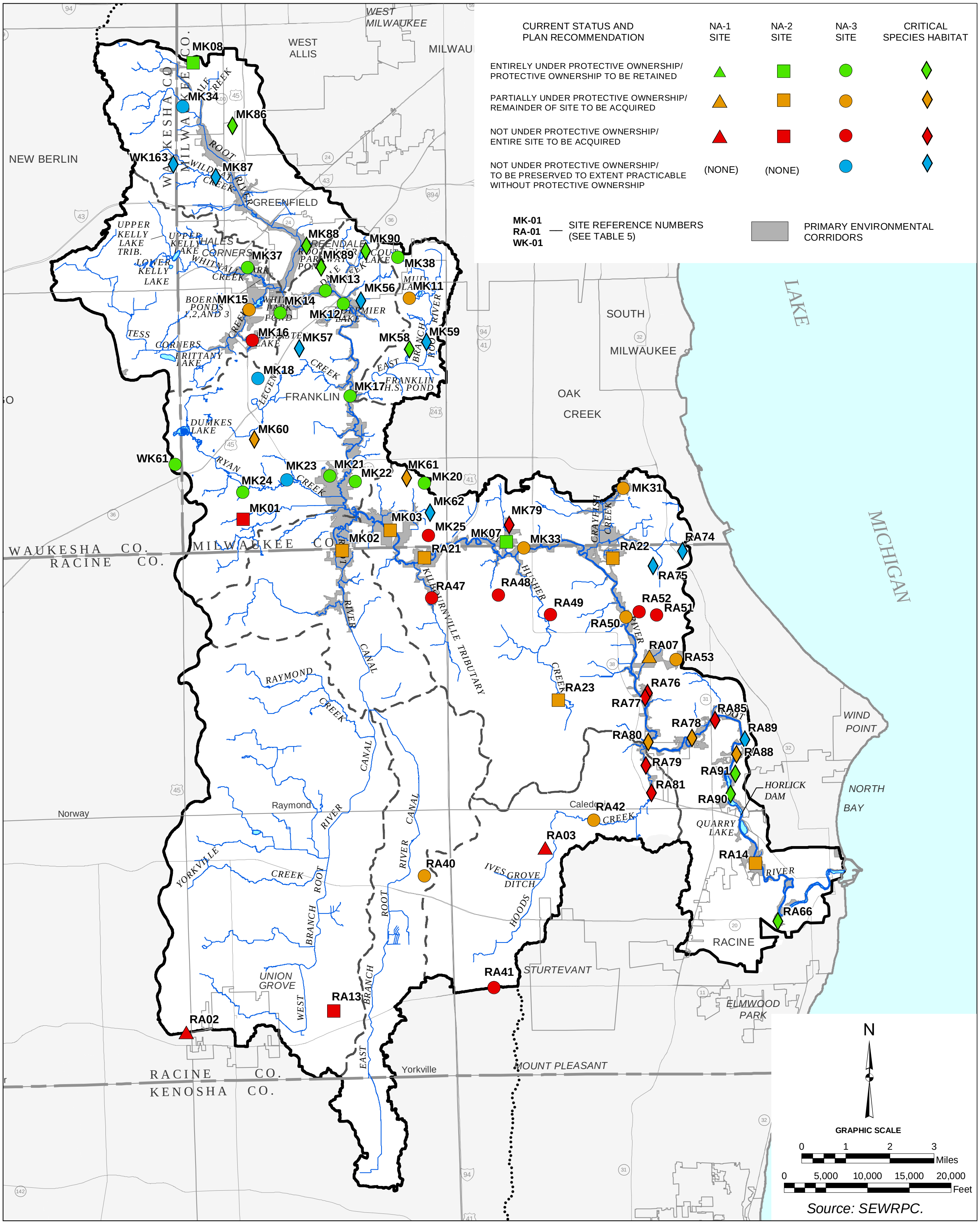
PROTECTION OF PRIMARY ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED: 2000



Source: SEWRPC.

Map 6

PROTECTION STATUS OF NATURAL AREAS AND CRITICAL SPECIES HABITAT SITES IN THE ROOT RIVER WATERSHED



Source: SEWRPC.

Table 5

PROTECTION STATUS OF NATURAL AREAS AND CRITICAL SPECIES HABITAT SITES IN THE ROOT RIVER WATERSHED: 2010

Number on Map 6[a]	Name	Class[b]	Area (acres)	Area in Watershed (acres)	Area in Protective Ownership (acres)	Area in Private Ownership (acres)	Area to Be Acquired (acres)[c]
MK-01	Adams Prairie	NA-2	37	37	0	37	37
MK-02	Root River Canal Woods	NA-2	315	315	111	204	168
MK-03	Root River Wet-Mesic Woods-West	NA-2	273	273	166	107	107
MK-07	Root River Wet-Mesic Woods-East	NA-2	52	52	52	- -	- -
MK-08	Greenfield Park Woods	NA-2	52	33	52	- -	- -
MK-11	Grobschmidt Park Wetlands and Upland Woods	NA-3	83	83	79	4	4
MK-12	Bike Trail Marsh	NA-3	3	3	3	- -	- -
MK-13	Root River Low and Upland Woods	NA-3	76	76	76	- -	- -
MK-14	Root River Parkway Woods	NA-3	64	64	64	- -	- -
MK-15	Whitnall Park Woods-South	NA-3	145	145	144	1	1
MK-16	Monastery Lake Wetlands	NA-3	48	48	0	48	48
MK-17	Root River Bike Trail Woods	NA-3	108	108	108	- -	- -
MK-18	Mission Hills Wetland	NA-3	38	38	0	38	0
MK-20	Fitzsimmons Road Woods	NA-3	39	26	39	- -	- -
MK-21	Root River Parkway Prairie	NA-3	51	51	51	- -	- -
MK-22	60th Street Woods	NA-3	11	11	11	- -	- -
MK-23	Ryan Creek Woods	NA-3	102	102	0	102	0
MK-24	Franklin Oak Woods and Oak Savanna	NA-3[d]	79	79	79	- -	- -
MK-25	Elm Road Woods	NA-3	20	20	0	20	20
MK-31	Oak Creek Low Woods	NA-3	68	35	31	37	37
MK-33	Root River Riverine Forest	NA-3	331	331	330	1	1
MK-34	West Branch Root River Woods	NA-3	12	12	0	12	0
MK-37	Whitnall Park Woods-North	NA-3	82	82	82	- -	- -
MK-38	Grootemaat Woods	NA-3	20	20	20	- -	- -
MK-56	Russell Avenue Woods	CSH	9	9	0	9	0
MK-57	Loomis Road Woods	CSH	13	13	0	13	0
MK-58	Countryside Woods	CSH	26	26	26	- -	- -
MK-59	35th Street Woods	CSH	14	14	0	14	0
MK-60	Shooting Star Prairie and Shrubland[e]	CSH	18	18	15	3	3
MK-61	Oakwood Park Oak Woods	CSH	8	8	5	3	3
MK-62	Elm Road Woods-North	CSH	32	32	0	32	0

Table 5 (continued)

Number on Map 6[a]	Name	Class[b]	Area (acres)	Area in Watershed (acres)	Area in Protective Ownership (acres)	Area in Private Ownership (acres)	Area to Be Acquired (acres)[c]
MK-79	PPG Woods	CSH	19	19	0	19	19
MK-86	Holt Park Woods	CSH	8	8	8	- -	- -
MK-87	Cold Spring Road Thicket	CSH	2	2	0	2	0
MK-88	Grange Avenue Woods	CSH	14	14	14	- -	- -
MK-89	Westway Woods	CSH	9	9	9	- -	- -
MK-90	Scout Lake Park Woods	CSH	43	43	43	- -	- -
RA-02	Kansasville Railroad Prairie	NA-1	28	6	0	0	6
RA-03	Franksville Railroad Prairie	NA-1	4	4	0	4	0
RA-07	Renak-Polak Maple-Beech Woods State Natural Area	NA-1[d]	138	138	96	42	42
RA-13	Union Grove Railroad Prairie	NA-2	44	34	0	44	44
RA-14	Colonial Park Woods	NA-2	94	94	89	5	5
RA-21	County Line Riverine Woods	NA-2	141	141	41	100	100
RA-22	Hunts Woods	NA-2	36	36	5	31	31
RA-23	Caledonia Wildlife Area	NA-2	166	166	133	33	33
RA-40	Ives Grove Woods	NA-3	140	140	54	86	86
RA-41	Sylvania Railroad Prairie	NA-3	11	5	0	11	11
RA-42	Hoods Creek Woods	NA-3	72	72	9	63	63
RA-47	Kimmel Woods	NA-3	40	40	0	40	40
RA-48	Seven Mile Woods	NA-3	20	20	0	20	20
RA-49	Zirbes Woods	NA-3	13	13	0	13	13
RA-50	Caledonia Low Woods	NA-3	107	107	61	46	46
RA-51	Foley Road Woods-East	NA-3	24	24	0	24	24
RA-52	Foley Road Woods-West	NA-3	19	19	0	19	19
RA-53	Tabor Woods	NA-3	106	50	20	86	86
RA-66	Washington Park Woods	CSH	14	14	14	- -	- -
RA-74	WEPCo Woods	CSH	18	18	0	18	0
RA-75	Sherwood Property	CSH	4	4	0	4	0
RA-76	Forked Aster Site	CSH	18	18	0	18	18
RA-77	River Meadow Woods	CSH	14	14	0	14	14
RA-78	Caledonia Sanitary Sewer Right-of-Way	CSH	94	94	18	76	76
RA-79	Hoods Creek Swamp	CSH	13	13	0	13	13
RA-80	Root River Bluff	CSH	50	50	18	32	32
RA-81	STH 38/CTH K	CSH	4	4	0	4	4
RA-85	Four Mile Road Woods	CSH	31	31	0	31	31
RA-88	Caledonia Low Woods-South	CSH	30	30	20	10	10
RA-89	Root River Ravine Woods	CSH	5	5	0	5	0

Table 5 (continued)

Number on Map 6[a]	Name	Class[b]	Area (acres)	Area in Watershed (acres)	Area in Protective Ownership (acres)	Area in Private Ownership (acres)	Area to Be Acquired (acres)[c]
RA-90	Root River Strip Woods	CSH	2	2	2	- -	- -
RA-91	River Bend Upland Woods	CSH	14	14	14	- -	- -
WK-61	Luther Parker Cemetery Prairie	NA-3	1	1	1	- -	- -
WK-163	Schkeryantz Woods	CSH	6	6	0	6	0
	Total	- -	3,845	3,686	2,213	1,632	1,337

[a]*Numbers are those assigned in the county-level maps in the Amendment to SEWRPC Planning Report No. 42,* Natural Areas and Critical Species Habitat Protection and Management Plan for the Southeastern Wisconsin Region*, December 2010.*

[b]*NA-1 sites are areas of Statewide significance. These areas contain excellent examples of nearly complete and relatively undisturbed plant and animal communities which are believed to closely resemble those present prior to European settlement.*

NA-2 sites are areas of regional significance. These areas are so designated either because they show evidence of a limited amount of human disturbance or because they are of the highest quality but have less area than that required for the NA-1 ranking.

NA-3 sites area areas of local significance. While these areas are substantially altered by human activities, they may contain excellent wildlife habitat or provide refuge for native plant species which no longer exist in the surrounding region due to land use activities.

CSH sites are critical species habitat sites.

[c]*As recommended in the 2010 amendment to the regional natural areas and critical species habitat protection plan.*

[d]*This site is also designated as a State natural area.*

[e]*Also known as Carity Prairie.*

Source: SEWRPC.

Construct Two Additions to the MMSD Metropolitan Interceptor System

The RWQMPU recommended constructing two additions to the MMSD Metropolitan Interceptor System in the Root River watershed—a new Ryan Creek interceptor and a capacity upgrade to the Franklin-Muskego interceptor. As of February 2012, the design of the Ryan Creek interceptor was completed and a construction contract was awarded. The Ryan Creek interceptor was designed to eliminate the need to upgrade capacity of the Franklin-Muskego interceptor. Portions of the Metropolitan Interceptor System downstream from the Franklin-Muskego force main are being lined due to corrosion.

Nonpoint Source Pollution Abatement—Rural Control Measures

As previously noted, the RWQMPU makes several recommendations for controlling nonpoint source pollution in rural areas. These recommendations include:

- Implementing practices to reduce soil loss from cropland to attain erosion rates less than or equal to "T," the maximum average annual rate of soil loss that can occur without significantly affecting crop productivity,
- Require livestock operations in the study area with 35 combined animal units or greater as defined in Chapter NR 243 *to* provide six months of manure storage,
- Establishing minimum 75-foot-wide riparian buffers along each side of streams flowing through current crop and pasture land,

- Limiting the numbers of stream crossing and configuring them to minimize fragmentation of stream habitat, and

- Taking measures to ensure proper handling and treatment of milking center wastewater.

The county land conservation offices in Kenosha, Milwaukee, Racine, and Waukesha Counties have been pursuing implementation of these recommendations by providing cost-share assistance and technical assistance to landowners to install practices that address soil erosion and agricultural nonpoint source pollution. Examples of practices that have been installed in the Root River watershed in recent years include grassed waterways, lined outlets, clean water diversions, gulley stabilizations, and riparian buffers.

Convert Marginally Productive Agricultural Lands to Wetland and Prairie Conditions
As described previously, the RWQMPU recommends that a total of 10 percent of existing farmland and pasture be converted to either wetland or prairie conditions, with first consideration for conversion being given to marginally productive lands. There have been some efforts to implement this recommendation. In 2010, the Milwaukee County Department of Parks, Recreation and Culture (DPRC) converted two agricultural fields adjacent to Franklin State Natural Area to native prairie. This project was conducted in partnership with the Urban Ecology Center and the U.S. Forest Service. Funding for the project was provided by Root-Pike WIN. DPRC has also restored 19 acres of farmland within the Franklin State Natural Area to native prairie and is restoring 16 acres at this site to native savanna. Funding for this project was provided by Root-Pike WIN and the Milwaukee Area Land Trust. Through its Greenseams program, MMSD has acquired 357 acres in the Root River watershed, including over 150 acres in the headwaters of Ryan Creek and more than 80 acres adjacent to Crayfish Creek. Restoration activities to re-create a wooded wetland and native prairie are ongoing on the Crayfish Creek project site. In June 2012, the Racine County Land Division completed a project along the East Branch of the Root River Canal in the Town of Yorkville in which three acres of marginal farmland were converted to wetland.

Nonpoint Source Pollution Abatement—Urban Control Measures
Programs to Detect and Eliminate Discharges and Control Pathogens that Are Harmful to Human Life
As previously described, the RWQMPU recommends enhanced urban illicit discharge control and/or innovative methods to identify and control possible pathogen sources in stormwater runoff from all urban areas in its study area, including the Root River watershed. This recommendation is intended to address fecal coliform bacteria, the presence of which may indicate risks to human health from pathogens. As part of its sampling program, the Racine Health Department has been sampling stormwater outfalls that discharge into the Root River in the City of Racine.

Chloride Reduction Programs
The RWQMPU makes several recommendations to reduce the amount of chlorides introduced into the environment. These recommendations include:

- Evaluation of deicing practices by counties and municipalities to obtain optimal application rates to ensure public safety without applying more chlorides than necessary for that purpose;

- Consideration of alternatives to current ice and snow control programs;

- Implementation of education programs to provide information about alternative ice and snow control measures in public and private parking lots, optimal deicer application rates in such areas; and

- Implementation of education programs to provide information about alternative water softening media and the use of more efficient water softeners.

A number of efforts have been made to reduce the use of chlorides in deicing. In 2008 and 2009, Milwaukee County sponsored three winter maintenance workshops that focused on road salt use reduction for public works employees and maintenance employees of public spaces such as schools and parking lots. In 2012, the impacts and management of road salt and prevention of pollution related to road salt were major topics presented at the annual stormwater municipal separate storm sewer system workshops sponsored by Waukesha County.

The City of Racine is purchasing a brine system for use in its deicing operations. It is initially intended to be used for ice control on arterial streets.

Fertilizer Management Programs
As described previously, the RWQMPU recommends that information and education programs required under municipal WPDES stormwater discharge permits promote voluntary practices that optimize urban fertilizer application consistent with the requirements of WDNR Technical Standard No 1100, "Interim Turf Nutrient Management." Several programs provide information and education regarding fertilizer application and management to residents of the Root River watershed. Root-Pike WIN conducts the Keep Our Waters Clean program, an educational program providing information with the long-term goal of reducing polluted runoff and improving water quality in local waterways. This program is conducted under contract for the Southeast Wisconsin Clean Water Network, a group of 18 municipalities, including 9 in the Root River watershed. The WDNR and the University of Wisconsin-Extension also provide educational materials regarding urban fertilizer management.

Beach and Riparian Litter and Debris Control Programs
As previously noted, the RWQMPU recommends that existing litter and debris control programs along the urban streams of the study area be continued and that opportunities to expand such efforts be explored. A number of agencies and entities have been conducting riparian litter and debris control activities in the Root River watershed.

The City of Racine Department of Parks, Recreation and Cultural Services, in conjunction with Leadership Racine, conducts an Adopt-A-River program for the reaches of the Root River in the City. Under this program, participating community organizations, associations, and agencies assume responsibility for litter control along the banks of the River that pass through City of Racine parks. Each participating organization agrees to pick up litter on its segment at least two times a year between April 1 and November 1. The City of Racine also conducts an Adopt-A-Beach program for Lake Michigan beaches.

Since 1999, the Badger Trails hiking organization has sponsored an annual hike along the Root River Trail in Greendale, Greenfield, and West Allis that includes litter pickup and removal.

Other organizations that have conducted or sponsored litter and debris control activities in the Root River watershed in recent years include S.C. Johnson Corporation, the Racine Marriott, the Sierra Club, Racine Lutheran High School Environmental Club, the YWCA of Racine Kids Nature Kamp, and the West Allis Central High School Conservation Club.

Instream Water Quality Management Measures
Implement Projects Called for Under the Milwaukee County Stream Assessment Study
The RWQMPU recommends that the projects called for under the Milwaukee County stream assessment study be implemented over time in a manner consistent with the need to provide flood protection and consistent with the stream rehabilitation recommendations of the regional plan update. Milwaukee County has been pursuing funding to implement projects recommended by this assessment.

Culverts, Bridges, Drop Structures, and Channelized Stream
As discussed previously, the RWQMPU makes several recommendations regarding culverts, bridges, drop structures, and channelized stream sections. It recommends limiting the installation of these features, removing them where possible, and retrofitting them to allow the passage of fish and other aquatic organisms. At least one recent project has addressed these recommendations. In 2010 and 2011, the Wisconsin Department of Transportation replaced and retrofitted culverts along Husher Creek at STH 38. This project incorporated features

to enhance fish and organism passage.[31] The project included the removal of an abandoned and failing bridge and reconstruction of a more natural channel upstream from the culvert.

Protect Remaining Natural Stream Channels

The RWQMPU recommends that to the extent practicable, remaining natural stream channels, including small tributaries and shoreland wetlands that provide habitat for the continued survival, growth, and reproduction of a sustainable fishery throughout the study area, be protected. No specific examples of implementation of this recommendation were identified within the Root River watershed.

Restore Wetlands, Woodlands, and Grasslands Adjacent to
Stream Channels and Establish Minimum 75-Foot-Wide Buffers

As previously noted, the RWQMPU recommends restoring wetlands, woodlands, and grasslands adjacent to stream channels and establishing buffers that are a minimum of 75 feet in width to reduce pollutant loads entering the stream and protect water quality. Some of the projects previously discussed in this chapter included restoration activities that address this recommendation. Examples of these products include the Milwaukee County DPRC restoration activities at Franklin State Natural Area and MMSD activities related to its Greenseams project along Crayfish Creek. Other DPRC projects addressing this recommendation include planting a mixture of native hardwood trees on five acres adjacent to the Root River in Hales Corners in 2010 and removing brush from 12.5 acres of grassland adjacent to Mud Lake. In addition, the stream channel restoration project along a tributary to Upper Kelly Lake that is described in the next section includes the restoration of a riparian wetland. Finally, several agricultural runoff projects include installation of riparian buffers.

Restore and Enhance Stream Channels

The RWQMPU recommends the restoration, enhancement, and/or rehabilitation of stream channels. Several recent projects have addressed these recommendations. The Racine County Land Conservation Division has provided cost-share and technical assistance to landowners for steam channel projects that address agricultural runoff. These projects, which include streambank protection and streambank sloping, were conducted on a number of streams in the watershed, including Caledonia Creek, Hoods Creek, the Root River, and the West Branch of the Root River Canal. In 2004, the City of New Berlin conducted streambank stabilization projects along a tributary to the Root River and a stream within the New Berlin Hills Golf Course. In 2004, the Town of Yorkville conducted a streambed stabilization project along an unnamed tributary to the West Branch of the Root River Canal. In 2004 and 2005, the Kelly Lakes Association and the City of New Berlin relocated and remeandered a tributary to Upper Kelly Lake. This project included restoration of the wetland that the tributary flows through and reconnection of the stream to its floodplain. In 2008, the City of Racine conducted a streambank stabilization and restoration project along a section of the Root River between Colonial Park and Lincoln Park. In 2008, the Wisconsin Department of Transportation relocated and restored a section of the Kilbournville Tributary at the IH 94/CTH G interchange. This project also reconnected the stream to its floodplain and improved fish passage through this reach. In 2005, the City of Racine commissioned a study to evaluate the condition of storm sewer outfalls and streambanks and associated erosion and erosion potential along the Root River within the City.[32] The City is currently updating this study.

Monitor Fish and Macroinvertebrate Populations

The RWQMPU recommends that fish and macroinvertebrate populations be monitored to evaluate the effectiveness of the water quality management program. The WDNR conducts monitoring of these organisms in the Root River watershed. The most recent monitoring was conducted in 2011. In 2004 and 2007, fish and

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[31]*SEWRPC Staff Memorandum, "Data Analysis and Recommendations Related to the Proposed Restoration of Husher Creek, Tributary to the Root River in the Village of Caledonia, Racine County," December 28, 2011.*

[32]*Earth Tech, Inc.,* Root River Outfall and Streambank Erosion Assessment, *January 2005.*

macroinvertebrate data were also collected at two sampling stations along the mainstem of the Root River in Milwaukee County as part of the MMSD Corridor Study.[33] In addition, Root-Pike WIN has funded a study of freshwater mussels in the Root River watershed. This study will examine the mainstem of the River and the canals for the presence and species of mussels. Field work for this study will be conducted in 2012.

Consider More Intensive Fisheries Manipulation Measures Where Warranted Based Upon Specific Goals Developed in Detailed Local Level Planning
The RWQMPU recommends that more intensive fisheries manipulation measures be considered where warranted based upon specific goals and objectives for particular fisheries. As part of its fisheries management programs, the WDNR considers the appropriate management measures for fisheries in the Root River watershed.

As part of its Southeast Region Urban Fishing Program, the WDNR annually stocks catchable-size rainbow trout in Franklin High School Pond, Quarry Lake, Schoetz Park Pond, and Scout Lake. In addition, the Hunger Task Force stocks several species of fish into Milwaukee County park ponds and lagoons.

Inland Lake Water Quality Management Measures
Implement Recommendations of Milwaukee County Park Pond and Lagoon Management Plan
The RWQMPU recommends implementation of the recommendations of the Milwaukee County park pond and lagoon management plan. Milwaukee County has been pursuing funding to implement projects recommended under the plan.

Establish Long-Term Monitoring Stations in Inland Lakes
The RWQMPU recommends that long-term monitoring stations be established in inland lakes. While several lakes and ponds in the Root River watershed have been sampled on single occasions, only four—Lower Kelly Lake, Quarry Lake, Scout Lake, and Upper Kelly Lake—have been sampled repeatedly. Two of these lakes have been sampled recently and continue to be sampled. Volunteers from the Wisconsin Citizen Lake Monitoring Network have monitored Secchi depth in Upper Kelly Lake at its deepest point since 1994. The City of Racine Health Department has sampled Quarry Lake for bacteria since at least 1990.

Auxiliary Water Quality Management Measures
Continue, Support, and Institute Household Hazardous Waste Collection Programs
The RWQMPU recommends that the existing collection programs for household hazardous wastes be continued and supported and that those communities not served by such programs consider developing and instituting them. Most communities in the Root River watershed have provisions for collection of household hazardous wastes. Kenosha County sponsors an annual collection event for County residents outside of the City of Kenosha. In Milwaukee County, MMSD has three collection facilities that are open two to three days per week throughout the year. These sites serve all of Milwaukee County. In addition, the MMSD sponsors periodic mobile collection events for Milwaukee County residents. Five of these events are scheduled for 2012. In Racine County several communities conduct hazardous waste collection activities. The City of Racine and the Villages of Caledonia, Mount Pleasant, and Sturtevant jointly conduct monthly collection events between April and October for their residents.[34] The Village of Union Grove and the Town of Dover in conjunction with several other Racine County

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[33]*U.S. Geological Survey Scientific Investigations Report No. 2007-5084,* Water-Quality Characteristics for Selected Sites within the Milwaukee Metropolitan Sewerage District Planning Area, Wisconsin: February 2004-September 2005, 2007*; U.S. Geological Survey Scientific Investigations Report No. 2010-5166,* Biological Water-Quality Assessment of Selected Streams within the Milwaukee Metropolitan Sewerage District Planning Area of Wisconsin: 2007*, 2010.*

[34]*The Villages of Elmwood Park, North Bay, and Wind Point, which are located outside of the Root River watershed, also participate in this program.*

municipalities that are not located in the Root River watershed conducted a collection event in April 2012. The Town of Norway has contracts with local waste disposal firms that allow residents to drop off household hazardous wastes at the firms' facilities on Saturdays. In the recent past, the Town of Raymond has made a similar arrangement with a local waste disposal firm. Waukesha County has established four drop-off sites for the collection of household hazardous wastes. In addition, the County schedules periodic special collection events.

Financial assistance is available from the State of Wisconsin to counties, municipalities, town sanitary districts, metropolitan sewerage districts, lake protection and rehabilitation districts, county utility districts, and regional planning commissions for household hazardous waste collection activities through the Wisconsin Clean Sweep program that is administered by the State Department of Agriculture, Trade and Consumer Protection.

Continue, Support, and Institute Collection Programs for Unused and Expired Medications

As indicated above, the RWQMPU recommends that periodic collections of expired and unused prescription medications be conducted. Three types of programs have been developed that are implementing this recommendation in the Root River watershed. First, several jurisdictions have held periodic collection events. In Milwaukee County, MMSD has periodically sponsored Countywide collection events. In Racine County, the City of Racine Health Department, the Central Racine County Health Department, and the Western Racine County Health Department conduct annual collection events in April and October. Communities located in the Root River watershed that have participated in these events include the City of Racine; the Villages of Caledonia, Mount Pleasant, Sturtevant, and Union Grove; and the Town of Dover. The Waukesha County Drug Free Communities Coalition coordinates an annual Countywide drug collection to dispose of unused and expired medications.

Second, several jurisdictions have established drop-off sites or drop boxes where residents may dispose of expired or unused medications. These sites are usually located at law enforcement offices. Kenosha County has established four sites that serve the entire County. In Milwaukee County, collection sites have been established at the police departments in the Cities of Franklin, Oak Creek, and West Allis, and the Village of Greendale. In addition, the City of Greenfield Health Department has established a collection site. These Milwaukee County sites serve their local residents. In Racine County, collection sites serving local residents have been established at the City of Racine and Village of Sturtevant police departments. In addition, the Town of Waterford Police Department has established a drop box for communities in the area.

Third, mail-back programs for disposal of expired or unwanted medications also serve residents of the watershed. In 2011 and 2012, three active mail-back programs served the Root River watershed residents. The University of Wisconsin-Extension's Get the Meds Out program provides free, prepaid mail-back envelopes to any interested pharmacy, clinic, health department, senior center, or police department within the 36 counties in the State of Wisconsin that are located in the Great Lakes basin. This program serves residents in all four of the Counties that contain portions of the Root River watershed. Participating facilities distribute the envelopes free-of-charge to their customers or clients upon request. Individuals who are unable to pick up an envelope may call to request one over the phone. This program is funded through a grant from the USEPA under the Great Lakes Restoration Initiative.

Nationally, Walgreens and CVS pharmacies also have established mail-back programs. Under these programs, individuals may purchase a mail-back envelope at a participating pharmacy for returning expired or unwanted medications. It is important to note that these two programs do not accept controlled substances.

As is the case for household hazardous waste collection, financial assistance from the State of Wisconsin is available to local units of government for expired and unused prescription medication collection activities through the Wisconsin Clean Sweep program that is administered by the State Department of Agriculture, Trade and Consumer Protection.

Continue and Support Programs to Reduce the Introduction and Spread of Exotic and Invasive Species
In addition to the regulatory approaches previously described, there are a number of ongoing efforts for reducing the introduction and spread of exotic and invasive species in the Root River watershed.

The Milwaukee County Department of Parks, Recreation and Culture (DPRC) conducts aquatic plant management activities in park ponds and lagoons for aquatic invasive plants such as Eurasian water milfoil. Management efforts are conducted on an as-needed basis. Similarly, the Kelly Lakes Association conducts aquatic plant management activities on Lower and Upper Kelly Lakes.

DPRC also conducts terrestrial invasive plant management and removal activities in parks and natural areas of the Milwaukee County Park System. The methods used depend on the particular invasive species and the biological community in which they are located. These methods include mowing, prescribed burns, hand removal, mechanical removal, and application of herbicides. Many of DPRC's activities in the management of invasive species are conducted in cooperation with partner groups. The Park People of Milwaukee County, an umbrella organization of park friends groups, park watch groups, and neighborhood associations concerned with specific parks of the Milwaukee County Park System, coordinates weed-out events in the Milwaukee County Park System. This coordination includes recruiting volunteers and providing onsite tools and training. Other recent partners include Americorps, the Student Conservation Association, the Boy Scouts and Girl Scouts, and service learning programs at local colleges and universities.

Several organizations in Racine County conduct or have conducted activities to remove invasive species. The Racine County Parks Department sponsors an Adopt-A-Park program. Invasive species removal is one of the activities that participating organizations pursue. Weed Out! Racine annually organizes and sponsors invasive plant removal activities in parks and natural area within the Root River watershed. In cooperation with the Village of Caledonia, the Hoy Audubon Society, the Sierra Club Southeast Gateway Group, and Weed Out! Racine have conducted invasive species removal at Nicholson Wildlife Area. The Kenosha/Racine Land Trust has conducted invasive species removal and management activities on conservancy land and conservation subdivisions. Groups from the University of Wisconsin-Parkside have conducted invasive species management activities in the Renak-Polak Woods and at the Root River Environmental Education Center. Similar activities have been conducted by organizations in Milwaukee County. The Greendale Environmental Group has conducted invasive species removal activities in the Dale Creek Parkway.

Document and Monitor the Occurrence and Spread of Exotic and Invasive Species
As noted previously, the RWQMPU recommended that the occurrence and spread of exotic and invasive species be documented and monitored. Several ongoing efforts have addressed this recommendation in recent years.

As part of its field activities, the WDNR documents occurrence of exotic and invasive species. In addition, in 2003 and 2004, the Department used satellite data to map the degree to which wetlands in the State are infested with reed canary grass.[35] Distributions of several invasive species are documented on the Department's surface water data viewer, an internet-based mapping utility.[36] The Department has also implemented an internet-based reporting system for citizens and other agencies to report occurrences of invasive species.[37]

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[35]*Wisconsin Department of Natural Resources,* Mapping Wisconsin Wetlands Dominated by Reed Canary Grass, *Phalaris arundinacea* L.: A Landscape Level Assessment*, Final Report to the U.S. Environmental Protection Agency, October 2008.*

[36]*The surface water data viewer can be accessed at* http://dnr.wi.gov/org/water/data_viewer.htm*.*

[37]*This can be accessed at* http://dnr.wi.gov/topic/Invasives/report.html*.*

As part of its activities, the Milwaukee County DPRC has conducted natural resource inventories for natural areas management units within the Park System. These inventories include inventories of invasive species. Parks and natural areas within the Root River watershed that have been recently examined include Dale Creek Park, Franklin State Natural Area, Rainbow Airport Prairie, the Root River Parkway, Scout Lake Park, and Whitnall Park.

In 2011, volunteers under the direction of the Southeastern Wisconsin Invasive Species Consortium (SEWISC)—a coalition of local units of government; Federal, State, and local government agencies; businesses; land trusts; and nongovernmental organizations that promotes efficient and effective management of invasive species throughout Kenosha, Milwaukee, Ozaukee, Racine, Sheboygan, Walworth, Washington, and Waukesha Counties—conducted roadside surveys for the presence and population sizes of four invasive plant species: common teasel (*Dipsacus sylvestris*), cut-leaf teasel (*Dipsacus laciniatus*), giant reed grass (*Phragmites australis*), and Japanese knotweed (*Polygonum cuspidatum*). This survey covered all roads with lane markings within eight counties served by SEWISC. As part of this effort, surveys were also performed on areas in or near primary and secondary environmental corridors and isolated natural resource areas. SEWISC plans on conducting additional surveys for invasive plant species in the future.

Continue and Support Current Surface Water Quality Monitoring Programs
The RWQMPU recommends that the surface water quality monitoring programs currently being conducted by the MMSD, WDNR, and USGS be supported and continued. While there have been some changes to sampling sites and sampling frequencies in response to budget considerations, these monitoring programs continue to operate in the Root River watershed. In addition, the City of Racine Health Department conducts water quality sampling, both within the City of Racine and at other locations in the watershed.

Extend Long-Term Monitoring Programs to Areas Outside of the MMSD Service Area
As discussed previously, the RWQMPU recommends that long-term monitoring programs be extended to areas outside of the MMSD service area. Discussion of this recommendation in the plan noted that there were considerable data gaps, especially with respect to monitoring of tributary streams. Beginning in 2011, the City of Racine Health Department expanded its water quality monitoring program to several sampling sites in portions of the Root River watershed that have not been recently monitored. Two of the sites established are providing data from a 12-mile-long section of the River that has not previously been monitored. In addition, the Racine Health Department has established sampling stations on seven tributary streams. Monitoring continued through 2012.

Establish Long-Term Fisheries, Macroinvertebrate, and Habitat Monitoring Stations
As noted previously, the RWQMPU recommends establishing long-term fisheries, macroinvertebrate, and habitat monitoring stations in streams—ideally at sites where water quality is also being monitored. As part of its 2011 monitoring efforts the WDNR monitored macroinvertebrate populations at the sample sites in the watershed that had been previously sampled as part of the final evaluation of the Root River Priority Watershed project in 1990.[38] In addition, the Racine Health Department coordinated its selection of water quality sampling sites in the watershed with WDNR staff in order to provide water quality data at some of the WDNR's fisheries and macroinvertebrate sampling sites.

Maintain and Update RWQMPU/MMSD 2020 FP Water Quality Models
The RWQMPU recommends periodic maintenance and updating of the water quality models developed under the RWQMPU/MMSD 2020 FP. As part of its ongoing activities, SEWRPC has been maintaining and updating these models.

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[38]*Wisconsin Department of Natural Resources,* An Evaluation of Water Quality in the Root River Priority Watershed: Final Report, *Publication WR-298-92, January 1992.*

Groundwater Management Measures

Maintain Important Groundwater Recharge Areas

As previously discussed, the RWQMPU recommends that consideration be given to following the recommendations of the regional water supply plan regarding maintenance of groundwater recharge areas. The regional water supply plan recommended the preservation and protection of groundwater recharge areas having a high or very high recharge potential.[39] This plan went on to note that such protection may be largely achieved through the implementation of the adopted design year 2035 regional land use plan and supporting county comprehensive plans, since these plans recommend the preservation of environmental corridors, isolated natural resource areas, and prime and other agricultural areas that facilitate recharge. The plan estimated that, within the Southeastern Wisconsin Region, about 76 percent of the highly rated and very highly rated recharge areas may be expected to be preserved by inclusion in environmental corridors, isolated natural resource areas, and prime and other agricultural areas identified for preservation in the adopted regional land use plan.

Management Strategies Recommended by the RWQMPU that Are Not Yet Implemented

Some recommendations of the RWQMPU have not yet been implemented in the Root River watershed. These are summarized in Table 6.

[39]*SEWRPC Planning Report No. 52*, op. cit.

Table 6

MANAGEMENT STRATEGIES RECOMMENDED FOR IMPLEMENTATION IN THE REGIONAL WATER QUALITY MANAGEMENT PLAN UPDATE BUT NOT YET IMPLEMENTED

Recommendation or Management Strategy	Focus Area Primarily Addressed				Responsible and Participating Organizations[a]
	Water Quality	Recreational Use and Access	Habitat Condition	Flooding	
Abandon Yorkville sewage treatment plant at the end of its useful life	X	X	- -	- -	Yorkville Sewer Utility No. 1
Evaluate the need to reduce infiltration and inflow of clearwater into sanitary sewers	X	X	- -	- -	MMSD, municipalities
Consider increasing the levels of cost-share funding for barnyard runoff BMPs	X	X	- -	- -	Counties, USDA
Conduct targeted research on bacteria and pathogens and research on stormwater BMP techniques and programs	X	X	- -	- -	MMSD WDNR, RHD
Prepare abandonment and riverine restorations plans for dams	- -	- -	X	- -	Racine County, WDNR
Conduct assessments and evaluations of the significance for human health and wildlife of the presence of pharmaceuticals and personal care products in surface waters	X	- -	- -	- -	MMSD, USGS
Continue efforts to facilitate consolidation of data from different monitoring programs	X	X	X	- -	MMSD, WDNR, UWEX, USGS, USEPA
Continue and expand citizen-based monitoring efforts, with an emphasis on filling geographical data gaps	X	X	X	- -	UWEX, WDNR
Upgrade objectives for Hoods Creek, Tess Corners Creek, and Whitnall Park Creek to Fish and Aquatic Life	X	X	- -	- -	WDNR
Upgrade objective for Ives Grove Ditch to Limited Forage Fish	X	X	- -	- -	WDNR
Consider groundwater sustainability guidance from the regional water supply plan in evaluating the sustainability of proposed development and local land use planning	X	- -	X	- -	Counties, municipalities

[a]*Abbreviations for organizations are:*

MMSD = Milwaukee Metropolitan Sewerage District
RHD = City of Racine Health Department
USDA = U.S. Department of Agriculture
USEPA = U.S. Environmental Protection Agency
USGS = U.S. Geological Survey
UWEX = University of Wisconsin-Extension
WDNR = Wisconsin Department of Natural Resources

Source: SEWRPC.

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Chapter III

RECENT AND ONGOING WATERSHED MANAGEMENT PROGRAMS AND INITIATIVES

The Root River Watershed Restoration Plan is designed to serve as a practical guide over the period 2014 through 2018 for the management of both the water resources within the Root River watershed and the land surfaces that drain directly and indirectly to the waterbodies of the watershed. It refines and details the recommendations of the Southeastern Wisconsin Regional Planning Commission's (SEWRPC) regional water quality management plan update for the greater Milwaukee watersheds[1] (RWQMPU) to provide specific, targeted recommendations to address four focus issues: water quality, recreational access and use, habitat conditions, and flooding.

While this plan represents a refinement of the RWQMPU as it relates to the Root River watershed, it must be recognized that findings and recommendations of a number of other planning efforts and goals and objectives of actions undertaken by a number of recent, current, and ongoing natural resource management programs and efforts also bear upon the focus issues addressed by this plan. In order to promote effective and sound management of land and water resources, it is important that management activities be conducted in a coordinated manner that takes into account both the needs of the watershed and the objectives and goals of the various programs, initiatives, and efforts involved in natural resource management within the watershed. Achieving this coordination requires that the findings and recommendations of related plans and the goals and objectives of relevant management programs and efforts be taken into account in the design of this watershed restoration plan. Where goals and objectives are consistent with the RWQMPU and where they address the focus issues for this watershed restoration plan, it may be desirable to integrate them into this plan. Thus an important step to be undertaken is the inventory, collation, and review of the recommendations of relevant previously prepared reports and plans and of relevant recent, current, and ongoing management programs and efforts. This chapter presents a summary of plans and programs that were reviewed.

RELATIONSHIP TO OTHER PLANS

A number of plans address the natural resources of the Root River watershed. These plans include recommendations and programs which address the interconnectedness of the natural resources of the Root River watershed with those of the towns, villages, cities, and counties within the watershed and which focus on the importance of natural resources at the community level. Elements of these plans directly or indirectly address the focus issues that constitute the emphasis of this plan.

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[1]*SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007.*

The plans that were collated and reviewed for input into this current planning effort were relevant to actions undertaken or potentially to be undertaken by a variety of entities, including county and local governments, special purpose units of government, and community groups. They include plans that were drafted to specifically address the Root River watershed, as well as regional and subregional plans that include the Root River watershed as a portion of their areas of interest. Selected plans prepared at the local level were considered, including local comprehensive plans, land use plans, park and open space plans, lake and water quality management plans, and sewer service area plans for individual communities or special-purpose units of government. Because a goal of this planning effort is to develop specific, targeted recommendations for the Root River watershed, this review also included consideration of plans that have relatively narrow scopes. Examples of these include management plans pertaining to particular parks or wildlife areas. The identified, pertinent plan reports, which are described below, are listed in Table 7. They provide the basis for developing an integrated scheme for the restoration and sustainable management of the natural resources of the Root River watershed through the coordinated efforts of State, county, and local governments, special-purpose units of government, and community groups.

Land Use Plans

The socioeconomic factors that determine growth in a large urbanizing region, such as Southeastern Wisconsin, operate on an areawide basis, transcending both political and natural watershed boundaries. Because of this, the land use plans for a watershed and for portions of a watershed within such a region must be set within the framework of an areawide, or regional, land use plan. The regional land use plan for the year 2035 was adopted by the Commission in 2006. It is documented in SEWRPC Planning Report No. 48, *A Regional Land Use Plan for Southeastern Wisconsin: 2035*. This plan is a fifth-generation plan that updates and revises previous regional land use plans that had design years of 1990, 2000, 2010, and 2020. The regional land use plan provides a long-range guide to land use development and open space preservation in the Southeastern Wisconsin Region. The plan provides a basis for other elements of the regional plan, including the regional transportation plan, park and open space plan, water quality management plan, and water supply plan. The regional land use plan is also intended to serve as a framework for county and local comprehensive planning within the Region.

The regional land use plan seeks to encourage the centralization of urban development to the greatest degree practicable; to encourage new urban development to occur in locations and at densities consistent with the economical provision of public, centralized sanitary sewer, water supply, and mass transit facilities and services; and to encourage new urban development only in areas that are not subject to such special hazards such as flooding and that are covered by soils well suited to urban use.

The regional land use plan has been refined and detailed locally through the preparation and adoption of local land use and comprehensive plans. In 1999, the Wisconsin Legislature enacted legislation that greatly expanded the scope and significance of comprehensive plans within the State. The legislation, often referred to as the State's "Smart Growth" law, provides a new framework for the development, adoption, and implementation of comprehensive plans by regional planning commissions and by county, city, village, and town units of government. The law is set forth in Section 66.1001 of the *Wisconsin Statutes*. The law has been amended periodically, most recently in June 2010 through enactment of 2009 Wisconsin Act 372. The law does not require the adoption of county and local comprehensive plans. However, Section 66.1001(3) of the *Statutes* requires that county and local general zoning ordinances; county, city, and village shoreland and floodplain zoning ordinances; county and local subdivision ordinances, and local official mapping ordinances enacted or amended on or after January 1, 2010, be consistent with the comprehensive plan adopted by the unit of government enacting or amending an ordinance. With the exception of Milwaukee County, all of the counties and municipalities in the Root River watershed have either prepared and adopted independent comprehensive plans, adopted multi-jurisdictional county-local comprehensive plans as their comprehensive plans, or adopted local plans that were prepared as part of a county-local multi-jurisdictional process.[2]

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[2]*Because all of the municipalities in Milwaukee County are incorporated as either cities or villages, the County has not prepared or adopted a comprehensive plan.*

Table 7

LIST OF MANAGEMENT PLANS RELEVANT TO THE ROOT RIVER WATERSHED

Plan Type	Community	Plan and Date of Publication
Land Use	Regional	SEWRPC Planning Report No. 48, *A Regional Land Use Plan for Southeastern Wisconsin: 2035,* June 2006
	Kenosha County[a]	SEWRPC Community Assistance Planning Report No. 299, *A Multi-Jurisdictional Comprehensive Plan for Kenosha County: 2035,* April 2010
	Racine County[a]	SEWRPC Community Assistance Planning Report No. 301, *A Multi-Jurisdictional Comprehensive Plan for Racine County: 2035,* November 2009
	Waukesha County	Waukesha County Department of Parks and Land Use, Waukesha County University of Wisconsin-Extension, and Waukesha County Municipalities, *A Comprehensive Development Plan for Waukesha County,* February 2009
	City of Franklin	City of Franklin Department of City Development, *City of Franklin 2025 Comprehensive Master Plan,* September 2009
	City of Greenfield	Vandewalle & Associates, *City of Greenfield Comprehensive Plan 2008,* November 2008
	City of Milwaukee[b]	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: An Area Plan for the Southeast Side,* October 2008 City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Southwest Side—A Plan for the Area,* December 2009 City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Citywide Policy Plan,* March 2010
	City of Muskego	Muskego Planning Department, *City of Muskego 2020 Comprehensive Plan,* April 2009
	City of New Berlin	PDI/Graef, *New Berlin 2020 Comprehensive Plan,* December 2009
	City of Oak Creek	Vandewalle & Associates, *2020 Vision-A Comprehensive Plan for the City of Oak Creek,* April 2002
	City of Racine	Downtown Racine Corporation and the City of Racine, *Racine Downtown Plan,* May 2005 Root River Council and River Alliance of Wisconsin, *Back to the Root: An Urban River Revitalization Plan,* July 2008 SEWRPC Community Assistance Planning Report No. 305, *A Comprehensive Plan the City of Racine: 2035,* November 2009 Root River Council, City of Racine, and River Alliance of Wisconsin, *RootWorks-Revitalizing Racine's Urban River Corridor*, July 2, 2012
	City of West Allis	Graef, *City of West Allis Comprehensive Plan 2030,* February 2011
	Village of Caledonia	SEWRPC Community Assistance Planning Report No. 272, *A Land Use Plan Implementation Strategy for the Rural Area of the Town of Caledonia,* March 2004
	Village of Greendale	PDI/Graef, *Village of Greendale Comprehensive Plan: 2010-2035,* November 2009
	Village of Hales Corners	Village of Hales Corners, *Village of Hales Corners Comprehensive Plan,* December 2009
	Village of Mt. Pleasant	Town of Mt. Pleasant, *Year 2030 Master Plan for Land Use and Transportation,* January 2003
	Village of Union Grove and Town of Yorkville	SEWRPC Community Assistance Planning Report No. 277, *A Land Use Plan for the Village of Union Grove and the Town of Yorkville: 2020,* December 2003
	Town of Dover	SEWRPC Community Assistance Planning Report No. 243, *A Land Use Plan for the Town of Dover: 2020, Racine County, Wisconsin,* August 1999
	Town of Paris	Camiros, Ltd., *Town of Paris, Wisconsin Land Use Plan,* April 1995
	Town of Raymond	Ruekert & Mielke, Inc., *Land Use Plan, Town of Raymond, Wisconsin,* July 2005

Table 7 (continued)

Plan Type	Community	Plan and Date of Publication
Stormwater Drainage, Stormwater Management, and Flood Control	Kenosha County	SEWRPC Community Assistance Planning Report No. 278, 2nd Edition, *Kenosha County Hazard Mitigation Plan Update: 2011-2015,* June 2011
	Milwaukee County	Milwaukee County Emergency Management, *Milwaukee County Wisconsin Pre-Disaster Mitigation Plan,* June 2011
	Racine County	SEWRPC Community Assistance Planning Report No. 266, 2nd Edition*, Racine County Hazard Mitigation Plan Update: 2010-2015,* July 2010
	Waukesha County	EPTEC, Inc., *Hazard Mitigation Plan, Waukesha County, Wisconsin,* March 15, 2011
	MMSD	SEWRPC Community Assistance Planning Report No. 130, *A Stormwater Drainage and Flood Control Policy Plan for the Milwaukee Metropolitan Sewerage District,* March 1989 SEWRPC Community Assistance Planning Report No. 152, *A Stormwater Drainage and Flood Control System Plan of the Milwaukee Metropolitan Sewerage District,* December 1990 Camp Dresser & McKee, Inc., *Root River Phase I Watercourse System Management Plan,* August 2000
	City of Franklin	Bonestroo, Rosene, Anderlik, & Associates, Inc., *City of Franklin Stormwater Management Plan Update-2002,* 2002
	City of Greenfield	AECOM, *City of Greenfield Stormwater Utility Manual,* August 2009, updated January 2010
	City of Milwaukee	SEWRPC Community Assistance Planning Report No. 261, *Flood Mitigation Plan for the City of Milwaukee, Milwaukee County, Wisconsin,* April 2003 SEWRPC Community Assistance Planning Report No. 282, *City of Milwaukee All Hazards Mitigation Plan, Milwaukee County, Wisconsin,* May 2005
	City of New Berlin	Camp Dresser & McKee, Inc. *City of New Berlin Stormwater Management Master Plan,* June 2000 HNTB Corporation, *Addendum 1, City of New Berlin Stormwater Management Master Plan,* April 2010
	City of Oak Creek	SEWRPC Memorandum Report No. 35, *A Stormwater Management Plan for the Crayfish Creek Subwatershed, City of Oak Creek, Milwaukee County, Wisconsin,* June 1988 R.A. Smith & Associates, Inc. and Hey & Associates, Inc., *City of Oak Creek, WI Stormwater Management Master Plan,* December 2001 SEWRPC Community Assistance Planning Report No. 274, *Flood Mitigation Plan for the City of Oak Creek, Milwaukee County, Wisconsin,* April 2004
	City of Racine	Earth Tech, Inc., *City of Racine Flood Response Plan Spring Flood Control,* August 2003 City of Racine, *City of Racine Stormwater Utility Manual,* December 2004
	Village of Caledonia	Bonestroo, Rosene, Anderlik, & Associates, Inc., *Village of Caledonia Stormwater Management Plan,* October 2006
	Village of Greendale	R.A. Smith & Associates, Inc. and Hey & Associates, Inc., *Village of Greendale Stormwater Management Master Plan,* 2002
	Village of Hales Corners	SEWRPC Community Assistance Planning Report No. 121, *A Stormwater Management Plan for the Village of Hales Corners, Milwaukee County, Wisconsin,* March 1986
Sanitary Sewer	City of Franklin	SEWRPC Community Assistance Planning Report No. 176, 2nd Edition, *Sanitary Sewer Service Area for the City of Franklin, Milwaukee County, Wisconsin,* June 2011
	City of Muskego	SEWRPC Community Assistance Planning Report No. 64, 3rd Edition, *Sanitary Sewer Service Area of the City of Muskego, Waukesha County, Wisconsin,* December 1997, as amended

Table 7 (continued)

Plan Type	Community	Plan and Date of Publication
Sanitary Sewer (continued)	City of New Berlin	SEWRPC Community Assistance Planning Report No. 157, *Sanitary Sewer Service Area for the City of New Berlin, Waukesha County, Wisconsin,* November 1987, as amended
	City of Oak Creek	SEWRPC Community Assistance Planning Report No. 213, *Sanitary Sewer Service Area for the City of Oak Creek, Milwaukee County, Wisconsin,* July 1994, as amended
	City of Racine	SEWRPC Community Assistance Planning Report No. 147, 2nd Edition, *Sanitary Sewer Service Area for the City of Racine and Environs, Racine County, Wisconsin,* June 2003, as amended
	Village of Union Grove	SEWRPC Community Assistance Planning Report No. 180, *Sanitary Sewer Service Area for the Village of Union Grove and Environs, Racine County, Wisconsin (revised July 1991),* August 1990, as amended
Environmental	Regional	SEWRPC Planning Report No. 30, *A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000,* September 1978 SEWRPC Memorandum Report No. 93, *A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report,* March 1995 SEWRPC Planning Report No. 42, *A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin,* September 1997 SEWRPC Planning Report No. 50, *A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds,* December 2007[c] SEWRPC, *Amendment to the Natural Areas and Critical Species Habitat Protection and Management Plan for the Southeastern Wisconsin Region,* December 2010
	Watershed	SEWRPC Planning Report No. 9, *A Comprehensive Plan for the Root River Watershed,* July 1966 SEWRPC Community Assistance Planning Report No. 37, *A Nonpoint Source Water Pollution Control Plan for the Root River Watershed,* March 1980 Wisconsin Department of Natural Resources, *State of the Root-Pike Basin,* WDNR PUBL WT-700-2002, May 2002
	Kenosha County	SEWRPC Community Assistance Planning Report No. 129, *A Solid Waste Management Plan for Kenosha County, Wisconsin,* May 1989 SEWRPC Community Assistance Planning Report No. 255, 2nd Edition, *A Land and Water Resource Management Plan for Kenosha County: 2008-2012,* October 2007
	Milwaukee County	SEWRPC Community Assistance Planning Report No. 120, *A Solid Waste Management Plan for Milwaukee County, Wisconsin,* July 1987 SEWRPC Community Assistance Planning Report No. 312, *A Land and Water Resource Management Plan for Milwaukee County: 2012-2021,* August 2011
	Racine County	SEWRPC Community Assistance Planning Report No. 160, *Racine County Agricultural Soil Erosion Control Plan,* July 1988 Racine County Land Conservation Division, *A Land and Water Resource Management Plan for Racine County: 2013-2022,* July 2012
	Waukesha County	SEWRPC Community Assistance Planning Report No. 156, *Waukesha County Animal Waste Management Plan,* August 1987 SEWRPC Community Assistance Planning Report No. 159, *Waukesha County Agricultural Soil Erosion Control Plan,* June 1988 SEWRPC Memorandum Report No. 145, *Lake and Stream Resources Classification Project for Waukesha County, Wisconsin: 2000,* December 2005 Waukesha County Department of Parks and Land Resources, *Waukesha County Land and Water Resource Management Plan: 2006-2010,* January 2006

Table 7 (continued)

Plan Type	Community	Plan and Date of Publication
Park and Open Space	Regional	SEWRPC Planning Report No. 27, *A Regional Park and Open Space Plan for Southeastern Wisconsin: 2000,* November 1977
	Kenosha County	SEWRPC Community Assistance Planning Report No. 131, 2nd Edition, *A Park and Open Space Plan for Kenosha County,* April 2012
	Milwaukee County	SEWRPC Community Assistance Planning Report No. 132, *A Park and Open Space Plan for Milwaukee County,* November 1991 Milwaukee County Department of Parks, Recreation and Culture, *Grobschmidt Park Restoration and Management Plan,* December 2011
	Racine County	SEWRPC Community Assistance Planning Report No. 134, 2nd Edition, *A Park and Open Space Plan for Racine County,* July 2001
	Waukesha County	SEWRPC Community Assistance Planning Report No. 137, *A Park and Open Space Plan for Waukesha County,* December 1989
	MMSD	The Conservation Fund, Applied Ecological Services, Resource Data, Heart Lake Conservation Associates, and Velasco and Associates, *Milwaukee Metropolitan Sewerage District Conservation Plan,* October 2001 SEWRPC Memorandum Report No. 152, *A Greenway Connection Plan for the Milwaukee Metropolitan Sewerage District,* December 2002
	City of Franklin	SEWRPC Memorandum Report No. 70, *A Wildlife Habitat Management Plan for the Franklin Lions Legend Park Study Area,* August 1991
	City of Muskego	SEWRPC Community Assistance Planning Report No. 202, *A Park and Open Space Plan for the City of Muskego, Waukesha County, Wisconsin,* January 1992
	City of New Berlin	SEWRPC Community Assistance Planning Report No. 66, 3rd Edition, *A Park and Open Space Plan for the City of New Berlin, Waukesha County, Wisconsin,* May 2003
	City of Racine	SEWRPC Community Assistance Planning Report No. 270, 2nd Edition, *A Park and Open Space Plan for the City of Racine: 2035, Racine County, Wisconsin,* December 2011
	Village of Caledonia	SEWRPC Community Assistance Planning Report No. 146, *A Wildlife Habitat Management Plan for the Nicholson Wildlife Center, Town of Caledonia, Racine County, Wisconsin,* May 1986 SEWRPC Community Assistance Planning Report No. 179, 2nd Edition, *A Park and Open Space Plan for the Town of Caledonia, Racine County, Wisconsin,* April 2000
	Village of Mount Pleasant	SEWRPC Community Assistance Planning Report No. 199, *A Park and Open Space Plan for the Town of Mt. Pleasant, Racine County, Wisconsin,* April 2003
	Village of Sturtevant	Crispell-Snyder, Inc., *Comprehensive Outdoor Recreation Plan: Village of Sturtevant, Racine County, Wisconsin,* March 2003 Bicycle Federation of Wisconsin, *Village of Sturtevant Bicycle Master Plan,* 2007
	Village of Union Grove	SEWRPC Community Assistance Planning Report No. 271, *A Park and Open Space Plan for the Village of Union Grove, Racine County, Wisconsin,* July 2003
	Town of Norway	Michael V. Raap and Collinane Design, *An Outdoor Recreation and Open Space Plan for the Township of Norway-2010,* January 1990
	Town of Raymond	Michael V. Raap , *An Outdoor Recreation and Open Space Plan for the Township of Raymond,* January 1979
	River Bend Nature Center	Cedarburg Science, LLC., *River Bend Nature Center Stewardship Plan,* April 2010

Table 7 (continued)

Plan Type	Community	Plan and Date of Publication
Lake Planning	Milwaukee County Parks	Milwaukee County Environmental Services, *Milwaukee County Park and Lagoon Management Plan,* June 2005
	Kelly Lakes	SEWRPC Memorandum Report No. 135, 2nd Edition, *A Lake Protection Plan for the Kelly Lakes, Milwaukee and Waukesha Counties, Wisconsin,* April 2007

[a]*With the exception of the City of Racine, each of the Root River watershed municipalities within Kenosha and Racine Counties is covered under the county multi-jurisdictional comprehensive plan.*

[b]*The City of Milwaukee's comprehensive plan consists of a citywide policy plan and 13 area plans which address specific neighborhoods or districts of the City. Only those plans pertaining to areas which include portions of the Root River watershed are included in this inventory.*

[c]*See also SEWRPC Technical Report No. 39, Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, November 2007.*

Source: SEWRPC.

The City of Racine, in cooperation with several partners including the Downtown Racine Council, the River Alliance of Wisconsin, and the Root River Council, has developed a series of plans addressing redevelopment of the City's downtown area.[3] The major emphasis of this series of plans is downtown redevelopment; however, they each contain recommendations that address issues relating to three of the focus areas of this watershed restoration plan: water quality, recreational access and use, and habitat conditions.

Stormwater Drainage, Stormwater Management, and Flood Mitigation Plans

A number of counties, municipalities, and special-purpose units of government in the Root River watershed have developed plans to address stormwater drainage, stormwater management, and or flood control issues within their jurisdictions. The distinctions between stormwater drainage, stormwater management, and flood control are not always clear. For the purposes of this report, flood control is defined as the prevention of damage from the overflow of natural streams and watercourses. Stormwater drainage is defined as the control of excess stormwater on the land surface before such water has entered stream channels. The term stormwater management encompasses stormwater drainage, nonpoint source pollution control measures, and measures to mitigate the impacts of increased stormwater runoff on the receiving riparian and aquatic environment in stream channels.

The comprehensive watershed plan for the Root River watershed includes recommendations for flood control.[4]

The Milwaukee Metropolitan Sewerage District's (MMSD) responsibilities for floodplain management planning are carried out within explicit policy guidelines set forth by the governing body of the District, as well as within the context of a watercourse management plan consistent with those policies. The MMSD program consists of two parts: a policy plan[5] and watercourse management plans for the watersheds which contain streams for which

[3]*Downtown Racine Corporation and the City of Racine,* Racine Downtown Plan, *2005; Root River Council and River Alliance of Wisconsin,* Back to the Root: An Urban River Revitalization Plan, *July 2008; and Root River Council, City of Racine, and River Alliance of Wisconsin,* RootWorks-Revitalizing Racine's Urban River Corridor, *July 2, 2012.*

[4]*SEWRPC Planning Report No. 9,* A Comprehensive Plan for the Root River Watershed, *July 1966.*

[5]*SEWRPC Community Assistance Planning Report No. 130,* A Stormwater Drainage and Flood Control Policy Plan for the Milwaukee Metropolitan Sewerage District, *March 1986.*

the District has jurisdiction.[6] The policy plan identifies the streams and watercourses for which the MMSD has assumed jurisdiction for the resolution of drainage and flood control problems, makes recommendations regarding the types of improvements for which the MMSD should assume responsibility, and makes recommendations regarding how costs are to be shared. The watercourse system plan identifies the types, general locations, and horizontal and configurations of needed flood mitigation and stream rehabilitation facilities within the District's jurisdiction. The following streams and Rivers within the watershed were studied under the MMSD watercourse planning program, and flood mitigation measures were identified for all but Tess Corners Creek and 104th Street Branch, neither of which has identified hazards to structures during floods with annual probabilities of occurrence of 1 percent or more:

- Upper North Branch of the Root River and Hale Creek,
- Lower North Branch of the Root River,
- East Branch of the Root River,
- Whitnall Park Creek, including the North and Northwest Branches of Whitnall Park Creek,
- Crayfish Creek, including the Caledonia Branch of Crayfish Creek,
- Tess Corners Creek, and
- An unnamed tributary to the Root River identified as the 104th Street Branch.

The MMSD watercourse system planning program is an update to an initial stormwater drainage and flood control system plan prepared for MMSD by SEWRPC.[7]

The MMSD also enforces its Chapter 13, "Surface Water and Storm Water," rule that provides stormwater management criteria that must be met for new development and redevelopment. The rule is designed to control flood flows and ensure the viability of MMSD flood mitigation projects.

Several local stormwater management plans cover portions of the Root River watershed. These plans contain specific recommendations regarding nonpoint source water pollution control and the collection, conveyance, and storage of stormwater and. They are listed in Table 7. Finally, all four counties in the Root River watershed have developed multi-jurisdictional hazard mitigation plans. These plans include recommendations for mitigating the impacts of flooding. With one exception, all of the municipalities in the watershed are covered under their respective county's plan. The City of Milwaukee has developed and adopted its own hazard mitigation plan. These plans are also listed in Table 7.

Sanitary Sewer Service Area Plans

Sanitary sewer service area plans identify the boundary of the area to which sanitary sewer service may be extended. The plans also identify the extent of environmentally sensitive lands within each sewer service area, wherein sanitary sewer extensions will be approved only on a special exception basis. These sensitive lands include all primary environmental corridors and those portions of secondary environmental corridors and isolated natural resource areas comprised of wetlands, 1-percent-annual-probability floodplain, shoreland areas, and

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[6] *Camp Dresser & McKee, Inc.,* Root River Phase I Watercourse System Management Plan, *August 2000.*

[7] *SEWRPC Community Assistance Planning Report No. 152,* A Stormwater Drainage and Flood Control System Plan of the Milwaukee Metropolitan Sewerage District, *December 1990.*

areas with slope of 12 percent or greater. Within these areas, sewered development is confined to limited recreational and institutional uses and rural-density (one dwelling unit per five acres) residential development in upland areas. Currently, much of the watershed is contained within planned sewer service areas. Planned sewer service areas include the northern, southeastern, and southwestern portions of the watershed. The planned sewer service areas are described in Chapter IV of this report.

Environmental Management Plans

Regional Water Quality Management Plan

In 1979, SEWRPC completed and adopted an areawide water quality management plan for the seven-county Southeastern Wisconsin Region as a guide to achieving clean and healthy surface waters within the Region.[8] The plan was designed, in part, to meet the mandate of the Federal Clean Water Act that the waters of the United States be made "fishable and swimmable" to the extent practicable. With respect to the Root River watershed, a major issue that this plan addressed was the fact that water quality in the Root River watershed often failed to meet the adopted or recommended water quality criteria for dissolved oxygen, fecal coliform bacteria, ammonia, and phosphorus. In general, water quality in the watershed was described as being poor to fair. For each of the 11 subwatersheds in the watershed, the plan identified the pollutant load reductions required in order for water quality to meet the applicable water quality criteria. Subsequently, SEWRPC completed a report documenting the updated content and implementation of the regional water quality management plan.[9] This status report also documents the extent of progress which had been made toward meeting the water use objectives and supporting water quality standards set forth in the regional plan.

The 2007 RWQMPU covered six watersheds, including the Root River watershed. The RWQMPU addressed three major elements of the regional water quality management plan: the land use element, the point source pollution abatement element, and the nonpoint source pollution abatement element. In addition, the updated plan included consideration of several issues that were not considered in the initial plan, including instream and riparian habitat conditions and groundwater management. The RWQMPU planning effort was conducted in conjunction and coordination with the development of the MMSD 2020 facilities plan. The recommendations of the RWQMPU pertaining to the Root River watershed and their implementation status are reviewed in detail in Chapter II of this report.

Other Water Resources Plans that Address the Root River Watershed

In addition to the updated regional water quality management plan, other water resources plans address the Root River watershed at the watershed scale.

The Regional Planning Commission developed a comprehensive watershed plan for the Root River watershed in 1966 to assist in abating the water-related problems of the watershed through the staged development of multipurpose water-related facilities and related resource conservation and management programs.[10] This plan was developed with the recognition that problems such as stormwater management, flood control, and surface water quality can only be properly addressed within an areawide planning framework involving the cooperative efforts of the local governments which are contained wholly or partly within the watershed. This plan included the

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[8]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, *Volume One,* Inventory Findings, *September 1978; Volume Two,* Alternative Plans, *February 1979; and Volume Three*, Recommended Plan, *June 1979.*

[9]*SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995.*

[10]*SEWRPC Planning Report No. 9,* op. cit.

first delineation of floodplain boundaries along streams in the watershed. Recommendations were developed for land use, park and open space needs, and water quality management. While this plan is dated, some of its recommendations remain relevant.

A priority watershed plan was prepared for the Root River watershed under the Wisconsin Nonpoint Source Water Pollution Abatement Program.[11] This plan sought to reduce the amount of nonpoint source pollution contributed from both rural and urban sources. Major recommendations of this plan included:

- Reduction of pollutant loads from urban nonpoint sources by 50 percent through the application of a number of practices, including septic system management programs; roadside, streambank, recreation and construction site erosion control; street sweeping; leaf collection; industrial and commercial site housekeeping; and public education,

- Reduction of pollutant loads from rural sources of 50 percent in the Root River Canal subwatershed and 25 percent from the rest of the Root River watershed through installation of agricultural best management practices (BMPs), and

- Installation of BMPs at specified sites to produce a 37 percent reduction in existing soil loss from the watershed as a whole.

The Wisconsin Department of Natural Resources published two reports evaluating implementation of this plan.[12] The assessment of water quality that was part of this evaluation was based upon field observations of habitat and stream quality, changes in the abundance and distribution of fish species derived from past fisheries assessments, compilation and review of data from WDNR records and from records provided by county land conservation staff on the implementation of BMPs, and sampling of aquatic macroinvertebrates at five sites along the mainstem of the Root River and eight sites along tributary streams. Sampling of macroinvertebrates was conducted twice—once after the beginning of plan implementation and again at the end of the implementation period. It is important to note that sample sites for the macroinvertebrate surveys that the WDNR conducted in 2011 included the sites sampled as part of this assessment. While evaluation of trends in water quality was hampered by the limited amount of data collected in the watershed prior to the implementation phase of the priority watershed plan, the evaluation of the plan made several findings. These included the findings that:

- The Root River continued to experience detrimental effects from rural and urban nonpoint source pollution,

- Biological data suggested both that there were water quality impairments within the watershed and that water quality was continuing to decline, and

- While improvements had occurred in land management within the watershed, the rate of participation in the installation of BMPs by landowners was much lower than projected.

The evaluation concluded that the levels of participation by landowners in implementing BMPs and increasing land development within the watershed will probably preclude watershedwide improvements in water quality.

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[11] *SEWRPC Community Assistance Planning Report No. 37,* A Nonpoint Source Water Pollution Control Plan for the Root River Watershed, *March 1980.*

[12] *M. Miller, J. Ball, and R. Kroner,* An Evaluation of Water Quality in the Root River Priority Watershed, *Wisconsin Department of Natural Resources Publication WR-298-92, January 1992; S.A. Rice,* Root River Priority Watershed Project Final Report, *Department of Natural Resources Publication WR-311-92, 1992.*

As the State agency tasked with water resources management, the WDNR prepares basin-level plans that guide the application of State resources to the major drainage basins of the State. The Root River watershed is a part of the Root-Pike basin, which also contains the Oak Creek, the Pike River, and Pike Creek watersheds and the adjacent direct drainage area to Lake Michigan. The plan for the Root-Pike basin provided an overview of the land and water resource quality and identified challenges facing these resources in these watersheds and recommended actions to be taken by the WDNR and its partners.[13] It also summarized the codified and potentially achievable water use objectives for streams and lakes of the watersheds. The monitoring and management recommendations in this plan pertaining to the Root River watershed include:

- Encouraging the implementation of urban nonpoint source BMPs;
- Encouraging implementation of agricultural nonpoint source BMPs, including buffer strip development;
- Conducting baseline surveys on streams within the watershed;
- Assessing sediment delivery, sediment transport, and streambank erosion within the watershed;
- Evaluating, assessing, and improving aquatic and riparian habitat in cooperation with the MMSD and their ongoing flood management improvement projects;
- Conducting aquatic habitat and sediment assessments above and below Horlick Dam;
- Evaluating Horlick Dam for removal;
- Evaluating Hoods Creek Dam for removal;
- Evaluating and implementing aquatic habitat restoration and water quality improvement practices where practicable;
- Evaluating and implementing wetland restoration projects where practicable; and
- Assessing impacts and improvements to water quality within communities subject to NR 216, “Storm Water Discharge Permits,” municipal stormwater permitting requirements.

County Land and Water Resource Management Plans

The 1997 revisions to Chapter 92, “Soil and Water Conservation and Animal Waste Management,” of the *Wisconsin Statutes* require each county to develop a multi-year land and water resource management plan (LWRM) to conserve long-term soil productivity, protect the quality of related natural resources, enhance water quality, and focus on severe soil erosion problems. These plans address both rural and urban nonpoint source pollution problems. Chapter ATCP 50, “Soil and Water Resource Management Program,” of the *Wisconsin Administrative Code* contains details of the planning requirements. These plans serve as work plans for the counties’ land conservation departments.

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[13] *Wisconsin Department of Natural Resources*, The State of the Root-Pike Basin, *WDNR PUBL WT-700-2002, May 2002.*

The Kenosha County LWRM Plan for 2008-2012 was approved by the Kenosha County Board in August 2007 and the Wisconsin Land and Water Conservation Board in October 2007.[14] This is a second-generation plan, updating the initial LWRM plan that was adopted in 2000. The LWRM plan is intended to guide the activities of the County Land and Water Conservation Department in its efforts to protect and improve land and water resources. The plan's goals include increasing overall education and awareness of natural resources, control of agricultural and urban nonpoint source pollution, more effectively controlling the infestation and spread of nonnative and invasive animal and plant species, protecting and preserving land and water resources, and increasing cooperation with local, State, and Federal partners.

The Milwaukee County LWRM Plan for 2012-2021 was approved by the Milwaukee County Board in June 2011 and the Wisconsin Land and Water Conservation Board in August 2011.[15] This is a third-generation plan, updating the initial LWRM plan that was adopted in 2001 and an updated plan that was adopted in 2006. The LWRM plan is intended to guide the activities of the County Environmental Services Division in its efforts to protect and improve land and water resources. The plans goals include improving water quality through the reduction of sediment and nutrient delivery to surface waters; protecting, maintaining, and restoring land and water resources; enhancing Lake Michigan bluff protection initiatives; maintaining the existing information network and land information web portal; and limiting the introduction and reducing the spread of invasive species.

The Racine County LWRM Plan for 2008-2012 was approved by the Racine County Board in August 2007 and the Wisconsin Land and Water Conservation Board in October 2007.[16] This is a second-generation plan, updating the initial LWRM plan that was adopted in 2000. The LWRM plan is intended to guide the activities of the County Land Conservation Division in its efforts to protect and improve land and water resources. The plan's goals include increasing overall education and awareness of natural resources, control of agricultural and urban nonpoint source pollution, more effectively controlling the infestation and spread of nonnative and invasive animal and plant species, protecting and preserving land and water resources, and increasing cooperation with local, State, and Federal partners.

The Waukesha County LWRM Plan 2012 update was approved by the Waukesha County Board in July 2012 and the Wisconsin Land and Water Conservation Board in June 2012. This is a third-generation plan, updating the initial LWRM plan that was adopted in 1999 and an updated plan that was adopted in 2006. The LWRM plan outlines the conservation priorities for the Waukesha County Parks and Land Use, Land Resources Division for the next 10 years. Plan goals include controlling urban runoff pollution and flooding, protecting groundwater quantity and quality, controlling agricultural runoff pollution, educating the public on conservation issues, preserving targeted farmland and natural areas, supporting water quality monitoring, and reclaiming active nonmetallic mining sites.

Regional Natural Areas and Critical Species Habitat Protection and Management Plan

The regional natural areas and critical species habitat protection and management plan for the Southeastern Wisconsin was undertaken to identify the most significant remaining natural areas, including remnants of the pre-European-settlement landscape and other areas vital to the maintenance of endangered, threatened, and rare plant

[14]*SEWRPC Community Assistance Planning Report No. 255, 2nd Edition,* A Land and Water Resource Management Plan for Kenosha County: 2008-2012, *October 2007.*

[15]*SEWRPC Community Assistance Planning Report No. 312*, A Land and Water Resource Management Plan for Milwaukee County: 2012-2021, *August 2011.*

[16]*SEWRPC Community Assistance Planning Report No. 259, 2nd Edition,* A Land and Water Resource Management Plan for Racine County: 2008-2012, *October 2007.*

and animal species in the Region.[17] Under the plan, natural areas are defined as tracts of land or water so little modified by human activity, or which have sufficiently recovered from the effects of such activity, that they contain intact native plant and animal communities believed to be representative of the pre-European-settlement landscape. Critical species habitats are defined as additional tracts of land or water that support endangered, threatened, or rare plant or animal species. The plan recommends that each of the identified natural areas and critical species habitat sites be protected and preserved to the maximum extent practicable as urban and rural development in the Region proceeds. The plan provides descriptive information for each natural area and critical species habitat site, along with the recommended means for preservation. The plan was updated and revised in 2010 in a major plan amendment.[18] This amendment incorporated changes in the regional landscape, new findings concerning natural areas and critical species habitat sites, and updated recommendations for the protection of the identified natural areas and critical species habitat sites. The protection status of natural areas and critical species habitat sites in the Root River watershed is shown on Map 6 and in Table 5 in Chapter II of this report.

Park and Open Space Plans

The regional park and open space plan consists of two basic elements: an open space preservation element and an outdoor recreation element.[19] The open space preservation element consists of recommendations for the preservation of primary environmental corridors within the Region. The outdoor recreation element consists of a resource-oriented outdoor recreation plan providing recommendations for the number and location of large parks, recreation corridors to accommodate trail-oriented activities, and water-access facilities and an urban outdoor recreation plan providing recommendations for the number and distribution of local parks and outdoor recreational facilities required in urban areas of the Region.

County-level park and open space plans have been prepared for all counties in the Region. These plans refine, detail, and extend the regional park and open space plan. Upon adoption by the Regional Planning Commission, the county plans serve as amendments to the regional park and open space plan. The county-level plans applicable to the Root River watershed are listed in Table 7.

Major recommendations related to the Root River watershed are set forth in the plans for Milwaukee and Racine Counties. These include:

- Extension of the recreational corridor along the mainstem of the Root River in both Milwaukee and Racine Counties,
- Public acquisitions of land to link sections of parkway along the River, mostly in the City of Franklin, and
- Additional public interest ownership along the mainstem of the River in Racine County.

Park and open space plans have also been prepared, and in some cases updated, for several municipalities within the watershed. This work is conducted on an as-requested basis and in part is intended to help local governments

[17]*SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997.*

[18]*SEWRPC,* Amendment to the Natural Areas and Critical Species Habitat Protection and Management Plan for the Southeastern Wisconsin Region, *December 2010.*

[19]*SEWRPC Planning Report No. 27,* A Regional Park and Open Space Plan for Southeastern Wisconsin: 2000, *November 1977.*

meet Federal and State requirements for securing grants to help preserve park and open space land and develop recreational facilities. Local park and open space plans for communities in the Root River watershed are listed in Table 7.

Some jurisdictions have also developed management plans for specific parks or natural areas. These plans provide specific recommendations for management and restoration of sites. At least two of these plans have been developed in the Root River watershed: one for Grobschmidt Park in the Milwaukee County Parks System[20] and one for Nicholson Wildlife Center in the Village of Caledonia.[21]

Planning relative to open space and greenway connection has also been conducted by MMSD. The District completed and adopted a conservation plan that identifies land parcels which are recommended to be protected for multiple purposes, including flood reduction potential and stormwater management benefits, as well as wildlife habitat, water quality, and recreational benefits.[22] The MMSD conservation plan identified 165 sites, including 42 high-priority sites, for protection through public acquisition or conservation easements, throughout the Menomonee River, Root River, and Oak Creek watersheds within the District. The District later adopted a greenway connection plan that identified potential greenway corridors connecting, and typically downstream of, the isolated parcels identified in the MMSD conservation plan.[23] This plan also synthesized the results of other related open space planning efforts undertaken in the MMSD area to date, resulting in a comprehensive District-wide greenway connection plan having flood mitigation benefits as well as a wide range of other environmental benefits. Several of the linking parcels identified are along either the mainstem of the Root River or tributaries to the Root River.

Lake Management Plans

Lake management plans address a variety of issues related to the management of lakes and ponds. These plans can be developed to target specific issues, correct or manage current problems, or address the full range of management issues. Two plans address the management of lakes and ponds in the Root River watershed.

The Milwaukee County pond and lagoon management plan is a plan for the 68 ponds, lakes, and lagoons owned and maintained by Milwaukee County.[24] This plan addresses several ponds in the watershed including Mud Lake, Scout Lake, and several ponds in Whitnall Park, the Root River Parkway, and Oakwood Golf Course. The plan contains assessments of erosion and aquatic plant problems and water quality data for some of the ponds. In addition, it inventories chemicals used for aquatic plant control in some of the ponds over the period 2002-2004. General recommendations are made for all ponds. These recommendations include provision of riparian buffers, stabilization of shorelines, and water quality monitoring.

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[20]*Milwaukee County Department of Parks, Recreation, and Culture,* Grobschmidt Park Restoration and Management Plan, *December 21, 2011.*

[21]*SEWRPC Community Assistance Planning Report No. 146,* A Wildlife Habitat Management Plan for the Nicholson Wildlife Area, Town of Caledonia, Racine County, Wisconsin, *May 1986.*

[22]*The Conservation Fund; Applied Ecological Services, Inc.; Heart Lake Conservation Associates; Velasco and Associates; and K. Singh and Associates,* Conservation Plan, Technical Report Submitted to Milwaukee Metropolitan Sewerage District, *October 31, 2001.*

[23]*SEWRPC Memorandum Report No. 152,* A Greenway Connection Plan for the Milwaukee Metropolitan Sewerage District, *December 2002.*

[24]*Milwaukee County Environmental Services,* Milwaukee County Pond and Lagoon Management Plan, *June 2005.*

The SEWRPC Kelly Lakes protection plan provides recommendations for lake and watershed management measures that contribute to the protection of water quality and the use of Upper and Lower Kelly Lakes.[25] Specific recommendations in this plan include land management and nonpoint source control measures within the watershed, in-lake aquatic plant management measures, and fisheries management measures. The plan also recommended a wetland restoration project that has since been implemented along the Upper Kelly Lake tributary.

RECENT, CURRENT, AND ONGOING PROGRAMS AND INITIATIVES ACTIVE AND/OR AVAILABLE IN THE ROOT RIVER WATERSHED

Conservation Programs

There are several Federal, State, Local, and private conservation programs that help reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. These programs can provide both funding and technical assistance for local activities and initiatives. Public benefits of these programs include enhanced natural resources that help sustain agricultural productivity and environmental quality while supporting continued economic development, recreation, and scenic beauty.

Federal Programs

Conservation Reserve Program

The Conservation Reserve Program (CRP) is a voluntary program for agricultural landowners that provides annual rental payments and cost-share assistance to establish long-term, resource-conserving covers on eligible farmland. The CRP's goals are to reduce soil erosion, protect the nation's ability to produce food and fiber, reduce sedimentation in streams and lakes, improve water quality, establish wildlife habitat, and enhance forest and wetland resources. The program encourages farmers to convert highly erodible cropland or other environmentally sensitive areas to vegetative cover, such as a prairie-compatible, noninvasive forage mix; wildlife plantings; trees; filter strips; or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract based on the agriculture rental value of the land, and up to 50 percent Federal cost sharing is provided to establish vegetative cover. These contracts typically have a term of 10 to 15 years. The program is administered by the Farm Services Agency (FSA), an agency of the U.S. Department of Agriculture (USDA). Technical assistance and support of this program is provided by the USDA's Natural Resource Conservation Service (NRCS) and county conservation departments. NRCS works with landowners to develop their application, and to plan, design, and install the conservation practices on the land. With the passage of the 2008 Federal Farm Bill, municipalities are no longer eligible to receive CRP payments. The municipally owned CRP land enrolled prior to the 2008 Farm Bill, such as farmland owned by Milwaukee County, will continue to receive an annual rental rate until the CRP contracts for these parcels expire.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program that supports agriculture and environmental quality as compatible goals. Through EQIP, farmers may receive financial and technical help with structural and management conservation practices on agricultural land. EQIP offers contracts through the NRCS for conservation practice implementation for periods ranging from one to 10 years, and it pays up to 75 percent of the costs of eligible conservation practices. Incentive payments and cost-share payments may also be made to encourage farmers to adopt land management practices such as nutrient management, manure management, integrated pest management, or wildlife habitat management.

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[25]*SEWRPC Memorandum Report No. 135, 2nd Edition,* A Lake Protection Plan for Kelly Lakes, Milwaukee and Waukesha Counties, *April 2007.*

Wildlife Habitat Incentives Program
The Wildlife Habitat Incentive Program (WHIP) is a voluntary program for developing or improving high-quality habitat that supports fish and wildlife populations of National, State, Tribal, and local significance. Through WHIP, the NRCS provides technical and financial assistance to private and Tribal landowners for the development of upland, wetland, aquatic, and other types of wildlife habitat. Land eligible for WHIP includes private agricultural land including cropland, grassland, rangeland, pasture, and other land determined by NRCS to be suitable for fish and wildlife habitat development, nonindustrial private forest land including rural land that has existing tree cover or is suitable for growing trees, and Tribal land.

A WHIP plan of operations, which is required for the area covered in the application, becomes the basis for developing the WHIP cost-share agreement. Standard cost-share agreements between NRCS and the participant are for a minimum of one year after completion of the last conservation practice; they can extend up to 10 years. NRCS will reimburse up to 75 percent of the cost to install conservation practices for permanent priority fish and wildlife habitat. Participants are expected to maintain the cost-shared practices for their anticipated life spans. Up to 25 percent of WHIP funds will be available for long-term cost share agreements with periods of 15 years or longer to protect and restore essential plant and animal habitat. NRCS can pay up to 90 percent of the cost to install conservation practices under these long-term agreements.

NRCS established the following national priorities for WHIP for Federal fiscal year 2012:

- Promoting the restoration of declining or important native fish and wildlife habitats;

- Protecting, restoring, developing, or enhancing 1) fish and wildlife habitat to benefit at-risk species, 2) declining or important habitats for aquatic wildlife species; and 3) important migration and other movement corridors for wildlife; and

- Reducing the impacts of invasive species on fish and wildlife habitats.

Conservation Stewardship Program
The Conservation Stewardship Program (CSP) is a voluntary program that encourages agricultural and forestry producers to address natural resource concerns by undertaking additional conservation activities and by improving and maintaining existing conservation systems. CSP provides financial and technical assistance to help producers conserve and enhance soil, water, air, and related natural resources on their land. Eligible lands include cropland, grassland, improved pastureland, range land, nonindustrial private forest land, and agricultural land under the jurisdiction of an Indian tribe. CSP pays participants for conservation performance, with higher performance resulting in higher payment levels. Nationally, CSP addresses natural resource concerns related to soil quality, soil erosion, water quality, water quantity, air quality, plant resources, animal resources, and energy. In each state, the program focuses on three to five of these priority concerns. For agricultural land in Wisconsin, the Federal fiscal year 2012 priority resource concerns are soil erosion, water quality, plants, and energy. The program is administered by the NRCS and requires participating producers to enter into renewable five-year contracts.

Wetlands Reserve Program
The Wetlands Reserve Program (WRP) is a voluntary program through the NRCS that offers landowners the opportunity to protect, restore, and enhance wetlands on their property. The program's goal is to achieve the greatest wetland functions and values with optimum wildlife habitat on those lands that are enrolled. It provides landowners with technical assistance and financial incentives and assistance to restore and enhance wetlands in exchange for retiring marginal agricultural land. Lands eligible for WRP are wetlands farmed under natural conditions; farmed wetlands; prior converted cropland; farmed wetland pasture; certain lands that have the potential to become wetlands as a result of flooding; rangeland, pasture, or forest production lands where the hydrology has been significantly degraded and can be restored; riparian areas that link protected wetlands; lands adjacent to protected wetlands that contribute significantly to wetland functions and values; and wetlands previously restored under local, State, or Federal programs that need long-term protection.

The program offers landowners three options: permanent conservation easements, 30-year conservation easements, and restoration cost-share agreements of a minimum 10-year duration. For permanent easements, the WRP provides an easement payment of up to the fair market value of the land concerned, and pays 100 percent of the costs of restoration. For 30-year easements, the WRP pays an easement payment of 75 percent of what would be paid for a permanent easement. In addition, the program pays 75 percent of restoration costs. For restoration cost-share agreements, the WRP pays up to 75 percent of restoration costs. Under the 2008 Federal Farm Bill, municipalities are no longer eligible for payments under WRP, but private landowners remain eligible. Under the easement options the USDA will pay all costs associated with recording the easement in the local land records office, including recording fees, charges for abstracts, survey and appraisal fees, and title insurance. Under the voluntary easement the landowner retains the rights to control of access, title and right to convey title, quiet enjoyment, undeveloped recreational uses, subsurface resources, and water rights.

Grasslands Reserve Program

The Grassland Reserve Program (GRP) is a voluntary program through the NRCS for landowners and operators to protect grazing uses and related conservation values by conserving grassland, including rangeland, pastureland, shrubland, and certain other lands. Participants voluntarily limit future development and cropping uses of the land while retaining the right to conduct common grazing practices and operations related to the production of forage and seed. The program offers eligible landowners and operators two options: permanent easements and rental contracts of 10-year, 15-year, or 20-year duration. For permanent easements, the GRP offers compensation up to the fair market value of the land concerned less the grazing value of the land. For rental contracts, the GRP provides annual payments of 75 percent of the grazing value established by the Federal Farm Service Agency, up to $50,000 to a single person or legal entity. Certain grassland easements or rental contracts may also be eligible for cost-share assistance of up to 50 percent of the cost to reestablish grassland functions and values where land has been degraded or converted to other uses. Payments of this cost-share assistance may not exceed $50,000 per year to a single person or legal entity. A grazing management plan is required for participants.

Resource Conservation and Development

The Resource Conservation and Development (RC&D) program was established by the Federal Agricultural Act of 1962. This act directs the USDA to help units of government conserve and properly utilize all resources in solving local issues. Wisconsin has seven RC&Ds, covering all Wisconsin counties. All four counties in the Root River watershed are members of the Town and Country RC&D area. This RC&D was organized to cover 13 counties in southeastern Wisconsin. The Town and Country RC&D helps to facilitate the development and coordination of existing and innovative projects, and to assist in finding funding to implement them. Town and Country RC&D has helped promote agricultural, energy, water quality, and educational projects and programs throughout the Region.

The Pittman-Robertson Wildlife Restoration Program

The Pittman-Robertson Wildlife Restoration Program through the U.S. Fish and Wildlife Service provides grants to State fish and wildlife agencies for projects to restore, conserve, manage, and enhance wildlife and wildlife habitat. This program provides 75 percent Federal cost-share assistance for eligible projects and requires a 25 percent match from nonFederal sources. Eligible projects include identification, restoration, and improvement of areas of land or water adaptable as feeding, resting, or breeding places for wildlife.

The State Wildlife Grants Program

The U.S. Fish and Wildlife Service through the State Wildlife Grants Program provides Federal grant funds to state fish and wildlife agencies for the development and implementation of projects for the benefit of fish and wildlife and their habitats, including species that are not hunted or fished. Priority is placed on projects that protect species of greatest conservation concern. Two types of grants are made under this program: planning grants and implementation grants. Planning grants provide up to 75 percent Federal cost-share assistance for eligible projects and require a 25 percent match from nonFederal sources. Implementation grants under this program provide up to 50 percent Federal cost-share assistance for eligible projects and require a 50 percent match from nonFederal sources.

Great Lakes Restoration Initiative
The Great Lakes Restoration Initiative (GLRI) is a multiagency Federal effort that targets the most significant environmental problems affecting the Great Lakes, including toxic substances and areas of concern, aquatic invasive species, and nearshore health and nonpoint source pollution. The 2011 version of the Initiative also was intended to address accountability, education, monitoring, evaluation, communication, and partnerships. Funds are allocated strategically to implement both Federal programs and projects initiated by states, tribes, municipalities, universities, and other organizations. Grant funds are awarded competitively to projects which focus on achieving results in the identified target areas. For 2012 and 2013, the key priorities of the Initiative are to clean up Great Lakes Areas of Concern, reduce nutrients entering the Great Lakes, and prevent the introduction of new invasive species.

U.S. Environmental Protection Agency Clean Water State Revolving Fund
The USEPA Clean Water State Revolving Fund (CWSRF) provides funds to States for construction of municipal wastewater treatment facilities, nonpoint source pollution abatement projects, and estuary protection projects. Grants are provided to the State of Wisconsin Clean Water Fund (CWF) and a 20 percent match is provided by the State.[26] Additional contributions to the CWF may be made from the proceeds from tax-exempt revenue bonds, investment earnings, and loan repayments. The Wisconsin Departments of Administration and Natural Resources jointly administer the CWF loan program. Cities, towns, villages, counties, town sanitary districts, public inland lake protection and rehabilitation districts, metropolitan sewerage districts, and Federally recognized tribal governments are eligible to apply.

Since Federal fiscal year 2010, the CWSRF has had a "green project reserve requirement" that a specified percentage of the funds be used "for projects to address green infrastructure, water or energy efficiency improvements, or other environmentally innovative activities." As of Federal fiscal year 2012, the portion of appropriated funds to be used for green projects was 10 percent.

State Programs
Soil and Water Resource Management Program
The Department of Agriculture, Trade and Consumer Protection (DATCP) administers Wisconsin's soil and water resource management program (SWRM) under the provisions of Chapter 92 of the *Wisconsin Statutes* and Chapter ATCP 50 of the *Wisconsin Administrative Code.* The Soil and Water Resource Management grant program was developed to support locally led conservation efforts. Counties are awarded grant funds to pay for conservation staff and provide landowner cost-sharing to implement their land and water resource management plan. ATCP 50, as revised in April 2009, relates specifically to agricultural programs and it establishes requirements and/or standards for:

- Soil and water conservation on farms,
- County soil and water programs, including land and water resource management plans,
- Grants to counties to support county conservation staff,
- Cost-share grants to landowners for implementation of conservation practices,
- Design certifications by soil and water professionals,
- Local regulations and ordinances, and
- Cost-share practice eligibility and design, construction, and maintenance.

[26] *The Wisconsin Clean Water Fund is part of the State Environmental Improvement Fund.*

Wisconsin Department of Natural Resources Targeted Runoff Management and Notice of Discharge Grant Program

The Targeted Runoff Management (TRM) Grant Program, in operation since 1999, was significantly revised effective January 1, 2011. Targeted Runoff Management Grants are administered under Chapters NR 153, "Targeted Runoff Management and Notice of Discharge Grant Programs," and NR 154, "Best Management Practices and Cost Share Conditions," of the *Wisconsin Administrative Code*. These grants provide technical and financial assistance to local governments for managing nonpoint source pollution. Most grants address agricultural problems. The agricultural project grants address many types of water resources, including impaired waters in areas with Total Maximum Daily Loads (TMDL), impaired waters outside TMDL areas, high-quality surface waters threatened by degradation, and ground water protection and improvement. Agricultural projects can vary in scale, from small-scale projects addressing a single farm to larger-scale projects that address agricultural sources on a watershed basis. Projects that take place outside a TMDL area are required to implement the State's agricultural nonpoint source performance standards and prohibitions contained in Chapter NR 151, "Runoff Management." Projects designed to implement TMDLs may also implement practices that are not tied directly to achieving State standards and prohibitions as long as the management practices are required to achieve the goals of the TMDL. Targeted Runoff Management Grants also provide funding for a limited number of urban stormwater construction projects, but the urban TRM projects are restricted to TMDL areas.[27] Only small-scale projects are eligible in urban areas. All TRM grants provide 70 percent cost sharing for construction of management practices, with up to 90 percent cost sharing available for agricultural projects where the farmer qualifies for economic hardship. Large-scale TRM projects may also provide limited funding for staff support. Each year, the WDNR establishes caps on grant amounts consistent with available funding.

Chapter NR 153 is also used to administer Notice of Discharge Grants. Notices of Discharge are issued by the WDNR under Chapter NR 243, "Animal Feeding Operations." WDNR issues Notices of Discharge to small and medium livestock operations that fail to meet Federal point source discharge requirements or that are causing fecal contamination of drinking water wells. In many of these cases, the farmer is required to fix the site regardless of cost sharing. However, the WDNR may decide to offer a grant to help facilitate site clean-up. Problem sites that are not cleaned up are issued Wisconsin Pollutant Discharge Elimination System (WPDES) permits or referred directly to the Wisconsin Department of Justice for prosecution. The WDNR and DATCP work jointly to address these sites.

Wisconsin Department of Natural Resources Urban Nonpoint Source and Storm Water Management Grants

The Urban Nonpoint Source and Storm Water Management Grant Program, which is administered under Chapters NR 154 and NR 155, "Urban Nonpoint Source Water Pollution Abatement and Storm Water Management Grant Program," of the *Wisconsin Administrative Code*, provides cost-share funds for planning and construction activities for controlling nonpoint source pollution from urban areas. Projects funded by this program are site-specific, serve areas smaller than subwatersheds, and are targeted to address high-priority problems. These urban grants are available to address a wide range of water resources, including impaired waters in TMDL areas, impaired waters outside TMDL areas, high-quality waters that are threatened by stormwater runoff, and groundwater that is threatened or degraded by stormwater runoff.

Eligible applicants include cities, villages, towns, counties, regional planning commissions, and special purpose districts such as lake districts, sewerage districts, and sanitary districts. In addition, an urban project area must meet at least one of the following criteria:

- The area has a residential population density of at least 1,000 persons per square mile,
- The area has commercial land use,

[27] *A companion grant program, the Urban Nonpoint Source Storm Water Management Grant Program, which is administered as described in the following subsection, complements the TRM Program by making grants for urban areas available Statewide for a variety of planning and construction activities.*

- The area is a portion of a privately-owned industrial site not covered under a WPDES permit issued under Chapter NR 216 of the *Wisconsin Administrative Code,* or

- The area is a municipally owned industrial site.

The maximum cost-share rate available for planning grants is 70 percent of eligible costs. The cap on the total State share for planning projects is $85,000. The maximum cost-share rate available for construction grants is 50 percent of eligible costs, with a total State share for a construction project of $150,000 and a potential grant of an additional $50,000 for land acquisition, where needed. Planning grants can be used to pay for a variety of eligible activities, including stormwater management planning for existing and new development, related information and education activities, ordinance and utility district development, and enforcement. Construction grants can be used to pay for the construction of best management practices to control stormwater pollution from existing urban areas. Projects may be eligible for funding whether or not they are designed to meet the performance standards identified in Section NR 151.13 of the *Wisconsin Administrative Code*, but the highest priority in selecting projects under this program is given to projects that implement performance standards and prohibitions contained in Chapter NR 151 or that address waterbodies listed on the Federal Section 303(d) list of impaired waters.

Wisconsin Department of Natural Resources Knowles-Nelson Stewardship Program
The Knowles-Nelson Stewardship Program was established to preserve the State's most significant land and water resources for future generations and to provide the land base and recreational facilities needed for quality outdoor experiences. The program achieves these goals by funding the acquisition of land and easements for conservation and recreation purposes, developing and improving recreational facilities, and restoring wildlife habitat. The administrative rules for the program are set forth in Chapters NR 50, "Administration of Outdoor Recreation Program Grants and State Aids," and NR 51, "Administration of Stewardship Grants," of the *Wisconsin Administrative Code*. The program provides 50 percent matching grants to local units of government and qualified nonprofit conservation organizations for the acquisition of land and easements.

Wisconsin Department of Natural Resources Lake Protection Grant and River Protection Grant Programs
The Lake Protection Grant program as set forth in Chapter NR 191, "Lake Protection and Classification Grants," of the *Wisconsin Administrative Code* was designed to assist local governments, lake districts and associations, and other nonprofit organizations in improving and protecting water quality in lakes. A 75 percent State cost-share is available, with a 25 percent local match. Projects that are eligible for cost-share assistance include land acquisition for easement establishment, wetland restoration, and various lake improvement projects such as those involving pollution prevention and control, diagnostic feasibility studies, and lake restoration.

The River Protection Grant program as set forth in Chapter NR 195 of the *Wisconsin Administrative Code* was designed to assist local governments, lake districts and associations, and other nonprofit organizations in improving and protecting water quality in rivers. A 75 percent State cost-share is available, with a 25 percent local match. Cost-share funding cannot exceed $50,000 for a management project. The types of projects that are eligible for cost-share assistance include management activities such as land acquisition, easement establishment, ordinance development, installation of nonpoint source pollution abatement projects, river restoration projects, and river plan implementation projects.

Wisconsin Department of Natural Resources Municipal Flood Control Grant Program
Under Chapter NR 199, "Municipal Flood Control Grants," of the *Wisconsin Administrative Code* municipalities, including cities, villages, and towns, as well as metropolitan sewerage districts are eligible for cost-sharing grants from the State for projects to minimize flooding and flood-related damages. Projects may include acquisition and removal of structures; floodproofing of structures; riparian restoration projects, including removal of dams and other artificial obstructions, restoration of fish and native plant habitat, erosion control, and streambank restoration projects; acquisition of vacant land to create open-space flood storage areas; constructing structures for the collection, retention, storage, and transmission of stormwater and groundwater for flood control; and

preparation of flood insurance studies and other flood mapping projects. Municipalities and metropolitan sewerage districts are eligible for up to 70 percent State cost-share funding for eligible projects, and have to provide at least a 30 percent local match.

Wisconsin Department of Natural Resources Clean Water Fund Program
The State Clean Water Fund Program (CWFP) provides financial assistance to municipalities for the planning, design, and construction of projects to control and treat urban stormwater runoff. Eligible applicants include cities, towns, villages, counties, town sanitary districts, public inland lake protection and rehabilitation districts, and metropolitan sewerage districts. Projects must be required by either a WPDES permit, a performance standard, or a plan approved by the WDNR. The primary purpose of an eligible urban runoff project must be to improve water quality. The program provides loans at an interest rate of 65 percent of the current CWFP market rate.

The Clean Water Fund Program also has a Small Loan Program that provides interest rate subsidies to municipalities that have a loan from the State Trust Fund Loan Program for the planning, design, and construction of urban runoff projects with total estimated costs of $1 million or less.

Wisconsin Forest Landowner Grant Program
The Wisconsin Forest Landowner Grant Program (WFLGP), administered by the WDNR, is designed to assist private forest landowners in protecting and enhancing their forested lands, prairies, and waters. Qualified landowners can be reimbursed up to 50 percent of the cost of eligible practices. A practice must be identified in the landowner's forest stewardship plan to be eligible for cost sharing. The program also provides funds for plan development. Private landowners in Wisconsin are eligible for WFLGP funding if they own at least 10 contiguous acres of nonindustrial private forest, but not more than 500 acres within Wisconsin. Applicants must have a forest stewardship plan in place on their land or be applying to have one prepared through the WFLGP program. Landowners granted WFLGP funding can only be provided cost sharing for noncommercial practices. Landowners are required to contact their WDNR forester for guidance prior to completing the application and written approval must be obtained before beginning a practice.

Wisconsin Coastal Management Program
The Wisconsin Coastal Management Program (WCMP) is administered by the Department of Administration, Bureau of Intergovernmental Relations. The WCMP is a voluntary State-Federal partnership that works through a council appointed by the Governor to provide policy coordination among State agencies and to award Federal funds to local governments and other entities for the implementation of initiatives related to the management of coastal zones in the State. The program has identified wetlands protection, habitat restoration, public access, land acquisition, nonpoint source pollution control, land use and community planning, natural hazards, and Great Lakes education projects as current priorities. The program also provides assistance to local governments in the management and protection of shorelands, wetlands, and floodplains through zoning and permitting.

County Programs
Each of the four Counties in the Root River watershed has a county land and water conservation committee which is responsible for land conservation programs within the county and for implementing the State's soil and water resource management programs. These committees report to the county board, and their activities are closely supervised by the county board and subject to the fiscal resources made available by the county board. Sections 92.07 and 92.10 of the *Wisconsin Statutes* authorize the land and water conservation committees to have a broad range of powers and duties. These powers and duties include:

- Development and adoption of standard and specifications for management practices to control erosion, sedimentation, and nonpoint sources of water pollution;

- Distribution and allocation of available Federal and State cost-sharing funds relating to soil and water conservation;

- Implementation of research and educational information programs relating to soil and water conservation;

- Provision of financial, technical, and other assistance to landowners;

- Acquisition of land and other interests and property, machinery, equipment, and supplies required to carry out various land conservation programs;

- Construction, improvement, operation, and maintenance of structures needed for land conservation, flood prevention, and nonpoint source pollution control; and

- Preparation of a long-range natural resource conservation plan for the county, including an erosion control plan and program.

Day-to-day administration of the programs overseen by the county land conservation committees is performed by the counties' land conservation departments or divisions. These departments act through partnerships with local farmers, landowners, businesses, and State and Federal agencies, to address soil and water conservation issues. Each county in the Root River watershed has a land conservation department that provides local implementation and administration of the State's soil and water conservation program, including providing cost-share assistance through Federal, State, and other programs for the installation of conservation practices on agricultural land; technical assistance on controlling soil erosion and water pollution; and informational and educational programming. Some of the activities of these departments reflect services and programs that are mandated by State statute or administrative rule, such as development and updating of county land and water resource management plans, review of compliance with the conditions of the State Farmland Preservation Program-Working Lands Initiative, regulation of livestock facility siting, some regulation of nonmetallic mining, and some activities related to enforcement of State agricultural performance standards. Examples of other activities of these departments include participation in the State's gypsy moth suppression program, sponsorship of an annual rural landowner conference, sponsoring tree programs which provide seedling trees for conservation uses to land-owners at reduced prices, and development and maintenance of internet-based land information systems. Because the State requirements encourage counties to develop programs that address local problems and needs, there are differences among the counties' programs and activities

Other Programs and Initiatives

Local Grants Programs

Two local grants programs which provide funding to community-based projects are active in the Root River watershed.

Root-Pike Watershed Initiative Network (WIN) Watershed-Based Grant Program

Root-Pike WIN Watershed-Based Grant Program awards grants to fund a variety of community-based projects in the Root River, Pike River, and Oak Creek watersheds and in the associated Lake Michigan direct drainage area. The types of projects funded include environmental restoration efforts, planning studies and projects, research studies on topics related to restoration and management of the watersheds, construction and installation of recreational access facilities, workshops, and educational efforts. The focus areas for grants include projects to reduce and prevent water, soil, and air pollution from urban and rural sources; projects to establish or improve education and communication about watershed issues; projects that protect or restore natural areas; projects that improve public access to rivers, streams, lakes, and other public waterways. Potential projects are evaluated to the degree which the projects:

- Meet Root-Pike WIN's mission and vision;

- Follow the recommendations of or best management practices suggested by agencies such as SEWRPC and the WDNR;

- Protect unique environmental, archaeological, or cultural areas;
- Can be duplicated throughout the watershed;
- Encourage partnerships and leverage resources;
- Balance a long-term focus with short-term results; and
- Promote excellence by fostering a sense of pride and identification in the watershed.

Grants are awarded annually and awards generally range between $500 and $10,000, subject to the availability of funds.

Table 8 lists projects in the Root River watershed that have been funded by this program from its inception in 2001 through 2013.

Southeastern Wisconsin Watershed Trust (Sweet Water) Mini-Grant Program
The Sweet Water Mini-Grant program supports local, grassroots effort to improve water quality, restore habitat, promote conservation, and advance public education concerning water issues in the Greater Milwaukee watersheds, including the Root River watershed.[28] A special focus of this program is the use of green infrastructure practices. The program provides grants of $1,000 to $5,000 to established nonprofit organizations, community groups, and civic groups for projects and activities that advance the objectives of achieving healthy and sustainable water resources. This program began in 2007; Sweet Water became the lead organization for the program in 2009. In the Root River watershed, it has provided two grants to Root-Pike WIN to help support its rain garden program and a grant to Country Dale Elementary School for a water quality monitoring project along Tess Corners Creek in the City of Franklin.

Rain Garden Programs
Several programs are active in the Root River watershed or in portions of the watershed to support the construction and installation of rain gardens for infiltrating stormwater runoff.

Through its Rain Garden Initiative, the Root-Pike WIN conducts workshops on the construction of rain gardens; provides grant funding to homeowners, public entities, and others to help defray the costs of installing rain gardens; makes rain garden plants available to its grant recipients; and inspects rain gardens that are installed with its support. Since 2008, this initiative has funded the installation of 99 rain gardens in the Root River, Pike River, and Oak Creek watersheds and the Lake Michigan direct drainage area. About 32 of these rain gardens are in the Root River watershed. In addition, Root-Pike WIN has partnered with the Michigan State University Institute of Water Research Networked Neighborhoods for Eco-Conservation Online project to help map locations of rain gardens and other neighborhood water conservation practices.[29]

The Graham-Martin Foundation partners with local governments, conservation groups, nonprofit organizations, schools, and faith centers to help fund the installation of rain gardens. Funding from the Foundation enables local partners to provide rain garden plants to persons installing rain gardens at discounted prices. In the Root River watershed, the Foundation is currently partnering with MMSD and Waukesha County.

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[28]*The other greater Milwaukee watersheds are the Kinnickinnic, Menomonee, and Milwaukee River watersheds; the Oak Creek watershed; the Milwaukee Harbor estuary; the Lake Michigan direct drainage area; and part of the nearshore area of Lake Michigan.*

[29]*Information about this program can be accessed at* http://www.networkedneighbors.org/index.asp.

Table 8

PROJECTS IN THE ROOT RIVER WATERSHED FUNDED BY THE ROOT-PIKE WIN WATERSHED-BASED GRANT PROGRAM: 2001-2013

Type of Project	Project	Grant Recipient	Year
Education	Water quality education program and workshop	Citizens for a Better Environment	2001
	Water quality testing of the Root River	Prospect Hill Elementary School	2001
	Watershed-Sensitive Development Conference	UW-Extension and Sustainable Racine	2001
	Meetings to facilitate preservation of natural areas identified in the regional natural areas plan	Gathering the Waters Conservancy	2002
	Manual for native landscaping of retention and detention basins	UW-Extension	2002
	Interactive education activity for children and parents at Trout Pond Prairie	Caledonia Conservancy and Root River Chapter of the Wild Ones	2002
	Educational program and brochure on the watershed, native landscaping, erosion, and fertilizer	Olympia Brown School	2002
	Workshops on building rain gardens, native plants, and healthy lawn care	Village of Caledonia	2003
	Management of Tabor Woods and Signs	Caledonia Conservancy and Keep Caledonia Rural	2003
	Educational signs along the Root River Pathway	UW-Parkside	2003
	Environmental education program for 6th grade students in Racine and Kenosha Middle Schools	Hoy Audubon Society and the Environmental Education Alliance	2004
	Educational field studies of the Root and Pike Rivers and creation of multimedia presentations	St. Mary's School	2004
	Design and maintenance of a prairie and rain garden and field studies on the Root River	Carthage College and Racine Montessori	2004
	Community Conservation Conversation workshops	Kenosha-Racine Land Trust	2005
	Training sessions for land trust members focusing on improving land acquisition skills and revising land selection criteria	Kenosha-Racine Land Trust	2006
	Eye of Racine Watershed Project	Good Samaritan Center	2007
	Root River Parkway signage	Racine County	2007
	Educational signs for the Root River Environmental Education Community Center	UW-Parkside	2007
	Signs and water trial map for Root River Water Trail	Leadership Racine	2008
	Angling for Environmental Awareness fishing clinic	Leadership Racine	2008
	We All Take Environmental Responsibility educational program for 4th graders in Racine Unified School District	UW-Parkside	2010
	Storm drain marking project	City of Franklin Environmental Committee	2010
	School to Nature program to 6th graders in Racine Unified School District	Caledonia Conservancy	2012

Table 8 (continued)

Type of Project	Project	Grant Recipient	Year
Education (continued)	We All Take Environmental Responsibility educational program for 4th graders and 7th graders in Racine Unified School District	Hawthorn Hollow Nature Sanctuary and Arboretum	2012
	Construction of boardwalk in Nicholson Wildlife Area	Village of Caledonia	2012
	School to Nature education program for 4th graders and 6th graders	Caledonia Conservancy	2013
	WATERshed education program for 4th graders and 7th graders in Racine Unified School District	Hawthorn Hollow Nature Sanctuary and Arboretum	2013
Planning	Comprehensive plan for Historic Sixth Street	Historic Sixth Street Association	2005
	Development of policy and finance tools to implement the Root River Revitalization Plan	River Alliance of Wisconsin	2009
Recreation	Construction of an environmentally friendly and handicap accessible pier on Mallard Lake	Wehr Nature Center	2003
	Installation of a canoe and kayak launch on the Root River	Village of Caledonia	2007
Restoration	Stormwater detention pond improvement project	Lake Pointe Home Owners Association	2001
	Equipment for invasive plant removal in Colonial Park	St. Catherine's High School Environmental Club	2001
	Streambank stabilization of Root River in Lincoln Park	WDNR	2002
	Streambank stabilization of Hoods Creek	Racine County Land Conservation Division	2002
	Restoration and management of Carity Prairie Grass Preserve	Milwaukee Area Land Conservancy	2003
	Native plant restoration in Colonial Park	Southeast Gateway Group of the Sierra Club	2003
	Land restoration: planting seeds and plants in Bob Barbee park	Racine Earth Services Corps, Youth United, and City of Racine	2003
	Restoring native plantings along the Root River in Colonial Park and teaching students the important role of native plant species	Southeast Gateway Group of the Sierra Club and St. Catherine's High School Environmental Club	2004
	Garlic mustard removal in the Renak-Polak Woods	UW-Parkside and Cedarburg Science	2004
	Garlic mustard eradication in Renak-Polak Woods and educational activities	UW-Parkside	2005
	Land stewardship plan for Tabor Woods-Phase II	Caledonia Conservancy and Keep Caledonia Rural	2005
	Invasive plant removal in the Franklin Park Savanna	Milwaukee County Parks Department	2006
	Weed control equipment and plant material for the Milwaukee Weed-Out program	Park People of Milwaukee	2006
	Native plant restoration in Colonial Park	St. Catherine's High School and the Sierra Club	2006
	Invasive removal and tree planting along two drainage canals in the Root River Canal Woods	Wehr Nature Center	2006

Table 8 (continued)

Type of Project	Project	Grant Recipient	Year
Restoration (continued)	Expansion of Weed-Out! Racine Project and removal of invasive plants in City of Racine Parks	Sierra Club	2006
	Bluff restoration, invasive species removal, and installation of native plantings along the Root River in the City of Racine	UW-Parkside	2008
	Natural lawn demonstration project at Hales Corners Fire Station	Village of Hales Corners Environmental Committee	2008
	Franklin Park wetland restoration	Milwaukee County Parks Department	2008
	Ecological assessment and stewardship plan of River Bend Nature Center	YWCA River Bend Nature Center	2008
	Naturalization of two detention ponds in a subdivision in New Berlin	Park Central Homeowners Association	2012
	Purchase of equipment for removal of invasive plant species	River Bend Nature Center	2013
	Carity wetland complex restoration	Milwaukee Area Land Conservancy	2013
Study	Plant inventory of Mary Ellen Johnson Preserve	Kenosha-Racine Land Trust	2001
	Assessment of Root River utilizing the Rosgen classification method	WDNR	2002
	Impact of phytoremediation on river bank at the Mary Ellen Helgren Johnson Preserve	Kenosha-Racine Land Trust	2007
	Baseline water quality assessment of the Root River	City of Racine Health Department	2007
	Seasonal baseline water quality study of the Root River	City of Racine Health Department	2008
	Baseline inventory of freshwater mussels in the mainstem of the Root River	Waukesha County Land Trust	2012
	Baseline mussel inventory for the Pike River watershed and Root River tributaries	Hawthorn Hollow Nature Sanctuary and Arboretum	2013

Source: Root-Pike Watershed Initiative Network.

Through its partnership with the Graham-Martin Foundation, MMSD provides rain garden plants at discounted prices to homeowners within the District who are installing rain gardens. As an added incentive, the District also provides recipients with a five-pound bag of its Milorganite Garden Care fertilizer.

In 2012, Waukesha County conducted a workshop on rain gardens at its Retzer Nature Center facility. Through its partnership with the Graham-Martin Foundation, the County provides rain garden plants at discounted prices to homeowners within the County who are installing rain gardens.

The WDNR provides information and resources on designing, building, and maintaining rain gardens. These resources include a manual for homeowners.[30] These resources are available on the Department's website.[31] The

[30]*Roger Bannerman and Ellen Considine,* Rain Gardens: A How-To Manual for Homeowners, *Wisconsin Department of Natural Resources Publication Publ WT-776-2003, 2003.*

[31]*These resources can be accessed at* http://dnr.wi.gov/runoff/rg/.

University of Wisconsin-Extension (UWEX) also makes materials developed by UWEX staff and others on rain gardens available on its website.[32]

Rain Barrel Programs
There are several programs in the Root River watershed to promote and support the installation of rain barrels to collect and store for later use rain water that would otherwise run off roofs and lawns of homes. Information on the installation, use, and maintenance of rain barrels is available on the websites of the MMSD,[33] UWEX,[34] and WDNR.[35] Root-Pike WIN has provided rain barrels to some participants of its Green Yards, Cleaner Waters workshops. As noted above, Root-Pike WIN's partnership with Michigan State University includes mapping the locations of rain barrels. Several government agencies and nonprofit entities in and around the Root River watershed have rain barrels and diverter kits for diverting water from roof drains available for purchase. These include Boerner Botanical Gardens, Discovery World Museum, Keep Greater Milwaukee Beautiful, the Milwaukee County Zoo, MMSD, the City of Racine in conjunction with the Southeast Gateway Advisory Group of the Sierra Club, the Village of Caledonia, and Waukesha County's Retzer Nature Center. Rain barrels are also available for purchase from several commercial sources in the area.

Land Trusts and Conservancies
Land trusts and conservancies are private, nonprofit organizations that work to conserve land—such as sensitive natural areas, farmland, ranchland, water sources, cultural resources, or notable land marks. Land trusts work in partnership with landowners and communities to permanently conserve natural resources. These organizations use a variety of tools to accomplish their mission. For example, they may acquire land through purchase or donation. Once acquired, the land trust may retain ownership or pass ownership to a third party, such as a unit of government, which will protect and manage the land. Alternatively, they may purchase or otherwise acquire conservation easements on privately owned land. In a conservation easement, the owner of the land gives up some of the rights associated with the land. For example, under a conservation easement, the landowner may give up the right to build structures on the land, while retaining the right to grow crops. Future owners of the land will be bound by the conservation easement's terms. Finally, land trusts conduct and participate in stewardship of such lands, managing the land for preservation, recreational use, wildlife habitat, or other purposes.

There are several land trusts and conservancies active in the Root River watershed. The Caledonia Conservancy's service area is within the Village of Caledonia. This land trust has acquired and protected about 124 acres of land within the Village, most of it within the Root River watershed. It has also preserved a horse trail system on County and private land and manages and maintains trails. The Kenosha/Racine Land Trust serves Kenosha and Racine Counties. It has obtained conservation easements on two sites adjacent to natural areas in the Root River watershed totaling 50 acres. In addition, it was also involved in creating conservation easements in six conservation subdivisions in the watershed. The total area of these easements is about 620 acres. This land trust also acquired the Mary Ellen Helgren Johnson Memorial site, a four-acre plot which it donated to the Root River Parkway. The Milwaukee Area Land Conservancy is active in Milwaukee County. In the Root River watershed, it has acquired and protected about 25 acres of Fitzsimmons Woods, secured a conservation easement on a parcel adjoining Franklin State Natural Area, partnered with a developer to preserve a prairie remnant (Carity Prairie)

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[32]*These materials can be accessed at two sites at the UWEX:* http://fyi.uwex.edu/sewraingardens/ *and* http://runoff.info.uwex.edu/urban/education.html.

[33]*This material can be accessed at* http://v2.mmsd.com/rbfaqs.aspx.

[34]*This material can be accessed at* http://fyi.uwex.edu/sewraingardens/rain-barrels-rain-water-harvesting-techniques/.

[35]*This material can be accessed at* http://dnr.wi.gov/runoff/rg/links.htm#barrels.

and restore a sedge meadow complex, and negotiated a conservation management agreement with the owner of Adams Prairie. It is pursuing restoration efforts on the Adams Prairie site. The entire Root River watershed is served by the Prairie Enthusiasts and the portions of the Root River watershed in Muskego and New Berlin are served by the Waukesha County Land Conservancy. Neither of these land trusts has conducted any land acquisition or easement projects in the Root River watershed.

MMSD Greenseams

MMSD's Greenseams program is an innovative flood management program that reduces flooding risks and impacts from polluted stormwater runoff by permanently protecting key lands. The program makes voluntary purchases of undeveloped, privately owned properties in areas that are expected to have major growth over the next 20 years and in open space areas along streams, lakes, and wetlands. On some Greenseams properties, activities have been conducted to restore lands that were previously in agricultural land uses to their pre-European settlement vegetation. Following restoration, these properties are able to absorb more rain and snow melt, reducing and slowing down the flow of runoff into nearby waterbodies. In additions, these sites act as buffers to nearby waterbodies, filtering out nutrients and pollutants from water entering the waterbodies. Greenseams also preserves wildlife habitat and creates recreational opportunities. MMSD has hired The Conservation Fund to run the Greenseams program.

As of the end of 2010, the Greenseams program had acquired 357 acres in the Root River watershed, mostly in the headwaters of Ryan Creek and in areas adjacent to Crayfish Creek and the East Branch of the Root River.[36] In 2011, the Greenseams program acquired an additional 52 acre parcel in the headwaters of Ryan Creek.

Other Land Preservation Efforts

A tentative agreement was reached in 2010 to expand the Metro Recycling and Disposal Facility owned by Waste Management of Wisconsin and located in the City of Franklin. Under that agreement, this facility would add about 20 acres to the southeast of a 43-acre area that has reached capacity. A total of 143 acres at the site has already been licensed for use as a landfill. The tentative agreement also covers any future expansions and defines where they could occur. As part of the agreement, Waste Management would put 283 acres of land located to the east and south of the landfill into conservancy.

Citizen-Based Monitoring Programs

In addition to the long-term monitoring programs conducted by government agencies discussed in Chapter II of this report, several citizen-based volunteer monitoring programs have been active or could potentially be active in the Root River watershed. Citizen-based water quality monitoring programs can obtain data on waterbodies that may otherwise go unmonitored. In addition, citizen-based monitoring efforts can provide a variety of data that may be useful for conducting watershed management activities. Finally, citizen-based monitoring can act to increase awareness and understanding of local water quality issues.

Table 9 lists several citizen-based environmental monitoring programs that are available to the Root River watershed. Although the Root River watershed is not the focus of any of these programs, some of them have conducted monitoring activities within its boundaries. A few of these programs have established monitoring stations in the watershed. For instance, between 1997 and 2011 data were collected at sampling stations along the mainstem of the Root River that were established by the Water Action Volunteers program. Similarly, the Wisconsin Citizen Lake Monitoring Network and its predecessor the Wisconsin Lake Self Help Program have collected data from stations established on Scout Lake and Upper Kelly Lake. Other programs collected data along routes that pass through the Root River watershed. For example, the Southeastern Wisconsin Invasive Species Consortium's surveys of invasive plants are conducted from cars along road-based routes. The Wisconsin

[36]*Milwaukee Metropolitan Sewerage District and The Conservation Fund,* The Greenseams Program Preserve Guide 2001-2010: Ten Years in Review, *no date.*

Table 9

CITIZEN-BASED AND VOLUNTEER MONITORING PROGRAMS AVAILABLE IN THE ROOT RIVER WATERSHED

Name	Sponsors	Monitoring Scope	Activity in Root River Watershed[a]	
			Historical	Recent
Citizen Based Stream Monitoring Program (Level 2)	WDNR, UWEX, and River Alliance of Wisconsin	Water quality parameters in streams and rivers	N	Y[b]
Firefly Watch	Boston Museum of Science, Tufts University, Fitchburg State College	Population status and trends of fireflies	N	N
North American Breeding Bird Survey	USGS and Canadian Wildlife Service	Population status and trends of birds	Y	Y
Project Feeder Watch	Cornell University Laboratory of Ornithology	Population status and trends of birds	Unknown	Y
SEWISC Invasive Species Roadside Survey	Southeastern Wisconsin Invasive Species Consortium	Roadside surveys of invasive terrestrial plant species	N	Y
Southeast Wisconsin Ephemeral Pond Monitoring Project	Riveredge Nature Center	Mapping and physical and biological parameters of ephemeral ponds	N	Y
Water Action Volunteers	UWEX, WDNR	Flow, dissolved oxygen, temperature, transparency, and macroinvertebrates in streams	Y[c]	Y[d]
Sierra Club Water Sentinels	Sierra Club Southeast Gateway Group	Flow, dissolved oxygen, temperature, transparency, and macroinvertebrates in streams	N	Y
Waukesha County Citizen Stream Monitoring Program	Waukesha County Land Conservation Division	Physical, chemical, and biological parameters in streams and rivers	N	N
Wisconsin Bat Monitoring Program	WDNR	Population status and trends of bats	N	Y
Wisconsin Citizen Lake Monitoring Network	Wisconsin Lakes Partnership[e]	Water clarity, dissolved oxygen, some water chemistry, invasive species	Y[f]	Y[g]
Wisconsin Frog and Toad Survey	USGS, WDNR, North American Amphibian Monitoring Program	Population trends and species distribution of frogs and toads	Y	N
Wisconsin Odonata Survey	WDNR and Beaver Creek Reserve	Population status and trends and species distribution of dragonflies and damselflies	- -[h]	- -[h]

[a]*Historical activity indicates the existence of monitoring data from the program prior to 2007; recent activity indicates the existence of monitoring data in or after 2007.*

[b]*This program has produced some continuous temperature data from the mainstem of the Root River in the City of Racine.*

[c]*Historical data from 10 sites along the mainstem of the Root River.*

[d]*Recent data from five sites along the mainstem of the Root River.*

[e]*The Wisconsin Lakes Partnership is a partnership of the University of Wisconsin-Extension, the Wisconsin Association of Lakes, and the Wisconsin Department of Natural Resources.*

[f]*Historical data are available for Scout Lake and Upper Kelly Lake.*

[g]*Recent data are available for Upper Kelly Lake.*

[h]*Species records in the associated database are given on the basis of county. Some species records are available in each of the counties in which the Root River watershed is located.*

Source: Citizen-Based Monitoring Network of Wisconsin and SEWRPC.

Frog and Toad Survey also uses road-based routes. Some support for citizen-based monitoring in the State is provided by the Wisconsin Citizen-Based Monitoring Network. This group is a collaboration of monitoring groups, users of monitoring data, and others designed to improve the efficiency and effectiveness of citizen-based monitoring by providing coordination, communications, technical and financial resources, and recognition to the Wisconsin citizen-based monitoring community.

MMSD Regional Green Roof Initiative

MMSD's Regional Green Roof Initiative provides incentive funding to increase the use of green roofs within MMSD's service area, which includes the northern portion of the Root River watershed. This program provides up to $5 per square foot toward the installation of an approved green roof project. The District's interest in green roofs is to hold rainwater where it falls, thereby diminishing the risk of sewer overflows and improving overall water quality. In addition to managing stormwater, green roofs offer numerous additional environmental, economic, and social benefits.

As of September 2012, this program had provided assistance for the installation of one green roof in the Root River watershed. Aquatics Unlimited, a tropical fish store located within the Upper Root River subwatershed in the City of Greenfield, installed a green roof in 2010 with partial funding from this program.

Education Programs

Stormwater Educational Programs

Several organizations conduct public information and education activities in the Root River watershed related to urban stormwater runoff.

Under a contract with the Southeastern Wisconsin Clean Water Network, Root-Pike WIN conducts a public information and education program that meets the requirements of the municipal stormwater discharge permits for the 17 municipalities that are members of the Network. This network includes many municipalities that are wholly or partly located in the Root River watershed. As part of this information and education program, Root-Pike WIN conducted the Keep Our Waters Clean project. Activities of this project included:

- Surveying households to evaluate the target audiences' understanding of stormwater pollution;
- Writing and distributing newsletters, electronic newsletters, and articles intended for inclusion in municipal newsletters;
- Sending articles and news releases to local media outlets;
- Giving presentations to service organizations, student groups, and other interested parties;
- Developing and printing educational materials and distributing them to the participating municipalities; and
- Hosting and participating in workshops and fairs.

Beginning in 2012, Root-Pike WIN and Sweet Water have been conducting the Respect Our Waters campaign, a multi-year marketing initiative to educate area residents on actions that they can take to reduce water pollution associated with stormwater runoff. This initiative includes a 12-week television advertising campaign using four 30-second spots. These spots emphasize the importance of removing yard debris, cleaning up pet litter, using fertilizers and other yard chemicals responsibly, and preventing motor oil and other fluid from leaking from automobiles. This initiative also includes grassroots outreach, with Sweet Water and Root-Pike WIN being present at community events to educate residents. During these events, Sweet Water and Root-Pike WIN distribute pet waste bags, provide native plants for rain gardens, and conduct giveaways of rain barrels and

Milorganite fertilizer. This initiative is funded by the Southeastern Wisconsin Watersheds Trust, Inc., in conjunction with over 20 municipalities, including the members of the Southeastern Wisconsin Clean Water Network, and the WDNR.

In partnership with UWEX, Root-Pike WIN conducts workshops on topics related to reducing contributions of polluted stormwater to area waterbodies. Recent workshops include Greener Yards, Cleaner Waters workshops, which focus on the causes of polluted runoff and on landscaping and yard care practices that can reduce contributions of pollutants to waterbodies and composting workshops.

The UWEX also provides educational materials related to stormwater runoff.[37]

Nature Centers

Several nature centers located in or near the Root River watershed offer a variety of educational programs related to natural history, natural resources, and environmental issues. Each of these centers offers a unique set of programming. Common programs include offering field trip opportunities for school groups, providing nature and environmental education programs for visitors, conducting natural history and environmental education programs for adults and families, offering summer day camps for school-aged children, providing training and educational resources for educators, and providing materials for self-guided activities, such as nature study. Some of these centers also sponsor or conduct citizen-based science programs, provide nature-based programs to support merit badge programs or scouting organizations, or provide professional continuing education for teachers.

Three nature centers are located within the Root River watershed: River Bend Nature Center, the Root River Environmental Education Community Center, and Wehr Nature Center.

River Bend Nature Center is located along the Root River in the Village of Caledonia. The center is located on 78 acres of river-bottom land, wetland, open fields, ponds, and upland hardwood forest. The facility includes about 4,000 feet of river frontage, two activity buildings, and a network of hiking trails. The Racine YWCA operated it for almost 50 years, providing environmental education and outdoor recreation. In 2012, the center was purchased by Racine County. It is currently operated by River Bend Nature Center, Inc. (RBNC, Inc.), a nonprofit corporation, through a public-private partnership with the County. RBNC, Inc. has been renovating the facility and is developing programming. RBNC, Inc. anticipates that program offerings will include:

- Environmental education in partnership with area schools,
- Day camps with an emphasis on environmental education for children,
- Adult education in natural history and water quality,
- Naturalist programs,
- Special programs combining art and music with nature, and
- Outdoor recreation, including canoeing, cross-country skiing, and kayaking.

Rental of canoes, kayaks, cross-country skis, and snowshoes is available at River Bend Nature Center.

[37] *These materials can be accessed at:* http://clean-water.uwex.edu/pubs/.

The Root River Environmental Education Community Center (REC Center) is located along the Root River in the City of Racine. The REC Center is located west of downtown Racine and is downstream from much of the urban parkland that lines the banks of the River. The Root River Pathway connects the REC Center to other bicycle paths, including the Lake Michigan Pathway and the North Shore Bicycle Pathway. The REC Center was opened in 2008 through a partnership between the City of Racine Department of Parks, Recreation, and Cultural Services and the University of Wisconsin-Parkside (UWP), with support from the Wisconsin Coastal Management Program and UWEX. The REC Center offers the community opportunities for interaction with the natural world through recreation and education, in an urban setting. It provides education to youth and adults about the ecology of the Root River and Lake Michigan. In addition, the REC Center operates a bicycle, canoe, and kayak rental program. It also has fishing equipment available free of charge for onsite use by children under the age of 14. It provides guides and instructors for group canoeing on the Root River.

Wehr Nature Center is located along Tess Corners Creek in Whitnall Park in the City of Franklin. The centers 220-acre facility includes Mallard Lake, a variety of wetlands that are accessible via a boardwalk, restored oak savanna and prairie habitats, maple and oak woodlands, over five miles of hiking trails, a visitor center, and an outdoor amphitheater. Wehr Nature Center is the primary environmental education facility of the Milwaukee County Park System, and it provides a number of programs, including:

- Field trips for school groups, including opportunities for homeschooled students,
- Natural history education programs for adults and families,
- Nature hikes,
- Citizen-based science, and
- Training and resources for educators.

Wehr Nature Center also conducts the Nature in the Parks program. This is a cooperative effort of the Center, the University of Wisconsin-Cooperative Extension Service, and the Milwaukee County Park System. This program provides field trips, summer camps, and other youth programs in parks, schools, libraries, and other sites throughout Milwaukee County. These programs incorporate outdoor experience as often as possible.

In addition to the three nature centers located within the Root River watershed, there are several located in the Counties that contain the watershed. These include Bong State Recreation Area, Hawthorn Hollow Nature Sanctuary and Arboretum, and Pringle Nature Center in Kenosha County; Havenwoods Environmental Awareness Center, Hawthorn Glen, and the Urban Ecology Center in Milwaukee County; and Retzer Nature Center in Waukesha County.

Many of these centers also conduct or support outdoor recreation programs. Most of the centers in and near the Root River watershed have trail systems for hiking and nature study, and in some cases, other trail-based outdoor recreation. Some provide access to waterbodies for fishing, canoeing, and kayaking. Some rent or loan outdoor recreation equipment such as bicycles, canoes, kayaks, snowshoes, cross-country skis, fishing equipment, field guides, binoculars, or global positioning system units. Some also provide instruction in outdoor recreation activities, such as canoeing, kayaking, orienteering, snowshoeing, and cross-country skiing. Table 10 summarizes the outdoor recreation programs and facilities of the nature centers that are located within the Root River watershed.

University of Wisconsin-Extension Natural Resources Program

The UWEX's Regional Natural Resources Program includes a team of natural resource educators located throughout the State. These educators provide education, training, and technical support for environmental and natural resource issues. The UWEX has also developed publications on topics such as home and yard care,

Table 10

OUTDOOR RECREATION FACILITIES AND PROGRAMS OF NATURE CENTERS IN THE ROOT RIVER WATERSHED

Facility or Program	River Bend Nature Center	Root River Environmental Education Community Center	Wehr Nature Center
Trails			
Hiking	Y	N	Y
Cross-Country Skiing	Y	N	N
Connection to Bicycle or Multiuse Trails	N	Y	Y
Equipment Rentals			
Bicycles	N	Y	N
Canoes	Y	Y	N
Cross-Country Skis	Y	N	N
Fishing Gear	N	Y[a]	N
Kayaks	Y	Y	N
Snowshoes	Y	N	N
River Access for Canoes and Kayaks	Y	Y	N
Canoe Guides/Instructors	N	Y	N
Sledding	N	N	Y

[a]*Fishing equipment is available for onsite use free of charge to children under the age of 14.*

Source: Websites of River Bend Nature Center, Root River Environmental Education Community Center, and Wehr Nature Center, and SEWRPC.

agriculture, forestry, stormwater management, shoreland management, invasive species, and other environmental and natural resource-related topics.[38]

Clean Boats, Clean Waters Program

The Clean Boats, Clean Waters program was developed by the Wisconsin Lakes Partnership to prevent the spread of aquatic invasive species in the State. This program uses citizen volunteers and staff from the WDNR, the University of Wisconsin Sea Grant Institute, and other organizations to perform inspections of boats and trailers at boat landings, disseminate informational brochures, and educate boaters on how to prevent the spread of aquatic invasive species. The inspectors also note and report any new infestations of aquatic invasive species in waterbodies. The UWEX conducts training for new boat inspectors and coordinates volunteer efforts. The WDNR maintains a Statewide database of information tracked by inspectors at boat landings. In support of this program, the Wisconsin Lakes Partnership has developed a handbook for conducting inspections.[39] While inspections have not been conducted at landings along the Root River, its tributaries, or lakes within the watershed, this program has been active at a site along the Lake Michigan shore near the mouth of the Root River. From 2010 through August 2012, 663 watercraft inspections were conducted at Pershing Park in the City of Racine.

[38]*These publications can be accessed at:* http://clean-water.uwex.edu/pubs/.

[39]*Wisconsin Lakes Partnership,* Watercraft Inspection Handbook: 2012 Edition, *Wisconsin Department of Natural Resources Publication PUB-WT-780 2012, 2012. This handbook and associated material may be accessed at:* http://www4.uwsp.edu/cnr/uwexlakes/CBCW/handbook&forms.asp.

Wisconsin Clean Marina Program

The Wisconsin Clean Marina Program is administered by the Wisconsin Marina Association with guidance and technical assistance from the University of Wisconsin Sea Grant Institute and funding from the Wisconsin Coastal Management Program and the National Oceanic and Atmospheric Administration. The program promotes voluntary adoption of measures to reduce water pollution from maintenance, operation, and storage of recreational vessels, boatyards, and marinas. The purpose is to ensure clean water and to protect fish and wildlife. A Clean Marina Guidebook and other educational materials are available on the Wisconsin Marina Association website.[40] The program also offers workshops and technical assistance on best management practices for facility operators. Facilities that adopt the program's recommended practices may become certified as Wisconsin Clean Marinas and receive free publicity as environmentally responsible businesses. Additional partners include the University of Wisconsin-Extension's Solid and Hazardous Waste Education Center, the Wisconsin Coastal Management Program, the Wisconsin Department of Natural Resources Office of Great Lakes, and the U.S. Coast Guard.

[40] *This guidebook can be accessed at* http://www.wisconsincleanmarina.org.

Chapter IV

CHARACTERIZATION OF THE WATERSHED

INTRODUCTION

Information on the natural and constructed features of a watershed is essential to sound planning for water quality, habitat, and floodland management and for the provision of recreational access. Watershed topography and local hydrology influence rates and volumes of runoff, affecting instream water quality, the composition of plant and animal communities, and flooding conditions. Water pollution problems and their solutions are primarily a function of the human activities within a watershed and of the ability of the natural resource base to sustain those activities. Streams and lakes are susceptible to water quality degradation due to human activities within the watershed which can interfere with desired water uses, and which are often difficult and costly to correct. Because of this, the land uses and population levels in the watershed are important considerations in the protection, restoration, and management the water resources in the watershed.

This chapter presents a characterization of the features of the Root River watershed. This characterization represents a refinement and updating of the inventories presented in the regional water quality management plan update for the Greater Milwaukee watersheds (RWQMPU)[1]. This refinement and updating includes analysis of water quality data collected by the City of Racine Health Department, under a project funded by the Fund for Lake Michigan, and focused inventories and analyses of the watershed characteristics most relevant to the four plan focus issues. This characterization includes descriptions of physical conditions of the surface water system, existing surface water quality, and habitat and biological conditions in the Root River watershed. In addition, it presents information on the natural and human-made features of the watershed, including a description of the natural resource base and environmentally sensitive areas, land use data, and demographics.

ASSESSMENT AREAS

As previously noted, the characterization of the Root River watershed presented in this chapter represents a refinement and updating of the inventories presented in the RWQMPU. In several cases, this refinement includes examination of the features of the watershed on a finer scale than was conducted in the RWQMPU. In order to facilitate analysis on a finer scale, the watershed was divided into 15 assessment areas. These assessment areas correspond to subwatersheds or portions of subwatersheds. The assessment areas are shown on Map 7 and described in Table 11.

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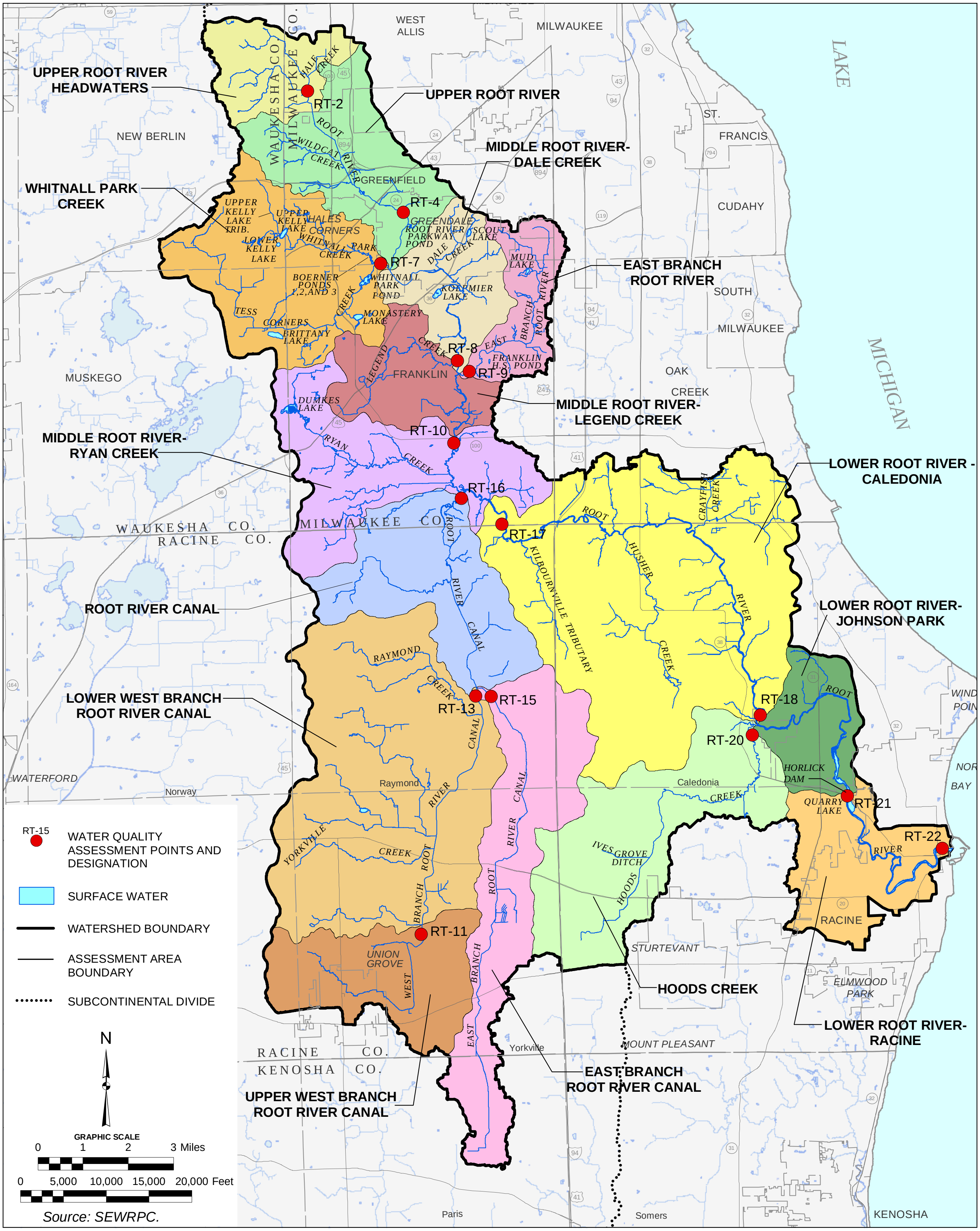
[1]*SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007.*

Map 7

WATER QUALITY ASSESSMENT AREAS WITHIN THE ROOT RIVER WATERSHED



Source: SEWRPC.

Table 11

ASSESSMENT AREAS IN THE ROOT RIVER WATERSHED

Assessment Area[a]	Name	Area (acres)	Principal Streams, Lakes, and Ponds
1	Upper Root River-Headwaters	3,577.1	Root River mainstem, Hale Creek, New Berlin Memorial Hospital Tributary
2	Upper Root River	6,681.6	Root River mainstem, Wildcat Creek
3	Whitnall Park Creek	9,588.2	Tess Corners Creek, Upper Kelly Lake Tributary, Whitnall Park Creek, Brittany Lake, Monastery Lake, Lower Kelly Lake, Upper Kelly Lake, Whitnall Park Pond
4	Middle Root River-Dale Creek	4,137.5	Root River mainstem, Dale Creek, Koepmier Lake, Scout Lake
5	East Branch Root River	3,136.5	East Branch Root River, Mud Lake
6	Middle Root River-Legend Creek	4,315.0	Root River mainstem, Legend Creek, Tuckaway Creek
7	Upper West Branch Root River Canal	6,429.6	West Branch Root River Canal
8	Lower West Branch Root River Canal	18,890.4	Raymond Creek, West Branch Root River Canal, Yorkville Creek
9	East Branch Root River Canal	9,976.4	East Branch Root River Canal
10	Middle Root River-Ryan Creek	8,768.1	Root River mainstem, Ryan Creek, Dumkes Lake
11	Root River Canal	7,809.1	Root River Canal
12	Lower Root River-Caledonia	23,670.0	Root River mainstem, Crayfish Creek, Husher Creek, Kilbournville Tributary
13	Hoods Creek	10,140.8	Hoods Creek, Ives Grove Ditch
14	Lower Root River-Johnson Park	3,589.4	Root River mainstem
15	Lower Root River-Racine	5,774.5	Root River mainstem, Quarry Lake
Total		126,484.0	- -

[a]*Assessment areas are shown on Map 7.*

Source: SEWRPC.

There were several steps in delineating the assessment areas. The contributing areas to each of the assessment points used in the water quality modeling conducted as part of the joint RWQMPU/Milwaukee Metropolitan Sewerage District 2020 facility plan planning effort were defined. These contributing areas are the land areas that were used in the water quality model to calculate the pollutant loads delivered to the stream system. Each of these contributing areas was compared to the areas immediately upstream and downstream to determine whether adjacent contributing areas could be consolidated into one assessment area. Comparisons were made on the basis of existing (2000) land use, planned 2035 land use, and the expected achievement of water quality criteria by 2020 based upon the results of the water quality modeling. In those cases where a contributing area was found to have similar land use and water quality characteristics to another area located immediately upstream or downstream, the two contributing areas were consolidated to form one assessment area.

Analysis on the basis of assessment areas may be useful in targeting recommendations and practices to areas where they may have the greatest impact. Analysis on this level may also be useful for geographically prioritizing implementation of recommendations that apply to the whole watershed or large portions of the watershed.

LAND USE

An important concept underlying the watershed planning effort is that land use development must be adjusted to the ability of the underlying natural resource base to sustain such development. The type, intensity, and spatial distribution of land uses determine, to a large extent, the resource demands within a watershed. The demands upon water resources can be correlated directly with the quantity and type of land use in the watershed. The same is true of the deterioration of water quality. The existing land use pattern can best be understood within the context of its historical development. This section presents information on existing and planned land use in the Root River watershed.

Civil Divisions

Superimposed over natural boundaries, such as watershed and subwatershed boundaries, is a pattern of local political boundaries. As shown on Map 2 in Chapter I of this report, the Root River watershed lies in portions of Kenosha, Milwaukee, Racine, and Waukesha Counties. Nineteen civil divisions lie wholly or partially within the watershed. Geographic boundaries of the civil divisions are an important factor because they form the basic foundation of the public decision-making framework within which intergovernmental, environmental, and development issues must be addressed. The areas of each assessment area and of the watershed within the jurisdiction of each civil division are set forth in Table 12.

Historical Urban Growth

The types, intensity, and spatial distribution of land uses within the Root River watershed are important elements in natural resource management. In this regard, the current and planned future land use patterns, placed in the context of the historical development of the area, are important considerations in developing and implementing this restoration plan.

Historical urban growth in the Root River watershed is summarized on Map 8 and Figure 2. By 2010, 28.7 percent of watershed had been developed for urban purposes. In the most highly developed areas of the watershed, the Lower Root River-Racine and the Upper Root River-Headwaters assessment areas, the majority of this development occurred prior to 1970. Since 1970, six assessment areas—the Upper Root River-Headwaters, the Upper Root River, the Middle Root River-Dale Creek, the Whitnall Park Pond, the East Branch Root River, and the Middle Root River-Legend Creek, have experienced increases in urban development that represent 20 percent or more of the land area of the assessment area. All of these assessment areas are in the northern portion of the watershed. Since 1970, the Lower Root River-Johnson Park and the Hoods Creek assessment areas have experienced increases in the amount of urban development that represent more than 10 percent of the land in these assessment areas.

Existing and Planned Land Use

This section characterizes existing land use conditions as of the year 2010 and examines changes anticipated to occur through 2035. Map 9 shows existing land use for the Root River watershed. Tables 13 and 14 set forth existing land use data, expressed as areas and percentages of the watershed area, respectively, for the assessment areas and the entire watershed. Similarly, Map 10 shows planned 2035 land use for the watershed. Tables 15 and 16 set forth planned 2035 land use conditions, expressed as areas and percentages of the watershed area, respectively, for the assessment areas and the entire watershed. The data in Table 14 and shown on Map 9 indicate that while portions of the watershed are heavily urbanized, about 65 percent of the land area of the watershed was still in rural and other open space land uses as of the year 2010.

A comparison of the proportions of year 2010 urban land use versus rural land use among assessment areas is shown in Figure 3. This comparison expresses these proportions as percentages of the entire Root River watershed. While the watershed is predominantly in rural land uses, several assessment areas, notably the Upper Root River-Headwaters, the Upper Root River, Whitnall Park Creek, and the Lower Root River-Racine assessment areas, consist mostly of urban land uses. With the exception of the Lower Root River-Racine assessment area, the most heavily urban assessment areas are in the northern portion of the watershed.

Table 12

CIVIL DIVISIONS IN THE ROOT RIVER WATERSHED: 2011

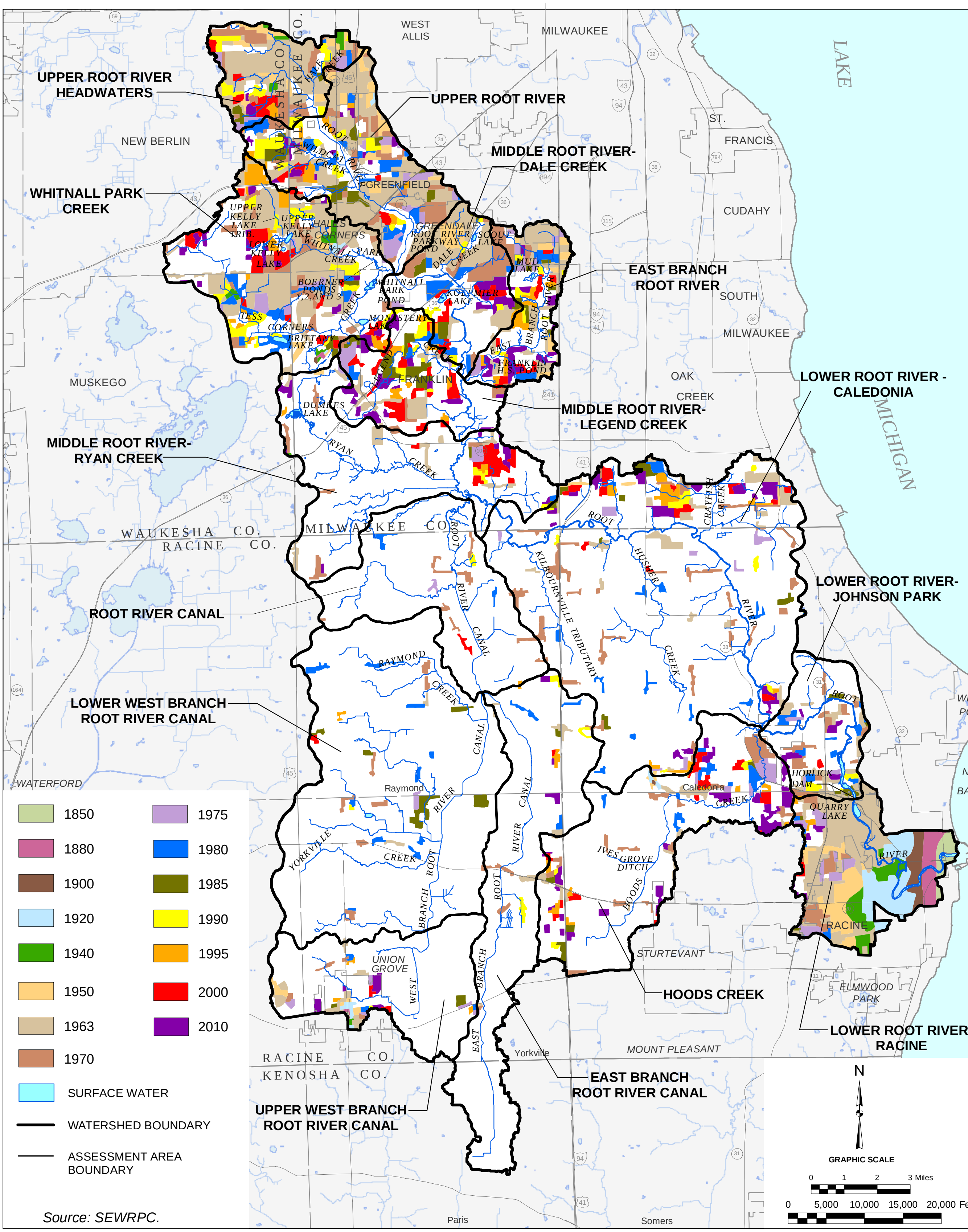
Category	Assessment Area[a]															Total (acres)
	1 Upper Root River-Headwaters (acres)	2 Upper Root River (acres)	3 Whitnall Park Creek (acres)	4 Middle Root River-Dale Creek (acres)	5 East Branch Root River (acres)	6 Middle Root River-Legend Creek (acres)	7 Upper West Branch Root River Canal (acres)	8 Lower West Branch Root River Canal (acres)	9 East Branch Root River Canal (acres)	10 Middle Root River-Ryan Creek (acres)	11 Root River Canal (acres)	12 Lower Root River-Caledonia (acres)	13 Hoods Creek (acres)	14 Lower Root River-Johnson Park (acres)	15 Lower Root River-Racine (acres)	
Kenosha County																
Town of Paris........................	- -	- -	- -	- -	- -	- -	- -	- -	1,762.8	- -	- -	- -	- -	- -	- -	1,762.8
Subtotal	- -	- -	- -	- -	- -	- -	- -	- -	1,762.8	- -	- -	- -	- -	- -	- -	1,762.8
Milwaukee County																
City of Franklin......................	- -	- -	2,660.6	2,046.8	2,192.7	4,315.0	- -	- -	- -	7,480.5	1,040.6	531.7	- -	- -	- -	20,267.9
City of Greenfield..................	34.5	3,467.8	94.3	- -	374.3	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	3,970.9
City of Milwaukee..................	- -	365.1	- -	- -	322.0	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	687.1
City of Oak Creek	- -	- -	- -	- -	41.7	- -	- -	- -	- -	- -	- -	4,529.8	- -	- -	- -	4,571.5
City of West Allis....................	1,280.3	614.1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1,894.4
Village of Greendale	- -	1,127.9	68.2	2,090.7	205.8	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	3,492.6
Village of Hales Corners	- -	355.7	1,690.1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	2,045.8
Subtotal	1,314.8	5,930.6	4,513.2	4,137.5	3,136.5	4,315.0	- -	- -	- -	7,480.5	1,040.6	5,061.5	- -	- -	- -	36,930.2
Racine County																
City of Racine	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	33.0	58.6	355.7	4,043.4	4,490.7
Village of Caledonia..............	- -	- -	- -	- -	- -	- -	- -	- -	1,028.9	- -	- -	16,390.3	2,412.8	3,112.6	- -	22,944.6
Village of Mount Pleasant	- -	- -	- -	- -	- -	- -	- -	- -	301.6	- -	- -	2.9	6,484.3	121.1	1,731.1	8,641.0
Village of Sturtevant..............	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	129.3	- -	- -	129.3
Village of Union Grove...........	- -	- -	- -	- -	- -	- -	878.3	- -	- -	- -	- -	- -	- -	- -	- -	878.3
Town of Dover	- -	- -	- -	- -	- -	- -	795.8	880.7	- -	- -	- -	- -	- -	- -	- -	1,676.5
Town of Norway.....................	- -	- -	- -	- -	- -	- -	- -	18.5	- -	59.0	- -	- -	- -	- -	- -	77.5
Town of Raymond.................	- -	- -	- -	- -	- -	- -	- -	9,673.5	2,272.2	878.0	6,768.5	2,182.3	- -	- -	- -	21,774.5
Town of Yorkville	- -	- -	- -	- -	- -	- -	4,755.3	8,317.7	4,610.9	- -	- -	- -	1,055.8	- -	- -	18,739.7
Subtotal	- -	- -	- -	- -	- -	- -	6,429.4	18,890.4	8,213.6	937.0	6,768.5	18,608.5	10,140.8	3,589.4	5,774.5	79,352.1
Waukesha County																
City of Muskego.....................	- -	- -	2,161.9	- -	- -	- -	- -	- -	- -	350.6	- -	- -	- -	- -	- -	2,512.5
City of New Berlin	2,262.3	751.0	2,913.1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	5,912.4
Subtotal	2,262.3	751.0	5,075.0	- -	- -	- -	- -	- -	- -	350.6	- -	- -	- -	- -	- -	8,438.9
Total	3,577.1	6,681.6	9,588.2	4,137.5	3,136.5	4,315.0	6,429.4	18,890.4	9,976.4	8,768.1	7,809.1	23,670.0	10,140.8	3,589.4	5,774.5	126,484.0

[a] *Assessment areas are shown on Map 7.*

Source: SEWRPC.

Map 8

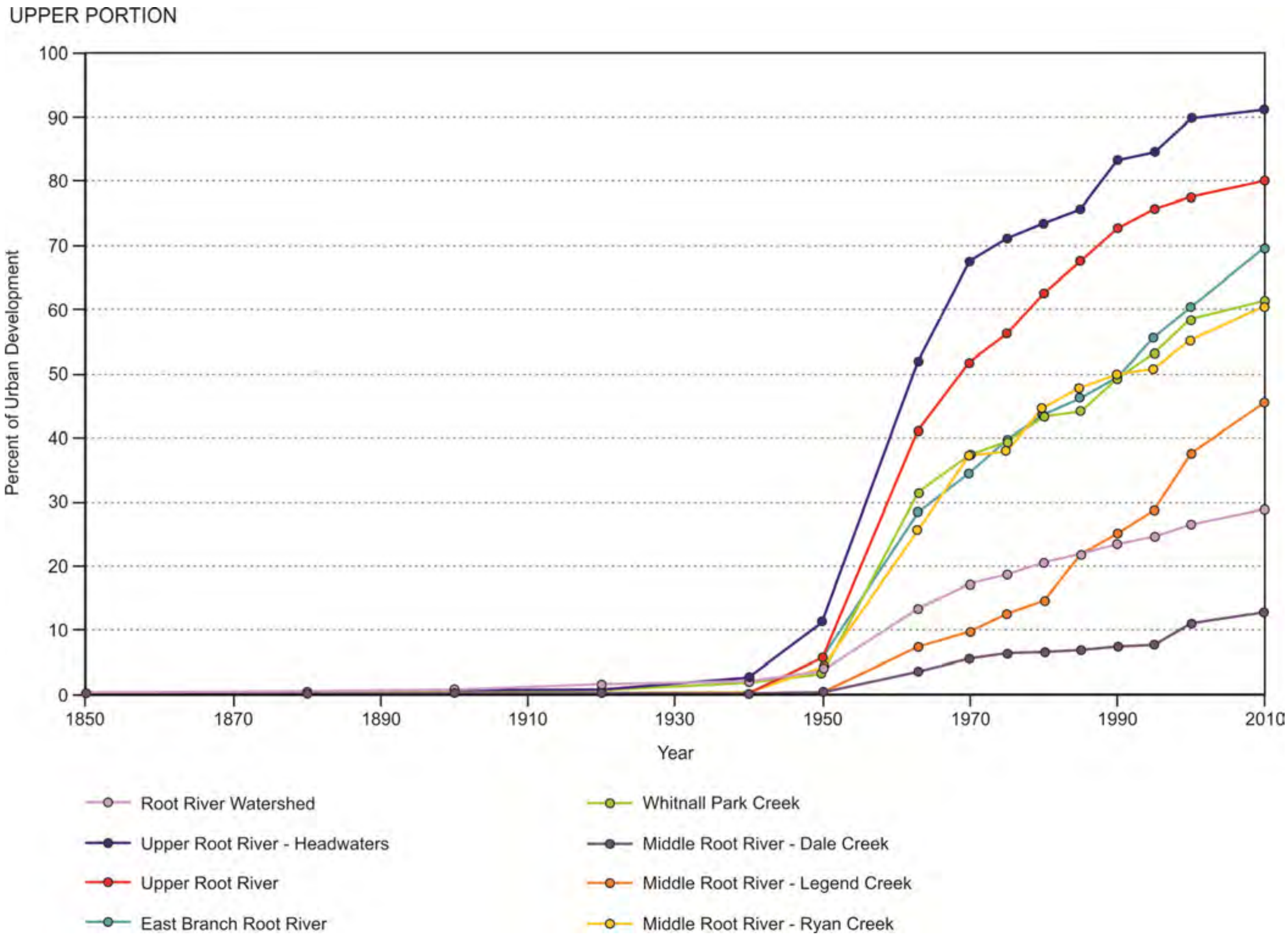
HISTORICAL URBAN GROWTH WITHIN THE ROOT RIVER WATERSHED: 1850-2010



Source: SEWRPC.

Figure 2

HISTORICAL URBAN GROWTH IN THE ROOT RIVER WATERSHED: 1850-2000



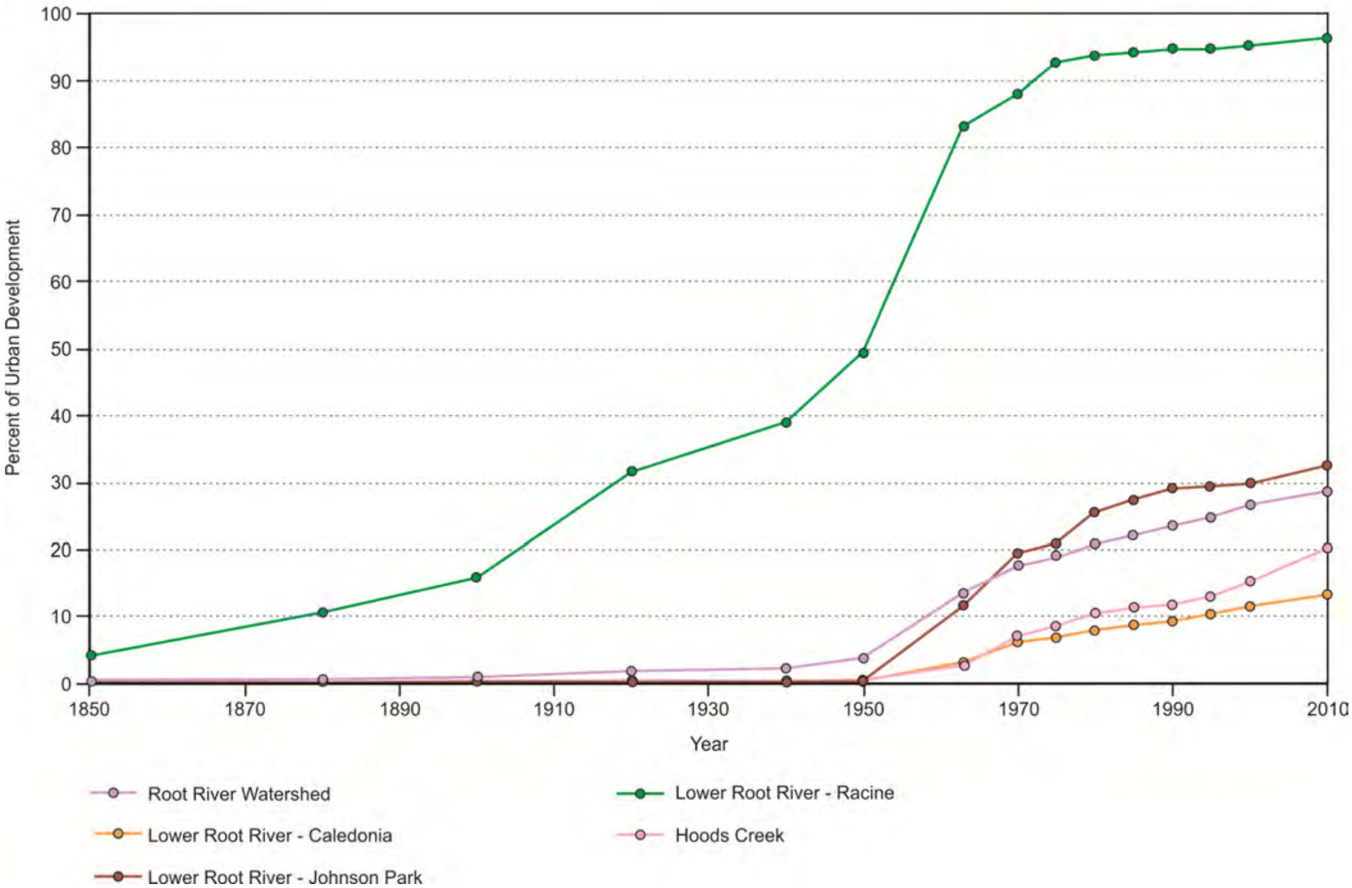
Urban Land Use

As shown in Table 14, in 2010, urban land uses encompassed about 35 percent of the total watershed area. Residential land uses comprised the largest category of largest urban land use in the watershed. These uses accounted for about 24,148 acres, or about 19.1 percent of the watershed. Transportation, communication, and utility land uses represented the next largest urban land use, accounting for about 11,200 acres, representing 8.8 percent of total watershed area. Recreational land uses covered about 3,440 acres, or about 2.7 percent of the watershed. Each of the other categories of urban land use represented less than 2 percent of watershed area.

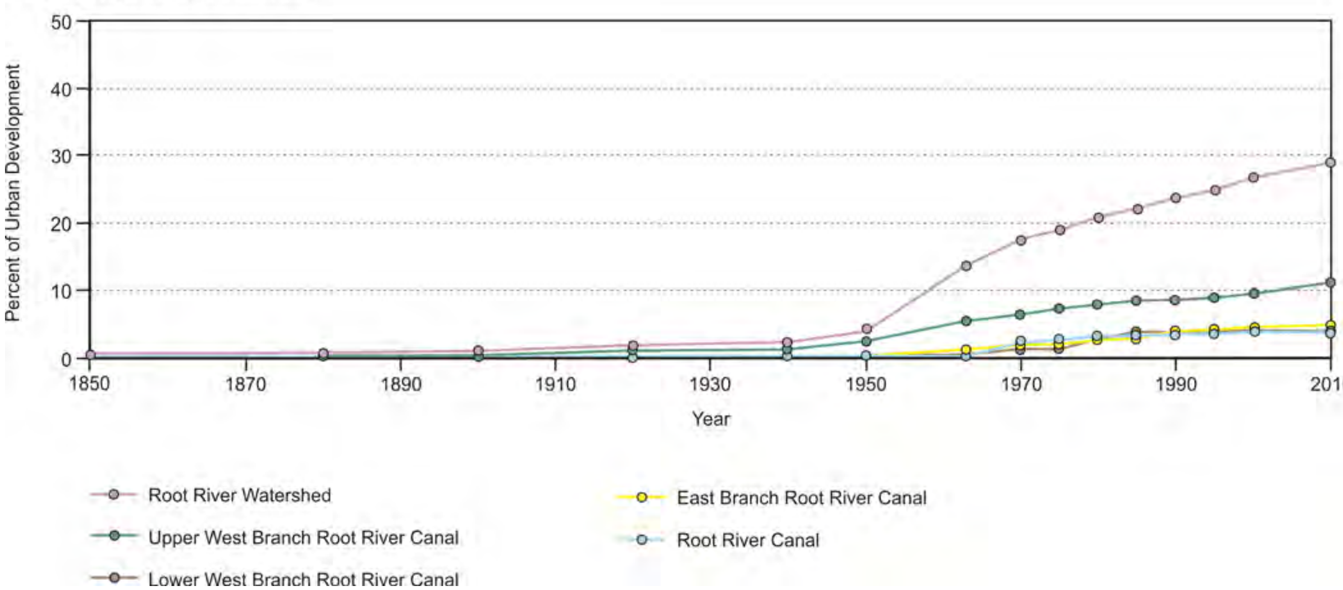
There are major differences among assessment areas in the proportion of the assessment area that is devoted to urban development. In three assessment areas—the Lower Root River-Racine, the Upper Root River, and the Upper Root River-Headwaters—urban land uses account for over 80 percent of the land within the assessment area. In three additional assessment areas—the East Branch Root River, the Middle Root River-Dale Creek, and the Whitnall Park Creek—urban land uses account for over 60 percent of the land within the assessment area. With the exception of the Lower Root River-Racine assessment area, these assessment areas are all in the northernmost portion of the watershed. By contrast, urban development represents less than 20 percent of land in the East Branch Root River Canal, Lower West Branch Root River Canal, the Middle Root River-Ryan Creek, the Root River Canal, and the Upper West Branch Root River Canal assessment areas.

Figure 2 (continued)

LOWER PORTION



ROOT RIVER CANAL PORTION



Source: SEWRPC.

Map 9

EXISTING LAND USE WITHIN THE ROOT RIVER WATERSHED: 2010

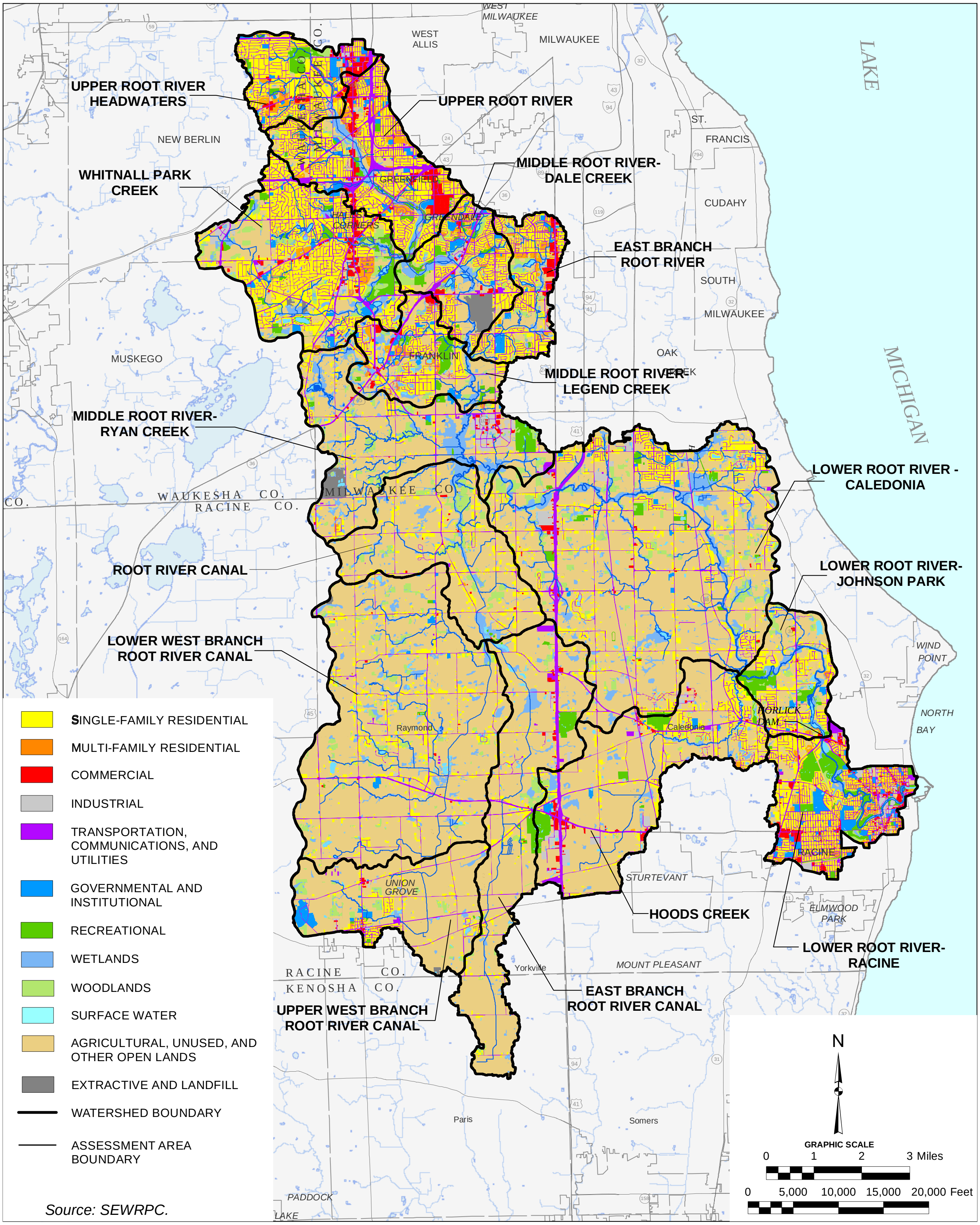


Table13

LAND USE IN THE ROOT RIVER WATERSHED (ACRES): 2010

Category	Assessment Area[a]															Total (acres)
	1 Upper Root River-Headwaters (acres)	2 Upper Root River (acres)	3 Whitnall Park Creek (acres)	4 Middle Root River-Dale Creek (acres)	5 East Branch Root River (acres)	6 Middle Root River-Legend Creek (acres)	7 Upper West Branch Root River Canal (acres)	8 Lower West Branch Root River Canal (acres)	9 East Branch Root River Canal (acres)	10 Middle Root River-Ryan Creek (acres)	11 Root River Canal (acres)	12 Lower Root River-Caledonia (acres)	13 Hoods Creek (acres)	14 Lower Root River-Johnson Park (acres)	15 Lower Root River-Racine (acres)	
Urban																
Residential																
Single-Family, Suburban Density	0	0	0	0	0	0	0	55	10	0	7	71	67	8	0	218
Single-Family, Low Density	978	1,343	3,202	291	250	542	331	1,349	503	542	752	2,371	1,016	677	371	14,518
Single-Family, Medium Density	637	1,069	544	962	895	512	157	0	14	28	0	392	204	213	840	6,467
Single-Family, High Density	74	264	0	0	0	0	0	0	0	0	0	0	0	0	740	1,078
Multi-Family	225	387	243	127	174	214	18	6	0	29	5	8	29	37	365	1,867
Commercial	199	506	236	77	185	99	31	19	52	71	21	112	160	16	304	2,088
Industrial	34	15	161	59	7	14	23	18	73	306	11	257	269	9	173	1,429
Transportation, Communication, and Utilities	647	1,547	1,297	641	485	547	313	621	531	454	242	1,565	878	297	1,135	11,200
Government and Institutional	178	253	244	143	127	122	190	78	5	51	1	116	86	55	435	2,084
Recreational	245	169	470	184	15	253	21	18	276	254	14	282	337	293	609	3,440
Subtotal	3,217	5,553	6,397	2,484	2,138	2,303	1,084	2,164	1,464	1,735	1,053	5,174	3,046	1,605	4,972	44,389
Rural																
Agriculture and Other Open Lands	139	550	1,702	591	580	1,292	4,859	14,996	7,777	4,935	5,488	14,730	6,597	1,309	423	65,968
Water	8	8	138	54	40	75	34	184	95	131	37	296	93	151	114	1,458
Wetlands	122	427	742	442	198	470	181	983	438	1,245	716	2,349	425	316	114	9,168
Woodlands	91	144	575	255	175	175	254	552	203	493	515	1,115	106	209	76	4,938
Landfill	0	0	15	0	0	0	0	11	0	229	0	3	0	0	0	258
Extractive	0	0	19	311	6	0	17	0	0	0	0	3	0	0	0	356
Subtotal	360	1,129	3,191	1,653	999	2,012	5,345	16,726	8,513	7,033	6,756	18,496	7,221	1,985	727	82,146
Total	3,577	6,682	9,588	4,137	3,137	4,315	6,429	18,890	9,977	8,768	7,809	23,670	10,267	3,590	5,699	126,535

[a] *Assessment areas are shown on Map 7.*

Source: SEWRPC.

Table 14

LAND USE IN THE ROOT RIVER WATERSHED BY PERCENTAGE: 2010

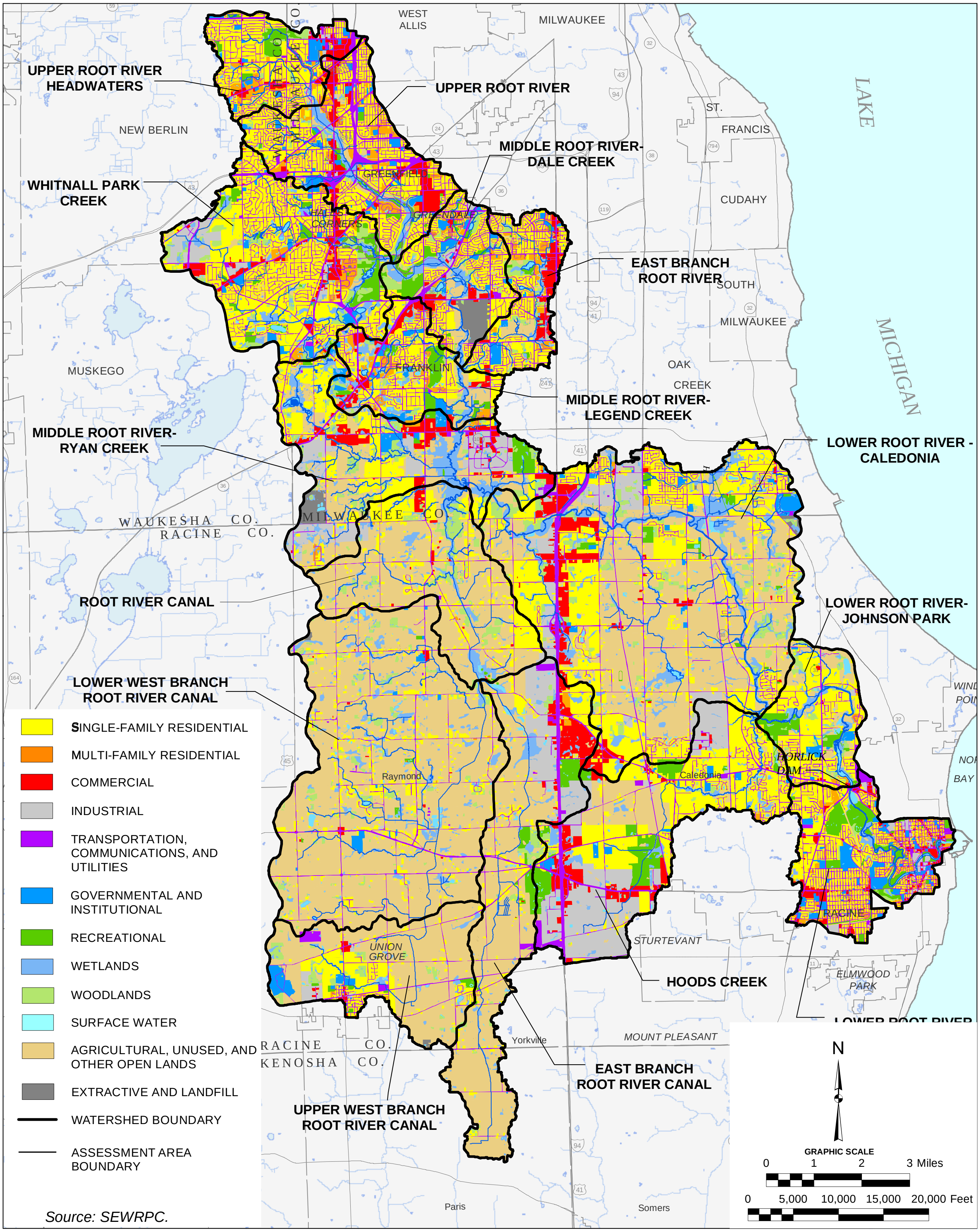
Category	Assessment Area[a]															Watershed (percent)
	1 Upper Root River-Headwaters (percent)	2 Upper Root River (percent)	3 Whitnall Park Creek (percent)	4 Middle Root River-Dale Creek (percent)	5 East Branch Root River (percent)	6 Middle Root River-Legend Creek (percent)	7 Upper West Branch Root River Canal (percent)	8 Lower West Branch Root River Canal (percent)	9 East Branch Root River Canal (percent)	10 Middle Root River-Ryan Creek (percent)	11 Root River Canal (percent)	12 Lower Root River-Caledonia (percent)	13 Hoods Creek (percent)	14 Lower Root River-Johnson Park (percent)	15 Lower Root River-Racine (percent)	
Urban																
Residential																
Single-Family, Suburban Density	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.1	0.3	0.6	0.2	0.0	0.2
Single-Family, Low Density	27.3	20.1	33.4	7.0	8.0	12.6	5.1	7.1	5.0	6.2	9.6	10.0	9.9	18.9	6.5	11.5
Single-Family, Medium Density	17.8	16.0	5.7	23.2	28.5	11.9	2.4	0.0	0.1	0.3	0.0	1.7	2.0	5.9	14.8	5.1
Single-Family, High Density	2.1	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0	0.9
Multi-Family	6.3	5.8	2.5	3.1	5.5	5.0	0.3	<0.1	0.0	0.3	0.1	<0.1	0.3	1.0	6.4	1.5
Commercial	5.6	7.6	2.5	1.9	5.9	2.3	0.5	0.1	0.5	0.8	0.3	0.5	1.6	0.4	5.3	1.7
Industrial	1.0	0.2	1.7	1.4	0.2	0.3	0.3	0.1	0.7	3.5	0.1	1.1	2.6	0.3	3.0	1.1
Transportation, Communication, and Utilities	18.1	23.2	13.5	15.5	15.5	12.7	4.9	3.3	5.3	5.2	3.1	6.6	8.6	8.3	20.0	8.8
Government and Institutional	5.0	3.8	2.5	3.5	4.0	2.8	3.0	0.4	0.1	0.6	<0.1	0.5	0.8	1.5	7.6	1.6
Recreational	6.8	2.5	4.9	4.4	0.5	5.9	0.3	0.1	2.8	2.9	0.2	1.2	3.3	8.2	10.7	2.7
Subtotal	90.0	83.2	66.7	60.0	68.1	53.5	16.8	11.4	14.6	19.8	13.5	21.9	29.7	44.7	87.3	35.1
Rural																
Agriculture and Other Open Lands	3.9	8.2	17.8	14.3	18.5	29.9	75.6	79.5	78.0	56.3	70.2	62.2	64.3	36.5	7.4	52.1
Water	0.2	0.1	1.4	1.3	1.3	1.7	0.5	1.0	1.0	1.5	0.5	1.3	0.9	4.2	2.0	1.2
Wetlands	3.4	6.4	7.7	10.7	6.3	10.9	2.8	5.2	4.4	14.2	9.2	9.9	4.1	8.8	2.0	7.2
Woodlands	2.5	2.1	6.0	6.2	5.6	4.0	4.0	2.9	2.0	5.6	6.6	14.7	1.0	5.8	1.3	3.9
Landfill	0.0	0.0	0.2	0.0	0.0	0.0	0.0	<0.1	0.0	2.6	0.0	<0.1	0.0	0.0	0.0	0.2
Extractive	0.0	0.0	0.2	7.5	0.2	0.0	0.3	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.3
Subtotal	10.0	16.8	33.3	40.0	31.9	46.5	83.2	88.6	85.4	80.2	86.5	78.1	70.3	55.3	12.7	64.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] *Assessment areas are shown on Map 7.*

Source: SEWRPC.

Map 10

PLANNED LAND USE WITHIN THE ROOT RIVER WATERSHED: 2035



Source: SEWRPC.

Table 15

PLANNED LAND USE IN THE ROOT RIVER WATERSHED (ACRES): 2035

Category	Assessment Area[a]															Total (acres)
	1 Upper Root River-Headwaters (acres)	2 Upper Root River (acres)	3 Whitnall Park Creek (acres)	4 Middle Root River-Dale Creek (acres)	5 East Branch Root River (acres)	6 Middle Root River-Legend Creek (acres)	7 Upper West Branch Root River Canal (acres)	8 Lower West Branch Root River Canal (acres)	9 East Branch Root River Canal (acres)	10 Middle Root River-Ryan Creek (acres)	11 Root River Canal (acres)	12 Lower Root River-Caledonia (acres)	13 Hoods Creek (acres)	14 Lower Root River-Johnson Park (acres)	15 Lower Root River-Racine (acres)	
Urban																
Residential																
Single-Family, Suburban Density	0	0	258	0	0	0	0	79	42	0	34	103	67	8	0	591
Single-Family, Low Density	1,005	1,424	3,560	339	286	740	763	1,388	539	1,599	1,237	3,865	2,339	1,237	431	20,752
Single-Family, Medium Density	645	1,097	552	981	937	607	175	0	186	53	0	1,443	502	226	919	8,323
Single-Family, High Density	74	264	0	0	0	0	0	0	0	0	0	0	0	0	754	1,092
Multi-Family	235	511	312	129	206	331	22	6	47	78	5	44	26	41	420	2,413
Commercial	221	554	355	143	318	251	53	44	404	527	85	862	514	17	341	4,689
Industrial	32	17	448	61	8	15	124	18	1,009	1,106	78	995	2,358	10	192	6,471
Transportation, Communication, and Utilities	649	1,559	1,517	666	527	661	502	628	803	929	386	2,519	1,668	439	1,184	14,637
Government and Institutional	204	298	286	150	129	245	226	119	5	209	1	275	155	105	467	2,874
Recreational	248	162	559	272	42	307	68	27	357	263	14	254	747	293	612	4,225
Subtotal	3,313	5,886	7,847	2,741	2,453	3,157	1,933	2,309	3,392	4,764	1,840	10,360	8,376	2,376	5,320	66,067
Rural																
Agriculture and Other Open Lands	43	218	283	319	262	436	4,010	14,851	5,849	1,906	4,701	9,507	1,267	538	75	44,265
Water	8	8	141	54	40	75	34	184	95	131	37	296	93	151	114	1,461
Wetlands	122	427	742	442	198	472	181	983	438	1,245	716	2,347	425	316	114	9,168
Woodlands	91	143	575	255	175	175	254	552	203	493	515	1,115	106	209	76	4,937
Landfill	0	0	0	0	0	0	0	11	0	229	0	42	0	0	0	282
Extractive	0	0	0	326	9	0	17	0	0	0	0	3	0	0	0	355
Subtotal	264	796	1,741	1,396	684	1,158	4,496	16,581	6,585	4,004	5,969	13,310	1,891	1,214	379	60,468
Total	3,577	6,682	9,588	4,137	3,137	4,315	6,429	18,890	9,977	8,768	7,809	23,670	10,267	3,590	5,699	126,535

[a] *Assessment areas are shown on Map 7.*

Source: SEWRPC.

Table 16

PLANNED LAND USE IN THE ROOT RIVER WATERSHED BY PERCENTAGE: 2035

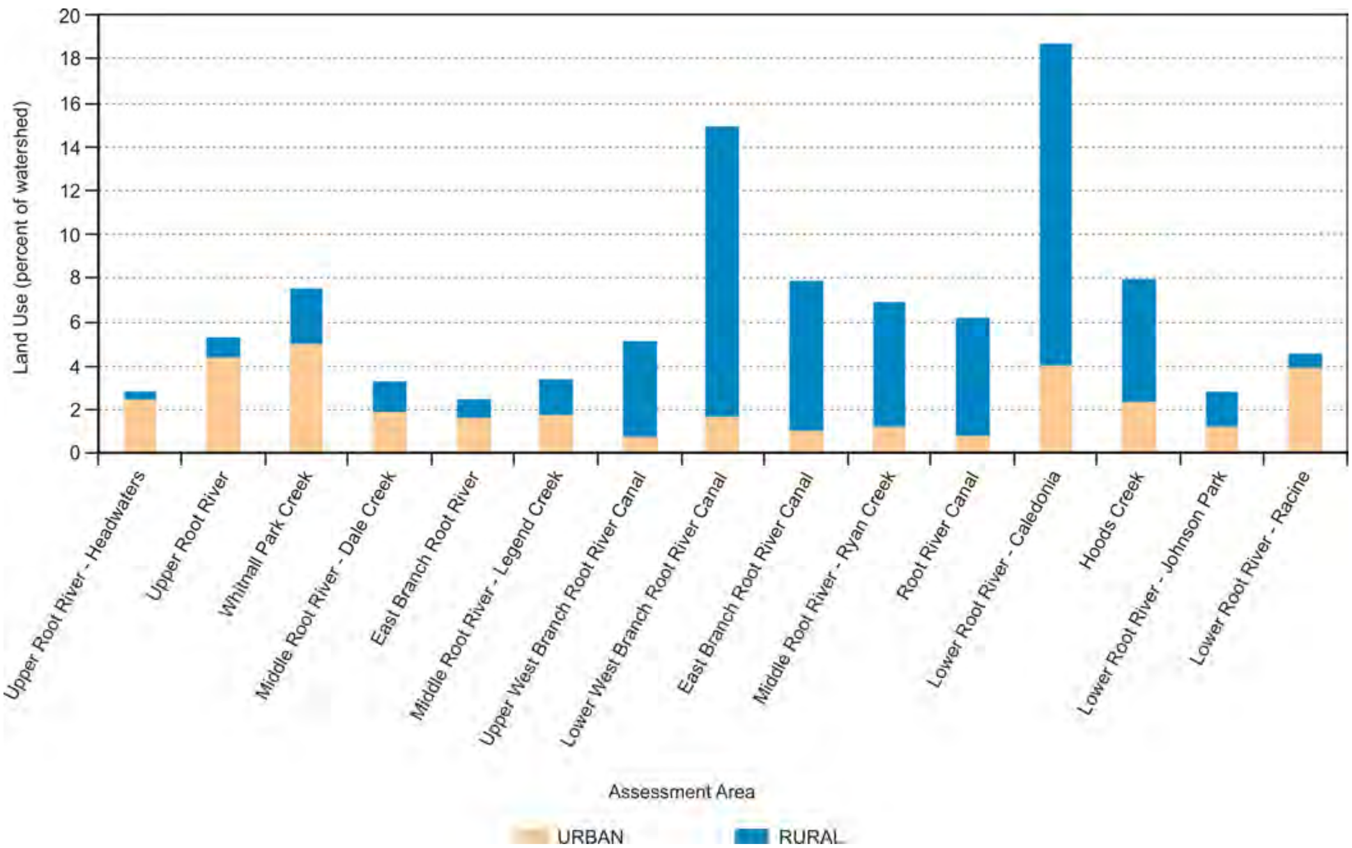
Category	Assessment Area[a]															
	1 Upper Root River-Headwaters (percent)	2 Upper Root River (percent)	3 Whitnall Park Creek (percent)	4 Middle Root River-Dale Creek (percent)	5 East Branch Root River (percent)	6 Middle Root River-Legend Creek (percent)	7 Upper West Branch Root River Canal (percent)	8 Lower West Branch Root River Canal (percent)	9 East Branch Root River Canal (percent)	10 Middle Root River-Ryan Creek (percent)	11 Root River Canal (percent)	12 Lower Root River-Caledonia (percent)	13 Hoods Creek (percent)	14 Lower Root River-Johnson Park (percent)	15 Lower Root River-Racine (percent)	Watershed (percent)
Urban																
Residential																
Single-Family, Suburban Density	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.4	0.4	0.6	0.2	0.0	0.5
Single-Family, Low Density	28.1	21.3	37.1	8.2	9.1	17.2	11.9	7.4	5.4	18.2	15.8	16.3	22.8	34.5	7.6	16.3
Single-Family, Medium Density	18.0	16.4	5.8	23.7	29.9	14.1	2.7	0.0	1.9	0.6	0.0	6.1	4.9	6.3	16.1	6.6
Single-Family, High Density	2.1	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2	0.9
Multi-Family	6.6	7.6	3.3	3.1	6.6	7.7	0.3	<0.1	0.5	0.9	0.1	0.2	0.3	1.1	7.4	1.9
Commercial	6.2	8.3	3.7	3.4	10.1	5.8	0.8	0.2	4.0	6.0	1.1	3.6	5.0	0.5	6.0	3.7
Industrial	1.0	0.3	4.7	1.5	0.2	0.3	1.9	0.1	10.1	12.6	1.0	4.2	23.0	0.3	3.4	5.1
Transportation, Communication, and Utilities	18.1	23.3	15.8	16.1	16.8	15.3	7.8	3.3	8.0	10.6	4.9	10.6	16.3	12.2	20.8	11.6
Government and Institutional	5.7	4.5	3.0	3.6	4.1	5.7	3.5	0.6	0.1	2.4	<0.1	1.2	1.5	2.9	8.2	2.3
Recreational	6.9	2.4	5.8	6.6	1.3	7.1	1.1	0.2	3.6	3.0	0.2	1.1	7.3	8.2	10.7	3.3
Subtotal	92.7	88.1	81.9	66.2	78.1	73.2	30.0	12.2	34.0	54.3	23.5	43.7	81.7	66.2	93.4	52.2
Rural																
Agriculture and Other Open Lands	1.2	3.3	2.9	7.7	8.4	10.2	62.4	78.7	58.6	21.8	60.2	40.2	12.3	15.0	1.3	35.0
Water	0.2	0.1	1.5	1.3	1.3	1.7	0.5	1.0	1.0	1.5	0.5	1.3	0.9	4.2	2.0	1.2
Wetlands	3.4	6.4	7.7	10.7	6.3	10.9	2.8	5.2	4.4	14.2	9.2	9.9	4.1	8.8	2.0	7.2
Woodlands	2.5	2.1	6.0	6.2	5.6	4.0	4.0	2.9	2.0	5.6	6.6	4.7	1.0	5.8	1.3	3.9
Landfill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	2.6	0.0	0.2	0.0	0.0	0.0	0.2
Extractive	0.0	0.0	0.0	7.9	0.3	0.0	0.3	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.3
Subtotal	7.3	11.9	18.1	33.8	21.9	26.8	70.0	87.8	66.0	45.7	76.5	56.3	18.3	33.8	6.6	47.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] *Assessment areas are shown on Map 7.*

Source: SEWRPC.

Figure 3

PERCENT OF URBAN VERSUS RURAL LAND USE AMONG ASSESSMENT AREAS WITHIN THE ROOT RIVER WATERSHED: 2000



Source: SEWRPC.

The existing and planned sanitary sewer service areas in the Root River watershed are shown on Map 11. These sewer service areas have been delineated through a local sewer service area planning process. As part of this process, the community concerned, assisted by SEWRPC, determines a precise sewer service area boundary consistent with local land use plan and development objectives. Sewer service area plans also include detailed maps that identify the extent of environmentally sensitive lands within each sewer service area, wherein sanitary sewer extensions will be approved only on a special exception basis. These sensitive lands include all primary environmental corridors and those portions of secondary environmental corridors and isolated natural resource areas comprised of wetlands, 1-percent-annual-probability floodplain, shoreland areas, and areas with slope of 12 percent or greater. Within these areas, sewered development is confined to limited recreational and institutional uses and rural-density (one dwelling unit per five acres of upland) residential development in upland areas. Following adoption of the plan by the designated management agency for the wastewater treatment plant, local sewer service area plans are considered for adoption by SEWRPC as a formal amendment to the regional water quality management plan. The Commission then forwards the plans to the WDNR for approval.

The existing areas served by public sanitary sewerage systems in the Root River watershed total about 36,440 acres, or about 29 percent of the watershed. The planned sewer service areas, including the existing service areas, total about 71,520 acres, or about 57 percent of the watershed. The planned areas include enclaves of urban development that are not currently served by public sanitary sewerage systems. These enclaves cover an area of

Map 11

PLANNED SEWER SERVICE AREAS AND AREAS SERVED BY SEWER WITHIN THE ROOT RIVER WATERSHED

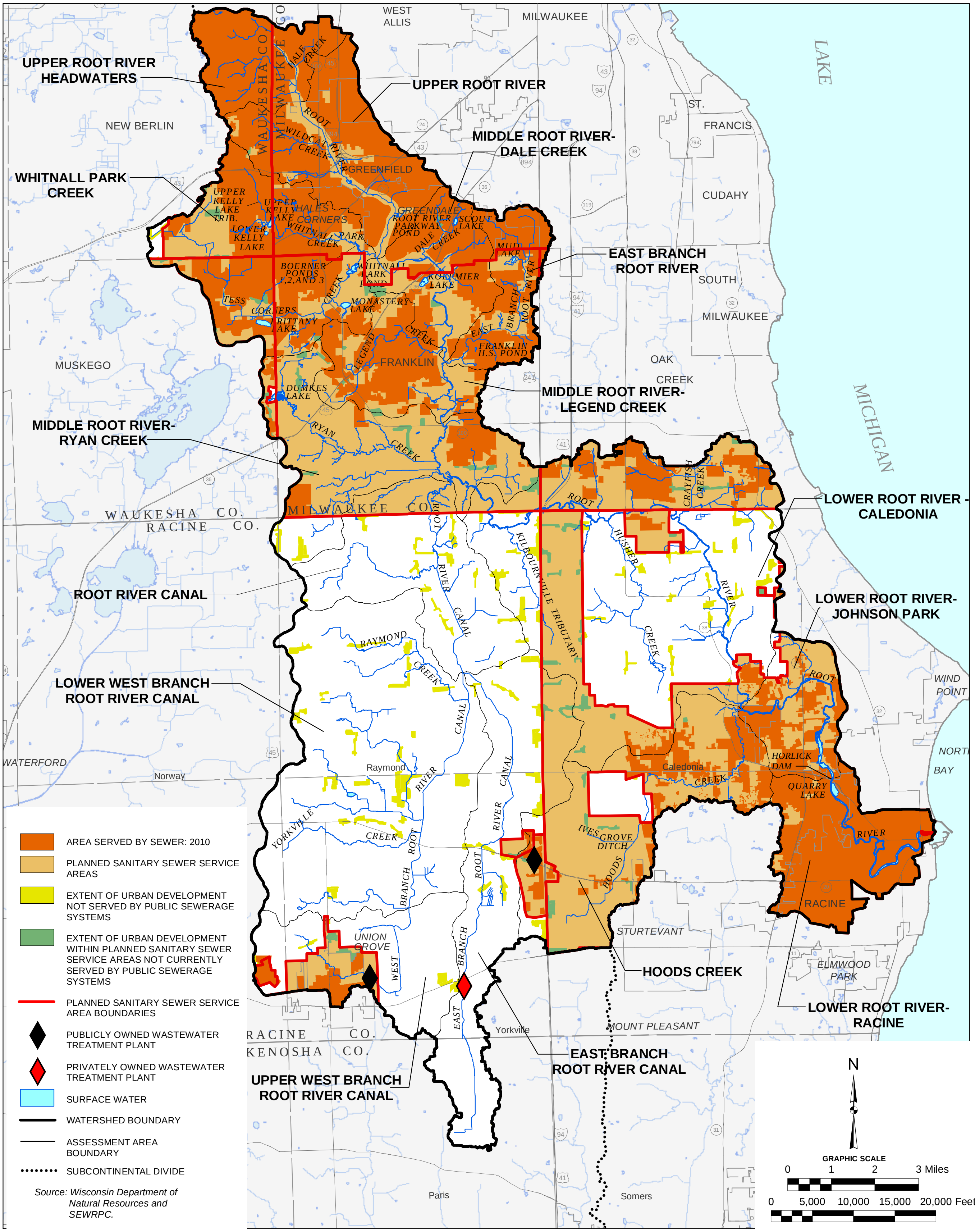


Table 17

PLANNED SANITARY SEWER SERVICE AREAS IN THE ROOT RIVER WATERSHED: 2012

Assessment Area	Planned Sewer Service Area (acres)	Area Served by Public Sanitary Sewerage Systems (acres)	Urban Areas within Planned Sewer Service Area Development Not Currently Served by Public Sanitary Sewerage Systems (acres)	Urban Development Outside of Planned Sewer Service Area (acres)
Upper Root River Headwaters	3,576.9	3,456.9	57.8	0.0
Upper Root River	6,681.6	5,644.1	161.3	0.0
Whitnall Park Creek	9,421.8	6,357.7	260.3	65.6
Middle Root River-Dale Creek	4,137.3	2,542.6	167.7	0.0
East Branch Root River	3,136.7	2,459.8	42.2	0.0
Middle Root River-Legend Creek	4,315.0	2,625.1	86.0	0.0
Upper West Branch Root River Canal	1,488.9	617.6	92.4	115.4
Lower West Branch Root River Canal	4.4	0.0	2.5	760.2
East Branch Root River Canal	1,485.3	17.7	82.0	382.1
Middle Root River-Ryan Creek	7,792.9	1,239.7	281.8	115.5
Root River Canal	1,040.6	0.0	0.0	304.7
Lower Root River-Caledonia	10,329.0	2,076.9	530.6	831.1
Hoods Creek	9,000.6	2,224.1	393.0	75.3
Lower Root River-Johnson Park	3,421.3	1,640.7	125.9	0.0
Lower Root River-Racine	5,690.1	5,536.5	40.0	0.0
Total	71,522.4	36,439.4	2,323.5	2,649.9

Source: SEWRPC.

about 2,320 acres, or slightly less than 2 percent of the watershed. In addition, there are enclaves of urban development outside of the planned sewer service areas that are not currently served by public sanitary sewerage systems. These enclaves cover an area of about 2,650 acres, or about 2 percent of the watershed. Urban development in both of these types of enclaves is served by onsite sewage disposal systems.

Several assessment areas contain land which is outside of planned sewer service areas (see Map 11). All of the Lower West Branch Root River Canal assessment area and large portions of the East Branch Root River Canal, Lower Root River-Caledonia, Lower West Branch Root River Canal, Root River Canal, and Upper West Branch Root River Canal assessment areas are outside of planned sewer service areas. In addition, relatively smaller portions of the Hoods Creek and the Middle Root River-Ryan Creek assessment areas are outside planned sewer service areas. The amount of each assessment area that is within planned sewer service area is summarized in Table 17.

As previously noted, urban development in areas not served by sanitary sewerage systems is served by onsite sewage disposal systems. An onsite sewage disposal system may be a conventional septic tank system; a mound system; an alternative system, such as an aerobic treatment unit or a sand filter; or a holding tank. Failure of an onsite sewage disposal system occurs when the soils surrounding the seepage area will no longer accept or properly stabilize the effluent, when the groundwater rises to levels which will no longer allow uptake of liquid effluent by the soils, or when age or lack of proper maintenance cause the system to malfunction. Hence, onsite disposal system failure may result from installation in soils with severe limitations for system use, improper design or installation of the system, or inadequate maintenance.

The pollution of surface water and groundwater from onsite sewage disposal systems potentially can be worsened by:

- The lack of resources for adequate inspection of systems, resulting in the continued use of systems that should be upgraded or replaced,

- The lack of public education on the proper operation and maintenance of private onsite sewage disposal systems, and

- Operation and maintenance abuses such as pumping from systems into ditches, puncturing tanks, and commercial haulers discharging effluent to surface waters.

Map 12 shows that about 1,877 acres of the urban-density enclaves that are served by onsite sewage disposal systems were developed prior to 1980. These older systems may be at particular risk for malfunctioning. It is likely that some of the systems within these enclaves have been replaced since 1980. For example, from 1981 through 2011 Racine County issued 2,310 permits for replacement of failing onsite sewage treatment systems within the County.[2]

Rural Land Use

As shown in Table 14, in 2010, rural lands—consisting of woodlands, wetlands, surface water, agricultural croplands and other open lands—comprised about 65 percent of the total land area of the Root River watershed. Agricultural and other open land uses were the largest rural land use in the watershed, encompassing about 52 percent of the total land area. Agricultural land use is divided between active cropland and other open lands, which includes farm buildings, pastures, grasslands that have not succeeded to wetland or woodland communities, and lands adjacent to cropland, such as treelines and hedgerows. Surface water, wetlands, and woodlands comprised about 12 percent of the land area in the watershed.

Historically, agricultural land was the most dominant land use and comprised about 62 percent of the total watershed area in 1970. Comparing this area of land with the year 2010 data, there has been a loss of nearly 18,000 acres. This agricultural land has been largely converted into urban land uses, altering how the landscape is used, with resultant consequences for water quality, water quantity, and wildlife.

Planned Land Use: 2035

Planned 2035 land use in the Root River watershed is shown on Map 10 and summarized in Tables 15 and 16. Under planned 2035 land use conditions, about 66,067 acres, or 52 percent of the watershed, are anticipated to be in urban land uses. Much of the increase in urban development between 2010 and 2035 is anticipated to result from residential development. Comparison of Tables 15 and 16 shows that this land use is anticipated to increase by over 9,000 acres between 2010 and 2035. Much of this growth in residential lands is anticipated to be at low densities. Several other urban land uses are also anticipated to increase between 2010 and 2035. This includes an increase of over 5,000 acres in the amount of land devoted to industrial land uses; an increase of about 3,400 acres in the amount of land devoted to transportation, communication, and utility uses; and an increase of about 2,600 acres in the amount of land devoted to commercial uses. Most of the increase in urban development is anticipated to result from conversion of agricultural and other open lands to urban lands.

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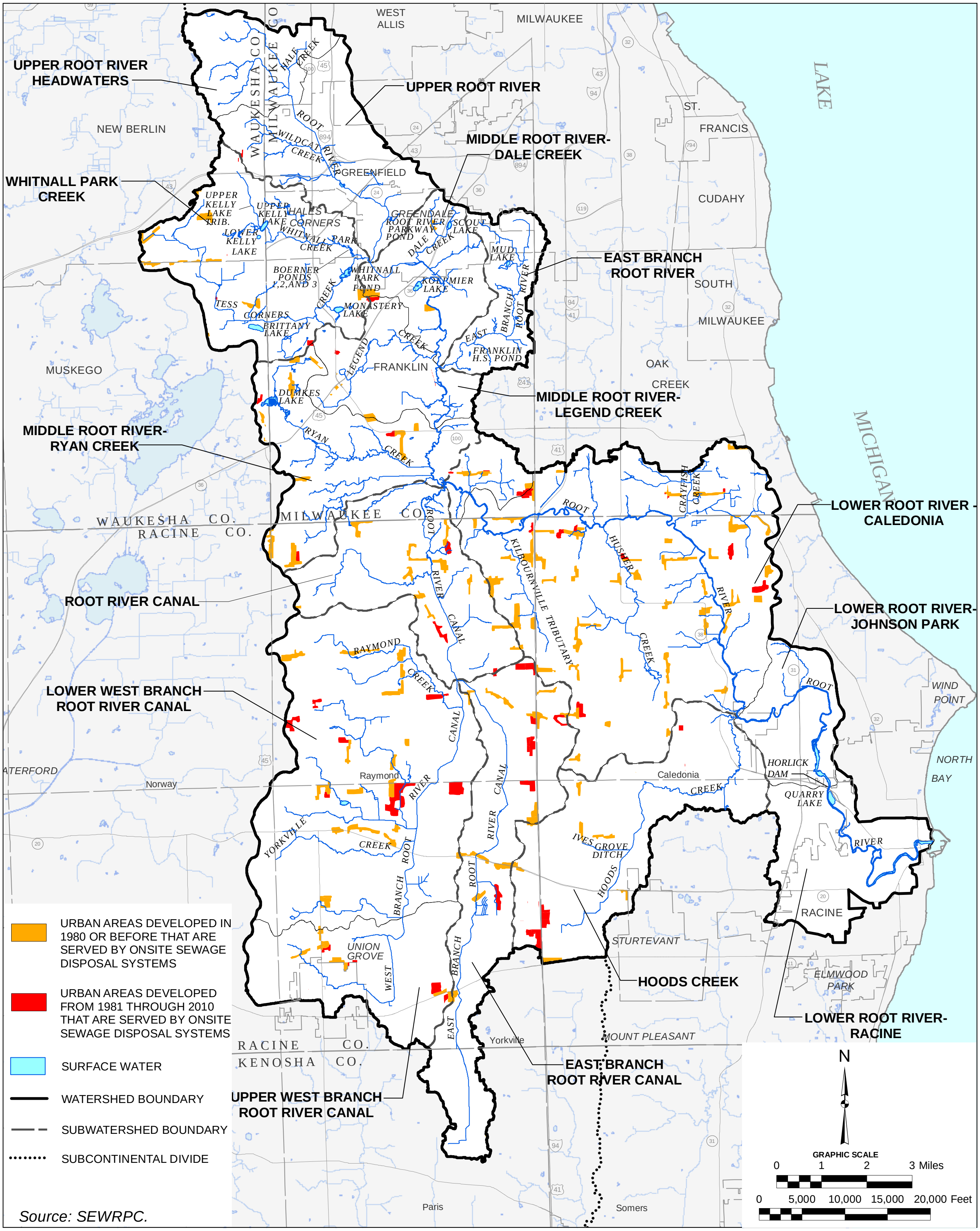
[2]*These data were not available on a watershed basis.*

Map 12

URBAN AREAS WITHIN THE ROOT RIVER WATERSHED THAT ARE SERVED BY ONSITE SEWAGE DISPOSAL SYSTEMS: 1980 AND PRIOR AND 1981 THROUGH 2010



Source: SEWRPC.

Between 2010 and 2035, it is anticipated that land will be converted to urban land uses in several portions of the watershed. These areas include the IH 94/USH 41 corridor in Milwaukee and Racine Counties, the corridors along STH 20 and CTH K/Northwestern Avenue in the Villages of Caledonia and Mt. Pleasant, western and southern portions of the City of Franklin, southern portions of the City of Oak Creek, eastern portions of the Cities of Muskego and New Berlin, and areas adjacent to the City of Racine and the Village of Union Grove. In addition, it is anticipated that infill development will occur within previously urbanized portions of the watershed.

It is anticipated that between 2010 and 2035 most assessment areas within the watershed will experience increases in their levels of urban development. Map 13 shows the percentages of urban development within each assessment area in 2010. Map 14 shows the percentage of urban development within each assessment area that is anticipated to be present in 2035, according to the regional land use plan. Comparison of these two maps illustrates the changes that are anticipated to occur in the assessment areas over this period. The number of assessment areas in the watershed with greater than 80 percent urban development is expected to increase from three in 2010 to five in 2035. The number of assessment areas in the watershed with 20 percent or less urban development is expected to decrease from five in 2010 to one in 2035. Especially large increases in the percentage of urban development are anticipated to occur in the Hoods Creek and Middle Root River-Ryan Creek assessment areas, with about 52 percent and 34 percent, respectively, of the land in these areas being converted from rural to urban land uses.

CLIMATE

Long-term average annual air temperature and total precipitation values for the Root River watershed are set forth in Figures 4 and 5, respectively. These averages were taken from official National Oceanic and Atmospheric Administration (NOAA) records for the weather recording stations at General Mitchell International Airport in Milwaukee (GMIA) and the John Batten Airport in Racine. These stations were selected because they have the longest and most complete records of meteorological conditions of any of the weather stations in the vicinity of the watershed. Due to their relative proximity to the project area and the fact that they are located near different portions of the watershed, the records of these stations may be considered to represent the range of conditions typical of the entire watershed. Some years were not characterized at the Racine station because of large amounts of missing data in the record.

The mean annual temperature at Milwaukee between 1940 and 2011 was 47.1 degrees Fahrenheit (°F), and the mean annual precipitation was 32.20 inches. The mean annual temperature at Racine over this same time period was 47.6 degrees Fahrenheit (°F), and the mean annual precipitation was 34.82 inches. Figures 4 and 5 show that variability in these parameters is high from year to year. This contributes to the fact that a statistically significant linear trend in either the temperature or precipitation data over the period of record could not be found. The figures distinguish warm years from cold years and wet years from dry years. These distinctions are based upon the calculated upper and lower limits of the 99 percent confidence intervals for the entire period of record at each station.[3]

Based upon the resulting classification of warm and cold years shown in Figure 4, it is easy to see that there was a much higher proportion of warmer years after 1985, indicating that the past 27 years have been relatively warmer than the preceding years in the 72-year period of record. At the Milwaukee station for example, 18 of the 27 years from 1985 through 2011, or about 67 percent of the period, were classified as warm compared to three of the

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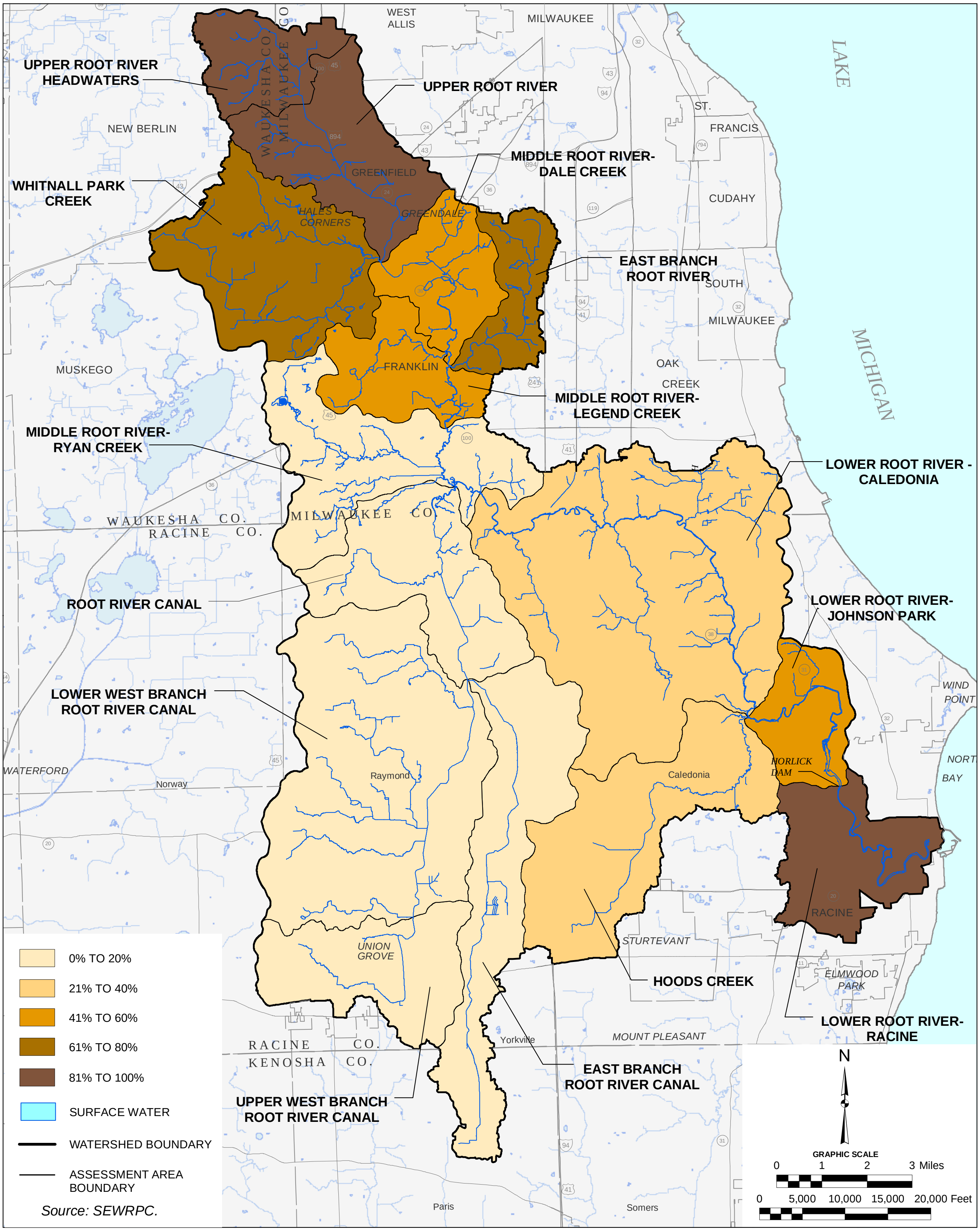
[3]*The 99 percent confidence interval is a statistical measure of the range of values that has a 99 percent probability of including the actual mean value of a parameter based upon the data used to estimate the mean. It expresses a "likely" range for the true average value of the parameter. It can serve as a means of characterizing "normal" conditions, with values of the mean that are within the 99 percent confidence interval being considered normal and values of the mean that are outside of the interval being considered different from normal.*

Map 13

URBAN LAND USES WITHIN ASSESSMENT AREAS IN THE ROOT RIVER WATERSHED: 2010



Source: SEWRPC.

Map 14

PLANNED URBAN LAND USES WITHIN ASSESSMENT AREAS IN THE ROOT RIVER WATERSHED: 2035

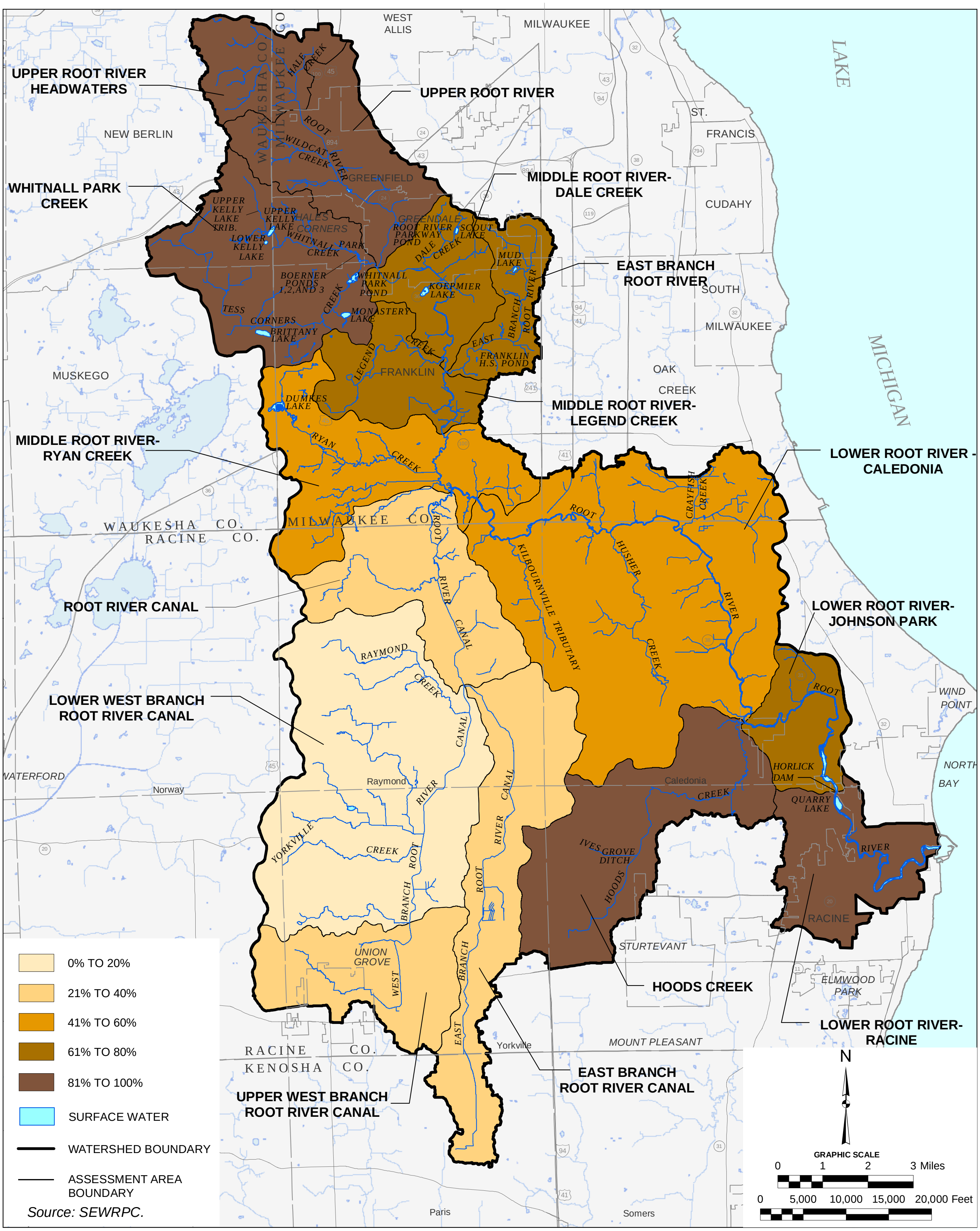
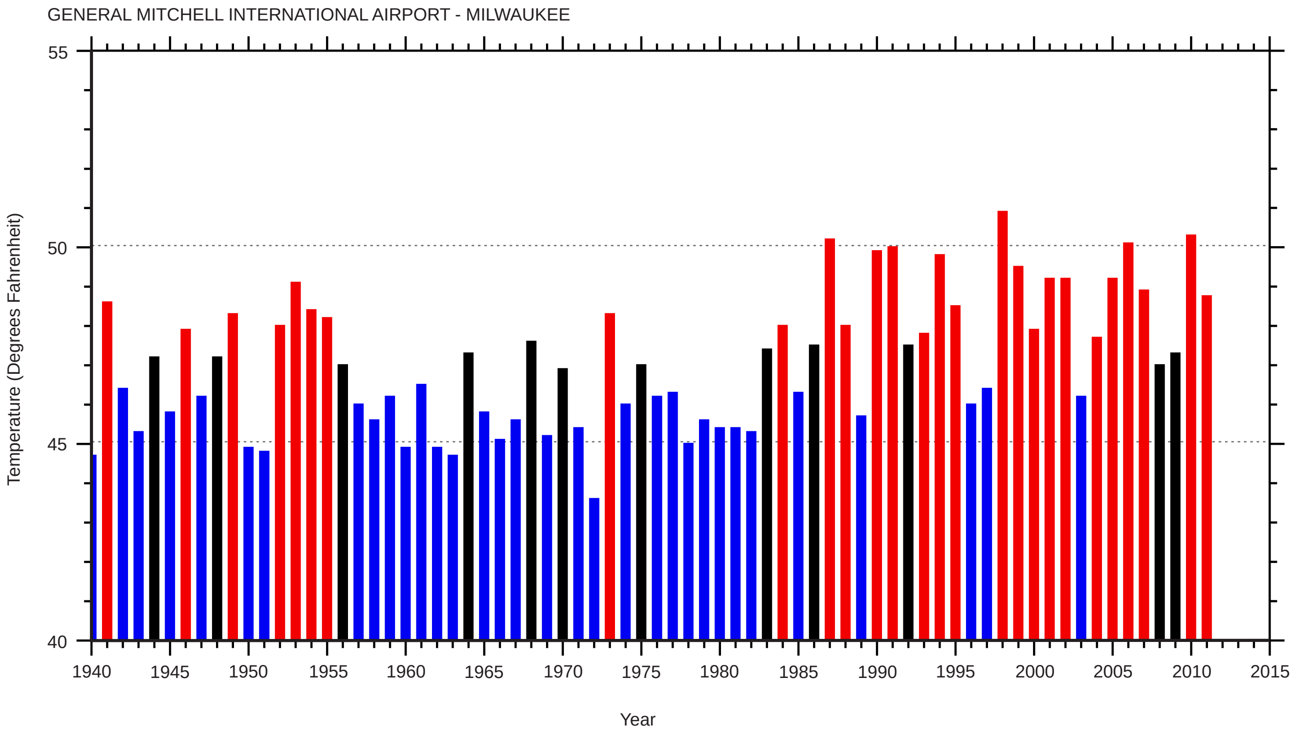
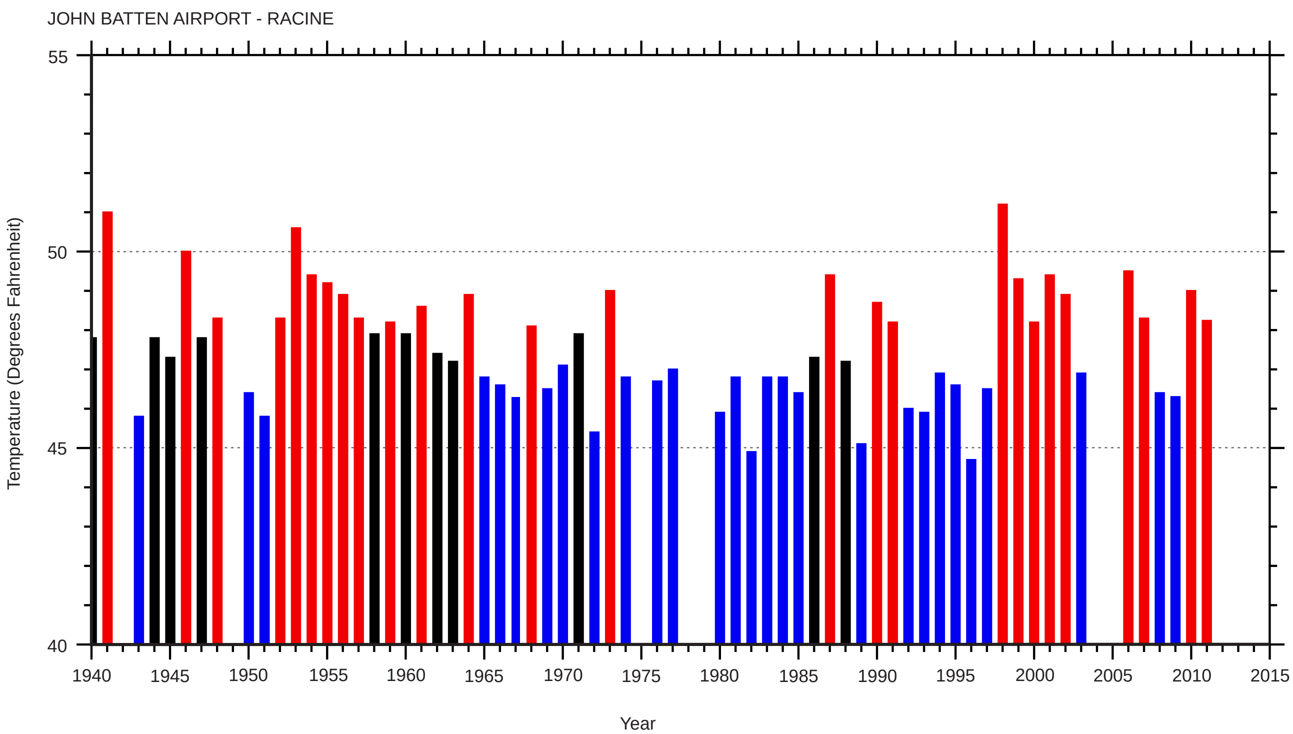


Figure 4

AVERAGE ANNUAL TEMPERATURE AT THE NOAA WEATHER RECORDING STATIONS AT GENERAL MITCHELL INTERNATIONAL AIRPORT AND RACINE: 1940-2011



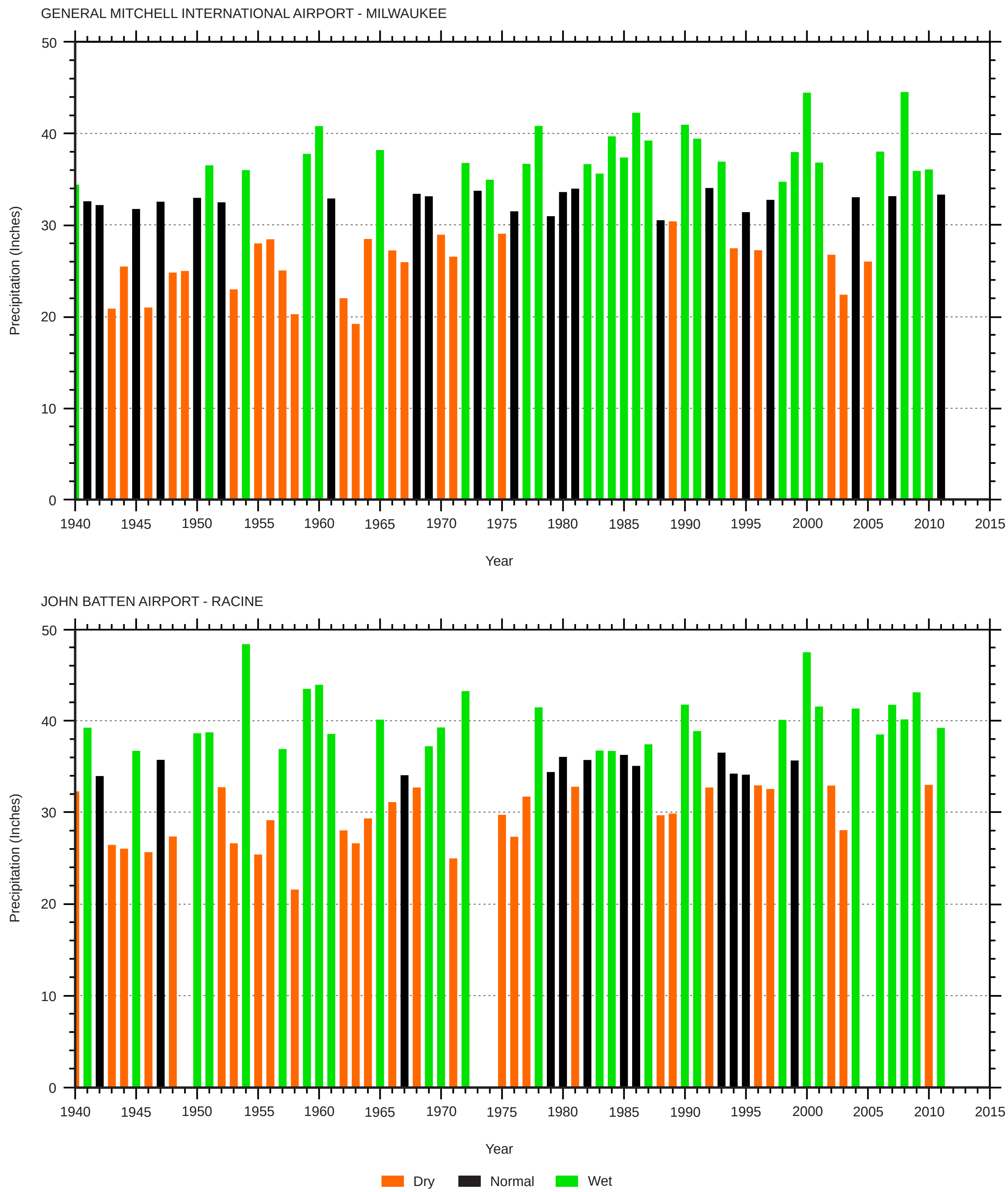


NOTE: Cool years and warm years were determined by the 99 percent lower and upper confidence intervals of the mean for the entire period of record 1940-2011. For General Mitchell International Airport, annual average temperatures that are lower than 46.6 degrees Fahrenheit were classified as cool, annual average temperatures that are higher than 47.6 degrees Fahrenheit were classified as warm, and all other years were classified as normal. For Racine, annual average temperatures lower than 47.2 degrees Fahrenheit were classified as cool, annual average temperatures higher than 48.0 degrees Fahrenheit were classified as warm, and all the other years were classified as normal.

Source: National Oceanic and Atmospheric Administration and SEWRPC.

Figure 5

TOTAL ANNUAL PRECIPITATION AT THE NOAA WEATHER RECORDING STATIONS AT GENERAL MITCHELL INTERNATIONAL AIRPORT AND RACINE: 1940-2011



NOTE: Dry years and wet years were determined by the 99 percent lower and upper confidence intervals of the mean for the entire period of record 1940-2011. For General Mitchell International Airport, years with total annual precipitation that are lower than 30.39 inches were classified as dry, years with total annual precipitation that are higher than 34.0 inches were classified as wet, and all other years were classified as normal. For Racine, years with total annual precipitation lower than 33.01 inches were classified as dry, years with total annual precipitation higher than 36.64 inches were classified as wet, and all the other years were classified as normal.

Source: National Oceanic and Atmospheric Administration and SEWRPC.

29 years from 1956 through 1984, or about 10 percent of the period of record. This difference is also present, though less pronounced in the data from the Racine station. A this site, 12 of the 25 years from 1985 through 2011 for which adequate temperature data were available, or about 44 percent of the period, were classified as warm as compared to eight of the 27 years of available data from 1956 through 1984, or about 30 percent of the period of record. The weaker difference in conditions may be due in part to the large amount of missing data at the Racine weather station.

The classification of wet and dry years shown in Figure 5 suggests that a similar change has occurred in precipitation conditions in northern portions of the Root River watershed. This change in annual precipitation seems to appear earlier than the change in average annual temperature shown in Figure 4. At the Milwaukee station, 19 of the 37 years from 1975 through 2011, or about 51 percent of the period, were classified as wet compared to seven of the 30 years from 1945 through 1974, or about 23 percent of the period of record. The data from the Racine station did not show this difference; however, because of missing data, several years within the period of record for this station were not included in the analysis. It should be noted that in a similar analysis of data collected at the weather station at Union Grove, 16 of the 36 years from 1976 through 2011, or about 44 percent of the period, were classified as wet compared to eight of the 24 years of available data between 1945 and 1975, or about 33 percent of the period of record.

Based on this analysis, it seems that there has been a shift from dryer and cooler conditions to wetter and warmer conditions in the Root River watershed over the period of record. These climatic conditions are drivers of water quality conditions within lake and stream systems and are important considerations in water quality assessments.[4]

Winter temperature and precipitation trends are potentially important indicators for short- and long-term aquatic health and recreation. Winter temperatures are a major determinant of nonnative aquatic plant growth in lakes and streams in the Midwest. Warmer winters can provide advantages to nonnative species. For example, continued growth of Eurasian water milfoil (*Myriophyllum spicatum*) under the ice or early emergence following spring iceout contributes to the degradation of the native aquatic plant community, impairment of water uses, and increased management costs and/or user conflicts. Warmer winters also may provide opportunities for colonization by other nonnative plant species, such as Hydrilla (*Hydrilla verticillata)* and fishes, among others. Warmer winters also may result in decreased winter recreational opportunities, limiting ice fishing and snowmobiling due to unsafe or variable ice conditions. Figure 6 shows the departures of annual winter average temperatures from the long-term average winter temperatures at the GMIA and Racine weather stations. These data suggest that winters were generally colder prior to 1985 and warmer since 1985, with five of warmest winters on record at Milwaukee and three of the warmest winters on record at Racine occurring during this latter period. On average, winter temperatures since 1985 have been 1.7°F above the long-term mean at the GMIA station and 0.6°F above the long-term mean at the Racine station. The recent winter warming is consistent with other observations throughout the State of Wisconsin. Figure 7 shows the departures of annual winter average precipitation from the long-term average winter precipitation at the GMIA and Racine weather stations. These data show that since the mid-1990s, annual winter precipitation, while highly variable, has been about 0.5 inch above the average.

Approximately one-third of the annual precipitation occurs during the winter or early spring when the ground may be frozen. This may result in higher surface runoff rates and/or volumes, especially when air temperatures are high enough for the precipitation to fall as rain or cause rapid snowmelt, or to result in rainfall with associated snowmelt.

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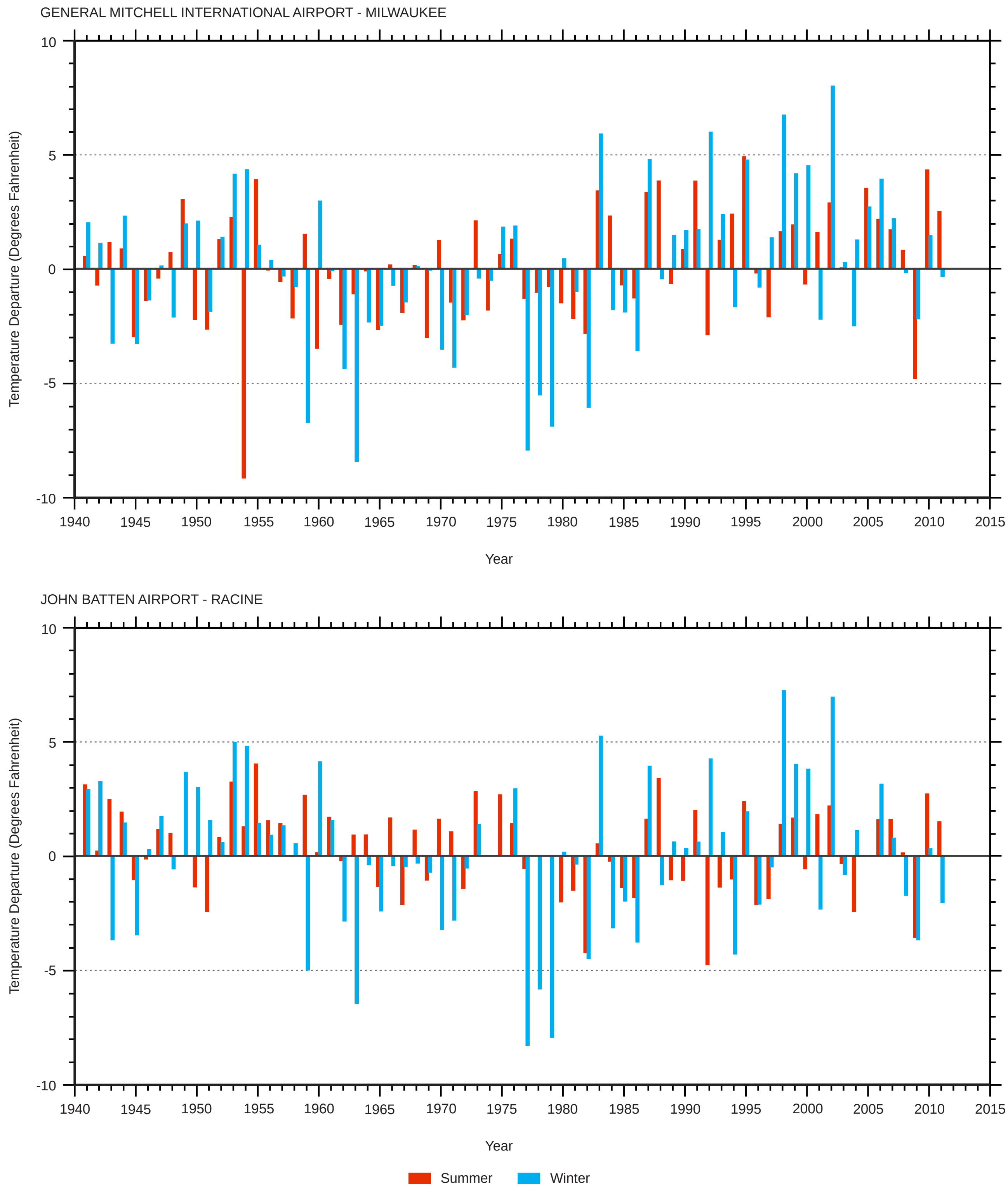
[4]*Wisconsin Academy of Sciences, Arts and Letters,* Waters of Wisconsin: The Future of Our Aquatic Ecosystems and Resources, *Madison, Wisconsin, 2003.*

Figure 6

SUMMER AND WINTER TEMPERATURE DEPARTURES FROM SEASONAL AVERAGES AT THE NOAA WEATHER RECORDING STATIONS AT GENERAL MITCHELL INTERNATIONAL AIRPORT AND RACINE: 1940-2011

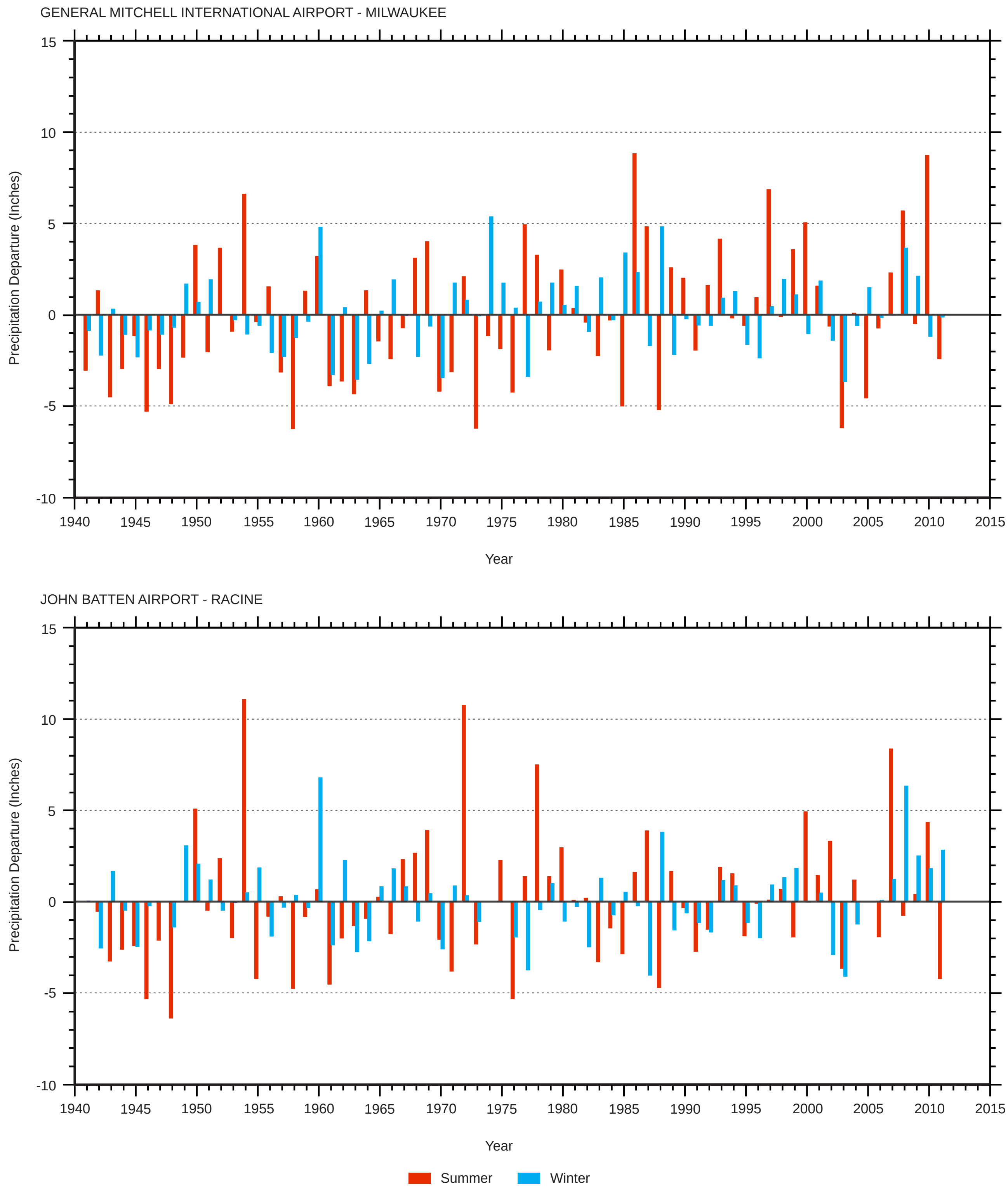


NOTE: Summer was defined as the months of June, July, and August. Mean summer temperatures were 69.0 degrees Fahrenheit at General Mitchell International Airport and 69.4 degrees Fahrenheit at Racine. Winter was defined as the months of December, January, and February. Mean winter temperatures were 23.8 degrees Fahrenheit at General Mitchell International Airport and 24.5 degrees Fahrenheit at Racine.

Source: National Oceanic and Atmospheric Administration and SEWRPC.

Figure 7

SUMMER AND WINTER PRECIPITATION DEPARTURES FROM SEASONAL AVERAGES AT THE NOAA WEATHER RECORDING STATIONS AT GENERAL MITCHELL INTERNATIONAL AIRPORT AND RACINE: 1940-2011



NOTE: Summer was defined as the months of June, July, and August. Mean summer precipitation was 10.66 inches at General Mitchell International Airport and 11.09 inches at Racine. Winter was defined as the months of December, January, and February. Mean winter precipitation was 5.14 inches at General Mitchell International Airport and 5.49 inches at Racine.

Source: National Oceanic and Atmospheric Administration and SEWRPC.

More than one-half of the normal yearly precipitation falls during the growing season, between May and September. During this period, runoff volumes are moderated because evapotranspiration rates are high, vegetative cover is good, and the soils are not frozen, so infiltration can occur. However, the occurrence of intense thunderstorms during this period can result in high rates of runoff and associated flooding. Normally, about 20 percent of the summer precipitation is expressed as surface runoff.

These climatic indicators can affect water quality. For example, higher air temperatures, which warm water and land surfaces, when combined with periods of decreased precipitation during the summer, can negatively affect surface water dissolved oxygen concentrations. Low dissolved oxygen concentrations can be a major concern during the summer months. Even short periods of time when dissolved oxygen concentrations fall below 5.0 mg/l can cause significant decreases in the abundance and diversity of the aquatic organisms in streams.

The average temperature for the summer months (June, July, and August, combined) over the past 72 years was 69.0°F at GMIA and 69.4°F at Racine. The year-to-year variability in summer average temperature is quite high at both stations (see Figure 6). The deviation from normal air temperature during the period examined ranged from nearly zero to over 5 °F at the Racine station and from nearly zero to over 9°F at the GMIA station. Summer precipitation at these stations also shows high variability (see Figure 7). The average precipitation for the summer months over the period 1940 to 2011 was 10.66 inches at the GMIA station and 11.09 inches at the Racine station. The deviation from normal precipitation over the period examined ranged from zero to almost nine inches at the GMIA station and zero to over 11 inches at the Racine station. The variability in summer temperature and precipitation can result in variability in streamflow and dissolved oxygen concentrations.

In like manner to annual average temperature and winter temperature trends summarized above, summer average temperatures seem to have shifted from a cooler condition prior to about 1980 to a much warmer condition post-1980, with the warmest recorded summer average temperature being recorded at GMIA during 1995. Changes in summer precipitation in the Root River watershed are more complicated. Average summer precipitation in the northern portions of the watershed appears to have increased by about 0.5 to 1.5 inches since 1950.[5] At the same time, average summer precipitation in the southern portions of the watershed appears to have decreased by about 0.5 inches.[6] This suggests, that absent any other influences, base flows may have increased since 1950 in the northern portions of the watershed and stayed about the same in the southern portions of the watershed.[7]

The high interannual variability in temperature and precipitation, both on an annual and a seasonal basis, emphasizes the importance of protecting the quality and quantity of groundwater as future development continues to occur in this watershed.

GEOLOGY AND PHYSIOGRAPHY

The topographic elevations in the Root River watershed are shown on Map 15. They range from approximately 580 feet above National Geodetic Vertical Datum, 1929 adjustment (NGVD 29) near the confluence of the Root River with Lake Michigan to about 960 feet above NGVD 29 along a glacial ridge in the City of New Berlin, a variation of about 380 feet.

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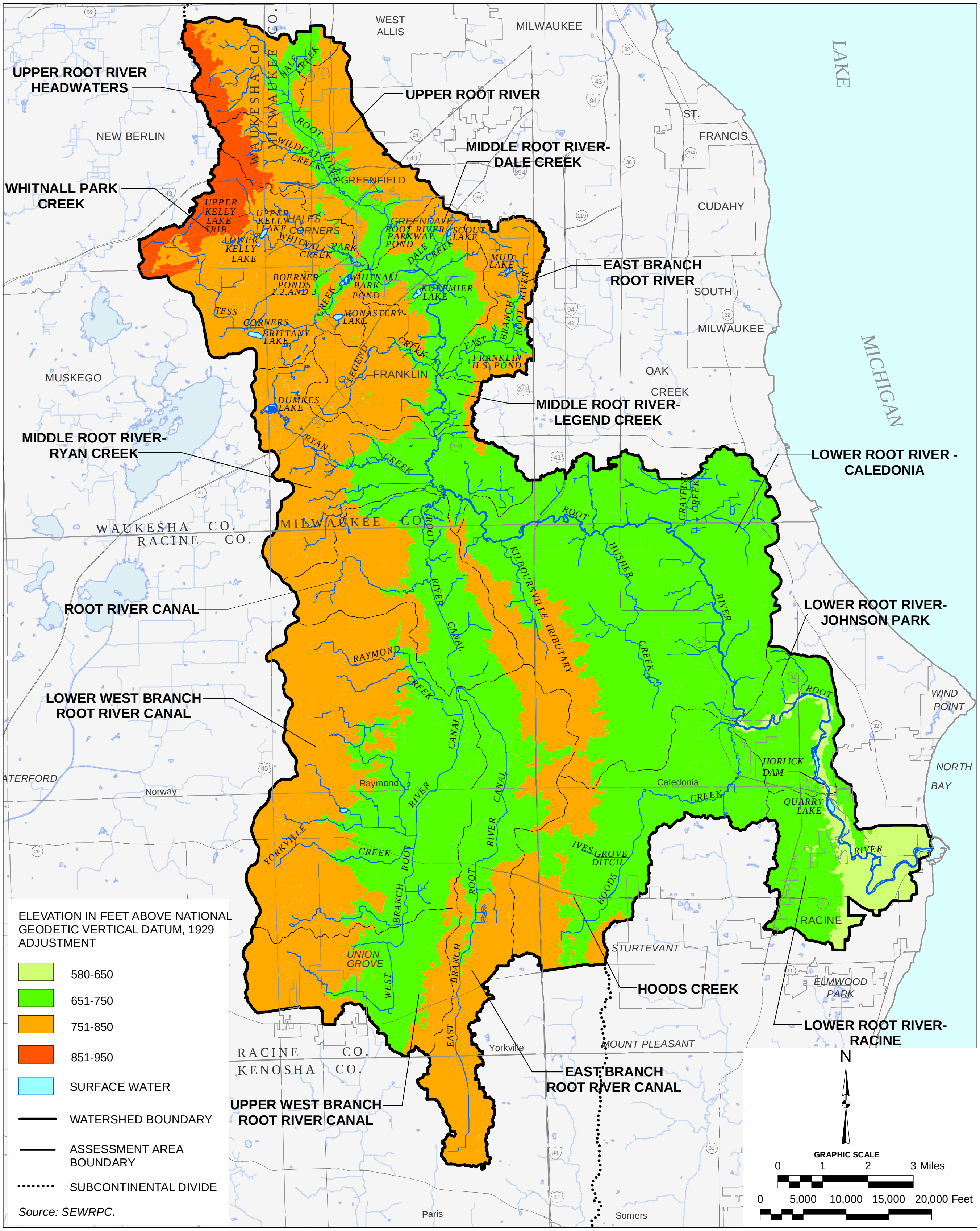
[5]*Christopher J. Kucharik, Shawn P. Serben, Steve Vavrus, Edward J. Hopkins, and Mellissa M. Motew, "Patterns of Climate Change Across Wisconsin from 1950 to 2006,"* Physical Geography, *Volume 31, 2010.*

[6]Ibid.

[7]*Wisconsin Initiative on Climate Change Impacts,* Wisconsin's Changing Climate: Impacts and Adaptation, *Madison, Wisconsin, 2011.*

Map 15

TOPOGRAPHIC AND PHYSIOGRAPHIC CHARACTERISTICS WITHIN THE ROOT RIVER WATERSHED



Much of the topography of the Root River watershed was determined by surface deposits left by glaciers. The Root River watershed is a rolling plain marked by broad asymmetrical ridges and small, shallow waterways. The ridges are moraines, deposits of poorly sorted material left by the glaciers. These moraines strongly influence the slopes of the land and the drainage network. Many of the streams occupy northerly trending valleys between the morainal ridges. These valleys tend to have relatively steep westward-facing slopes and gentle eastward-facing slopes. This pattern is particularly well developed in Racine County.

Topographical features, particularly slopes, have a direct bearing on the potential for soil erosion and the accumulation of sediment on the beds of surface waters. Map 16 shows the steepness of the land slopes in the Root River watershed. Slope steepness affects the velocity, and accordingly, the erosive potential of runoff. The amount of slope, or relief, on the land is one of the most important factors governing soil development processes and determines many of the physical and chemical properties of a specific soil. As slopes increase, the rate of soil erosion increases. Highly erodible lands are those areas in the watershed that have slopes greater than 6 percent. Although areas that have slopes less than 6 percent are still prone to erosion without proper management, the areas that are greater than 6 percent slope are of most concern. The U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS) considers a farm field to be highly erodible if one-third or more of that field contains slopes of 6 percent or greater. The soils in these areas are difficult to manage, not only for agriculture, but also for urban development. Land surface slopes, based on soils classification interpretations, within the Root River watershed range from less than 1 percent to over 20 percent. The majority of land area in the watershed, approximately 89 percent, has slopes that are between 0 and 6 percent, based upon soil interpretations. The remaining classes of 6 to 12, 12 to 20, and greater than 20 percent occupy approximately 8 percent, 1 percent, and less than 1 percent, of the watershed's land area, respectively. Additionally, about 2 percent of the land area is not assigned a slope classification, either because soil surveys were not conducted because of the presence of urban development or because the land is described as disturbed land, such as landfills and gravel pits.

Several assessment areas in the watershed have high proportions of land area with slopes greater than 6 percent. About 30 percent of the land area of the Middle Root River-Dale Creek assessment area and about 15 percent or more of the land area of the East Branch Root River, Upper Root River, Upper Root River-Headwaters, and Whitnall Park Creek assessment areas have slopes greater than 6 percent. These assessment areas are all in the northern portion of the watershed and all have a high proportion of land in urban land uses (see Table 14). In the assessment areas which are still predominantly agricultural, 10 percent or less of the land area has slopes greater than 6 percent.

Surface and Bedrock Geology

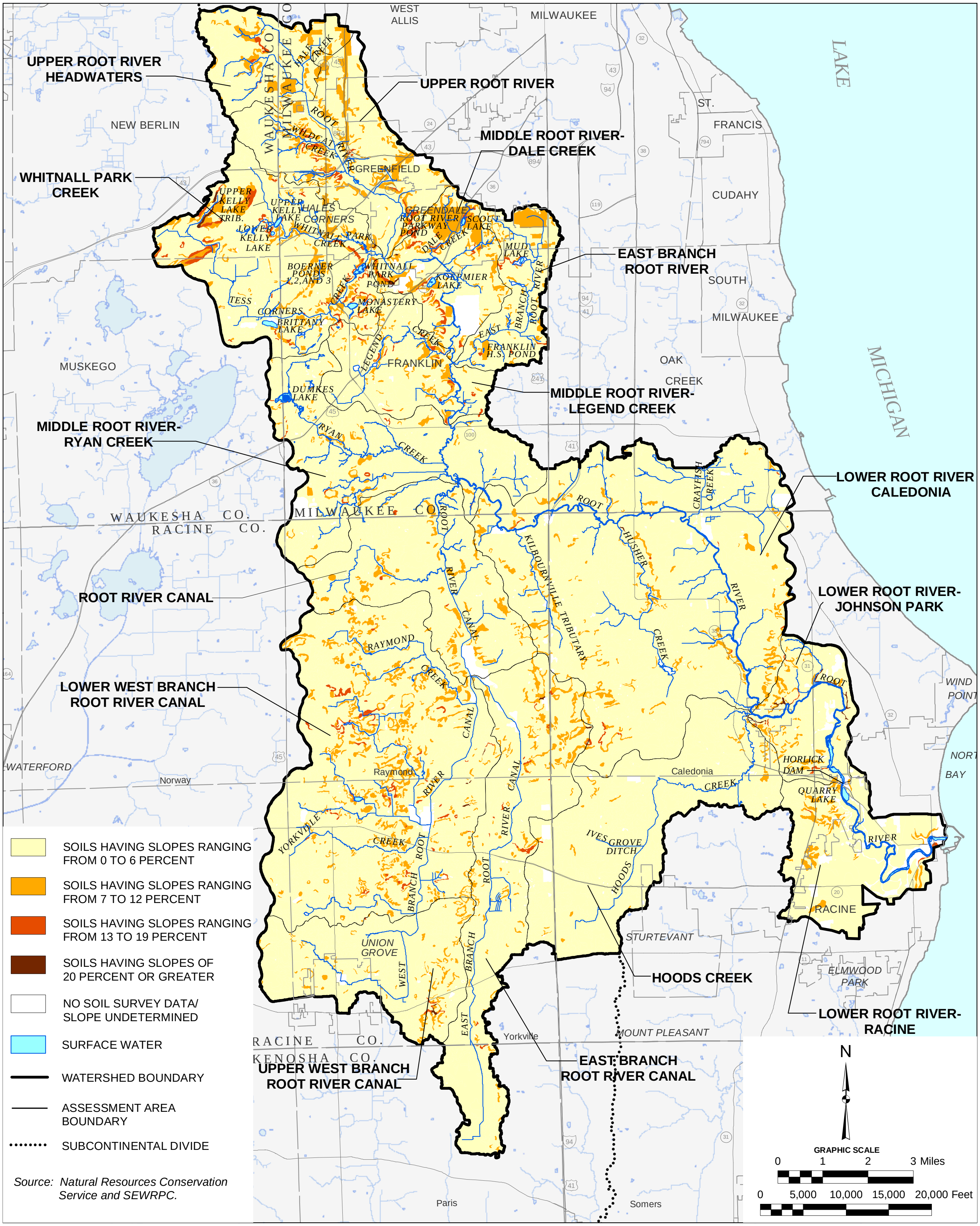
Bedrock and surface deposits directly and indirectly affect the quantity and quality of surface waters in the Root River watershed. Discharge from groundwater is the source of base flows in streams of the watershed. Especially at low flows, the chemistry of the streams reflects the influence of the composition of the bedrock and surface deposits.

The surface deposits in the watershed consist of unconsolidated sediments that were deposited by glaciers during the Pleistocene glaciations that ended about 11,000 years ago. These are mostly unsorted tills—unlayered mixtures of material consisting of debris of a variety of sizes. The surface layers vary in thickness from less than 25 feet to almost 400 feet.

The Root River watershed is underlain by Niagara dolomite, a sedimentary rock similar to limestone. In most of the watershed, this bedrock is located between 50 and 400 feet below the surface of the ground. There are some areas in the watershed where the bedrock is at the ground surface and visible as bedrock outcrops. Map 17 shows that these outcrops are located in the City of Franklin and the Villages of Greendale and Hales Corners. Groundwater is stored in fissures in the Niagara dolomite. Historically, these fissures were tapped by moderately deep wells for water supply purposes. Although much of the watershed relies on water drawn from Lake Michigan for water supply purposes, some of these wells are still in use. Underlying the Niagara dolomite is the Maquoketa shale. This layer is relatively impervious to water. In some portions of the watershed, mostly in the

Map 16

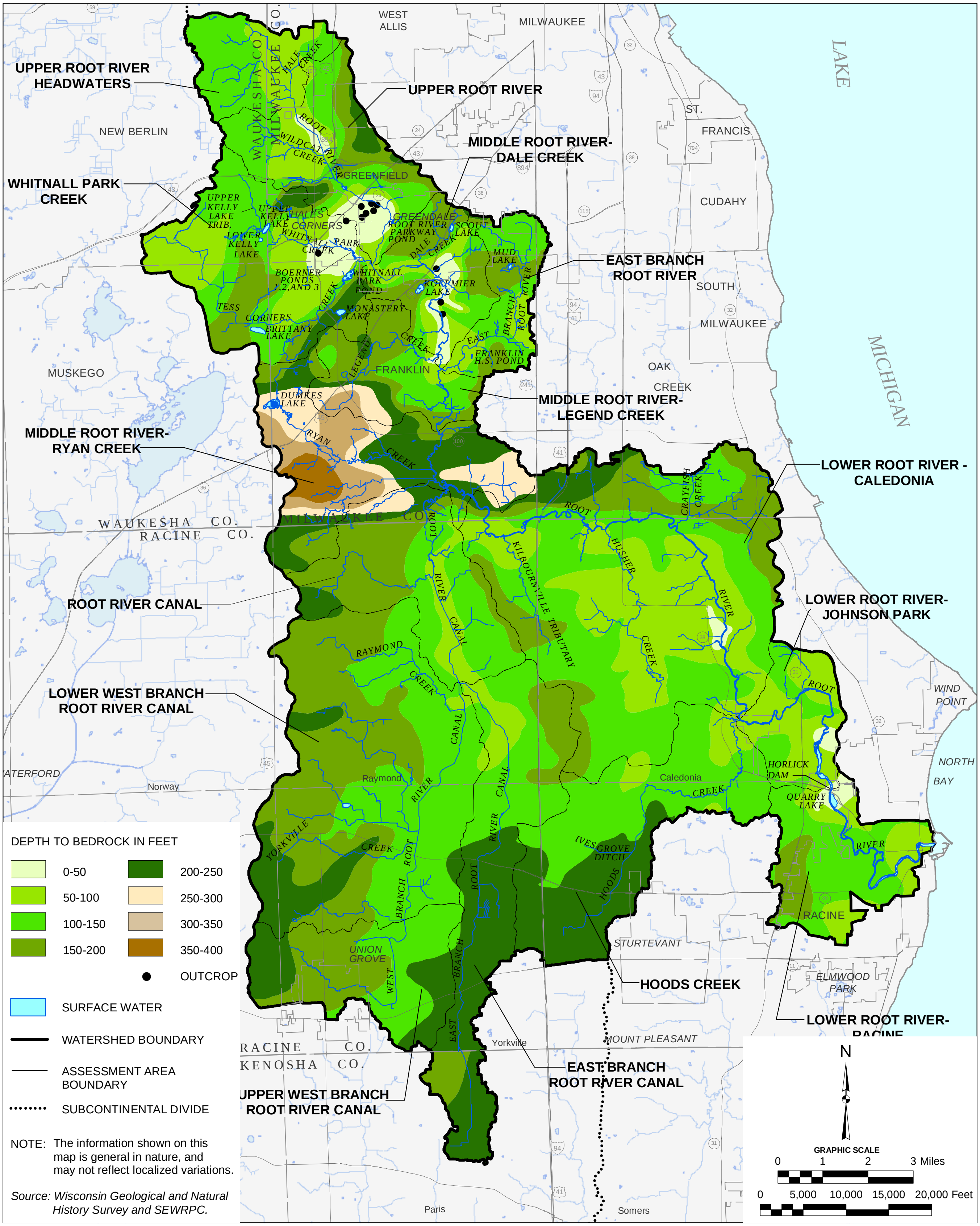
LAND SLOPES WITHIN THE ROOT RIVER WATERSHED



Source: Natural Resources Conservation Service and SEWRPC.

Map 17

DEPTH TO BEDROCK WITHIN THE ROOT RIVER WATERSHED



Town of Yorkville just north of the Village of Union Grove, the Niagara dolomite is absent and the Maquoketa shale constitutes the uppermost bedrock unit. Below the Maquoketa shale are dolomite and sandstone formations that constitute the deep sandstone aquifer. Because the Maquoketa shale serves as a barrier to the vertical transmission of water between the Niagara dolomite and the deep sandstone aquifer, the deep sandstone aquifer has little influence on surface waters of the Root River watershed.

A striking feature of the bedrock surface is the presence of a deep buried valley that runs west to east along and north of the Racine-Waukesha and Racine-Milwaukee County lines. This buried valley was part of a pre-glacial drainage network and may have served as an outlet to Lake Michigan during glacial periods. The bedrock surface in this valley is irregular, particularly in southern Milwaukee County, with changes in the elevation of the bedrock surface of over 100 feet within 500 feet of distance.[8] This may reflect the existence of reefs in the dolomite formation. This bedrock valley may play an important role in groundwater-surface water interactions.

Map 18 shows the generalized water table elevations in and adjacent to the Root River watershed. The general direction of groundwater movement in the aquifers above the Maquoketa shale is from west to east. There are local areas where the direction of flow is toward the southeast or, in the northernmost portion of the watershed, toward the northeast. Any efforts to influence base flows in streams of the watershed through methods using infiltration will need to take the direction of groundwater flow in these shallow aquifers into account.

SOILS

The glaciers deposited a wide variety of soil-forming materials and sculpted many different landforms that influence soil type and stream hydrology in the Southeastern Wisconsin Region. Soil type, along with land slope, land use, and vegetative cover, are important factors determining stream water quality conditions and affecting the rate, amount, and quality of stormwater runoff. Soil texture and soil particle structure influence the permeability, infiltration rate, and erodibility of soils. Land slopes are important determinants of stormwater runoff velocities and, therefore, significantly influence the susceptibility of soils to erosion. The erosivity of the runoff can be moderated or modified by vegetation.

The soils in the Root River watershed range from very poorly drained soils to well-drained soils. General grouping of these soils into soil associations is useful for comparing the suitability of relatively large areas of the watershed for various land uses. For this purpose, soil associations—defined as a landscape with a distinctive proportional pattern of soils comprised of one or more major soil types with at least one minor soil type as identified by the NRCS, and named after the major soils—are commonly utilized. Seven such soil associations exist in the Root River watershed. Their spatial distribution patterns within the watershed are shown on Map 19. The seven soil associations are described as follows:

- The Fox-Casco association is comprised of well-drained soils that have a subsoil of clay loam. This association is moderately deep over sand and gravel and can be found on outwash plains and stream terraces.

- The Hebron-Montgomery-Aztalan association is comprised of well-drained to poorly drained soils that have a loam to silty clay subsoil. This association is underlain by clayey to loamy lacustrine and outwash material and is found along the mainstem of the Root River and several tributaries in Racine and Kenosha Counties.

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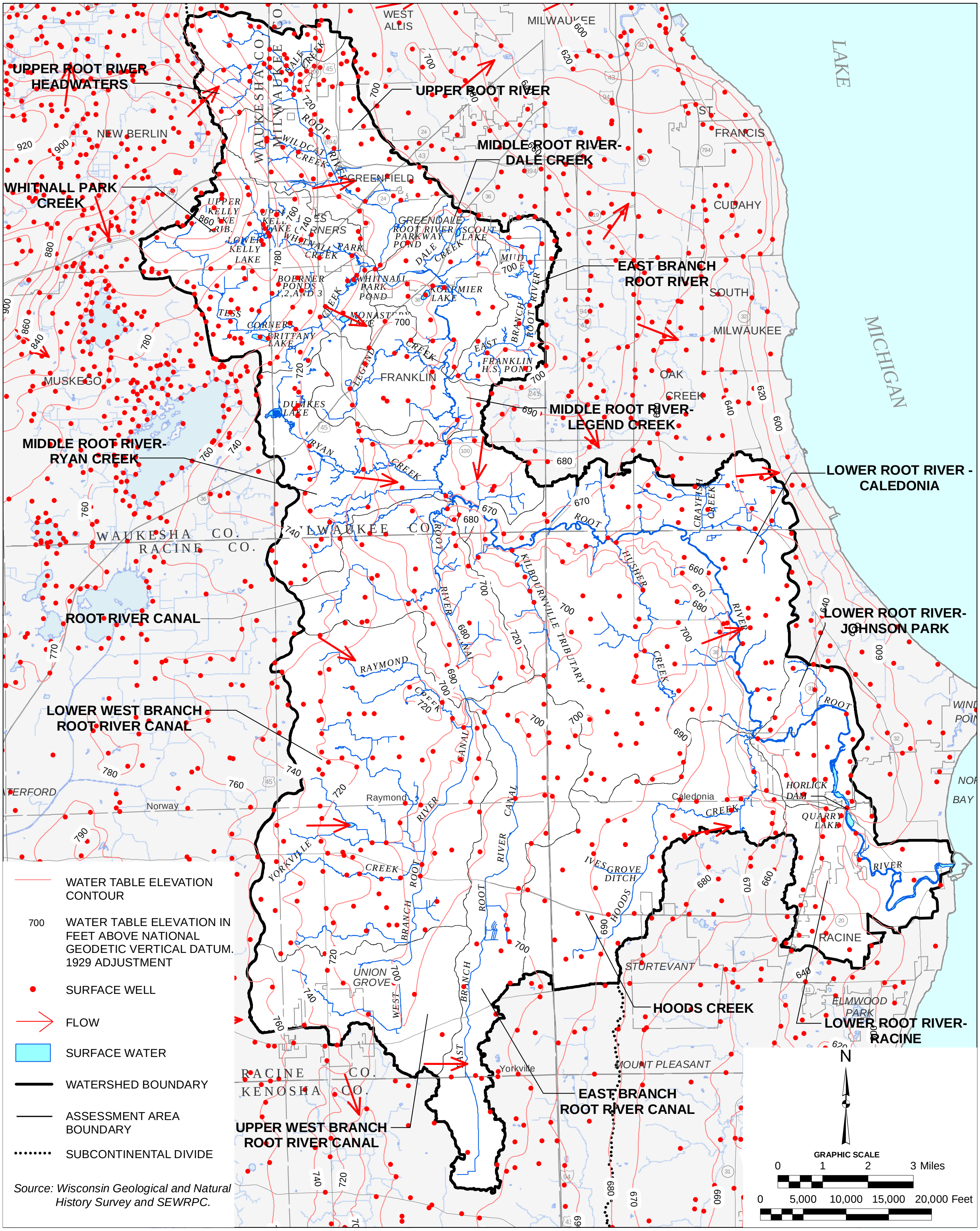
[8]*SEWRPC Technical Report No. 37,* Groundwater Resources of Southeastern Wisconsin, *June 2002*.

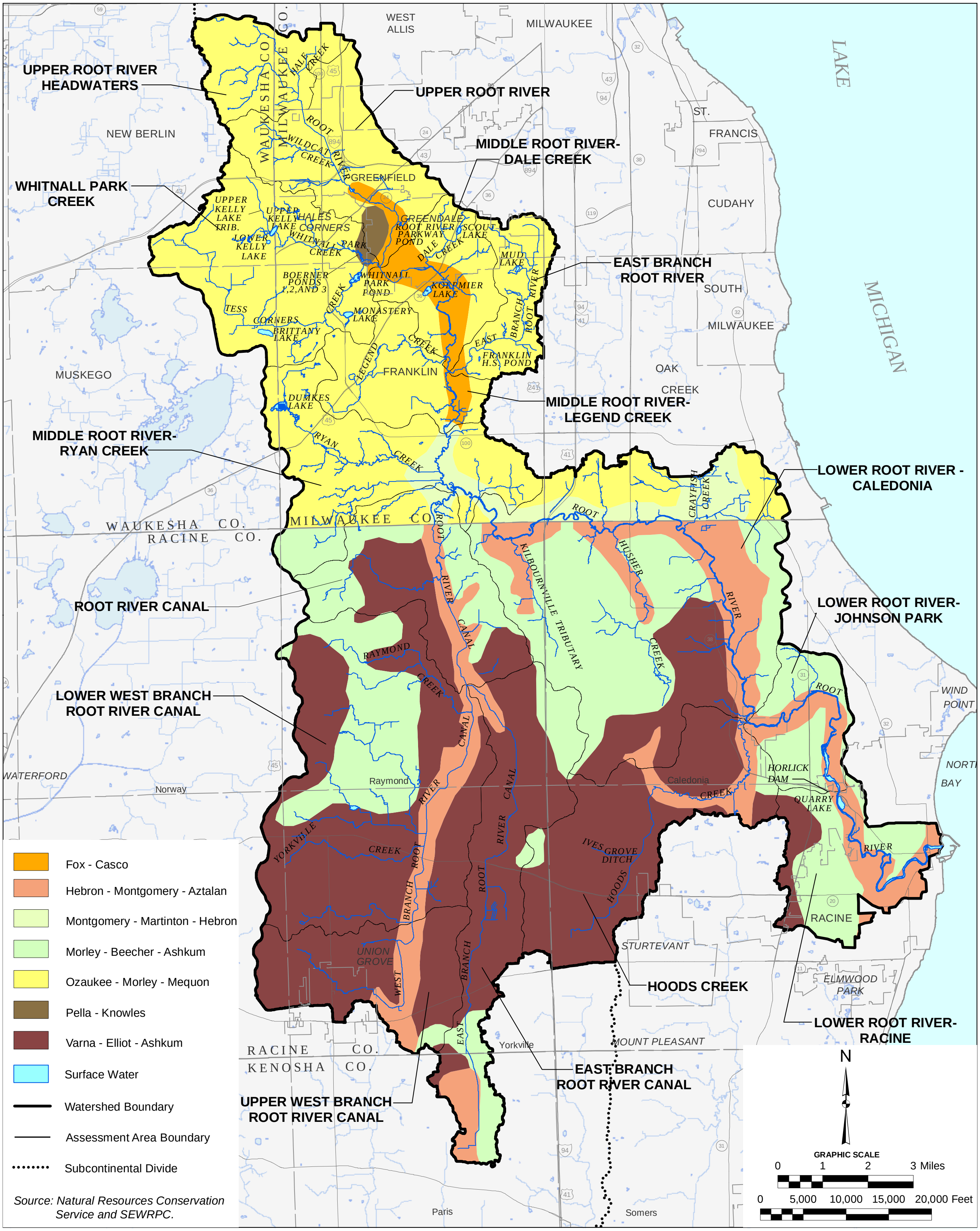
Map 18

WATER TABLE ELEVATIONS WITHIN THE ROOT RIVER WATERSHED



Map 19

SOIL ASSOCIATIONS WITHIN THE ROOT RIVER WATERSHED



- The Montgomery-Martinton-Hebron association is comprised of poorly drained to well-drained soils that have a subsoil of clay to clay loam. This association in formed in silty clay or silty clay loam sediments and is found along the mainstem of the Root River and the Root River Canal in Milwaukee County.

- The Morley-Beecher-Ashkum association is comprised of well-drained to poorly drained soils that have a silty clay or silty clay loam subsoil. This association is formed in glacial till consisting of thin loess and underlying clay loam or silty clay loam and is found on glacial ridges.

- The Ozaukee-Morley-Mequon association is comprised of well-drained to somewhat poorly drained soils that have a subsoil of silty clay loam and silty clay. This association is formed in glacial till consisting of thin loess and silty clay loam and is found on glacial moraines.

- The Pella-Knowles association is comprised of poorly drained to well-drained soils that have a subsoil of silty clay loam or clay loam. This association is moderately shallow and found over dolomite bedrock.

- The Varna-Elliot-Ashkum association is comprised of well-drained to poorly drained soils that have a silty clay loam to clay subsoil. This association is formed in glacial till consisting of thin loess and underlying clay loam or silty clay loam and is found on glacial ridges.

Using the regional soil survey, an assessment was made of the hydrologic characteristics of the soils within the watershed. Soils were classified into four main hydrologic groups: well-drained soils, moderately drained soils, poorly drained soils, and very poorly drained soils. The Root River watershed is made up of about 72 percent poorly drained soils. Thus, the soils of the watershed generally exhibit low permeability with moderate to low groundwater recharge potential.[9]

Agricultural Classifications

Map 20 shows lands in the Root River watershed with soils suitable for agricultural uses as of the year 2000.[10] Soils that meet the Federal Natural Resources Conservation Service definition of "prime" agricultural soils comprise about 109,205 acres, or about 86 percent of the watershed. This includes those lands that would meet the prime classification if artificially drained or protected from flooding. A second category includes agricultural land that does not meet the Federal definition of prime agricultural soils, but is classified by the State as being "soils of statewide importance." These lands include 10,271 acres, or 8 percent of the watershed land area. The third category, shown on Map 20, includes other lands that do not meet either the State or Federal definitions, and primarily includes land with slopes greater than 12 percent. This category includes 7,009 acres, or about 6 percent of the watershed.

WATER RESOURCES

The area of the Root River watershed is about 197 square miles (about 126,484 acres). Surface water resources include streams, ponds, and wetlands.

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[9]*SEWRPC Technical Report No. 47,* Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Water-Balance Model, *July 2008.*

[10]*The classification of soils for agricultural purposes is independent of the actual use of the land. Thus, the soils in significant areas of existing urban land use are included in the agricultural classification.*

Map 20

FEDERAL AND STATE SOIL CLASSIFICATIONS FOR AGRICULTURAL USES WITHIN THE ROOT RIVER WATERSHED

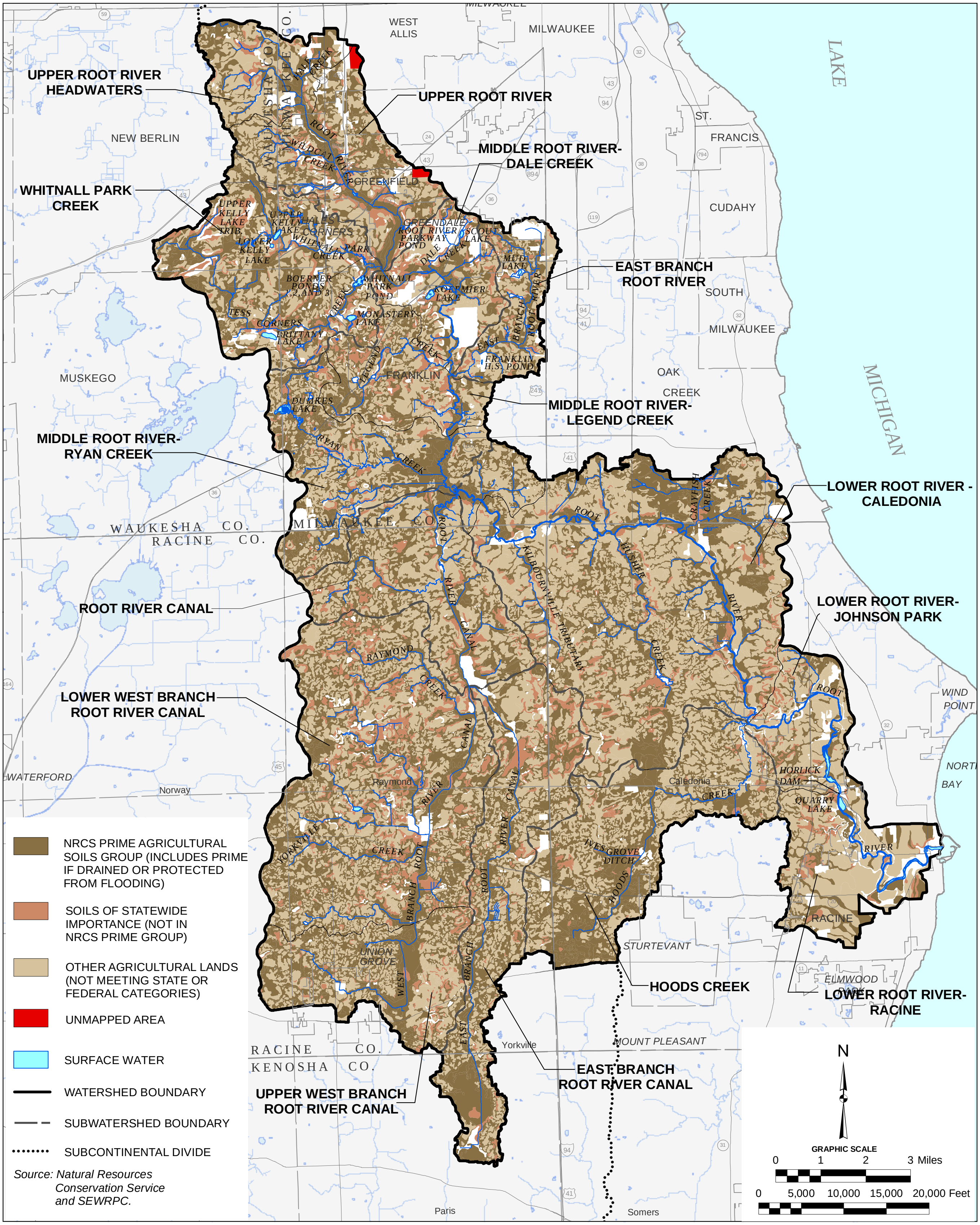

Table 18

LAKES AND PONDS OF THE ROOT RIVER WATERSHED

Name	Area (acres)	Maximum Depth (feet)	Mean Depth (Feet)	Lake Type	Public Access
Boerner Botanical Garden Pond No. 1	2	3	- -	Drainage lake	- -[a]
Boerner Botanical Garden Pond No. 2	1	4	- -	Drainage lake	- -[a]
Boerner Botanical Garden Pond No. 3	8	5	- -	Drainage lake	- -[a]
Dumkes Lake	7	11	- -	Seepage lake	- -
Franklin High School Pond	2	- -	- -	- -	Shoreline accessible[b]
Koepmier Lake	8	35	- -	Seepage lake	- -
Lake Brittany	- -	- -	- -	- -	- -
Lower Kelly Lake	3	36	12	Seepage lake	Walk in trail
Monastery Lake	12	30	- -	Seepage lake	- -
Mud Lake	5	21	- -	Seepage lake	- -[a]
North Golf Course Pond No. 1	1	4	- -	Drainage lake	- -[a]
North Golf Course Pond No. 2	1	4	- -	Drainage lake	- -[a]
North Golf Course Pond No. 3	3	8	- -	Drainage lake	- -[a]
Quarry Lake	20	64	- -	Seepage lake	Boat ramp[b]
Root River Parkway Pond[c]	8	17	- -	Seepage lake	- -[a]
Scout Lake	8	19	6	Seepage lake	Shoreline accessible[b]
Shoetz Park Pond	2	- -	- -	- -	Shoreline accessible[b]
Upper Kelly Lake	12	31	17	Spring lake	Boat ramp
Whitnall Park Pond	15	4	6	Drainage lake	- -[a]

[a]*Private boats of any kind are not allowed on ponds in the Milwaukee County Parks. Where available, commercial facilities provide boat liveries operated by the park.*

[b]*Urban fishing water.*

[c]*Also known as Anderson Lake.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Surface Water Resources
The Root River is approximately 44 miles in length, extending from its headwaters in the City of New Berlin to its confluence with Lake Michigan in the City of Racine (see Map 1 in Chapter I of this report). Several tributary streams flow into the Root River. Major tributaries are listed in Table 11. The watershed provides opportunities for canoeing, kayaking, hunting, fishing, wading, bird watching and other uses. While the Root River watershed contains no major lakes with a surface area of 50 acres or more, it does contain several named lakes and ponds. These are listed in Table 18.

As described in Chapter I of this report, several problems have been identified which restrict the potential uses of surface waters in the Root River watershed and threaten the watershed's ecological integrity.[11] These include concentrations of dissolved oxygen that are often below the levels necessary to support fish and other aquatic organisms, high concentrations of bacteria that indicate contamination with fecal material, streambed and stream-bank erosion, the presence of aquatic and terrestrial exotic invasive species, and a poor quality fishery upstream from Horlick dam.

Runoff from Urban Development and Impervious Surfaces

As indicated above, urban land use in the Root River watershed is expected to increase between the present and 2035. In the absence of planning, such urbanization can create negative impacts on streams and lakes. Urbanization itself is not the main factor driving the degradation of the local waterbodies. Lakes and streams can survive and even flourish in urban settings with appropriate measures to control the impacts of urbanization. The main factors leading to the degradation of urban waterbodies include: the creation of large areas of connected impervious surfaces, the lack of adequate stormwater management facilities to control the quantity and quality of runoff, the proximity of development to waterbodies, loss of natural areas, and inadequate construction site erosion controls. These factors increase the potential for the occurrence of the negative water quality/quantity effects associated with urbanization. Good land use planning, creative site design, and the application of best management practices for construction site erosion control and post-construction stormwater management can greatly reduce the potential for urban development to negatively affect the surrounding environment.

Industrial and commercial land uses generally have significantly more impervious area than residential land uses, while smaller residential lots generally have more impervious surface than larger residential lots. Table 19 lists the approximate amounts of impervious surface created by residential, industrial, and commercial development. Although commercial and industrial developments generally have a larger percentage of impervious surface, residential developments, where lawns are the single largest use of the land area, show some similarities to impervious surfaces. When lawns are compared to woodlands and cropland, they are found to contain less soil pore space (up to 15 percent less than cropland and 24 percent less than woodland), reducing their ability to infiltrate water. In many instances, considerable soil compaction occurs during grading of the home sites, significantly reducing the perviousness of lawns. Compared to turf grass, native grasses, forbs, and sedges have significantly deeper root systems, which loosen the soil and create flow channels that increase infiltration capacity. Also, owing to excessive application of fertilizers and pesticides, urban lawns typically produce higher unit loads of nutrients and pesticide than do croplands.[12] When new commercial or residential developments are built near a stream, the area of driveways, rooftops, sidewalks, and lawns increases; the area of native plant growths and undisturbed soils decrease; and, the ability of the shoreland area to perform its natural functions (flood control, pollutant removal, wildlife habitat, and aesthetic beauty) is decreased. In the absence of mitigating measures, urbanization impacts the watershed not only by altering the ratio between stormwater runoff and groundwater recharge, but also through changing stream hydrology (i.e., increasing stormwater runoff volumes and peak flows and altering the baseflow regime) and altering the seasonal thermal regimes in flowing water systems. Changes in watershed hydrology resulting from urban development can also affect channel morphology, water quality/quantity, and biological diversity.

When urban development increases, the ratio of impervious surface area to water surface area increases proportionately to the decrease in the amount of pervious surface area. For this reason alone, many researchers throughout the United States, including researchers at the WDNR, report that the amount of connected impervious

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[11]*SEWRPC Technical Report No. 39,* op. cit.

[12]*Center for Watershed Protection,* Impacts of Impervious Cover on Aquatic Systems, *Watershed Protection Research Monograph No. 1, March 2003.*

Table 19

APPROXIMATE PERCENTAGES OF CONNECTED IMPERVIOUS SURFACES CREATED BY URBAN DEVELOPMENT

Type of Urban Development	Impervious Surface (percent)
Suburban-Density Residential	10-15
Low-Density Residential	20-25
Medium-Density Residential	25-30
High-Density Residential	30-50
Governmental and Institutional	40-75
Industrial	70-80
Commercial	85-95

Source: Natural Resources Conservation Service and SEWRPC.

surface is the best indicator of the level of urbanization in a watershed.[13,14] The studies mentioned above have found that relatively low levels of urbanization, 8 to 12 percent connected impervious surface, can cause subtle changes in properties of a stream. These changes include alterations to physical properties, such as increased temperature and turbidity, and to chemical properties, such as reduced dissolved oxygen concentration and increased concentrations of pollutants. These changes lead to a decline in the biological integrity of the stream. For example, each 1 percent increase in watershed imperviousness can lead to an increase in water temperature of nearly 2.5°F.[15] This temperature increase can have significant impacts on those species of fish and other organisms that have a low tolerance to temperature fluctuations or that require that their habitat have very specific temperature ranges in order to flourish.

In the absence of mitigating measures, one of the consequences of urban development is the increase in the amount of stormwater, which runs off the land surface rather than infiltrating into the groundwater system. A parking lot or driveway produces much more runoff than an undisturbed prairie or agricultural hay field. Furthermore, runoff traveling over the surface of a parking lot or driveway will pick up heavy metals, bacteria, pathogens, and other pollutants which otherwise might be removed as the stormwater is filtered through vegetation or infiltrated into the groundwater. Runoff traveling over such impervious surfaces bypasses the filtering action of the soil particles, soil microbes, and vegetation present above (stems and leaves) and below (roots) the soil surface. In addition, the location of impervious surfaces determines the degree of direct impact they will have on a stream. There is a greater impact from impervious surfaces located close to a stream—due to the fact that less time and distance exists wherein the polluted runoff can be naturally treated before entering into the stream. A study of 47 watersheds in Southeastern Wisconsin indicated that one acre of impervious surface located near a stream could have the same negative effect on aquatic communities as 10 acres of impervious surface located further away from the stream.[16]

Because urban lands located adjacent to a stream have a greater impact on the biological community, an assumption might be made that riparian buffer strips located along the streambank could mitigate some of the negative runoff effects attributed to urbanization. While riparian buffers do have a mitigating effect, streambank buffers may not be the complete answer to urban stormwater impacts within the watershed since most urban stormwater is delivered directly to the stream via storm sewers or engineered channels and enters the stream

[13]*L. Wang, J. Lyons, P. Kanehl, and R. Bannerman, "Impacts of Urbanization on Stream Habitat and Fish Across Multiple Spatial Scales,"* Environmental Management, *Volume 28, 2001.*

[14]*Directly connected impervious area is area that discharges directly to the stormwater drainage system without the potential for infiltration through discharge to pervious surfaces or facilities specifically designed to infiltrate runoff.*

[15]*L. Wang, J. Lyons, and P. Kanehl, "Impacts of Urban Land Cover on Trout Streams in Wisconsin and Minnesota,"* Transactions of the American Fisheries Society, *Volume 132, 2003.*

[16]*L. Wang, J. Lyons, P. Kanehl, and R. Bannerman*, op. cit.

without passing through the buffer zone. Riparian buffers need to be combined with other management practices, such as infiltration facilities, detention basins, and grass swales, in order to adequately mitigate the effects of urban stormwater runoff. Combining practices into such a "treatment train" can provide a much higher level of pollutant removal than single, stand-alone practices could ever achieve. In this regard, it is important to note that stormwater treatment and erosion control practices vary in their function, which in turn influences their level of effectiveness. Their location on the landscape, as well as their construction and maintenance, greatly influences their level of pollutant removal.

Researchers evaluating 134 sites on 103 streams throughout the State of Wisconsin have found that the amount of urban land upstream of their sample sites had a negative relationship with the biotic integrity scores at the sites.[17] There appeared to be a threshold of about 10 percent directly connected impervious cover in the areas tributary to the streams, beyond which Index of Biotic Integrity (IBI) scores declined dramatically. The IBI is a measure of the quality of the fishery community and combines elements, such as abundance, diversity (number of different species), tolerance (ability of a species to tolerate pollution), feeding or trophic classifications (e.g., top carnivores, or fish that feed on other fish, vertebrates, or large aquatic insects), and healthy appearance (e.g., no deformities, eroded fins, lesions). Fish IBI scores were found to be good to excellent below this threshold, but were consistently rated as poor to fair above this threshold.

Wang and others studied 47 small streams in 43 watersheds in southeastern Wisconsin to retrospectively analyze fisheries and land use data acquired between 1970 and 1990.[18] Historical changes in land uses were determined from data provided by SEWRPC and the changes in the fishery were evaluated over the two decades. Streams that were already extensively urbanized as of 1970 had fish communities characterized as highly tolerant with low species richness.[19] As these areas urbanized even further, the fish communities changed little since they were already considered to be degraded. In contrast, stream sites that had little urbanization (characterized by connected imperviousness) in 1970, but which were urbanizing by 1990, showed decreases in the quality of the fish community. This study further supported the finding that major differences occurred in the fisheries at the 10 percent connected impervious cover threshold, with poorer fisheries quality generally being reported for stream sites above this threshold. In addition, other studies in different eco-regions and using various techniques have supported these findings, suggesting that, as watersheds become highly urban, aquatic diversity becomes degraded.[20] In addition to increases in the amount of impervious land cover that are associated with urbanization, urban development has often been accompanied by the alteration or loss of wetlands; disturbance or reduction in the size of riparian corridors; stream channel modification, including straightening and lining with concrete; and occasional spills of hazardous materials. All of these factors contribute to degradation of fish communities and of aquatic diversity.

A further important concern related to urban development is thermal pollution. Thermal pollution results when stormwater flows over heated surfaces, such as roads, rooftops, and parking lots, before entering a stream. The main consequence of thermal pollution is oxygen depletion, because warm water cannot hold as much oxygen as

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[17]*L. Wang, J. Lyons, P. Kanehl, and R. Gatti, "Influences of Watershed Land Use on Habitat Quality and Biotic Integrity in Wisconsin Streams,"* Fisheries, *Volume 22, 1997.*

[18]*L. Wang, J. Lyons, P. Konehl, R. Bannerman, and E. Emmons, "Watershed Urbanization and Changes in Fish Communities in Southeastern Wisconsin Streams,"* Journal of the American Water Resources Association, *Volume 36, 2000.*

[19]*Highly tolerant fish species can survive under degraded conditions, particularly low dissolved oxygen concentrations and high temperatures.*

[20]*Center for Watershed Protection,* op. cit.

cold water. As these oxygen-deficit events increase, the aquatic organisms living in the stream become more stressed, leading to decreased growth and reproduction, migration out of the system, and, in extreme cases, death of the aquatic organisms. Rainfall events that occur during the warmer summer months are more stressful to fish and other water dwelling organisms than rainfall at other times of the year, due to runoff being heated as it flows over sun-warmed impervious surfaces. When coupled with the chronic affects of reduced infiltration on baseflows to streams when imperviousness increases, these events can lead to significantly elevated temperatures in the flowing water systems.

As noted above, the amount of imperviousness in a watershed that is directly connected to the stormwater drainage system can be used as a surrogate for evaluating the combined impacts of urbanization in the absence of mitigation. The Root River watershed had about 24 percent urban land use in 1970, which approximately corresponds to 7 percent directly connected imperviousness in the watershed. As of 2010, it had about 35 percent urban land overall, corresponding to about 9 percent directly connected imperviousness. That level of imperviousness is within the threshold range of 8 to 12 percent at which changes in properties of streams—such as increased temperature and turbidity, reduced dissolved oxygen concentration, and increased concentrations of pollutants—can occur. These changes can lead to a decline in the biological integrity of the stream.[21]

Table 20 sets forth connected impervious area percentages by assessment area for existing year 2010 and planned year 2035 land use conditions. The 2010 connected impervious area percentages by assessment area range from 2.5 (Lower West Branch Root River Canal) to 25.2 (Lower Root River-Racine). The 2035 connected impervious area percentages by assessment area range from 2.8 (Lower West Branch Root River Canal) to 30.0 (Hoods Creek). Under 2010 conditions, six of the 15 assessment areas have connected impervious area percentages below the 8 percent lower bound of the threshold level at which changes in stream properties may occur in the absence of mitigating measures on the landscape. Those six areas are:

- Upper West Branch Root River Canal,
- Lower West Branch Root River Canal,
- East Branch Root River Canal,
- Middle Root River-Ryan Creek,
- Root River Canal, and
- Lower Root River-Caledonia.

Under planned year 2035 conditions, only two of the 15 assessment areas—Lower West Branch Root River Canal and Root River Canal—would be expected to have connected impervious area percentages below the 8 percent lower bound of the threshold level.

The implementation of green infrastructure to manage stormwater through infiltration of runoff could mitigate the effects of connected impervious area in those assessment areas that have existing 2010 and planned 2035 impervious percentages that are above, or within, the threshold range. Also, if sufficient green infrastructure projects are implemented to capture significant volumes of precipitation, such implementation could also effectively reduce the percent connected impervious area to less than the 8 percent lower threshold limit in the four assessment areas that could transition to exceeding the limit between 2010 and 2035 (Upper West Branch Root River Canal, East Branch Root River Canal, Middle Root River-Ryan Creek, and Lower Root River-Caledonia). In addition, the Hoods Creek assessment area is anticipated to experience significant residential and industrial development between 2010 and 2035. That development could result in the connected impervious area increasing from an existing level of about 9 percent to 30 percent in 2035, a level that is well beyond the impact threshold range. However, there is also an opportunity to significantly moderate the increase in impervious area through implementation of green infrastructure as the area develops. Recommendations regarding the provision of green infrastructure are set forth in Chapter VI.

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[21]*L. Wang, J. Lyons, P. Kanehl, and R. Bannerman, 2001,* op. cit.

Table 20

ESTIMATED CONNECTED IMPERVIOUS PERCENTAGES BY ASSESSMENT AREA: 2010 AND 2035

Category	Assessment Area[a]															Total Watershed
	1 Upper Root River-Headwaters	2 Upper Root River	3 Whitnall Park Creek	4 Middle Root River-Dale Creek	5 East Branch Root River	6 Middle Root River-Legend Creek	7 Upper West Branch Root River Canal	8 Lower West Branch Root River Canal (acres)	9 East Branch Root River Canal	10 Middle Root River-Ryan Creek	11 Root River Canal	12 Lower Root River-Caledonia	13 Hoods Creek	14 Lower Root River-Johnson Park	15 Lower Root River-Racine	
Estimated 2010 Percent Impervious	22.3	24.2	14.9	15.7	19.3	13.0	4.9	2.5	3.9	6.3	2.7	5.6	8.6	8.2	25.2	9.1
Estimated 2035 Percent Impervious	23.2	25.7	19.9	17.5	23.7	19.4	8.5	2.8	14.4	20.6	5.3	13.4	30.0	12.2	27.0	15.6

[a] *Assessment areas are shown on Map 7.*

Source: SEWRPC.

Runoff from Agricultural Development

In addition to the urban impacts discussed above, researchers in Wisconsin have found that the amount of agricultural land use upstream of sample sites had a negative relationship with biotic integrity scores. There appeared to be a threshold of about 50 percent agricultural land use, above which IBI scores declined dramatically.[22] A separate study looking at the effects of multi-scale environmental characteristics on the biota in agricultural streams in eastern Wisconsin demonstrated a strong negative correlation between fishery IBI scores and increased proportions of agricultural land, ranging up to 80 percent of the land surface within the studied watersheds, which indicates that, as the percentage of agricultural land increased, the resultant fishery community decreased in abundance and diversity.[23]

About 62 percent of the Root River watershed was in agricultural land use in 1970. In 2010, agricultural land comprised about 52 percent of the land surface area within the watershed. While agricultural land use constitutes the dominant class of land use in the Root River watershed as a whole, there are considerable differences among assessment areas in the proportion of land devoted to agriculture (see Table 14). In several assessment areas, the proportion of agricultural land use is greater than the threshold of 50 percent agricultural land use at which declines in fishery abundance and diversity may be expected to begin to occur. These include the East Branch Root River Canal, Hoods Creek, Lower Root River-Caledonia, Lower West Branch Root River Canal, Middle Root River-Ryan Creek, Root River Canal, and Upper West Branch Root River Canal assessment areas. In some other assessment areas, agricultural land uses make up a very small fraction of the area. In the case of the Lower Root River-Racine, Upper Root River, and Upper Root River-Headwaters assessment areas, agricultural land uses make up less than 3 percent of the area.

Riparian Corridor Conditions

Healthy riparian corridors help to protect water quality, groundwater, fisheries and wildlife, and ecological resilience to invasive species, as well as reducing potential flooding of structures and harmful effects of climate change.[24] The health of riparian corridors is largely dependent upon width (size) and continuity. Therefore, efforts to protect and expand the remaining riparian corridor width and continuity are the foundation for protecting and improving the fishery and recreation within the Root River watershed.

Buffer Width Considerations

The provision of buffer strips along waterways addresses anthropogenic sources of contaminants, with even relatively small buffer strips providing a degree of environmental benefit, as suggested in Table 21 and Figure 8.[25] The Wisconsin Buffer Initiative (WBI) further developed two key concepts that are relevant to this plan: 1) riparian buffers are very effective in protecting water resources and 2) riparian buffers need to be a part of a larger

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[22]*L. Wang, J. Lyons, P. Kanehl, and R. Gatti, 1997,* op. cit.

[23]*F. Fitzpatrick, B. Scudder, B. Lenz, and D. Sullivan, "Effects of Multi-Scale Environmental Characteristics on Agricultural Stream Biota in Eastern Wisconsin,"* Journal of the American Water Resources Association, *Volume 37, 2001.*

[24]*N.E. Seavy, et al., "Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research,"* Ecological Restoration, *Volume 27(3), pages 330-338, September, 2009; "Association of State Floodplain Managers, Natural and Beneficial Floodplain Functions: Floodplain Management—More Than Flood Loss Reduction, 2008,"* www.floods.org/NewUrgent/Other.asp.

[25]*Data were drawn from A. Desbonnet, P. Pogue, V. Lee, and N. Wolff, "Vegetated Buffers in the Coastal Zone – a Summary Review and Bibliography," CRC Technical Report No. 2064. Coastal Resources Center, University of Rhode Island, 1994.*

Table 21

EFFECT OF BUFFER WIDTH ON CONTAMINANT REMOVAL

Buffer Width Categories (feet)	Contaminant Removal (percent)[a]				
	Sediment	Total Suspended Sediment	Nitrogen	Phosphorus	Nitrate-Nitrogen
1.5 to 25					
Mean	75	66	55	48	27
Range	37-91	31-87	0-95	2-99	0-68
Number of Studies	7	4	7	10	5
25 to 50					
Mean	78	65	48	49	23
Range	- -	27-95	7-96	6-99	4-46
Number of Studies	1	6	10	10	4
50 to 75					
Mean	51	- -	79	49	60
Range	45-90	- -	62-97	0-99	- -
Number of Studies	5	- -	2	2	1
Greater than 75					
Mean	89	73	80	75	62
Range	55-99	23-97	31-99	29-99	- -
Number of Studies	6	9	8	7	1

[a]*The percent contaminant reductions in this table are limited to surface runoff concentrations.*

Source: University of Rhode Island Sea Grant Program.

conservation system to be most effective.[26] However, it is important to note that the WBI limited its assessment and recommendations solely to the protection of water quality, and did not consider the additional values and benefits of riparian buffers. Research clearly shows that riparian buffers can have many potential benefits such as flood control, prevention of channel erosion, provision of fish and wildlife habitat, enhancement of environmental corridors, and water temperature moderation (see Figure 8); however, the nature of the benefits and the extent to which the benefits are achieved is very site-specific. Consequently, the ranges in buffer width for each of the buffer functions shown in Figure 8 are large. Determining what buffer widths are needed should be based on what functions are desired as well as site conditions. For example, as shown in Figure 8, water temperature protection generally does not require as wide a buffer as provision of habitat for wildlife. Based on the needs of wildlife species found in Wisconsin, the minimum core habitat buffer width is about 400 feet and the optimal width for sustaining the majority of wildlife species is about 900 feet. Thus, large undistributed parcels along waterways which are part of, and linked to, an environmental corridor system have great value for the provision of wildlife habitat.

While it is clear from the literature that wider buffers can provide a greater range of values for aquatic systems, the need to balance human access and use with the environmental benefits to be achieved suggests that a 75-foot-wide riparian buffer provides a minimum width necessary to contribute to good water quality and a healthy aquatic ecosystem. In general, most pollutants are removed within a 75-foot buffer width. However, from an

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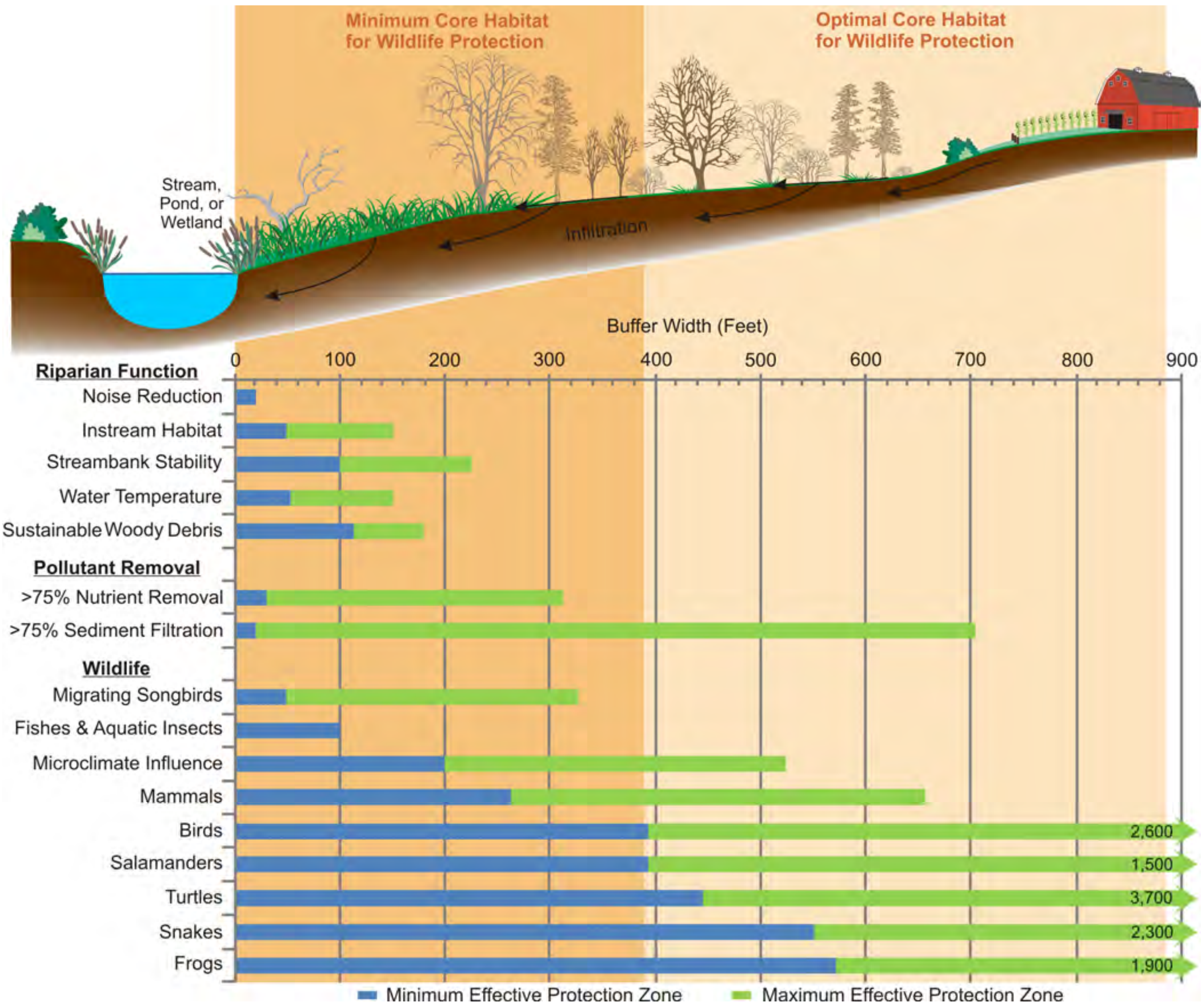
[26]*University of Wisconsin-Madison, College of Agricultural and Life Sciences,* The Wisconsin Buffer Initiative, *December 2005.*

Figure 8

RANGE OF BUFFER WIDTHS FOR PROVIDING SPECIFIC BUFFER FUNCTIONS



Source: SEWRPC.

ecological point of view, 75-foot-wide buffers are inadequate for the protection and preservation of wildlife species. Riparian buffer strips greater than 75 feet in width provide significant additional physical protection of streams by intercepting additional sediment and other contaminants mobilized from the land surface as a result of natural and anthropogenic activities. They also provide biological benefit through creation of habitat within the shoreland and littoral areas associated with streams and lakes.[27]

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[27]*See, for example, Brian M. Weigel, Edward E. Emmons, Jana S. Stewart, and Roger Bannerman, " Buffer Width and Continuity for Preserving Stream Health in Agricultural Landscapes,"* Wisconsin Department of Natural Resources Research and Management Findings, *Issue 56, December 2005.*

Riparian Management Practices in Rural and Urban Areas

The studies of the effects of agricultural land use on biotic integrity scores indicated a positive relationship between fishery IBI and increased agricultural riparian buffer vegetation width. This suggests that the impacts of increased urban land use may also be mitigated by an increased width of riparian buffer, which, in turn, will act to protect the stream aquatic biota. A follow-up study investigating the influence of watershed-, riparian corridor-, and reach-scale characteristics on aquatic biota in agricultural watersheds found that the type(s) of land use within the watershed, the presence of riparian corridors, and the degree of fragmentation of vegetation were the most important variables influencing fish and macroinvertebrate abundance and diversity.[28] In addition, upland best management practices (BMPs)—such as barnyard runoff controls, manure storage, contour plowing, and reduced tillage, when combined with riparian BMPs—such as streambank fencing, streambank sloping, and limited streambank riprapping, significantly improved overall stream habitat quality, bank stability, instream cover for fishes, and fish abundance and diversity.[29] Improvements were most pronounced at sites with riparian BMPs. At sites with limited upland BMPs installed, there were few improvements in water temperature or in the quality of fish community.

Public financial assistance for implementation of riparian and upland BMPs is often available to qualifying landowners. The Racine County Land Conservation Division (LCD) works with rural landowners to provide cost-share assistance through Federal, State, and other programs for the installation of conservation practices on agricultural land, and assists landowners in deciding which program best fits their situation. County programs, such as the Land and Water Resource Management Program, as well as Federal programs, such as the Conservation Reserve Program (CRP), the Conservation Reserve Enhancement Program (CREP), and the Environmental Quality Incentives Program (EQIP), help to implement agricultural BMPs, create and expand riparian buffers, protect shoreline, and restore wetlands, all with the goals of protecting wildlife habitat, reducing erosion, and improving water quality. Through these programs, 69 landowners within the Racine County portion of the Root River watershed have successfully implemented at least one conservation project each from 2001 to 2012. Conservation projects implemented within the watershed are summarized and mapped in Table 22 and Map 21, respectively. Over this time period, about 20 miles of grassed waterways and 38 acres of grass buffers were implemented in portions of the watershed where agricultural land uses have greatly reduced riparian buffer protection along streams. These waterways and buffers allow for the removal of nutrients and sediments before entering streams and rivers and can provide vital links to quality upland habitats for wildlife.

Around lakes where development generally has a more urban character stormwater management and runoff controls—such as the application of stormwater infiltration practices, onsite detention/retention of stormwater, adoption of good shorescaping measures, and shoreland management practices—offer similar benefits.[30] Wetlands adjacent to lakes and streams help enhance water quality conditions while preserving desirable open space characteristics for residents to participate in a wide range of resource-oriented recreational activities. Protection of shoreland wetlands also helps to avoid the creation of new environmental and developmental problems as urbanization proceeds within the watershed. In parallel with such protection and preservation, the use of natural and native vegetation as shoreline protection is required pursuant to Chapter NR 328, "Shore Erosion Control Structures in Navigable Waterways," of the *Wisconsin Administrative Code* as best practice along lake shorelines

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[28]*J. Stewart, L. Wang, J. Lyons, J. Horwatich, and R. Bannerman, "Influence of Watershed, Riparian Corridor, and Reach Scale Characteristics on Aquatic Biota in Agricultural Watersheds,"* Journal of the American Water Resources Association, *Volume 37, 2001.*

[29]*L. Wang, J. Lyons, and P. Kanehl, "Effects of Watershed Best Management Practices on Habitat and Fish in Wisconsin's Streams,"* Journal of the American Water Resources Association, *Volume 38, 2002.*

[30]*See University of Wisconsin-Extension, Publication No. GWQ045,* Storm Water Basins: Using Natural Landscaping for Water Quality and Esthetics, *2005.*

Table 22

CONSERVATION PROJECTS WITHIN THE RACINE COUNTY PORTION OF THE ROOT RIVER WATERSHED: 2001-2012

Project Type	Number of Landowners Participating in Associated Project Type[a]	Number of Individual Project Components[b]	Combined Size of Projects	Associated Program Providing Cost-Share Assistance
Barnyard Runoff System	2	2	- -	Environmental Quality Incentives Program, Land and Water Resource Management Program
Field Diversion	10	10	2,564 linear feet	Environmental Quality Incentives Program, Land and Water Resource Management Program
Grade Stabilization Structure	19	35	1,998 linear feet	Environmental Quality Incentives Program, Land and Water Resource Management Program, Conservation Reserve Enhancement Program, Conservation Reserve Program
Grass Buffer	11	20	38 acres	Land and Water Resource Management Program, Conservation Reserve Enhancement Program
Grassed Waterway	45	121	106,754 linear feet	Environmental Quality Incentives Program, Land and Water Resource Management Program, Conservation Reserve Enhancement Program, Conservation Reserve Program
Lined Waterway Outlet	6	14	- -	Land and Water Resource Management Program
Nutrient Management Areas	2	6	132 acres	Land and Water Resource Management Program
Rock Crossing	10	13	525 feet	Environmental Quality Incentives Program, Land and Water Resource Management Program, Conservation Reserve Program
Streambank Shoreline Protection	4	6	5,237 linear feet	Land and Water Resource Management Program
Subsurface Drain	16	29	28,464 linear feet	Environmental Quality Incentives Program, Land and Water Resource Management Program, Conservation Reserve Enhancement Program, Conservation Reserve Program
Surface Inlet	11	14	- -	Environmental Quality Incentives Program, Land and Water Resource Management Program, Conservation Reserve Enhancement Program, Conservation Reserve Program
Underground Outlet	8	9	10,419 linear feet	Environmental Quality Incentives Program, Land and Water Resource Management Program, Conservation Reserve Enhancement Program, Conservation Reserve Program
Well Abandonment	12	13	- -	Land and Water Resource Management Program

[a]*Some landowners participate in several different types of conservation projects. Several landowners have participated in these project types in multiple years.*

[b]*Some projects contain multiple site components and some projects are repeated in multiple years.*

Source: Racine County Land Conservation and SEWRPC.

where such measures are feasible. Recent studies of the potential impact of riparian landscaping activities on nutrient loadings to lakes in southeastern Wisconsin have suggested that urban residential lands can contribute up to twice the mass of phosphorus to a lake when subjected to an active program of urban lawn care than similar lands managed in a more natural fashion.[31] The application of agrochemicals to such lands, in excess of the plant requirements, therefore, results in enhanced nutrient loading directly to the adjacent waterbodies. To this end, the State of Wisconsin has promulgated guidance for turf nutrient management targeted at residential lands, parks, and high use areas, such as golf courses and parks.[32]

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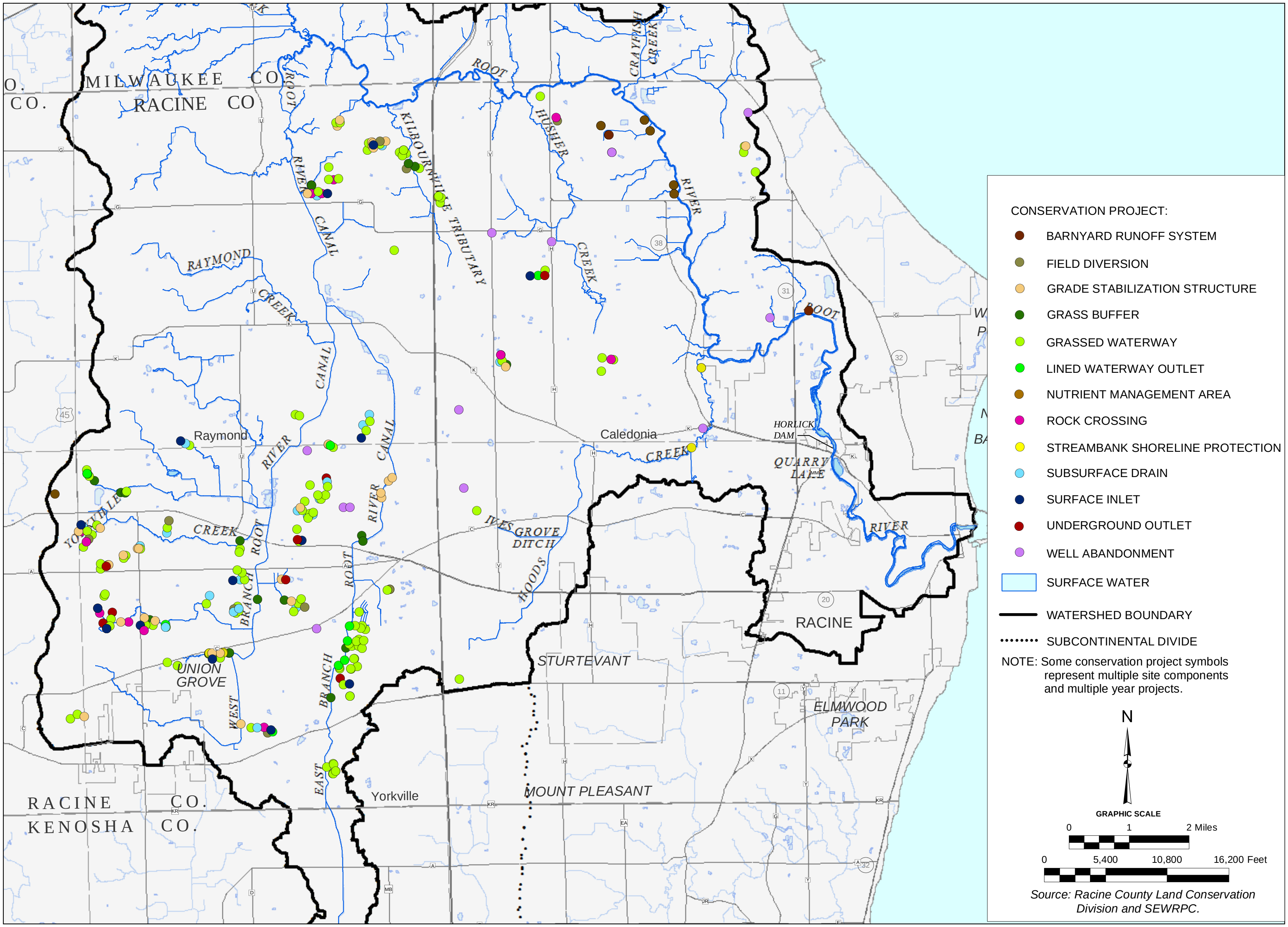
[31]*U.S. Geological Survey Water-Resources Investigations Report No. 02-4130,* Effects of Lawn Fertilizer on Nutrient Concentration in Runoff from Lakeshore Lawns, Lauderdale Lakes, Wisconsin, *July, 2002.*

[32]*Wisconsin Department of Natural Resources, Technical Standard No. 1100,* Turf Nutrient Management, *2006; 2009 Wisconsin Act 9 created Section 94.643 of the* Wisconsin Statutes *which places restrictions on the use and sale of fertilizer containing phosphorus as well as on the use and sale of other turf fertilizers, codifying in part the recommended land management measures set forth in Technical Standard No. 1100.*

Map 21

CONSERVATION PROJECTS WITHIN THE RACINE COUNTY PORTION OF THE ROOT RIVER WATERSHED: 2001-2012



Source: Racine County Land Conservation Division and SEWRPC.

In addition to the protection of water quality, riparian buffers simultaneously protect wildlife including both aquatic and terrestrial habitats. Buffer zones adjacent to waterbodies such as lakes, rivers, and wetlands minimize the impacts of human activities on the landscape and contribute to recreation, aesthetics, and quality of life.[33] Riparian buffers are unique ecosystems that are exceptionally rich in biodiversity since they function as core habitat and travel corridors for many wildlife species including birds, fishes, amphibians, insects, reptiles, and plants. Previous observations of the quality of the fishery in the Root River watershed have indicated that the watershed has a poor quality fishery, especially upstream of Horlick dam.[34] Factors influencing this may include: changes in instream channel features including discharge, groundwater inputs, substrates, and gradient; land use changes and the presence, absence, and condition of measures to mitigate the adverse effects of land uses,[35] and extent of riparian buffers protecting lakes and streams. The existing state of the fishery is discussed later in this chapter.

Existing and Potential Riparian Buffers

Riparian corridors along the mainstem and major tributaries of the Root River watershed were delineated under the SEWRPC RWQMPU based upon the presence of natural vegetation, as shown on year 2000 digital orthophotographs. The riparian widths were classified based on the average distance between the edge of the stream channel and the exterior border of the natural vegetation. For each stream reach or segment evaluated, the average riparian width was evaluated for both the left and right bank and was placed into one of four categories: 0 to 25 feet, 26 to 50 feet, 51 to 75 feet, and greater than 75 feet.

For the purpose of this report a more-detailed approach was taken whereby the areal extents of riparian buffers were delineated, enabling visualization of existing buffer connections, which is a more powerful tool for planning purposes. Buffers within the Root River watershed were primarily developed from 2010 digital orthophotographs and the 2005 WDNR Wisconsin Wetland Inventory as well as the SEWRPC primary and secondary environmental corridors inventory. Polygons were created using geographic information system (GIS) techniques to delineate contiguous natural lands comprised of wetland, upland, woodland, and other open lands adjacent to streams. The total area of riparian buffer could then be calculated for the entire watershed, subwatershed, subbasin, and reach levels, where appropriate. Map 22 shows the Root River watershed divided into 23 separate stream reach areas (mainstem reaches and 18 tributary reaches), which allows the major tributary areas to be partitioned from the mainstem areas of the watershed. These reach areas are derived from combinations of multiple subbasins and form the basis for summary statistics and analysis of riparian buffers. Mainstem reach areas include from upstream to downstream, RR-10, RR-13, RR-17, RR-22, and RR-23. Tributary stream reach areas are generally numbered by position within the watershed and increase from upstream to downstream and include, RR-1 through RR-9, RR-11, RR-12, RR-14 through RR-16, and RR-18 through RR-21.

Map 23 shows the year 2010 status of riparian buffers along the Root River and its tributary streams. Riparian buffers comprise a total of 12,208 acres, or about 9.7 percent of the entire watershed area, as shown in Table 23. Mainstem reach areas contain 3,498 acres of riparian buffer, or about 14.0 percent of the total mainstem reach

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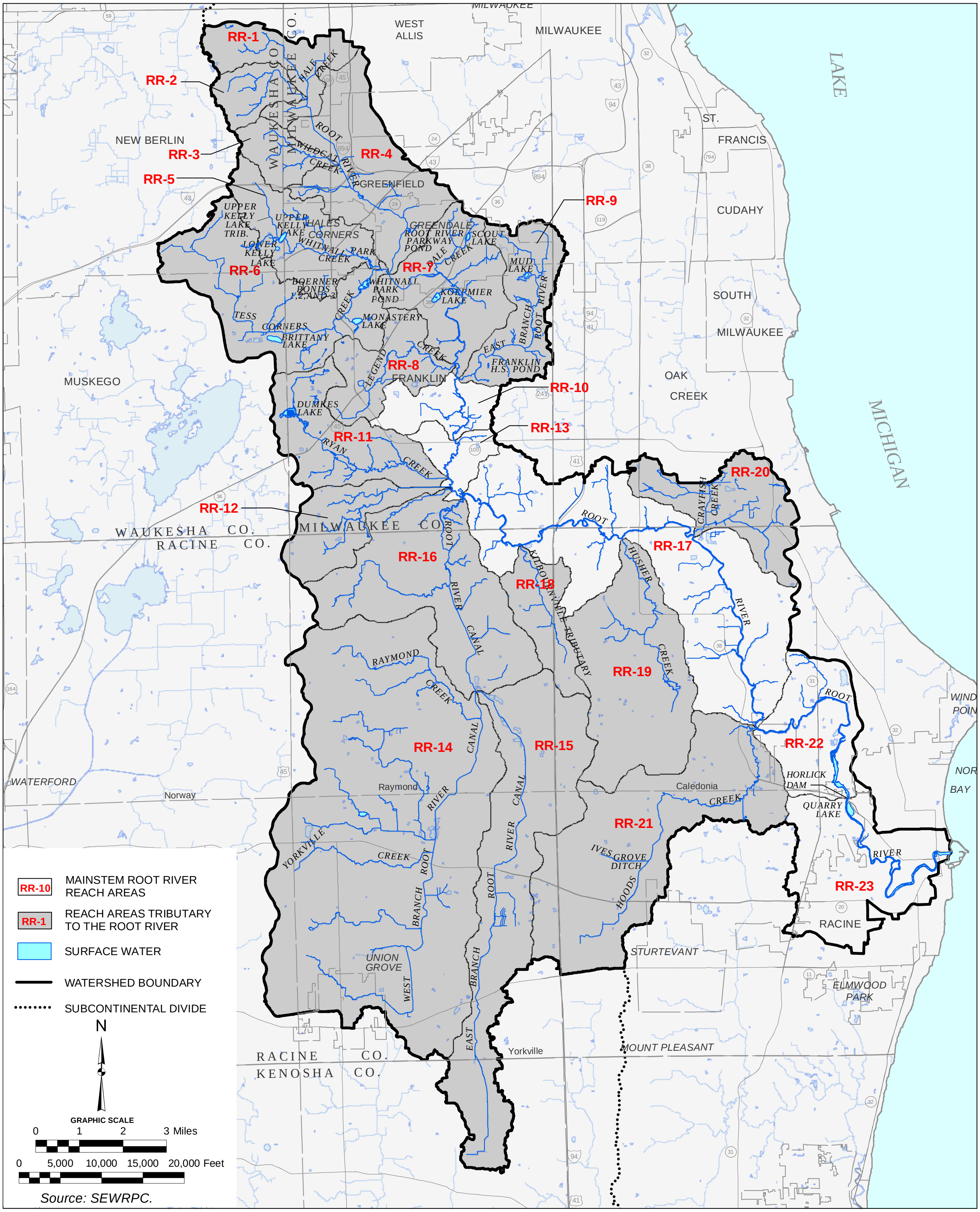
[33]*This is discussed in SEWRPC Riparian Buffer Management Guide No. 1,* Managing the Water's Edge: Making Natural Connections, *2010; which is included in this report as Appendix B.*

[34]*SEWRPC Technical Report No. 39,* op. cit.

[35]*The standards and requirements of Chapters NR 151, "Runoff Management," and NR 216, "Storm Water Discharge Permits," of the* Wisconsin Administrative Code *are intended to mitigate the impacts of existing and new urban development and agricultural activities on surface water resources through control of peak flows in the channel-forming range, promotion of increased baseflow through infiltration of stormwater runoff, and reduction of sediment loads to streams and lakes. The implementation of those rules is intended to protect, or improve, water quality and instream/inlake habitat conditions.*

Map 22

MAINSTEM AND TRIBUTARY REACHES WITHIN THE ROOT RIVER WATERSHED: 2010



Source: SEWRPC.

Map 23

RIPARIAN BUFFERS WITHIN THE ROOT RIVER WATERSHED: 2010

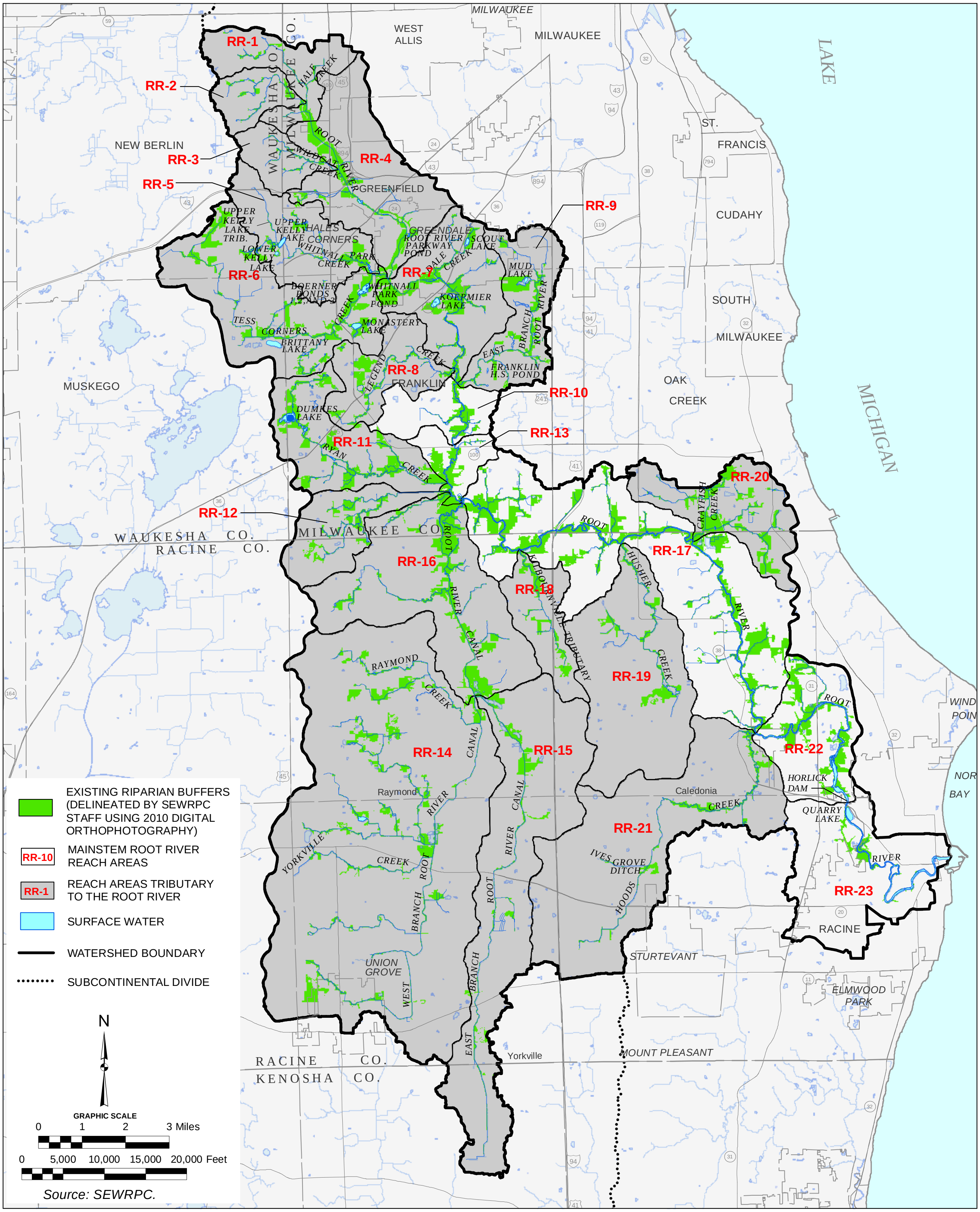


Table 23

EXISTING RIPARIAN BUFFER AREAS IN THE ROOT RIVER WATERSHED

Stream Reach[a]		Stream Reach Area (acres)[a]	Riparian Buffer Area (acres)	Percent Riparian Buffer Area In the Reach	Associated Water Quality Assessment Area[b]	Principal Streams, Lakes, and Ponds
Mainstem Root River Reach Areas	RR-10	1,757.8	207.0	11.8	Middle Root River-Legend Creek	Root River mainstem, unnamed tributaries
	RR-13	1,153.1	289.1	25.1	Middle Root River-Ryan Creek	Root River mainstem, Tuckaway Creek, unnamed tributaries
	RR-17	12,707.2	2,123.1	16.7	Middle Root River-Ryan Creek, Lower Root River-Caledonia	Root River mainstem, unnamed tributaries
	RR-22	3,589.5	709.6	19.8	Lower Root River-Johnson Park	Root River mainstem, unnamed tributaries
	RR-23	5,699.4	169.2	3.0	Lower Root River-Racine	Root River mainstem
Subtotal		24,907.0	3,498.0	14.0	- -	- -
Reach Areas Tributary to the Root River	RR-1	2,339.9	123.3	5.3	Upper Root River Headwaters	Root River mainstem, Hale Creek
	RR-2	1,237.0	92.4	7.5	Upper Root River Headwaters	New Berlin Memorial Hospital Tributary
	RR-3	1,238.6	58.2	4.7	Upper Root River	Wildcat Creek
	RR-4	5,443.0	560.5	10.3	Upper Root River	Root River mainstem, unnamed tributaries
	RR-5	3,317.6	275.0	8.3	Whitnall Park Creek	Upper Kelly Lake Tributary, Whitnall Park Creek, Lower Kelly Lake, Upper Kelly Lake
	RR-6	6,270.8	898.8	14.3	Whitnall Park Creek	Tess Corners Creek, Brittany Lake, Monastery Lake, Whitnall Park Pond
	RR-7	4,137.3	738.7	17.9	Middle Root River-Dale Creek	Root River mainstem, Dale Creek, Koepmier Lake, Scout Lake
	RR-8	2,557.1	281.0	11.0	Middle Root River-Legend Creek	Legend Creek
	RR-9	3,136.7	453.8	14.5	East Branch Root River	East Branch Root River Canal, Mud Lake, unnamed tributaries
	RR-11	3,850.8	751.5	19.5	Middle Root River-Ryan Creek	Ryan Creek, Dumkes Lake
	RR-12	2,456.6	276.3	11.2	Middle Root River-Ryan Creek	Unnamed tributaries
	RR-14	25,319.8	1,307.7	5.2	Upper West Branch Root River Canal, Lower West Branch Root River Canal	Raymond Creek, West Branch Root River Canal, Yorkville Creek
	RR-15	9,976.5	406.4	4.1	East Branch Root River Canal	East Branch Root River Canal
	RR-16	7,723.7	1,065.1	13.8	Root River Canal	Root River Canal, unnamed tributaries
	RR-18	2,053.0	225.9	11.0	Lower Root River Canal-Caledonia	Kilbournville Tributary
	RR-19	6,920.6	295.6	4.3	Lower Root River Canal-Caledonia	Husher Creek, unnamed tributaries
	RR-20	3,382.0	589.2	17.4	Lower Root River Canal-Caledonia	Crayfish Creek, unnamed tributaries
	RR-21	10,266.9	310.8	3.0	Hoods Creek	Hoods Creek, Ives Grove Ditch
Subtotal		101,627.9	8,710.2	8.6	- -	- -
Total		126,534.9	12,208.2	9.7	- -	- -

[a]*Mainstem and tributary stream reach areas are shown on Map 22.*

[b]*Water Quality Assessment Areas are shown on Map 7.*

Source: SEWRPC.

area. Tributary reach areas contain 8,710 acres of riparian buffer or about 8.6 percent of the total tributary stream reach areas. The most extensive buffers relative to reach area were found in mainstem reaches RR-13 and RR-22 and tributary reaches RR-7, RR-11, and RR-20, where 25.1, 19.8, 17.9, 19.5, and 17.4 percent of each respective stream reach area are protected by buffers, as shown in Table 23 and Figure 9. Reaches RR-4, RR-5, RR-7, RR-10, RR-13, and portions of RR-17 benefit from the Milwaukee County Parks and Parkway system which provides extensive stream buffering despite, in many cases, being located in very densely urbanized portions of the watershed. This benefit of the parkway system is tempered by the fact that many storm sewer outfalls passing through parkway lands discharge directly to the streams of the watershed, completely, or partially, bypassing the riparian corridor. In general, as is illustrated in Figure 9, the percentage of riparian buffer protection in the mainstem stream reach areas increases from upstream to downstream, with the exception of RR-23 which contains one of the lowest percentage of buffers in the entire watershed. The RR-23 segment is highly urbanized and contains a large portion of the City of Racine. This same general pattern of increased buffer protection from upstream to downstream among the tributary reaches (based on the location where each tributary flows into the Root River main stem) was also observed for reach areas RR-2 to RR-12. In those reach areas the percentage of riparian buffer areas ranges from 4.7 to 19.5 percent. Downstream of the confluence of reach area RR-12 with the Root River mainstem, there is a substantial decrease in the area of riparian buffers among tributaries particularly among reaches RR-14, RR-15, RR-19, and RR-21, which all have less than 6 percent riparian buffer protection. These reaches are located in areas of the watershed which are comprised of mostly agricultural land uses.

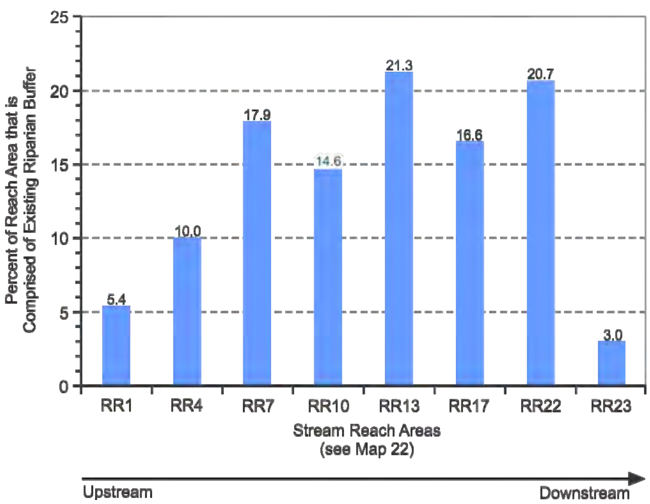
Map 24 shows the current status of existing and potential riparian buffers at the 75-foot, 400-foot, and 1,000-foot widths along the Root River and its tributary streams. Maps C-1 through C-23 in Appendix C show, at a more detailed scale, the individual reach areas along with the existing and potential buffer areas. Comparison between the existing buffers versus the potential buffers indicates that the existing buffers contain some areas whose widths exceed 1,000 feet from the edge of the stream, which indicates they are providing significant water quality and wildlife protection (see Map 24). As discussed above, this is mostly due to the protection of land through the Milwaukee County Parkway system. For example, in reach areas that contain existing buffers exceeding 1,000 feet in width, such as RR-4, RR-7, RR-10, and RR-13, Milwaukee County owns between 81 to almost 93 percent of the buffered lands. Map 25 shows the open space lands in public and private protection within the watershed.

Nonetheless, encroachments into the riparian buffer to less than 400 feet (orange color) and 75 feet (red color) from the edge of the stream can be found in reach areas throughout the watershed (see Appendix C, Maps C-1 through C-23 for detailed view). In particular, the most significant encroachments into the riparian corridor within the 400-foot and 75-foot widths are located within the upper portions of the watershed in Milwaukee County (specifically reach areas RR-1, RR-2, RR-3 and RR-5), as well as the lower portion of the watershed in Racine County (specifically reach area RR-23), where residential and commercial development has left less than 9 percent of each of the reach areas buffered (see Figure 9). Likewise, encroachments into the riparian corridor within the 400-foot and 75-foot widths are significant throughout the agricultural areas of Racine County (specifically reach areas RR-14, RR-15, RR-18, RR-19, and RR-21). An important distinction between the urban encroached areas and the agricultural encroached areas is the amount of land that is determined to be potential buffer in this analysis. Within the reach areas listed above in the upper portions of the watershed in Milwaukee County and the lower portion of the watershed in Racine County where urban encroachment into the riparian areas has occurred, only 1,430 acres (less than 6 percent of land in these reach areas) are determined to be potential land for riparian buffer expansion. Conversely, within the reach areas listed above that lack existing riparian buffer mostly due to agricultural encroachments, 12,720 acres (23 percent of the land in these reach areas) have been determined to be potential lands for riparian buffer expansion. Figure 9 shows that there is the potential to triple the area of riparian buffers throughout the watershed, adding about 25,294 acres.

Although the existing and potential buffers have been identified throughout the Root River watershed, it is important to recognize that some of these lands are more vulnerable to potential loss than others. For example, some of these buffer lands are protected through regulations and, as discussed above, some are already in some form of public or protected private ownership. Therefore, riparian buffer lands and potential riparian buffer expansion lands that are not within one of the following categories are considered to be vulnerable to potential

Figure 9

PERCENT OF RIPARIAN BUFFER AREA AMONG MAINSTEM ROOT RIVER REACH AREAS: 2010



Source: SEWRPC.

loss over time: 1) open lands owned under public interest ownership as shown on Map 25; 2) Federal Emergency Management Agency 1-percent-annual-probability (100-year recurrence interval) regulatory floodway (AE Floodway Zone) as shown in Map 26;[36] 3) Advanced Delineation and Identification (ADID) wetlands as shown on Map 27.

Approximately 37 percent of the existing riparian buffers within the watershed are protected through public interest ownership. In addition, significant amounts of the existing riparian buffers are within the 1-percent-annual-probability (100-year recurrence interval) regulatory floodway and/or within designated ADID wetlands, which provides additional protection for these areas. Based upon these criteria it was possible to distinguish protected existing riparian buffer lands from vulnerable existing riparian buffer lands. In addition it was also possible to distinguish protected versus vulnerable potential riparian buffer lands in the 75-foot, 400-foot, and 1,000-foot potential buffer width categories. The vulnerable existing and potential riparian buffer land acreages are summarized by stream reach area and shown in Figure 10 (also see Maps C-1 through C-23 in Appendix C). Figure 10 indicates that the greatest extent of vulnerable existing riparian buffers and vulnerable potential riparian buffers are located within Racine County, particularly in reach areas RR-14, RR-15, RR-16, RR-17, RR-19, and RR-21.[37] However, there are opportunities to protect vulnerable existing and potential buffers within every reach area throughout the watershed. These vulnerable areas are a high priority to protect to the extent practicable in order to preserve water quality, wildlife, and recreational opportunities in the Root River watershed and are mapped in greater detail on Maps C-1 through C-23 in Appendix C.

Biological Characteristics

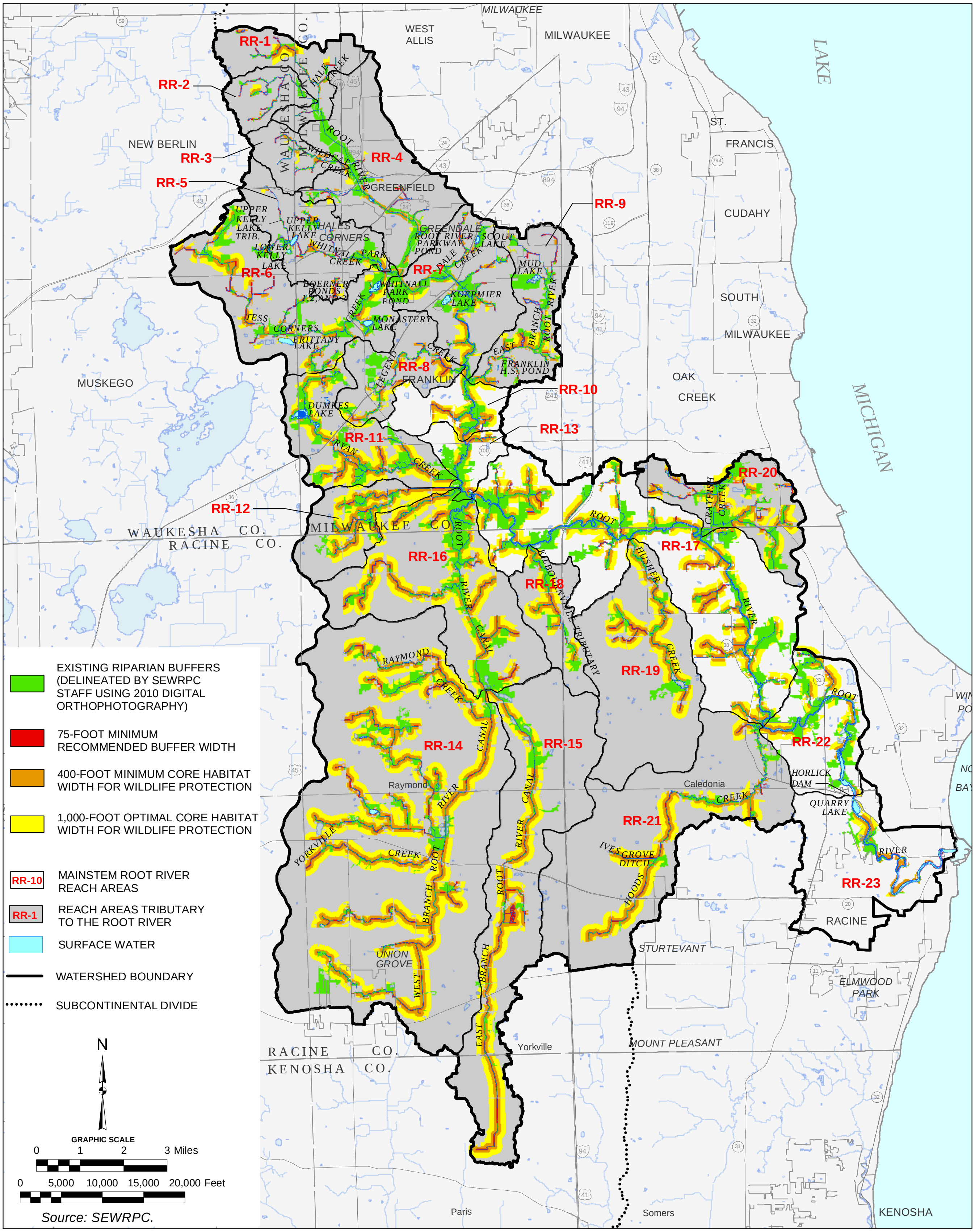
Primary and secondary environmental corridors (PEC and SEC) and isolated natural resource areas (INRA) are distributed throughout the Root River watershed. As shown on Map 28, much of these lands are located along the stream network within the watershed. In fact, the highest-quality environmental corridors, designated natural areas (NA), and critical species habitat sites are located within and adjacent to the stream system and many are associated with the riparian buffer network throughout the Root River watershed as shown in Map 29. Not only do riparian buffers make up much of the corridor, natural area, and critical species habitat lands, but in many

[36]*Digital floodway boundaries do not exist within Racine County, so the 1-percent-annual-probability regulatory floodplain boundary in the County was considered to be "vulnerable," unless it coincides with lands in a protected category. This boundary is susceptible to generally limited adjustment under a floodplain zoning ordinance variance process that enables placement of fill within the flood fringe if that filling is offset by the provision of an equal volume of excavated floodwater storage.*

[37]*It is important to note that because digital floodway boundaries are not available for Racine County, many existing and potential buffer areas that are located within the floodway, and are thus are protected from fill, are considered "vulnerable" in this analysis because no determination could be made as to which lands are within the floodway.*

Map 24

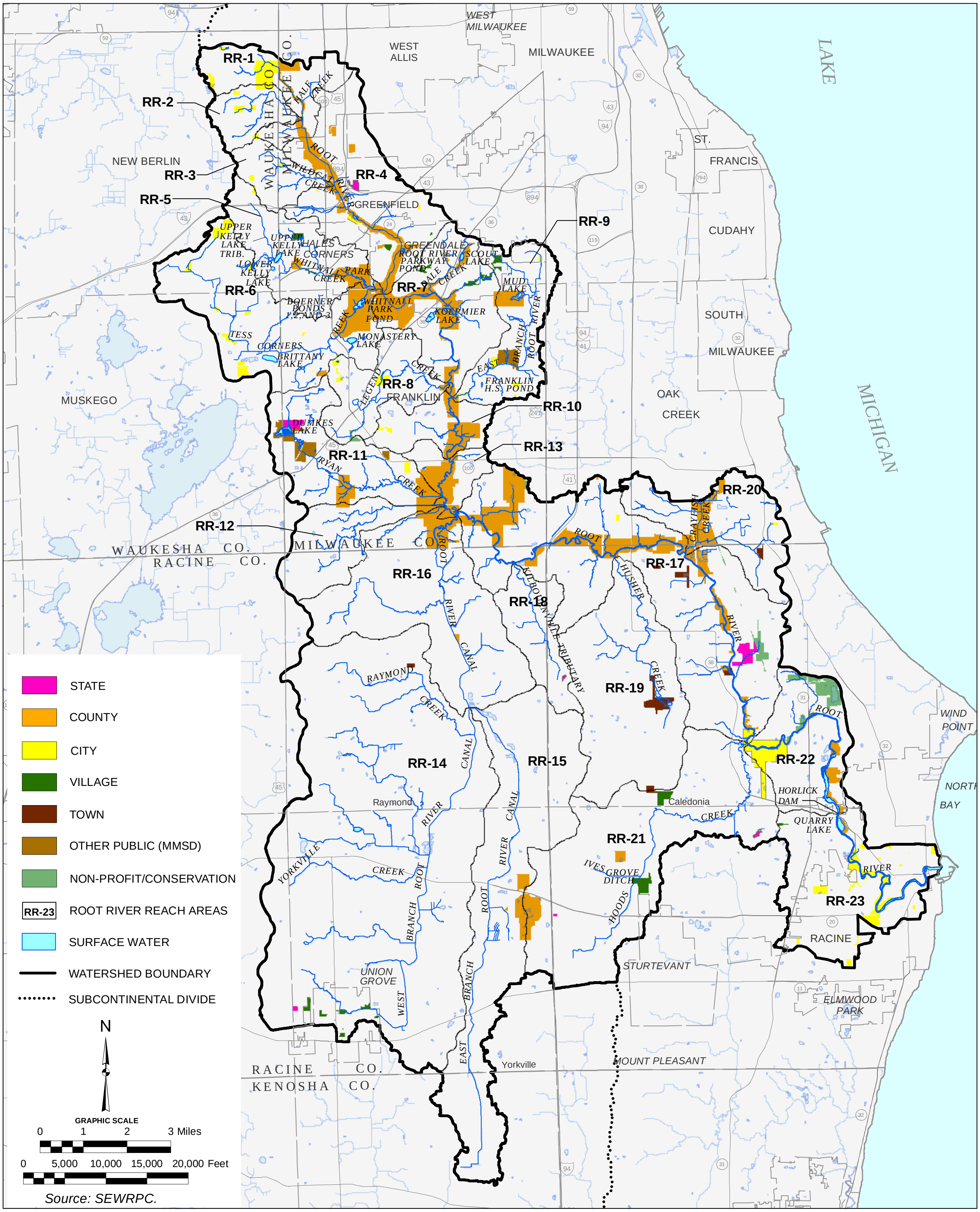
EXISTING AND POTENTIAL RIPARIAN BUFFERS WITHIN THE ROOT RIVER WATERSHED: 2010



Source: SEWRPC.

Map 25

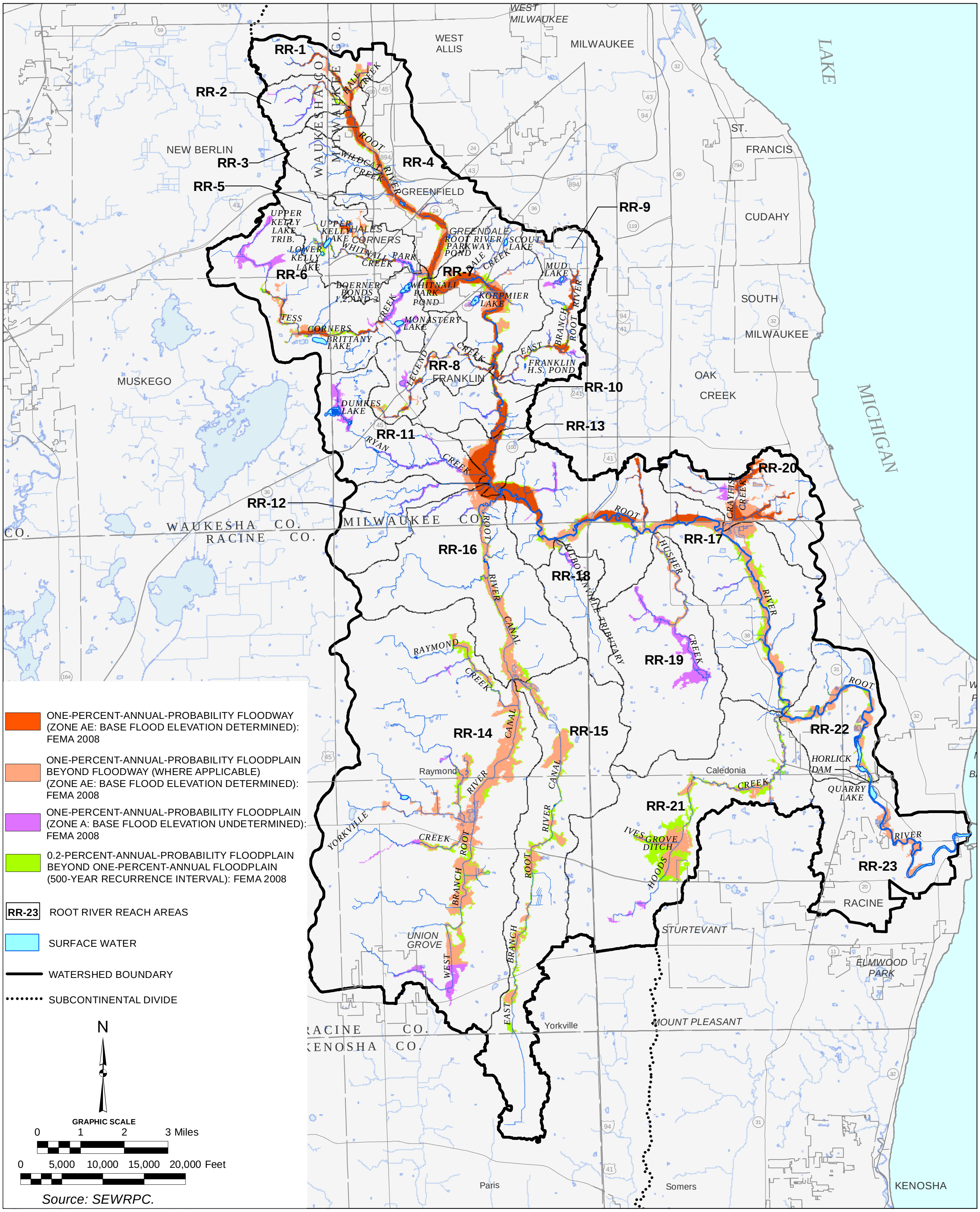
OPEN SPACE LANDS IN PUBLIC AND PRIVATE PROTECTION WITHIN THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 26

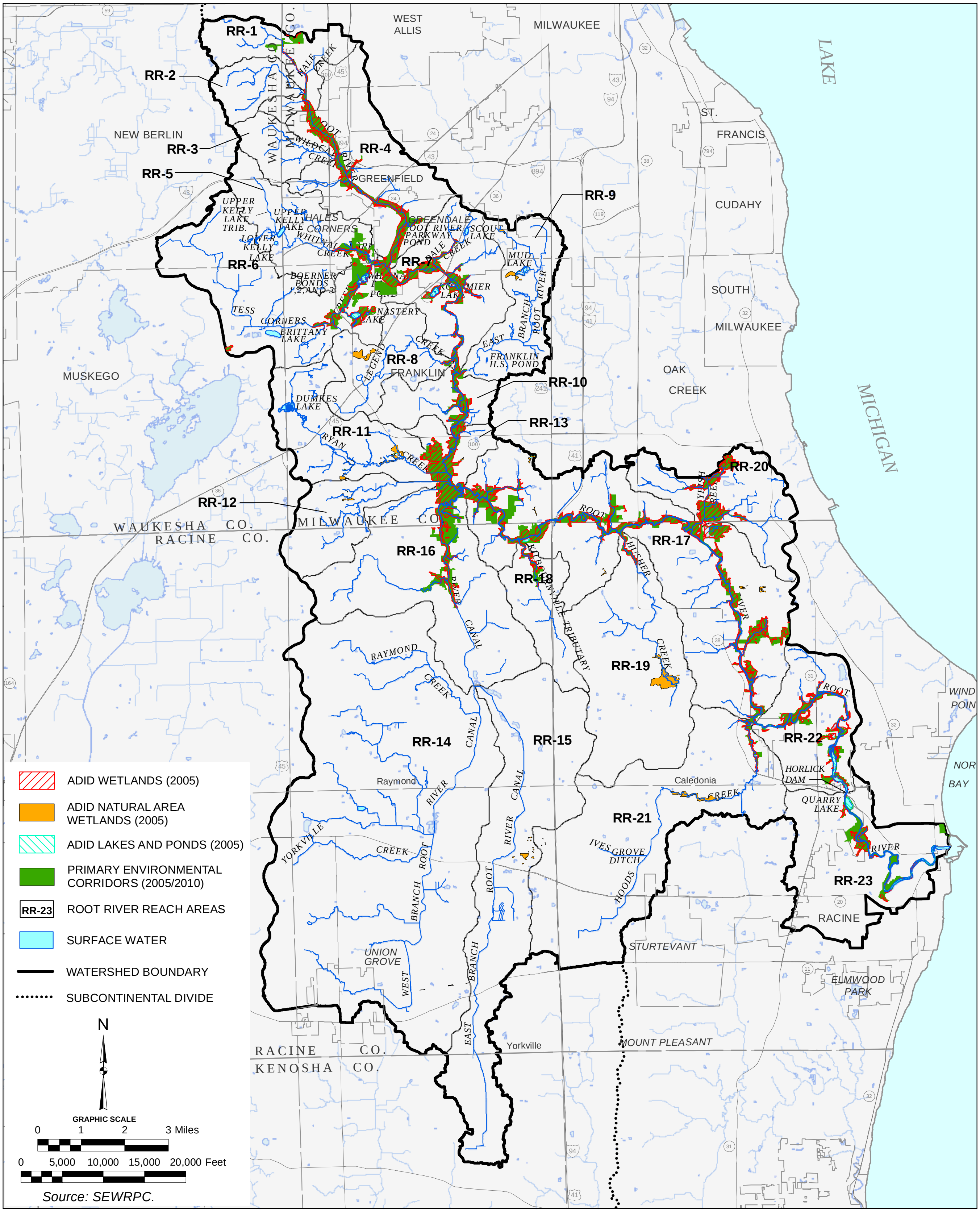
FLOODPLAIN DESIGNATIONS WITHIN THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 27

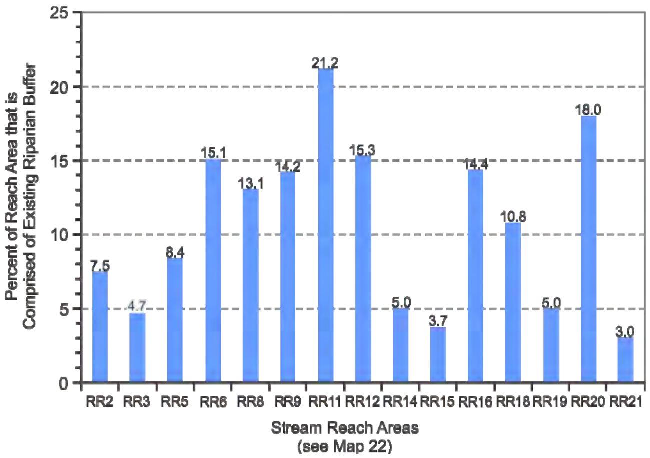
ADID WETLANDS AND WATERS WITHIN THE ROOT RIVER WATERSHED



Source: SEWRPC.

Figure 10

PERCENT OF RIPARIAN BUFFER AREA AMONG REACH AREAS TRIBUTARY TO THE ROOT RIVER: 2010



Source: SEWRPC.

cases they provide critical links between these areas. In other words, the riparian buffers are a vital conservation tool that provides the connectivity among different landscapes to improve the viability of wildlife populations within the habitats comprising these high-quality areas.[38]

Healthy and sustained aquatic and terrestrial wildlife diversity is dependent upon adequate riparian buffer width and habitat diversity. Specifically, as discussed above, recent research has found that the protection of wildlife species is determined by the preservation or protection of core habitat within riparian buffers ranging from a minimum 400-foot to optimal 900-foot-wide-buffers. These are essential for supporting multiple groups of organisms including birds, amphibians, mammals, reptiles, and insects and their various life stages. Hence preservation of riparian buffers to widths of 1,000 feet or greater represents the optimal condition for the protection of wildlife in the Root River watershed.[39]

Map 30 shows the major natural cover types both within and outside of the existing riparian buffers distributed throughout the Root River watershed based upon the WDNR 2010 wetland inventory. This inventory shows that the riparian buffers are comprised of a variety of wetland types such as emergent wet meadow, scrub/shrub wetlands, and wetland flats, as well as a variety of upland vegetation communities. This combination and diversity of wetland and upland cover types within the riparian buffers is essential to support an abundant and diverse wildlife community throughout the watershed.

Riparian Buffer Protection and Prioritization Strategies

All riparian buffers provide some level of protection that is greater than if there were no buffer at all. However, wider buffers provide a greater number of functions (infiltration, temperature moderation, species diversity) than narrower buffers. Therefore it is important that existing buffers be protected and expanded where practicable.

The riparian buffer network out to the 75-foot, 400-foot, and 1,000-foot widths as summarized above provides the framework upon which to protect and improve water quality and wildlife habitat within the Root River watershed. This framework can be achieved through a combination of strategies that include land acquisition, regulation, and implementing best management practices.

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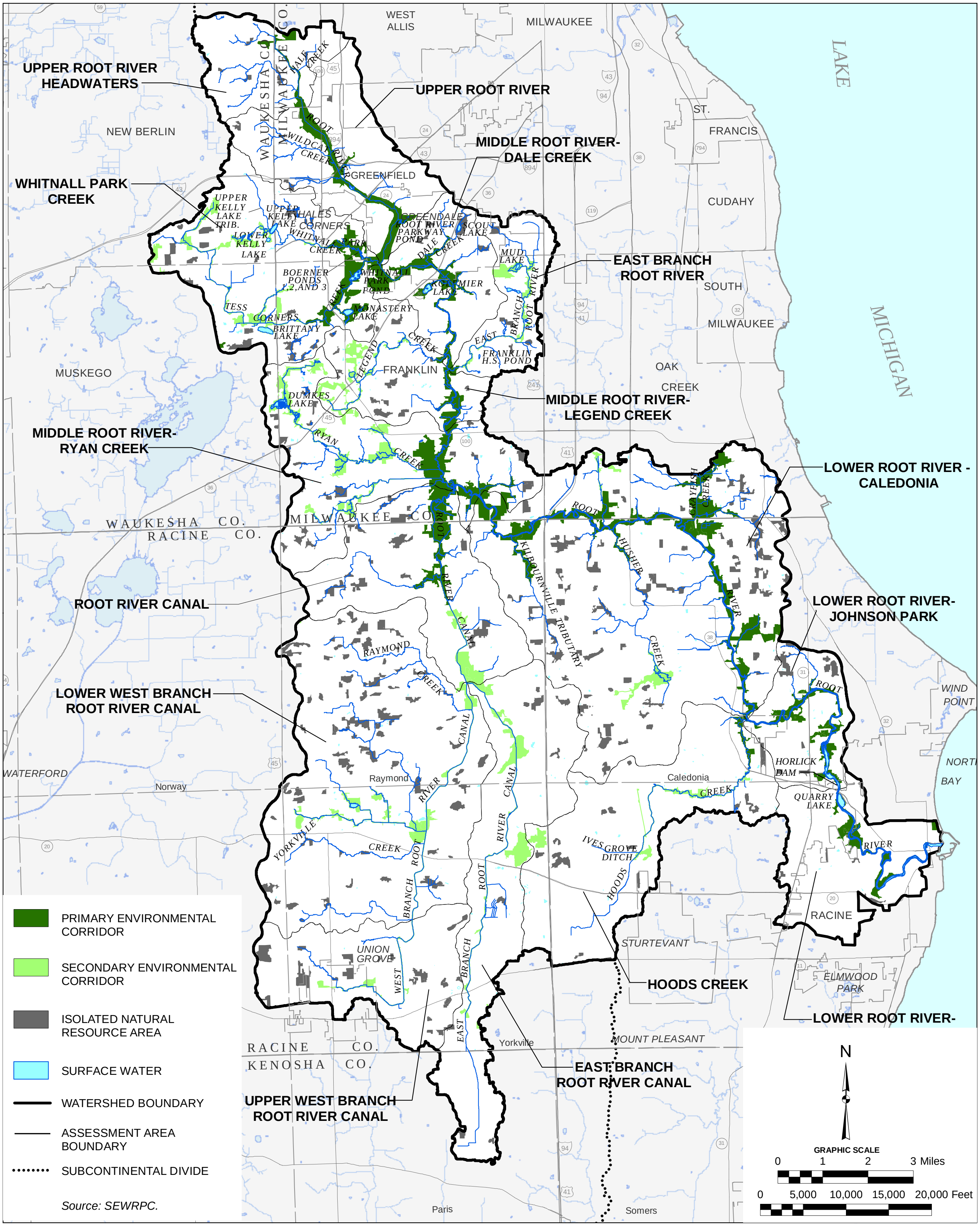
[38]*Paul Beier and Reed F. Noss, "Do Habitat Corridors Provide Connectivity?,"* Conservation Biology, *Volume 12, Number 6, December 1998.*

[39]*The shoreland zone is defined as extending 1,000 feet from the ordinary high water mark of lakes, ponds, and flowages and 300 feet from the ordinary high water mark of navigable streams, or to the outer limit of the floodplain, whichever is greater. To be consistent with that concept and to avoid confusion, the optimum buffer width for wildlife protection is defined as extending 1,000 feet from the ordinary high water mark on both sides of the lakes, ponds, and navigable streams in the watershed.*

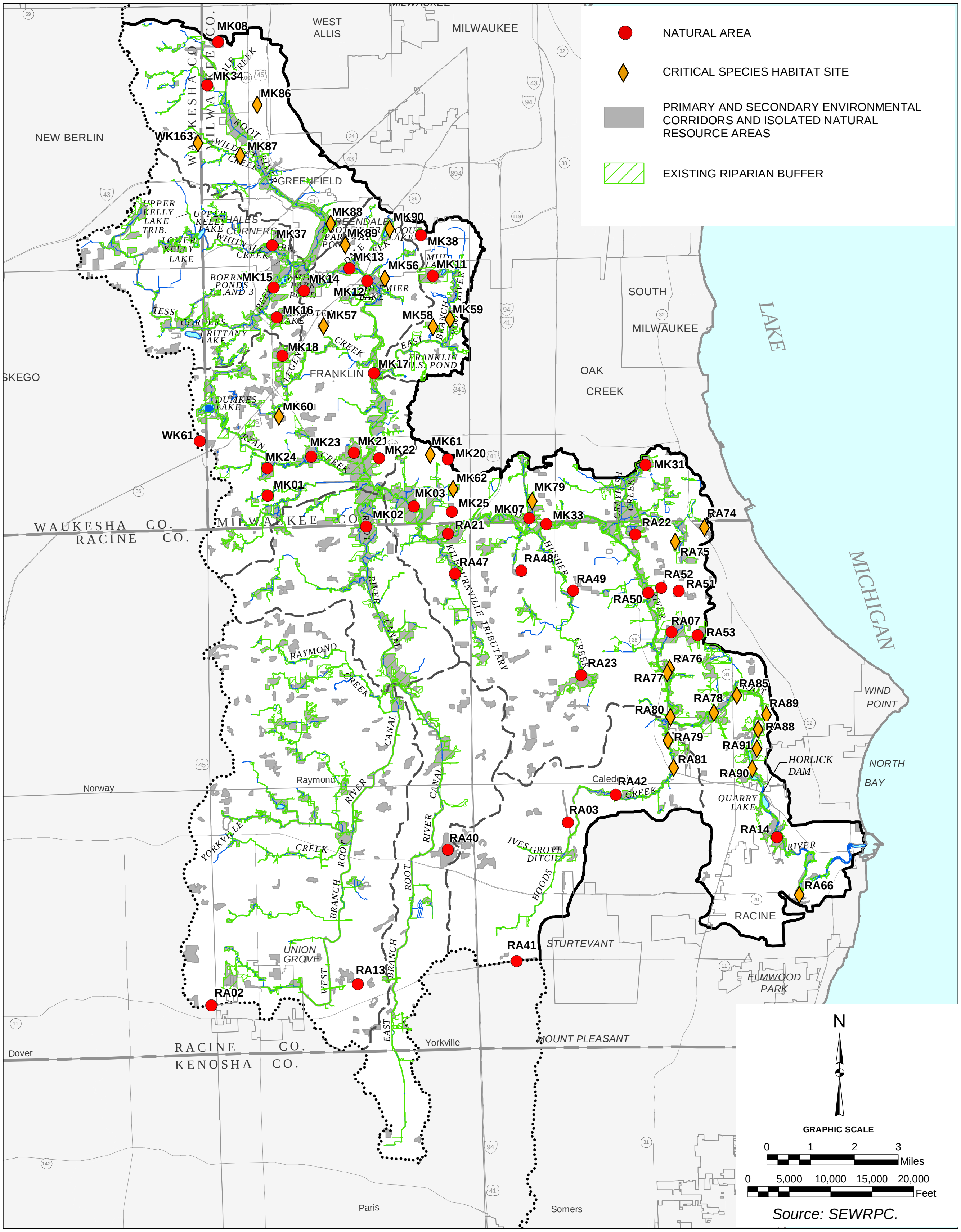
Map 28

ENVIRONMENTAL CORRIDORS WITHIN THE ROOT RIVER WATERSHED: 2005



Map 29

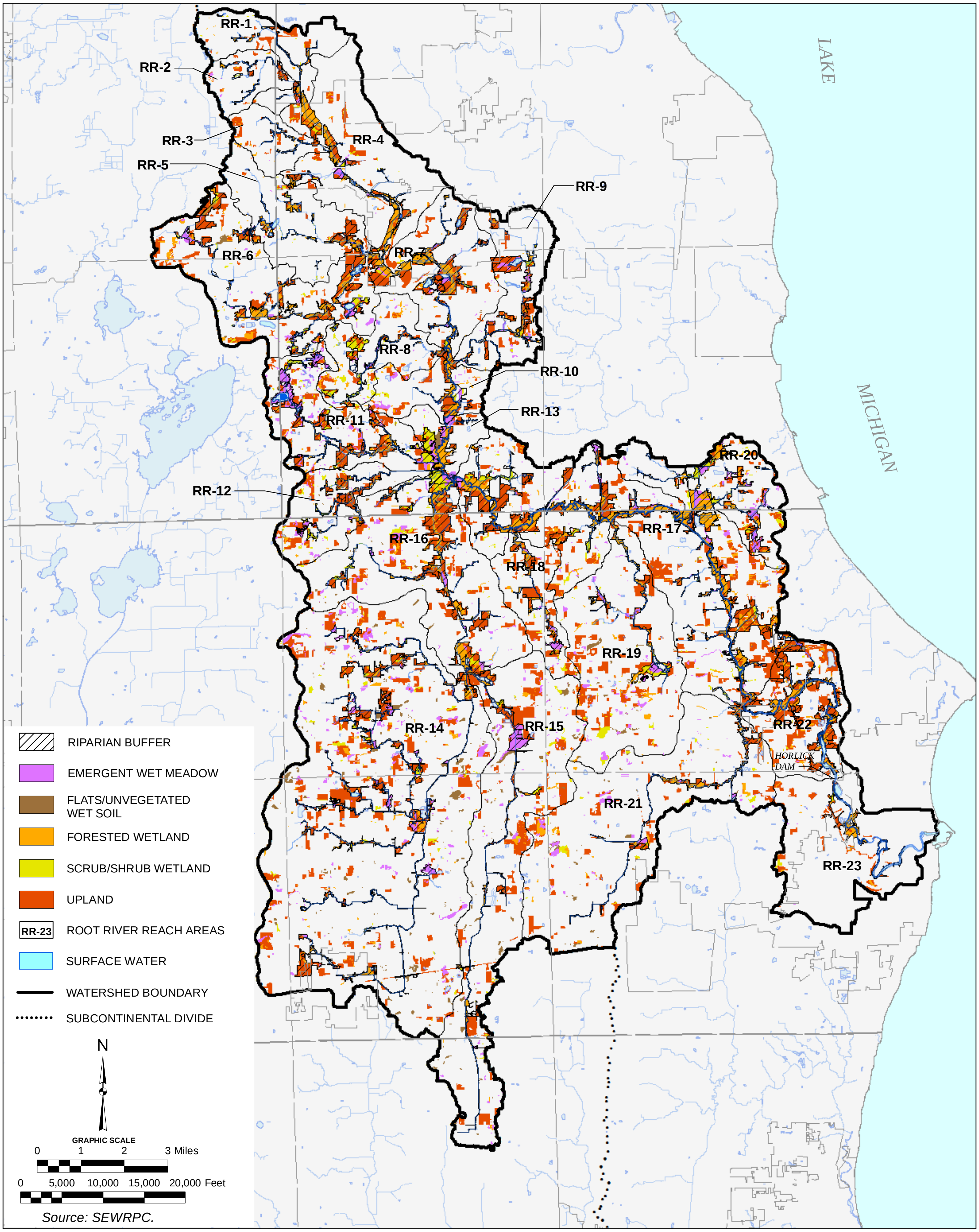
NATURAL AREAS, CRITICAL SPECIES HABITAT SITES, AND ENVIRONMENTAL CORRIDORS IN RELATIONSHIP TO EXISTING RIPARIAN BUFFERS IN THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 30

COVER TYPES AND RIPARIAN BUFFERS WITHIN THE ROOT RIVER WATERSHED: 2010



Source: SEWRPC.

LAND ACQUISITION

Not all of the environmental corridors and associated natural areas, which make up large portions of the existing and potential riparian buffer lands, are protected. It is therefore important that a prioritization for acquisition of these lands (including PEC, SEC, INRA, and NA) be based on the following order of importance in order from highest to lowest priority (see Maps C-1 through C-23 in Appendix C):

1. Vulnerable existing riparian buffer (protect what exists on the landscape);
2. Vulnerable potential riparian buffer lands up to 75 feet wide (minimum level of protection);
3. Vulnerable potential riparian buffer lands up to 400 feet wide (minimum for wildlife protection); and
4. Vulnerable potential riparian buffer lands up to 1,000 feet wide (optimum for wildlife protection).

In addition, special consideration for the acquisition of vulnerable existing and potential riparian buffers should be given to locations designated as having high to very high groundwater recharge potential as shown on Maps D-1 through D-23 in Appendix D. Existing and potential riparian buffer areas within the watershed contain over 6,100 acres of land with high to very high groundwater recharge potential. Of those lands, almost 3,600 acres, or 59 percent, are considered to be vulnerable. These lands are vital to maintain adequate base flows in the streams and rivers of the watershed. Also, connecting and expanding wetland and upland habitat complexes to protect wildlife abundance and diversity should be a priority. Lastly, connecting the SEC and multiple INRAs throughout the Root River watershed to the larger PEC areas (as shown Maps E-1 through E-23 in Appendix E), as well as expanding upon the existing protected lands, represents a sound approach to enhance the corridor system and wildlife areas within the watershed.

REGULATION

Since primary environmental corridors have a greater level of land use protection compared to secondary corridors, isolated natural resource areas, or designated natural areas, the regulatory strategy to expand protections for vulnerable existing and potential riparian buffers would be to increase the extent of primary environmental corridor designated lands within the Root River watershed.

Opportunities are present throughout the Root River watershed to expand primary environmental corridor lands. However, this can only be accomplished if there are sufficient natural resource features along the streams to meet the criterion for designation as a corridor and if the minimum area (400 acres), minimum length (two miles) and minimum width (200 feet) requirements for designation as a primary corridor are met.

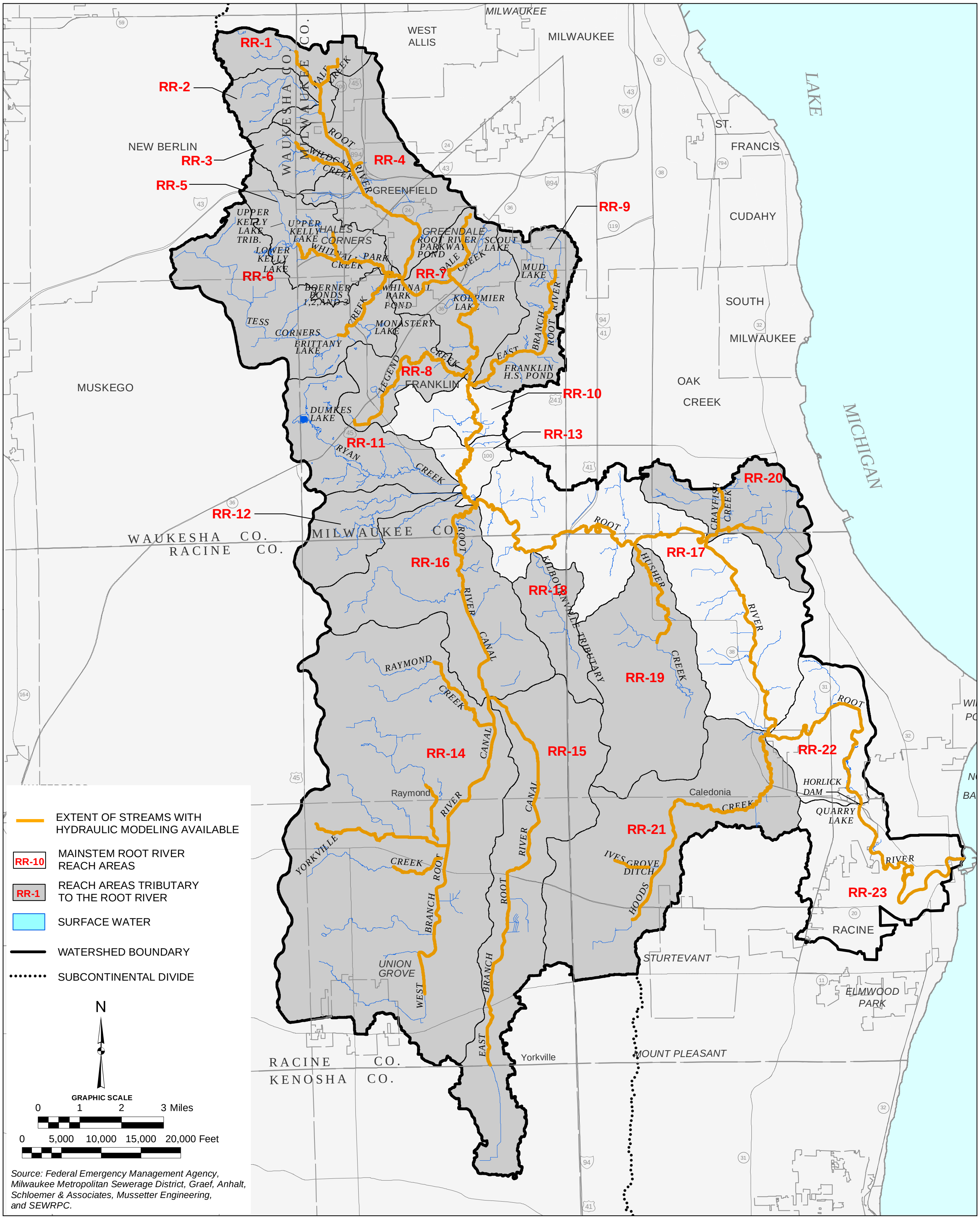
Map 31 indicates the extent of streams within the Root River watershed which have hydraulic modeling available. While all of the mainstem of the Root River and many of its major tributaries do have detailed hydraulic modeling available and thus a delineation of the 1-percent-annual-probability (100-year) floodplain, many tributaries have yet to be modeled. Delineation of the 1-percent-annual-probability (100-year) floodplains for these tributaries is one way to increase the “point value” assigned to the lands along the streams, which is the process for determining primary environmental corridors. The higher the “point value,” based on the presence of certain environmental features, that an area of land is allocated, the greater the possibly of its designation as a primary environmental corridor. Furthermore, since wetlands located within primary environmental corridors are considered to be wetlands of natural resource interest, or ADID wetlands, these wetlands would then be protected from filling, and thus retain their riparian buffer functions.

BEST MANAGEMENT PRACTICES

Since a large portion of the vulnerable existing and potential riparian buffers are privately owned within urban and agricultural areas of the watershed, it is entirely up to the private landowners as to whether a buffer is established. In addition, although riparian buffers can be effective in mitigating the negative water quality effects attributed to urbanization and agricultural management practices, they cannot on their own address all of the pollutant problems associated with these land uses. Therefore, riparian buffers need to be combined with other

Map 31

EXTENT OF STREAM REACHES WITH HYDRAULIC MODELING AVAILABLE WITHIN THE ROOT RIVER WATERSHED



Source: Federal Emergency Management Agency, Milwaukee Metropolitan Sewerage District, Graef, Anhalt, Schloemer & Associates, Mussetter Engineering, and SEWRPC.

management practices, such as infiltration facilities, detention basins, porous pavements, green roofs, and rain gardens, to mitigate the effects of urban stormwater runoff. In addition, riparian buffers need to be combined with other management practices, such as barnyard runoff controls, manure storage, contour plowing, constructed grassed waterways, and reduced tillage to mitigate the effects of agricultural runoff.

Summary

All riparian buffers provide some level of protection that is greater than if there were no buffer at all. However, wider buffers provide a greater number of functions (infiltration, temperature modification, species diversity) than narrower buffers. Many of the existing and potential buffers throughout the watershed are vulnerable to being lost to development. Therefore, it is important that existing buffers be protected and expanded where possible, beginning with those lands that are considered vulnerable.

Approximately 37 percent of the riparian buffer lands are protected from development through public and private ownership. In addition, significant amounts of these riparian buffers are within the 1-percent-annual-probability (100-year recurrence interval) regulatory floodway and/or within designated ADID wetlands, which both provide additional protection for these lands. However, despite these protections there are still many areas where encroachment into the riparian system, mostly due to urban development and agricultural land uses, has left the stream network inadequately buffered, as shown on Map 24 and Maps C-1 through C-23 in Appendix C. Other existing riparian buffer areas are without regulatory or ownership protections, and are, therefore, vulnerable to losing the valuable functions that the riparian buffers provide. Connecting the secondary environmental corridors and multiple isolated natural resource areas throughout the watershed to the larger primary environmental corridor areas as well as building upon the existing protected lands is a sound approach to enhance the corridor system (see Maps E-1 through E-23 in Appendix E). There is a large amount of land along the stream network within the 1,000 foot zone that is currently not functioning as riparian buffer, but still has the potential to be converted to buffer. Conversion of this land to riparian buffer could potentially triple the acreage of riparian buffers within the watershed. Each of these situations provides varying opportunities to enhance buffers within this watershed, and protect the water quality, aquatic habitat, and terrestrial habitat throughout the watershed.

Groundwater Resources

Inflow from groundwater sustains water levels in lakes, ponds, and wetlands and provides the perennial base flow of the streams. In some portions of the watershed it is also a major source of water supply. The amount, recharge, movement, and discharge of the groundwater is controlled by several factors, including precipitation, topography, drainage, land use, soil, the lithology and water-bearing properties of rock units, and withdrawals from groundwater for human uses. Recharge to groundwater is derived almost entirely from precipitation. Groundwater resources constitute an extremely valuable element of the natural resource base. The continued growth of population and industry within the watershed necessitates the wise development and management of groundwater resources. Because groundwater is recharged from the surface, certain land uses can result in pollution of groundwater, requiring costly or environmentally difficult cleanups.

Groundwater occurs in three major aquifers that underlie the Root River watershed and lands adjacent to the watershed. From the land’s surface downward they are: 1) the sand and gravel deposits in the glacial drift; 2) the shallow dolomite layers in the underlying bedrock; and 3) the deeper sandstone, dolomite, siltstone, and shale strata. Because of their proximity to the land’s surface and their hydraulic interconnection, the first two aquifers are commonly referred to collectively as the “shallow aquifer,” while the latter is referred to as the “deep aquifer” or the “sandstone aquifer.” Within the Root River watershed, the shallow and deep aquifers are separated by the Maquoketa shale, which forms a relatively impermeable barrier between the two aquifers.

The amount of precipitation and snowmelt that infiltrates at any location depends mainly on the permeability of the overlying soils, bedrock, or other surface materials—including human-made surfaces. As development occurs, stormwater management practices can be installed that encourage infiltration of runoff. To be effective, these practices need to be located on soils with permeable subsoils and adequate groundwater separation to allow infiltration, but minimize the potential for contamination. Because of the presence of the relatively impervious

Maquoketa shale layer between the shallow and deep aquifers, most of the precipitation that infiltrates in and around the Root River watershed will generally migrate only within the shallow aquifer system and may discharge to a nearby wetland or stream system. This process helps support base flows, wetland vegetation, and wildlife habitat in these water resources.

SEWRPC initiated a regional water supply study for the Southeastern Wisconsin Region that includes considera-tion of groundwater.[40] The preparation of this regional water supply plan represents the third, and final, element of the SEWRPC regional water supply planning program. The first two elements, consisting of the development of basic groundwater inventories and the development of a groundwater simulation model for the Southeastern Wisconsin Region, were completed prior to the development of the plan.[41] These elements involved an interagency partnership between SEWRPC and the U.S. Geological Survey (USGS), the Wisconsin Geological and Natural History Survey, the University of Wisconsin-Milwaukee, the WDNR, and many of the water supply utilities serving the Region.

As part of the water supply planning effort, a technical report on groundwater recharge for the Southeastern Wisconsin Region was prepared.[42] One of the reasons for conducting the water supply study was to better understand and protect recharge areas that contribute most to baseflow of the lakes, streams, springs, and wetlands of the Region. This is important in order to achieve sustainable use of groundwater and a healthy natural environment. Map 32 shows the groundwater recharge potential for the Root River watershed and surrounding areas as derived from a soil water balance recharge model developed for the Region. Groundwater recharge potential was divided into four main categories defined as low, moderate, high, and very high. Areas that could not be classified were placed into a fifth category as undefined. Some of these undefined areas may be areas of groundwater discharge. Most of the Root River watershed can be considered to have moderate groundwater recharge potential with this category accounting for about 82,000 acres, or almost 65 percent of the area of the watershed area. There are large areas of low recharge potential in the northern portion of the watershed and in the southeastern portion of the watershed. Relatively small areas of high and very high recharge potential are scattered throughout the watershed. Many of these areas are along or adjacent to the mainstem of the Root River or tributary streams. For each assessment area and for the entire watershed, Table 24 presents the percentage of land in each recharge potential category.

Vulnerability to Contamination

Groundwater quality conditions can be impacted by sources of pollution such as infiltration of stormwater runoff, landfill leachate, agricultural fertilizer and pesticide runoff, manure storage and application sites, chemical spills, leaking surface or underground storage tanks, and onsite sewage disposal systems. Compared to the deep aquifer, the shallow aquifers are more susceptible to pollution from the surface because they are nearer to the source, thus minimizing the potential for dilution, filtration, and other natural processes that tend to reduce the potential detrimental effects of pollutants. The potential for groundwater pollution in the shallow aquifer is dependent on the depth to groundwater; the depth and type of soils through which infiltrated runoff, leachate, outflows from onsite sewage disposal systems, and spills must percolate; the location of groundwater recharge areas; and the subsurface geology. Map 33 shows that groundwater levels are within 0 to 25 feet of the ground surface beneath approximately 16 percent of the watershed, which means there is moderate to high potential for contamination of

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[40]*SEWRPC Planning Report No. 52,* A Regional Water Supply Plan for Southeastern Wisconsin, *December 2012.*

[41]*SEWRPC Technical Report No. 37,* Groundwater Resources of Southeastern Wisconsin, *June 2002; SEWRPC Technical Report No. 41,* A Regional Aquifer Simulation Model for Southeastern Wisconsin, *June 2005.*

[42]*SEWRPC Technical Report No. 47,* Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Soil Water Balance Model, *July 2008.*

Map 32

GROUNDWATER RECHARGE POTENTIAL WITHIN THE ROOT RIVER WATERSHED

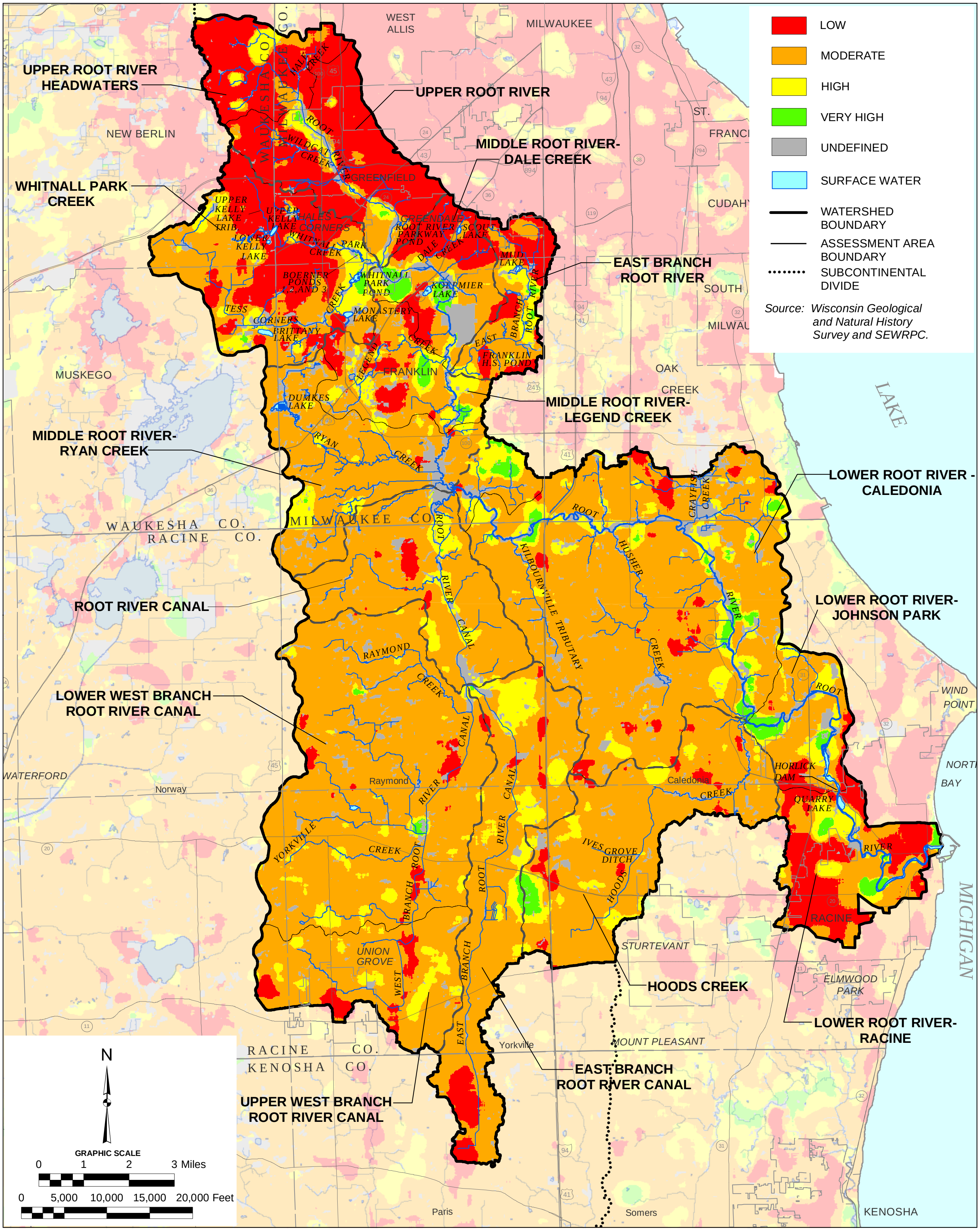


Table 24

GROUNDWATER RECHARGE POTENTIAL IN THE ROOT RIVER WATERSHED

Assessment Area	Recharge Potential (percent)					
	Low	Moderate	High	Very High	Undefined	Total
Upper Root River-Headwaters	76.1	12.5	8.9	0.0	2.5	100.0
Upper Root River	77.6	11.8	5.5	0.6	4.5	100.0
Whitnall Park Creek	42.2	38.9	10.7	0.8	7.4	100.0
Middle Root River-Dale Creek	37.1	30.5	7.8	7.0	17.6	100.0
East Branch Root River	38.0	41.7	14.3	1.3	4.7	100.0
Middle Root River-Legend Creek	19.0	48.3	18.9	4.0	9.8	100.0
Upper West Branch Root River Canal	9.0	78.9	9.9	0.0	2.2	100.0
Lower West Branch Root River Canal	2.5	89.1	3.9	0.3	4.2	100.0
East Branch Root River Canal	8.3	74.1	14.1	0.6	2.9	100.0
Middle Root River-Ryan Creek	1.1	73.4	12.3	2.1	11.1	100.0
Root River Canal	3.2	80.5	9.5	<0.1	6.8	100.0
Lower Root River-Caledonia	3.5	76.7	9.1	2.0	8.7	100.0
Hoods Creek	4.5	82.0	8.1	1.8	3.6	100.0
Lower Root River-Johnson Park	11.2	51.5	17.5	7.2	12.6	100.0
Lower Root River-Racine	48.0	33.4	10.7	4.2	3.7	100.0
Root River Watershed	17.5	64.8	9.6	1.6	6.5	100.0

Source: Wisconsin Geological and Natural History Survey and SEWRPC.

the shallow aquifers. Generally, the areas of the watershed most vulnerable to groundwater contamination are where both Niagara dolomite and the water table are near the surface. In the Root River watershed, the areas that are most vulnerable are immediately adjacent to the mainstem of the Root River and its major tributaries.[43]

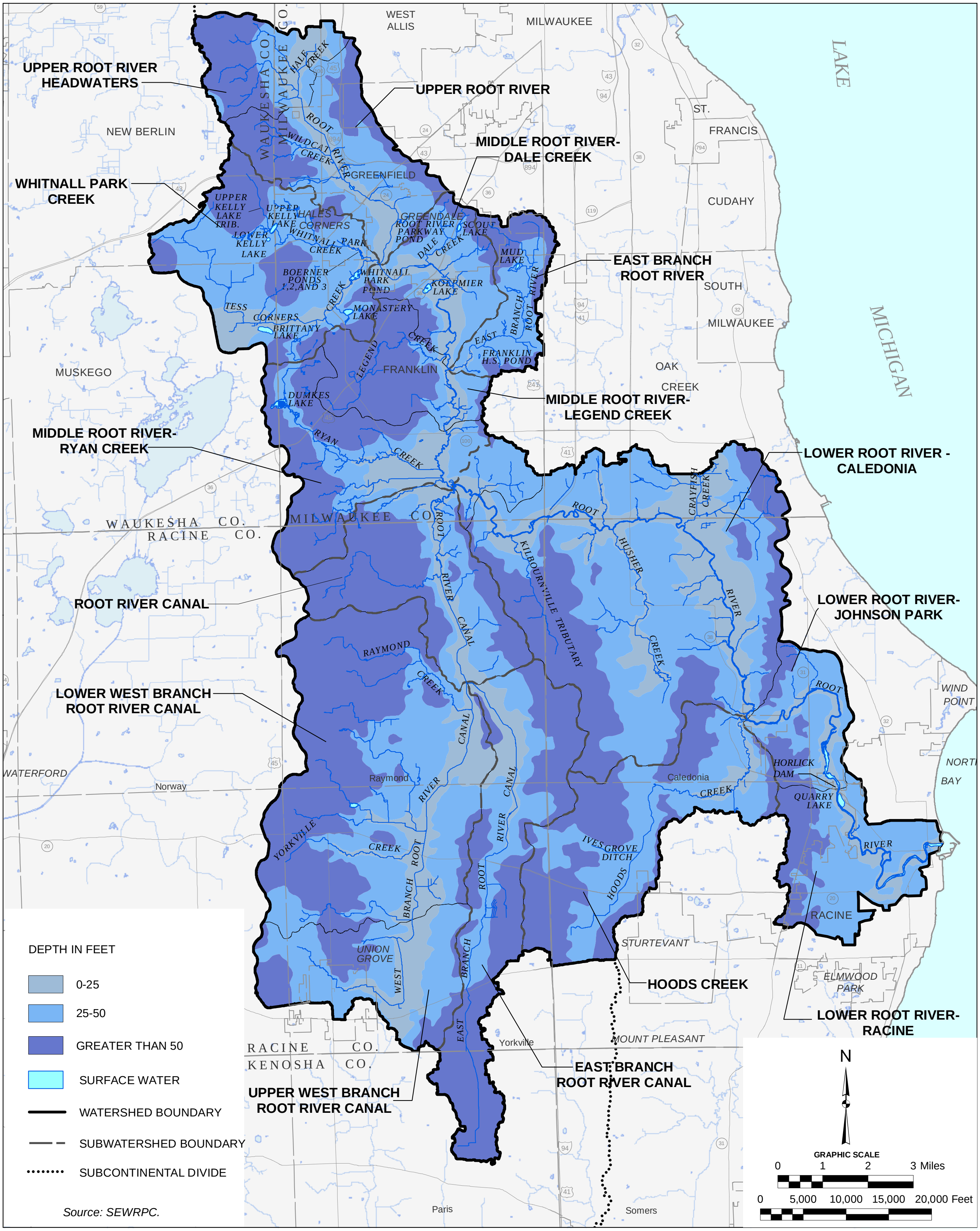
ELEMENTS OF THE NATURAL RESOURCE BASE

Many important interlocking and interacting relationships occur between living organisms and their environment. The destruction or deterioration of any one element may lead to a chain reaction of deterioration and destruction among the others. The drainage of wetlands, for example, may have far-reaching effects. Such drainage may destroy fish spawning grounds, wildlife habitat, groundwater recharge areas, natural filtration areas, and floodwater storage areas. The resulting deterioration of surface water quality may, in turn, lead to a deterioration of the quality of the groundwater. Groundwater serves as a source of domestic, municipal, and industrial water supply and provides a basis for low flows in rivers and streams. Similarly, the destruction of woodland cover, which may have taken a century or more to develop, may result in soil erosion and stream siltation and in more rapid runoff and increased flooding, as well as destruction of wildlife habitat. Although the effects of any one of these environmental changes in isolation may not be overwhelming, the combined effects may lead eventually to

[43]*SEWRPC Technical Report No. 37*, op. cit.

Map 33

DEPTH TO SEASONAL HIGH GROUNDWATER LEVELS WITHIN THE ROOT RIVER WATERSHED



Source: SEWRPC.

the deterioration of the underlying and supporting natural resource base, and of the overall quality of the environment for life. Thus, the need to protect and preserve these elements of the natural world within the watershed is apparent.

Environmental Corridors

The natural resource elements and resource-related features, when mapped on the landscape, concentrate in an essentially linear pattern of relatively narrow, elongated areas that have been termed, "environmental corridors" by the Regional Planning Commission. The Commission has identified two types of these corridors, primary environmental corridors and secondary environmental corridors. In addition, the Commission has identified smaller concentrations of natural resource features that, though isolated from the environmental corridors, still constitute natural resource areas of significant value. These are referred to as isolated natural resource areas. The environmental corridors and isolated natural resource areas in the Root River watershed are shown on Map 28.

Primary Environmental Corridors

Primary environmental corridors include a wide variety of important resource and resource-related elements and are at least 400 acres in size, two miles in length, and 200 feet in width. Primary environmental corridors encompassed about 6,032 acres, or about 4.8 percent of the Root River watershed, in 2005. These primary environmental corridors represent a composite of the best remaining elements of the natural resource base, and contain almost all of the best remaining woodlands, wetlands, and wildlife habitat areas in the watershed.

Secondary Environmental Corridors

Secondary environmental corridors generally connect with the primary environmental corridors and are at least 100 acres in size and one mile long. In 2005, secondary environmental corridors encompassed about 3,743 acres, or about 3.0 percent of the watershed. Secondary environmental corridors also contain a variety of resource elements, often remnant resources from primary environmental corridors. Secondary environmental corridors facilitate surface water drainage, maintain pockets of natural resource features, and provide corridors for the movement of wildlife, as well as for the movement and dispersal of seeds for a variety of plant species.

Isolated Natural Resource Areas

Smaller concentrations of natural resource features that have been separated physically from the environmental corridors by intensive urban or agricultural land uses have also been identified. These natural areas, which are at least five acres in size, are referred to as isolated natural resource areas. Widely scattered throughout the watershed, isolated natural resource areas included about 4,549 acres or about 3.6 percent of the total study area in 2005.

Natural Areas and Critical Species Habitat Sites

Natural areas, as defined by the Wisconsin Natural Areas Preservation Council, are tracts of land or water so little modified by human activity, or sufficiently recovered from the effects of such activity, that they contain intact native plant and animal communities believed to be representative of pre-European settlement landscape. Natural areas have been identified by SEWRPC for the seven-county Southeastern Wisconsin Region. A regional plan was developed for the protection and management of these areas and has been recently updated.[44] This plan was developed to assist Federal, State, and local units and agencies of government and nongovernmental organizations in making environmentally sound land use decisions, including acquisitions of priority properties, management of public lands, and location of development in appropriated locations that will protect and preserve the natural resource base of the Region.

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[44] *SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997; amended December 2010.*

The identified natural areas were classified into three categories:

1. Natural area of statewide or greater significance (NA-1);

2. Natural area of countywide or regional significance (NA-2); or

3. Natural area of local significance (NA-3).

Classification of an area into one of these categories was based upon consideration of several factors, including the diversity of plant and animal species and community types present; the structure and integrity of the native plant or animal community; the extent of disturbance by human activity, such as logging, grazing, water level changes, and pollution; the frequency of occurrence within the Region of the plant and animal communities present; the occurrence of unique natural features within the area; the size of the area; and the educational value of the area.

The plan also identified critical species habitats within the Region. Critical species are defined as those species that are considered to be endangered, threatened, or of special concern. The critical species known to occur within the Root River watershed area listed in Table 25.

The natural areas and critical species habitat sites in the Root River watershed are shown on Map 6 and inventoried in Table 5 in Chapter II of this report.

Wetlands

Wetlands are important resources for the ecological health and diversity of the watershed. Wetlands form the transition between surface water and groundwater resources and land resources. Wetlands are areas that are inundated or saturated by surface water or groundwater at a frequency, and with duration sufficient to support, and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally occur in depressions and near the bottom of slopes, particularly along lakeshores and streambanks, and on large land areas that are poorly drained. Wetlands may, however, under certain conditions, occur on slopes and even on hilltops. They provide essential breeding, nesting, sanctuary, and feeding grounds, as well as offer escape cover for many forms of fish and wildlife. In addition, wetlands perform an important set of natural functions which include: water quality protection; stabilization of lake levels and streamflows; reduction in stormwater runoff by providing areas for floodwater impoundment and storage; and protection of shorelines from erosion.

The location and extent of wetlands in the Root River watershed are shown on Map 34. These wetlands are based upon the Wisconsin Wetlands Inventory completed in the Region in 1982, updated to the year 2005 as part of the regional land use inventory. The land area covered by wetlands within the watershed and each assessment area is presented in Table 13. In total, wetlands within the watershed encompassed about 6,793 acres (10.6 square miles), or 5.4 percent of the area of the watershed, in 2000. These wetlands are classified predominantly as potholes, fresh meadows, shallow marshes, deep marshes, shrub swamps, timber swamps, and bogs.

Wetlands are constantly changing in response to changes in drainage patterns and climatic conditions. While wetland inventory maps provide a sound basis for areawide planning, they should be viewed as providing a point of departure to be supplemented with detailed field investigations for regulatory purposes.

The Root River watershed also contains ephemeral wetlands. These are depressional wetlands that temporarily hold water in the spring and early summer or after heavy rains. Periodically, these wetlands dry up, often in mid- to late summer. They are hydrologically isolated from other waterbodies. Ephemeral wetlands are free of fish, which makes them important breeding habitat for certain amphibian and invertebrate species. These habitats are typically smaller than two acres, with some being as small as six to 12 feet across. It should be noted that ephemeral wetlands can be difficult to define, identify, and protect because they tend to be small, isolated, and dry during certain times of the year.

Table 25

ENDANGERED AND THREATENED SPECIES AND SPECIES OF SPECIAL CONCERN IN THE ROOT RIVER WATERSHED: 2011

Common Name	Scientific Name	Status under the U.S. Endangered Species Act	Wisconsin Status
Crustacea			
Prairie Crayfish	*Procambarus gracilis*	Not listed	Special concern
Insects			
Douglas Stenelmis Riffle Beetle	*Stenelmis douglasensis*	Not listed	Special concern
Great Blue Skimmer	*Libellula vibrans*	Not listed	Special concern
Lemon-Faced Emerald	*Somatochlora ensigera*	Not listed	Special concern
Mottled Darner	*Aeshna clepsydra*	Not listed	Special concern
Painted Skimmer	*Libellula semifasciata*	Not listed	Special concern
Pronghorned Clubtail	*Gomphus graslinellus*	Not listed	Special concern
Regal Fritillary	*Speyeria idalia*	Not listed	Endangered
Slaty Skimmer	*Libellula incesta*	Not listed	Special concern
Swamp Darner	*Epiaeschna heros*	Not listed	Special concern
Fish			
Greater Redhorse	*Moxostoma valenciennesi*	Not listed	Threatened
Lake Chubsucker	*Erimyzon sucetta*	Not listed	Special concern
Lake Sturgeon	*Acipenser fulvescens*	Not listed	Special concern
Least Darter	*Etheostoma microperca*	Not listed	Special concern
Longear Sunfish	*Lepomis megalotis*	Not listed	Threatened
Pirate Perch	*Aphredoderus sayanus*	Not listed	Special concern
Pugnose Minnow	*Opsopoeodus emiliae*	Not listed	Special concern
Pugnose Shiner	*Notropis anogenus*	Not listed	Threatened
Redfin Shiner	*Lythrurus umbratilis*	Not listed	Threatened
Striped Shiner	*Luxilus chrysocephalus*	Not listed	Endangered
Reptiles and Amphibian			
Blanding’s Turtle	*Emydoidea blandingii*	Not listed	Threatened
Butler’s Gartersnake	*Thamnophis butleri*	Not listed	Threatened
Eastern Ribbonsnake	*Thamnophis sauritus*	Not listed	Endangered
Northern Cricket Frog	*Acris crepitans*	Not listed	Endangered
Queensnake	*Regina septemvittata*	Not listed	Endangered
Western Ribbonsnake	*Thamnophis proximus*	Not listed	Endangered
Birds			
Bald Eagle	*Haliaeetus leucocephalus*	Not listed	Special concern
Barn Owl	*Tyto alba*	Not listed	Endangered
Black-crowned Night-Heron	*Nycticorax nycticorax*	Not listed	Special concern
Black Tern	*Chidonias niger*	Not listed	Special concern
Forster’s Tern	*Sterna forsteri*	Not listed	Endangered
Least Bittern	*Ixobrychus exilis*	Not listed	Special concern
Peregrine Falcon	*Falco peregrinus*	Not listed	Endangered
Redhead	*Aythya americana*	Not listed	Special concern
Red-Shouldered Hawk	*Buteo lineatus*	Not listed	Threatened
Upland Sandpiper	*Bartramia longicauda*	Not listed	Special concern
Western Meadowlark	*Sturnella neglecta*	Not listed	Special concern
Yellow-Headed Blackbird	*Xanthocephalus xanthocephalus*	Not listed	Special concern
Plants			
American Fever-Few	*Parthenium integrifolium*	Not listed	Threatened
American Sea-Rocket	*Cakile lacustris*	Not listed	Special concern
Blue Ash	*Fraxinus quadrangulata*	Not listed	Threatened
Bluestem Goldenrod	*Solidago caesia*	Not listed	Endangered
Bog Bluegrass	*Poa paludigena*	Not listed	Threatened
Broad Beech Fern	*Phegopteris hexogonoptera*	Not listed	Special concern
Christmas Fern	*Polystrichum arcostichoides*	Not listed	Special concern
Climbing Fumitory	*Adlumia fungosa*	Not listed	Special concern
Clinton’s Woodfern	*Dropteris clintoniana*	Not listed	Special concern
Cluster Fescue	*Festuca paradoxa*	Not listed	Special concern

Table 25 (continued)

Common Name	Scientific Name	Status under the U.S. Endangered Species Act	Wisconsin Status
Plants (continued)			
Cooper's Milkvetch	*Astragalus neglectus*	Not listed	Endangered
Downy Willow-Herb	*Epilobium strictum*	Not listed	Special concern
Dwarf Lake Iris	*Iris lacustris*	Threatened	Threatened
Earleaf Foxglove	*Agalinis auriculata*	Not listed	Special concern
Elk Sedge	*Carex garberi*	Not listed	Threatened
False Hop Sedge	*Carex lupuliformis*	Not listed	Endangered
Forked Aster	*Aster furcatus*	Not listed	Threatened
Hairy Beardtongue	*Penstemon hirsutus*	Not listed	Special concern
Handsome Sedge	*Carex formosa*	Not listed	Threatened
Harbinger-of-spring	*Erigenia bulbosa*	Not listed	Endangered
Heart-Leaved Plantain	*Plantago cordata*	Not listed	Endangered
Heart-Leaved Skullcap	*Scutellaria ovate var. ovata*	Not listed	Special concern
Hill's Thistle	*Cirsium hillii*	Not listed	Threatened
Hooker's Orchid	*Platanthera hookeri*	Not listed	Special concern
Long-Spurred Violet	*Viola rostrata*	Not listed	Special concern
Low Calamint	*Calamintha arkansana*	Not listed	Special concern
Marsh Blazing Star	*Liatris spicata*	Not listed	Special concern
Pale Green Orchid	*Platanthera flava var. herbiola*	Not listed	Threatened
Pale Purple Cornflower	*Echinacea pallida*	Not listed	Threatened
Prairie Bush-Clover	*Lespedeza leptostachya*	Threatened	Endangered
Prairie Indian Plantain	*Cacalia tuberosa*	Not listed	Threatened
Prairie Milkweed	*Asclepias sullivantii*	Not listed	Threatened
Prairie Parsley	*Polytaenia nuttallii*	Not listed	Threatened
Prairie White-Fringed Orchid	*Platanthera leucophaera*	Threatened	Endangered
Purple False Oats	*Trisetum melicoides*	Not listed	Endangered
Purple Milkweed	*Asclepias purpurascens*	Not listed	Endangered
Ravenfoot Sedge	*Carex crus-corvi*	Not listed	Endangered
Rough Rattlesnake-Root	*Prenanthes aspera*	Not listed	Endangered
Seaside Crowfoot	*Ranunculus cymbalaria*	Not listed	Threatened
Seaside Spurge	*Chamaesyce polygonifolia*	Not listed	Special concern
Slender Bog Arrow-Grass	*Triglochin palustris*	Not listed	Special concern
Slim-stem Small Reed Grass	*Calamagrostis stricta*	Not listed	Special concern
Small White Lady's-Slipper	*Cypripedium candidum*	Not listed	Threatened
Smooth Black-Haw	*Viburnum prunifolium*	Not listed	Special concern
Smooth Phlox	*Phlox glaberrima ssp. interior*	Not listed	Endangered
Snow Trillium	*Trillium nivale*	Not listed	Threatened
Sticky False-Asphodel	*Tofieldia glutinosa*	Not listed	Threatened
Swan Sedge	*Carex swanii*	Not listed	Special concern
Thickspike	*Elymus lanceolatus ssp. psammophilus*	Not listed	Threatened
Tufted Hairgrass	*Deschampsia cespitosa*	Not listed	Special concern
Wafer-Ash	*Ptelea trifoliata*	Not listed	Special concern
Waxleaf Meadowrue	*Thalictrum revolutum*	Not listed	Special concern
Whip Nutrush	*Scleria triglomerata*	Not listed	Special concern
Wilcox's Panic Grass	*Dichanthelium wilcoxianum*	Not listed	Special concern
Wild Licorice	*Glycyrrhiza lepidota*	Not listed	Special concern
Wooly Milkweed	*Asclepias lanuginosa*	Not listed	Threatened
Yellow Gentian	*Gentiana alba*	Not listed	Threatened

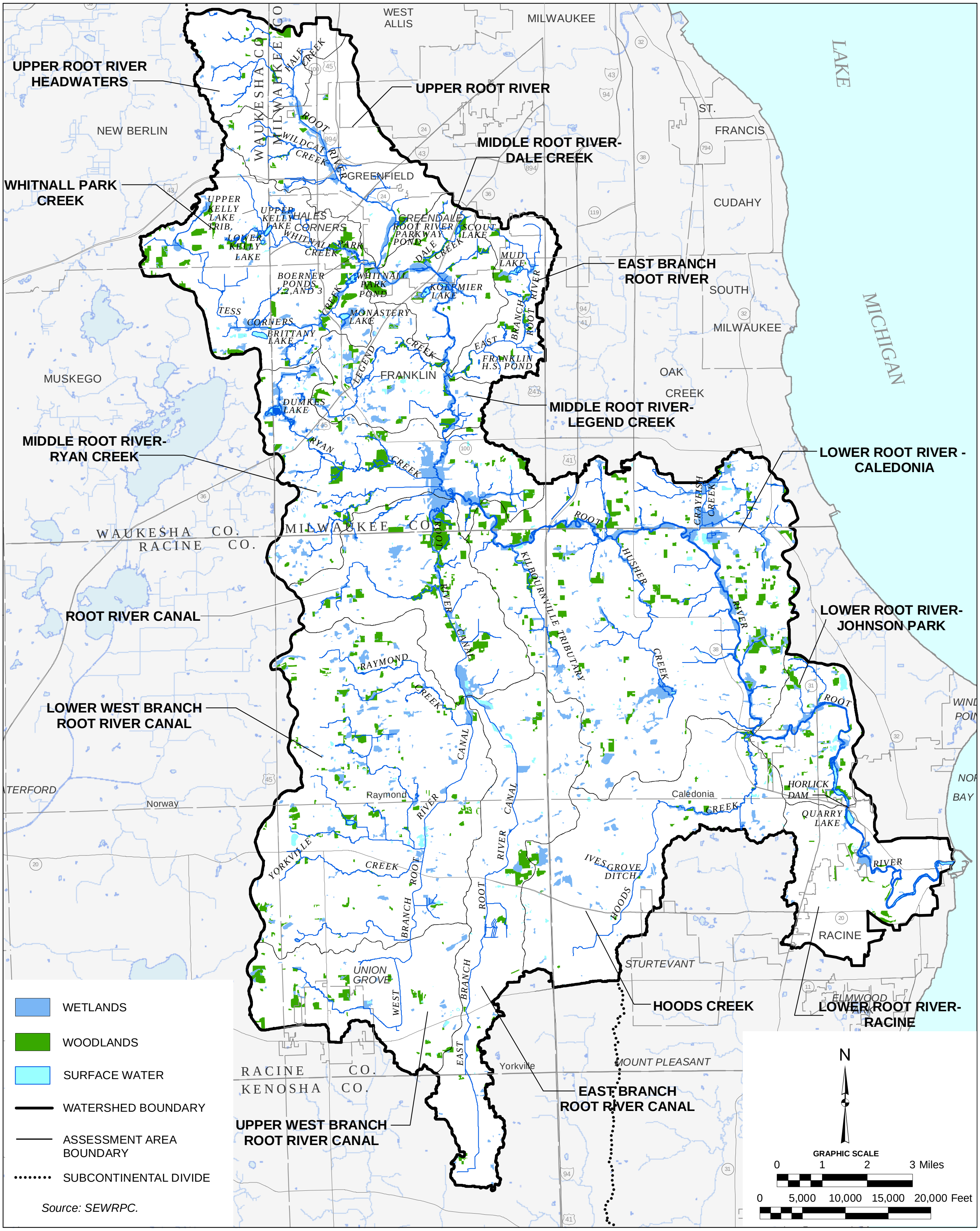
Source: Wisconsin Department of Natural Resources and SEWRPC.

Woodlands

With sound management, woodlands can serve a variety of beneficial functions. In addition to contributing to clean air and water and regulating surface water runoff, woodlands help maintain a diversity of plant and animal species. The destruction of woodlands, particularly on hillsides, can contribute to excessive stormwater runoff, siltation of lakes and streams, and loss of wildlife habitat. Woodlands identified under the 2000 SEWRPC land

Map 34

WOODLANDS AND WETLANDS WITHIN THE ROOT RIVER WATERSHED: 2000



use inventory are shown on Map 34. Woodlands are defined as upland areas of one acre or more in area, having 17 or more trees per acre measuring at least four inches in diameter at a height 4.5 feet above the ground and having canopy coverage of 50 percent or greater. Coniferous tree plantations and reforestation projects are also classified as woodlands. The land area covered by woodlands within the Root River watershed and each assessment area is presented in Table 13. In 2000, woodlands encompassed 4,937 acres, or about 3.9 percent of the area of the watershed.[45]

Wildlife Habitat

Wildlife in the Root River watershed include upland game and nongame species, such as rabbits, squirrels, shrews, mice, and woodchucks; predators, such as fox and mink; game birds, including pheasant and turkey; and marsh furbearers, such as muskrats and beaver. In addition, waterfowl and deer are present. The habitat areas and wildlife residing in those areas provide opportunities for recreational, educational, and scientific activities, and constitute an aesthetic asset to the watershed. Habitat areas capable of supporting and sustaining these animals were inventoried in 1985 as part of the regional classification of the natural areas and critical species for southeast Wisconsin.[46] This inventory was updated in 2005 by SEWRPC staff as part of the natural areas and critical species habitat protection and management planning effort. The five major criteria used to determine the value of these wildlife habitat areas are listed below:

1. Diversity: An area must maintain a high, but balanced, diversity of species for a temperate climate, balanced in such a way that the proper predator-prey (consumer-food) relationships can occur. In addition, a reproductive interdependence must exist.

2. Territorial Requirements: The maintenance of proper spatial relationships among species, allowing for a certain minimum population level, can occur only if the territorial requirements of each major species within a particular habitat are met.

3. Vegetative Composition and Structure: The composition and structure of vegetation must be such that the required levels for nesting, travel routes, concealment, and protection from weather are met for each of the major species.

4. Location with Respect to Other Wildlife Habitats: It is very desirable that a wildlife habitat maintain proximity to other wildlife habitats.

5. Disturbance: Low levels of disturbance from human activities are necessary, other than those activities of a wildlife management nature.

On the basis of these five criteria, the wildlife habitat areas in the Root River watershed were categorized as Class I, High-Value; Class II, Medium-Value; or Class III, Good-Value habitat areas. Class I wildlife habitat areas contain a good diversity of wildlife, are adequate in size to meet all of the habitat requirements for the species concerned, are generally located in proximity to other wildlife habitat areas, and meet all five criteria listed above. Class II wildlife habitat areas generally fail to meet one of the five criteria in the preceding list for a high-value wildlife area; however, they do retain a good plant and animal diversity. Class III wildlife habitat areas are remnant in nature, and they generally fail to meet two or more of the five criteria for a high-value wildlife habitat. These areas may be important if located in proximity to medium- or high-value habitat areas, especially if they provide corridors linking wildlife habitat areas of higher value or if they provide the only available range in an area.

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[45] *These data include upland woods only, not lowland woods, such as tamarack swamps, which are classified as wetlands.*

[46] *SEWRPC Planning Report No. 42*, op. cit.

As shown on Map 35, the 2005 inventory identified about 18,685 acres of wildlife habitat, covering approximately 14.8 percent of the area of the watershed. Approximately 4,547 acres, or about 3.6 percent of the watershed area, were classified as Class I habitat; 8,248 acres, or 6.5 percent of the watershed area, were classified as Class II habitat; and 5,890 acres or, 4.7 percent of the watershed area, were classified as Class III wildlife habitat. The distribution of these classes of wildlife habitat among the assessment areas is summarized in Table 26.

SURFACE WATER QUALITY IN THE ROOT RIVER WATERSHED

The term surface water quality refers to the physical, chemical, and biological characteristics of surface water. Water quality is determined both by the natural environment and by human activities. The uses which can be made of surface water resources are significantly affected by its quality and each potential use requires a certain level of water quality. Similarly, whether water quality in a waterbody is "good" or "bad" depends in part upon the uses or activities that the community desires the waterbody to support.

This section examines the existing state of water quality in the Root River watershed relative to those water quality constituents that impact upon the four focus areas of this watershed restoration plan.

Sources of Data and Analytical Procedures

Systematic water quality sampling in the Root River watershed has been conducted since 1964. Much of this sampling was conducted in conjunction with several planning and management efforts. The earliest watershed-wide systematic sampling effort began in the mid-1960s and continued into the mid-1970s.[47] This effort was conducted in conjunction with the preparation of a comprehensive plan for the watershed[48] and areawide water quality planning pursuant to Section 208 of the Clean Water Act.[49] Data from this sampling effort were also utilized for the preparation of a nonpoint source pollution control plan for the watershed under the State of Wisconsin's Priority Watershed Program.[50] Data collected since this initial effort were recently compiled and analyzed as part of the RWQMPU.[51] Although some of those data were specifically collected for that planning effort,[52] most were collected by a diverse set of agencies for a variety of purposes.

The data set for the Root River watershed that was used in the RWQMPU was drawn from several sources.[53] These sources included data from the Milwaukee Metropolitan Sewerage District's (MMSD) Corridor Study

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[47]*SEWRPC Technical Report No. 4,* Water Quality and Flow of Streams in Southeastern Wisconsin, *April 1967; SEWRPC Technical Report No. 17,* Water Quality of Streams and Lakes in Southeastern Wisconsin: 1964-1975, *June 1978.*

[48]*SEWRPC Planning Report No. 9,* A Comprehensive Plan for the Root River Watershed, *July 1966.*

[49]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin—2000, *Volume One,* Inventory Findings, *September 1978; Volume Two,* Alternative Plans, *February 1979; Volume Three,* Recommended Plan, *June 1979.*

[50]*SEWRPC Community Assistance Planning Report No. 37,* op. cit.

[51]*SEWRPC Technical Report No. 39,* op. cit.

[52]*D.W. Hall,* Surface-Water Quantity and Quality of the Upper Milwaukee River, Cedar Creek, and Root River Basins, Wisconsin: 2004, *U.S. Geological Survey Open File Report 2006-1121, 2006.*

[53]*SEWRPC Technical Report No. 39,* op. cit.

Map 35

WILDLIFE HABITAT WITHIN THE ROOT RIVER WATERSHED: 1985

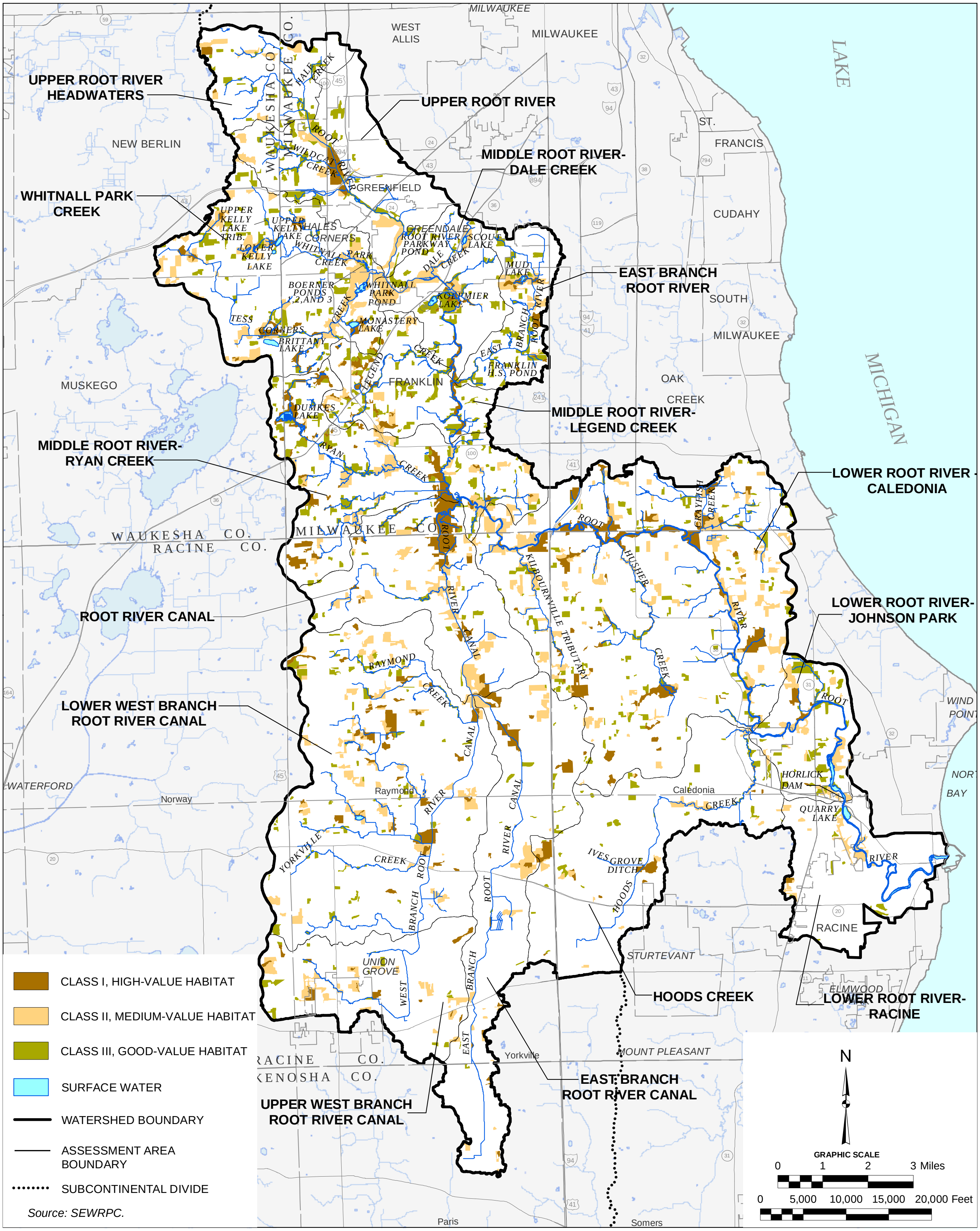

Table 26

WILDLIFE HABITAT IN THE ROOT RIVER WATERSHED

Assessment Area	Class I High Value (acres)	Class II Medium Value (acres)	Class III Good Value (acres)	Total (acres)
Upper Root River Headwaters	31.9	166.1	230.5	428.5
Upper Root River	159.1	365.9	531.5	1,056.5
Whitnall Park Creek	288.7	1,125.0	707.0	2,120.7
Middle Root River-Dale Creek	124.4	420.0	409.9	954.3
East Branch Root River	104.3	189.5	354.8	648.6
Middle Root River-Legend Creek	251.7	189.0	517.6	958.3
Upper West Branch Root River Canal	109.2	356.1	119.7	585.0
Lower West Branch Root River Canal	508.0	964.2	481.2	1,953.4
East Branch Root River Canal	253.7	386.1	91.0	730.8
Middle Root River-Ryan Creek	632.7	714.5	742.9	2,090.1
Root River Canal	562.8	648.7	163.6	1,375.1
Lower Root River-Caledonia	1,290.5	1,902.8	818.8	4,012.1
Hoods Creek	149.5	229.1	226.7	605.3
Lower Root River-Johnson Park	66.6	364.6	411.9	843.1
Lower Root River-Racine	13.7	226.9	82.8	323.4
Total	4,546.8	8,248.5	5,889.9	18,685.2

Source: SEWRPC.

Database.[54] In addition to data from MMSD's sampling program, this database contains data collected by the USGS and the WDNR. Because the Corridor Study Database contained data only for the MMSD planning area, the data set for the Root River watershed was supplemented with data downloaded from the USGS National Water Information System (NWIS) and the U.S. Environmental Protection Agency (USEPA) Storage and Retrieval (STORET) databases, and data provided by the City of Racine Health Department. The data from the STORET databases were collected by the WDNR over the period 1975 through 2004.

Data have also been collected since the end of the period examined in the RWQMPU. MMSD has continued its collection at sites in Milwaukee County. Data collected by USGS are available from the NWIS database. Data collected by WDNR are available from the STORET Modern databases and the WDNR Surface Water Information System (SWIMS) database. In addition, the City of Racine Health Department has collected data at sites within the watershed, both within the City and at other sites.[55] The City's data collection in 2011 and 2012

[54]*U.S. Geological Survey*, Water-Resources-Related Information for the Milwaukee Metropolitan Sewerage District Planning Area, 1970-2002, *U.S. Geological Survey Water-Resources Investigations Report 03-4240, 2004.*

[55]*Some of these data have been reported in: Julie Kinzelman, Emily Junion, and Tristan Begotka, "Baseline Assessment of Root River Water Quality with the City of Racine: May 31st to October 31st, 2007;" and Kirk J. Abbott, "Seasonal and Multi-Parameter Expansion of the Root River Baseline Assessment within the City of Racine: 2007/2008 Root River Raw Data."*

was conducted in support of this planning effort under a project funded by the Fund for Lake Michigan. Finally, some data are available from volunteer monitoring programs, mostly through the University of Wisconsin-Extension's Water Action Volunteers Program[56] and the Wisconsin Citizen Lakes Monitoring Program.

Sampling sites for surface water quality are shown on Map 36 and listed in Table 27. There are 47 sample sites along the mainstem of the Root River, 39 sample sites along tributary streams, and 10 sample sites in lakes and ponds.

Several things should be kept in mind regarding the data available for evaluating water quality in the Root River watershed. The data were collected by several agencies and organizations for a variety of purposes as part of a number of different studies. Each of these studies assessed a different group of water quality constituents. For some constituents, this means that data are only available for some portions of the watershed. Each study also sampled for a different period. These periods range from studies that collected a single sample at a site, through studies that collected over a season, to long-term sampling programs that collected data for over 20 years. Some sampling stations have been used by multiple agencies or in multiple studies (see Table 27). While the use of multiple data sources has extended the period of record at these stations, it should be kept in mind that differences among studies in the constituents sampled may allow for fewer time-based comparisons than would be expected based purely on the length of the period of record. Relatively few samples were collected during the winter months of December through February. Samples collected during the winter represent about 6 percent of the samples collected from streams and less than 1 percent of the samples collected from lakes and ponds.

For analytical purposes, data from six time periods were examined: 1964-1974, 1975-1986, 1987-1993, 1994-1997, 1998-2004, and 2005 through mid-2012. These analytical periods reflect those that were used in the initial regional water quality management plan and the RWQMPU and add the period following the RWQMPU analysis period. The initial regional water quality management plan was based upon data collected over the period beginning in 1964 and continuing through 1974. Bimonthly data records exist from two of MMSD's long-term monitoring stations beginning in 1975. After 1986, MMSD no longer conducted sampling during winter months. In 1994, MMSD's Inline Storage System (ISS), or Deep Tunnel, came online. The period 1998-2004 was used to define the baseline water quality conditions of surface waters in the RWQMPU. It was treated as a separate period from 1994-1997 in the RWQMPU in order to assess the effects of the ISS upon surface waters in the RWQMPU study area. The final period, 2005 through mid-2012, represent the time since the end of the baseline period for the RWQMPU. These periods were chosen to facilitate comparisons between water quality trends in the Root River watershed and the other watersheds in the RWQMPU study area. They are being used in this study in order to facilitate comparisons between the findings of this study and the findings of the RWQMPU.[57]

Water Quality Standards

Water quality standards are the basis for protecting and regulating the quality of surface waters. The standards implement portions of the Federal Clean Water Act by specifying the designated uses of waterbodies and setting water quality criteria to protect those uses. The standards also contain policies to protect high-quality waters and to protect waters from being further degraded. Water quality standards are established to sustain public health and public enjoyment of waters and for the propagation and protection of fish, aquatic organisms, and other wildlife.

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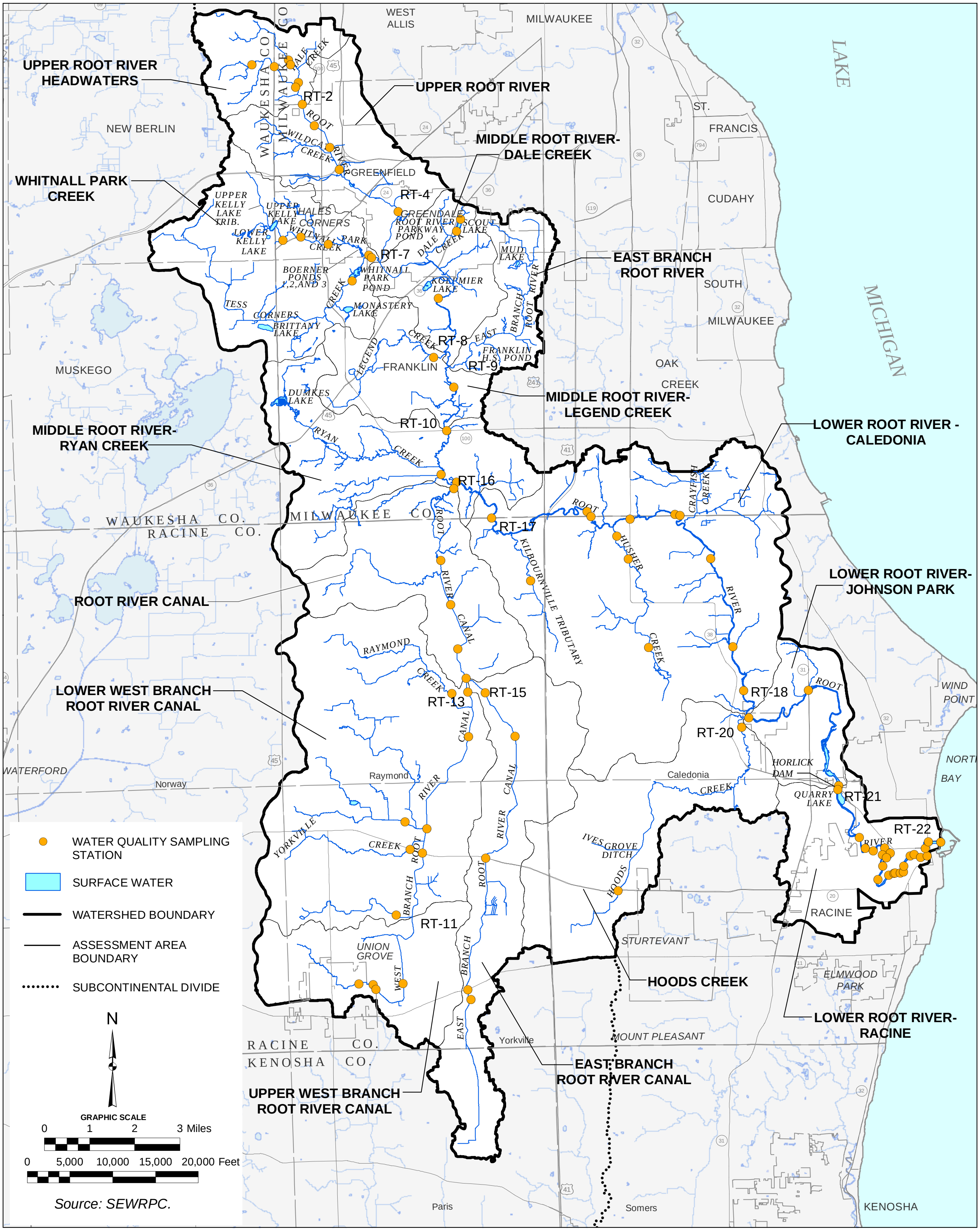
[56]*Water Action Volunteer data include data collected as part of the Sierra Club's Water Sentinel program.*

[57]*It should be noted that while operation of the ISS would not be expected to have as direct an effect on instream water quality in the Root River watershed as it does in the Kinnickinnic River, Menomonee River, and Milwaukee River watersheds, the ISS and the related MMSD water pollution abatement program and local sewerage systems improvements have reduced separate sanitary sewer overflows in the Root River watershed.*

Map 36

SURFACE WATER QUALITY SAMPLING STATIONS WITHIN THE ROOT RIVER WATERSHED: 1964-2012



Source: SEWRPC.

Table 27

SAMPLE SITES USED FOR ANALYSIS OF SURFACE WATER QUALITY TRENDS IN THE ROOT RIVER WATERSHED

Location	River Mile	Assessment Area	Period of Record	Data Sources
Mainstem				
Root River at W. Cleveland Avenue	41.5[a]	Upper Root River-Headwaters	1999-2012	MMSD
Root River at S. Seymour Place (extended)	41.4[a]	Upper Root River-Headwaters	2010	USGS
Root River at W. National Avenue and W. Oklahoma Avenue	41.0[a]	Upper Root River-Headwaters	1999-2012	MMSD
Root River at Morgan Avenue	40.4[a]	Upper Root River	2008	USEPA, WDNR
Root River at Beloit Road	39.8[a]	Upper Root River	1981, 2010-2011	USEPA, USGS, WDNR
Root River at W. Coldspring Road	39.2[a]	Upper Root River	1999-2012	MMSD
Root River at W. Layton Avenue	38.6[a]	Upper Root River	2004, 2007, 2010-2011	USEPA, USGS, WDNR
Root River at W. Grange Avenue	36.7[a]	Upper Root River	1964-1975, 1981-1982, 1996, 1999-2012	MMSD, SEWRPC, USEPA, USGS, WDNR
Root River at Rawson Avenue	32.4[a]	Middle Root River-Dale Creek	2008	USEPA, WDNR
Root River at Puetz Road	28.7[a]	Middle Root River-Legend Creek	2011-2012	City of Racine, USEPA, WDNR
Root River at W. Ryan Road	28.0[a]	Middle Root River-Legend Creek	1961, 1964-1982, 1985-1994, 1996, 1999-2012	SEWRPC, USEPA, USGS, WDNR
Root River at W. Oakwood Road	26.2[a]	Middle Root River-Ryan Creek	1981, 2007	USEPA, WDNR
Root River at S. 60th Street	25.5[a]	Middle Root River-Ryan Creek	2010	USEPA, WDNR
Root River at County Line Road	23.8[a]	Middle Root River-Ryan Creek	1964-1975, 1999-2012	MMSD, SEWRPC
Root River at CTH V	20.5[a]	Lower Root River-Caledonia	1981-1982, 2008	USEPA, WDNR
Root River at Milwaukee-Racine County Line	19.6[a]	Lower Root River-Caledonia	1996-1997	WDNR
Root River at STH 38 (S. Howell Avenue)	18.6[a]	Lower Root River-Caledonia	2011-2012	City of Racine
Root River at Nicholson Road	17.7[a]	Lower Root River-Caledonia	1964-1975, 2011	SEWRPC, USEPA, WDNR
Root River near Seven Mile Road and W. River Road	15.7[a]	Lower Root River-Caledonia	2011	WAV
Root River at Linwood Park (Five Mile Road)	13.6[a]	Lower Root River-Caledonia	1996-1997, 2010-2012	City of Racine, WAV, WDNR
Root River at Four Mile Road	12.4[a]	Lower Root River-Caledonia	1981-1982, 1996, 2005, 2007, 2010-2011	USEPA, WAV, WDNR
Root River at Johnson Park	11.5[a]	Lower Root River-Caledonia	1977-1983, 1986-1990, 1992-2012	City of Racine, USEPA, WAV, WDNR
Root River at STH 31 near Four Mile Road	9.4[a]	Lower Root River-Johnson Park	2011-2012	City of Racine
Root River above Horlick Dam	6.0[a]	Lower Root River-Johnson Park	1998, 2012	WAV

Table 27 (continued)

Location	River Mile	Assessment Area	Period of Record	Data Sources
Mainstem (continued)				
Root River below Horlick Dam	5.9[a]	Lower Root River-Johnson Park	1964-1981, 1985-1999, 2002, 2004-2005, 2007-2012	City of Racine, SEWRPC, USEPA, USGS
Root River at Colonial Park	4.3[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River at Lincoln Park Steelhead Facility	3.9[a]	Lower Root River-Racine	2007-2012	City of Racine
Root River at Lincoln Park (Spring Street)	3.8[a]	Lower Root River-Racine	1981-1982, 1996-1997, 2007-2010	City of Racine, WDNR
Root River at Spring Street and Domanik Drive	3.5[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River at Island Park Bridge to Liberty Street	3.1[a]	Lower Root River-Racine	2007-2012	City of Racine
Root River at Island Park Footbridge behind Racine Lutheran High School	3.0[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River at Island Park Footbridge to Park View Drive	2.9[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River at W. 6th Street at Rupert Boulevard	2.7[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River at Cedar Bend Park	2.3[a]	Lower Root River-Racine	1996-1997, 1999, 2004-2005, 2007-2010	City of Racine
Root River at Clayton Park Boat Launch	1.9[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River 100 meters upstream from Memorial Drive	1.8[a]	Lower Root River-Racine	2005-2006	USEPA, WDNR
Root River at Barbee Park	1.7[a]	Lower Root River-Racine	2005, 2007-2010	City of Racine, USEPA, WDNR
Root River at Environmental Education Center	1.6[a]	Lower Root River-Racine	2007-2012	City of Racine, WAV
Root River at Captain's Cove/REC Center Boat Launch	1.5[a]	Lower Root River-Racine	2007-2012	City of Racine
Root River at Captain's Cove/REC Center Last Painted Pier Footing	1.4[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River at S. Marquette Street	1.2[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River at Pier West of Water Street Outfall	1.1[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River at Azarian Marina-Upstream Site	0.9[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River at Azarian Marina-Downstream Site	0.7[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River at State Street Bridge	0.5[a]	Lower Root River-Racine	1999, 2004-2005, 2007-2010	City of Racine, WDNR
Root River at Main Street Bridge	0.3[a]	Lower Root River-Racine	2007-2010	City of Racine
Root River near Mouth	0.0[a]	Lower Root River-Racine	1996-1997, 1999, 2004-2005, 2007-2012	City of Racine, USGS
Tributaries				
East Branch Root River Canal upstream from Fonks Sewage Treatment Plant	8.3[b]	East Branch Root River Canal	1996, 2012	City of Racine, USEPA, WDNR
East Branch Root River Canal at STH 11	8.1[b]	East Branch Root River Canal	2011-2012	City of Racine

Table 27 (continued)

Location	River Mile	Assessment Area	Period of Record	Data Sources
Tributaries (continued)				
East Branch Root River Canal at STH 20	5.1[b]	East Branch Root River Canal	2012	City of Racine
East Branch Root River Canal at Three Mile Road	1.8[b]	East Branch Root River Canal	2012	City of Racine
East Branch Root River Canal at 4 Mile Road	0.5[b]	East Branch Root River Canal	1981-1982, 1996, 2011-2012	City of Racine, USEPA, WDNR
50th Road Tributary to West Branch Root River Canal	0.6[b]	Lower West Branch Root River Canal	2012	City of Racine
Hoods Creek at STH 20	6.5[c]	Hoods Creek	1981	USEPA, WDNR
Hoods Creek at Brooks Road	0.5[c]	Hoods Creek	1981-1982, 1996, 2004, 2007, 2011-2012	City of Racine, USEPA, USGS, WDNR
Husher Creek at Seven Mile Road	1.0[c]	Lower Root River-Caledonia	2011-2012	City of Racine
Husher Creek at 7 1/2 Mile Road	0.3[c]	Lower Root River-Caledonia	1981-1982, 1996, 2001	USEPA, USGS, WDNR
Kilbournville Tributary at 6 1/2 Mile Road	1.8[c]	Lower Root River-Caledonia	2007	USEPA, WDNR
Legend Creek at S. 68th Street	0.5[c]	Middle Root River-Legend Creek	2011-2012	City of Racine
New Berlin Memorial Hospital Tributary at 132nd Street	1.7[c]	Upper Root River-Headwaters	1981-1982	USEPA, WDNR
New Berlin Memorial Hospital Tributary at 124th Street	0.7[c]	Upper Root River-Headwaters	1981-1982	USEPA, WDNR
New Berlin Memorial Hospital Tributary at Root River Parkway Road	0.0[c]	Upper Root River-Headwaters	1981-1982	USEPA, WDNR
Raymond Creek at 4 Mile Road	0.8b	Lower West Branch Root River Canal	1981-1982, 1996, 2011-2012	City of Racine, USEPA, WDNR
Root River Canal at 4 1/2 Mile Road	5.3[c]	Root River Canal	1975	USEPA, WDNR
Root River Canal at Five Mile Road	4.8[c]	Root River Canal	1995	USGS
Root River Canal at CTH G	3.7[c]	Root River Canal	1964-1981, 1985-1994, 2004, 2011-2012	City or Racine, SEWRPC, USGS
Root River Canal at Seven Mile Road	2.6[c]	Root River Canal	1981-1982, 1996	USEPA, WDNR
Root River Canal upstream from Confluence with the Root River	0.1[c]	Root River Canal	1981,2010	USEPA, WDNR
Scout Lake Tributary to Dale Creek East Site (near Scout Lake Inlet)	0.5[e]	Middle Root River-Dale Creek	1981-1982	WDNR
Scout Lake Tributary to Dale Creek West Site (near Scout Lake Outlet)	0.4[e]	Middle Root River-Dale Creek	1981-1982	WDNR
Tess Corners Creek Upstream of Mallard Lake	0.8[d]	Whitnall Park Creek	1981	USEPA, WDNR
Union Grove Tributary to West Branch Root River Canal	0.4[b]	Lower West Branch Root River Canal	2012	City of Racine
West Branch Root River Canal above Union Grove Wastewater Treatment Plant	9.7[f]	Upper West Branch Root River Canal	1996	USEPA, WDNR
West Branch Root River Canal upstream from Union Grove WWTP outfall	9.4[f]	Upper West Branch Root River Canal	2012	City of Racine
West Branch Root River Canal at 67th Road	9.3[f]	Upper West Branch Root River Canal	2011-2012	City of Racine

Table 27 (continued)

Location	River Mile	Assessment Area	Period of Record	Data Sources
Tributaries (continued)				
West Branch Root River Canal at Oakdale Road	8.1[f]	Upper West Branch Root River Canal	2012	City of Racine
West Branch Root River Canal upstream from C&D Duck Farm (STH 20)	4.4[f]	Lower West Branch Root River Canal	1996, 2012	City of Racine, USEPA, WDNR
West Branch Root River Canal at 50th Road	3.8[f]	Lower West Branch Root River Canal	2012	City of Racine
West Branch Root River Canal at Three Mile Road	1.3[f]	Lower West Branch Root River Canal	2012	City of Racine
West Branch Root River Canal at Four Mile Road	0.3[f]	Lower West Branch Root River Canal	1981-1982, 1996, 2012	City of Racine, USEPA, WDNR
Whitnall Park Creek at S. Kurtz Road	3.3[c]	Whitnall Park Creek	1981	USEPA, WDNR
Whitnall Park Creek at STH 24	2.5[c]	Whitnall Park Creek	1981	USEPA, WDNR
Whitnall Par Creek at first bridge downstream from STH 100	1.7[c]	Whitnall Park Creek	1981	USEPA, WDNR
Whitnall Park Creek 0.1 Mile Upstream from the Confluence with Tess Corners Creek	0.5[c]	Whitnall Park Creek	1981	USEPA, WDNR
Whitnall Park Creek below Confluence with Tess Corners Creek	0.4[c]	Whitnall Park Creek	1981-1982, 1996	USEPA, WDNR
Yorkville Creek at STH 20	0.4[b]	Lower West Branch Root River Canal	2012	City of Racine
Lakes and Ponds				
Boerner Botanical Garden Pond No. 2	- -	Whitnall Park Creek	2004	Milwaukee County
Dumkes Lake	- -	Middle Root River-Ryan Creek	2001	WDNR
Koepmeir Lake	- -	Middle Root River-Dale Creek	2001	WDNR
Lower Kelly Lake	- -	Whitnall Park Creek	1994-1996	WDNR
Monastery Lake	- -	Whitnall Park Creek	2001	WDNR
Quarry Lake	- -	Lower Root River-Racine	1994-2011	City of Racine
Root River Parkway Pond	- -	Upper Root River	2001	WDNR
Scout Lake	- -	Middle Root River-Dale Creek	1980-1982, 1992-2005	Milwaukee County, USEPA, WDNR
Upper Kelly Lake	- -	Whitnall Park Creek	1994-2011	USEPA, WDNR
Whitnall Park Pond	- -	Whitnall Park Creek	2001	WDNR

[a] *River mile is measured as the distance upstream from the confluence with Lake Michigan.*

[b] *River mile is measured as the distance upstream from the confluence with the West Branch Root River Canal.*

[c] *River mile is measured as the distance upstream from the confluence with the mainstem of the Root River.*

[d] *River mile is measured as the distance upstream from the confluence with Whitnall Park Creek.*

[e] *River mile is measured as the distance upstream from the confluence with Dale Creek.*

[f] *River mile is measured as the distance upstream from the confluence with the East Branch Root River Canal.*

Source: SEWRPC.

Water quality standards consist of three elements: designated uses, water quality criteria, and anti-degradation policy. These are set forth in Chapters NR 102, “Water Quality Standards for Wisconsin Surface Waters,” NR 103, “Water Quality Standards for Wetlands,” NR 104, “Uses and Designated Standards and Secondary Values,” NR 105, “Surface Water Quality Criteria for Toxic Substances,” and NR 207, “Water Quality Antidegradation,” of the *Wisconsin Administrative Code*.

Designated Uses

The designated uses of a waterbody are a statement of the types of activities the waterbody should support—whether or not they are currently being attained. These uses establish water quality goals for the waterbody and determine the water quality criteria needed to protect the use. In Wisconsin, waterbodies are assigned four uses: fish and aquatic life, recreation, public health and welfare, and wildlife. The fish and aquatic life use is divided into several categories:

- Coldwater community,
- Warmwater sportfish community,
- Warmwater forage fish community,
- Limited forage fish community, and
- Limited aquatic life community.

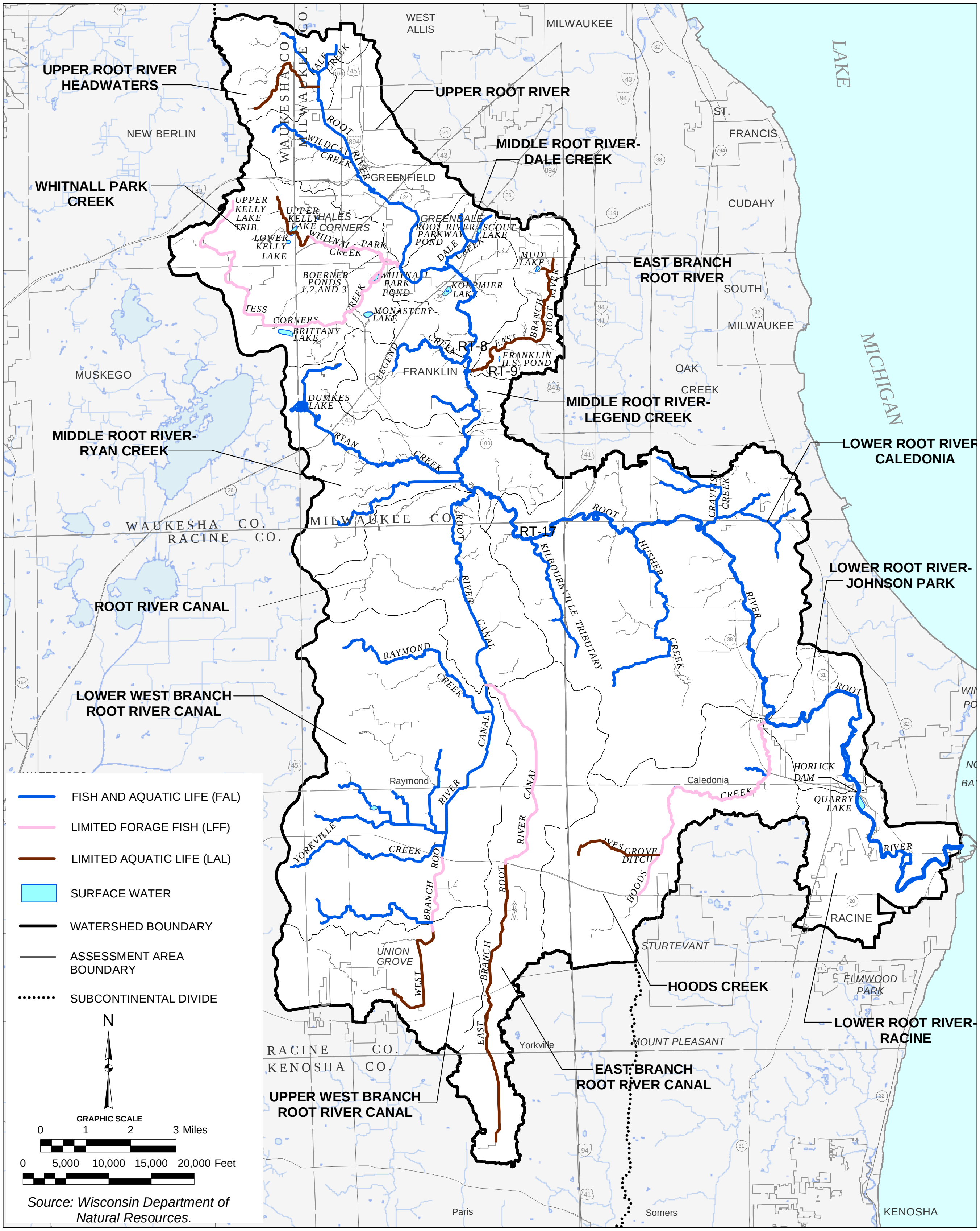
Coldwater communities include surface waters capable of supporting a community of coldwater fish and other aquatic organisms or serving as a spawning area for coldwater fish species. Warmwater sportfish waters include surface waters capable of supporting a community of warmwater sport fish or serving as a spawning area for warmwater sport fish, warmwater forage fish waters include those capable of supporting an abundant diverse community of forage fish and other aquatic organisms. Because identical water quality criteria apply to them, the warmwater sportfish and warmwater forage fish categories are sometimes referred to as “warmwater fish and aquatic life (FAL).” Limited forage fish waters include surface waters of limited capacity and naturally poor water quality or habitat. These waters are capable of supporting only a limited community of forage fish and other aquatic organisms. Limited aquatic life waters include surface waters of severely limited capacity and naturally poor water quality or habitat. These waters are capable of supporting only a limited community of aquatic organisms. The latter two categories are considered variance categories. It is important to note that establishment of a stream water use objective other than coldwater or warmwater fish and aquatic life is not necessarily an indication of reduced water quality, since such streams may be limited by flow or size, but may still be performing well relative to other functions.

For the purpose of anti-degradation policy to prevent the lowering of existing water quality, the WDNR has classified some waters of the State as outstanding or exceptional resource waters. These waters, listed in Sections NR 102.10 and NR 102.11 of the *Wisconsin Administrative Code*, are deemed to have significant value as valuable fisheries, hydrologically or geographically unique features, outstanding recreational opportunities, and unique environmental settings, and are not significantly impacted by human activities. Any discharge that may be allowed to these waters can generally not be above background levels.

The water use objectives for fish and aquatic life for all streams in the Root River watershed are shown on Map 37. Within the Root River watershed, most of the stream reaches are classified as warmwater fish and aquatic life communities and full recreational uses. The exceptions to this are all subject to variances under NR 104 of the *Wisconsin Administrative Code*. The East Branch of the Root River Canal from STH 20 to the confluence with the West Branch of the Root River Canal, Hoods Creek, Tess Corners Creek, the West Branch of the Root River Canal between STH 20 and CTH C, and Whitnall Park Creek downstream from the site of the former Hales Corners sewage treatment plant to Whitnall Park Pond are recommended for limited forage fish. The East Branch of the Root River, the East Branch of the Root River Canal upstream from STH 20, Ives Grove Ditch, the West Branch of the Root River Canal upstream from CTH C, Whitnall Park Creek upstream from the

Map 37

CURRENT REGULATORY WATER USE OBJECTIVES FOR SURFACE WATERS IN THE ASSESSMENT AREAS WITHIN THE ROOT RIVER WATERSHED



site of the former Hales Corners sewage treatment plant, and an unnamed tributary of the Root River from downstream from the site of the former New Berlin Memorial Hospital sewage treatment plant[58] are recommended for limited aquatic life. There are no Great Lakes, coldwater communities, or outstanding or exceptional resource waters contained within the Root River watershed.

Surface Water Quality Criteria

Water quality standards also specify certain criteria that must be met to ensure that the designated uses of waterbodies are supported. These water quality criteria are statements of the physical, chemical, and biological characteristics of the water that must be maintained if the water is to be suitable for the designated uses. Some criteria are limits or ranges of chemical concentrations that are not to be exceeded. Others are narrative standards which apply to all waters.

The applicable water quality criteria for all water uses designated in Southeastern Wisconsin are set forth in Tables 28 and 29. Table 28 shows the applicable water quality criteria for all designated uses for five water quality parameters—dissolved oxygen concentration, pH, fecal coliform bacteria concentration, total phosphorus concentration, and chloride concentration. It also shows the water quality criterion for temperature that applies to limited aquatic life communities. Table 29 shows the water quality criteria for temperature for those streams that have a seven-day, 10-percent probability low flow (7Q10)[59] of less than 200 cubic feet per second (cfs). The 7Q10 of all of the streams in the Root River watershed is less than 200 cfs.

In addition to the numerical criteria presented in the tables, there are narrative standards which apply to all waters. All surface waters must meet certain conditions at all times and under all flow conditions. Chapter NR 102 of the *Wisconsin Administrative Code* states that:

> "Practices attributable to municipal, commercial, domestic, agricultural, land development or other activities shall be controlled so that all waters including the mixing zone and the effluent channel meet the following conditions at all times and under all flow conditions:
>
> "(a) 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 the waters of the State.
>
> "(b) Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to interfere with public rights in the waters of the State.
>
> "(c) Materials producing color, odor, taste, or unsightliness shall not be present in such amounts as to interfere with public rights in the waters of the State.
>
> "(d) Substances in concentrations or combinations which are toxic or harmful shall not be present in amounts found to be of public health significance, nor shall such substances be present in such amounts as to interfere with public rights in the waters of the State."[60]

The State of Wisconsin has not promulgated numerical water quality criteria for some water quality constituents. Examples of this include total suspended solids, turbidity, and total nitrogen.

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[58]*This unnamed tributary is known as the West Branch of the Root River or as the New Berlin Memorial Hospital Tributary.*

[59]*Seven-day consecutive low flow with an annual probability of occurrence of 10 percent.*

[60]Wisconsin Administrative Code, *Section NR 102.04(1).*

Table 28

APPLICABLE WATER QUALITY CRITERIA FOR STREAMS IN SOUTHEASTERN WISCONSIN

Water Quality Parameter	Designated Use Category[a]						Source
	Coldwater Community	Warmwater Fish and Aquatic Life	Limited Forage Fish Community (variance category)	Special Variance Category A[b]	Special Variance Category B[c]	Limited Aquatic Life (variance category)	
Temperature (^{o}F)	See Table 29					86.0	NR 102 Subchapter II
Dissolved Oxygen (mg/l)	6.0 minimum 7.0 minimum during spawning	5.0 minimum	3.0 minimum	2.0 minimum	2.0 minimum	1.0 minimum	NR 102.04(4) NR 104.04(3) NR 104.06(2)
pH Range (S.U.)	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	NR 102.04(4)[d] NR 104.04(3)
Fecal Coliform Bacteria (MFFCC)	- -	- -	- -	- -	- -	- -	NR 102.04(5) NR 104.06(2)
Geometric Mean	200	200	200	1,000	1,000	200	
Maximum	400	400	400	2,000	- -	400	
Total Phosphorus (mg/l)	- -	- -	- -	- -	- -	- -	NR 102.06(3) NR 102.06(4) NR 102.06(5) NR 102.06(6)
Designated Streams[e]	0.100	0.100	0.100	0.100	0.100	0.100	
Other Streams	0.075	0.075	0.075	0.075	0.075	- -	
Chloride (mg/l)	- -	- -	- -	- -	- -	- -	NR 105.05(2) NR 105.06(5)
Acute Toxicity[f]	757	757	757	757	757	757	
Chronic Toxicity[g]	395	395	395	395	395	395	

[a]*NR 102.04(1) All surface waters shall meet the following conditions at all times and under all flow conditions: substances that will cause objectionable deposits on the shore or in the bed of a body of water, floating or submerged debris, oil, scum or other material, and 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. Substance 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.*

[b]*As set forth in Chapter NR 104.06(2)(a) of the* Wisconsin Administrative Code.

[c]*As set forth in Chapter NR 104.06(2)(b) of the* Wisconsin Administrative Code.

[d]*The pH shall be within the stated range with no change greater than 0.5 unit outside the estimated natural seasonal maximum and minimum.*

[e]*Designated in Chapter NR 102.06(3)(a) of the* Wisconsin Administrative Code*. There are no designated streams in the Root River watershed.*

[f]*The acute toxicity criterion is the maximum daily concentration of a substance which ensures adequate protection of sensitive species of aquatic life from the acute toxicity of that substance and will adequately protect the designated fish and aquatic life use of the surface water if not exceeded more than once every three years.*

[g]*The chronic toxicity criterion is the maximum four-day concentration of a substance which ensures adequate protection of sensitive species of aquatic life from the chronic toxicity of that substance and will adequately protect the designated fish and aquatic life use of the surface water if not exceeded more than once every three years.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Water Quality in Streams

Presentation of Data

In the analyses that follow, distributions of water quality data are shown using box plots to illustrate changes among stations from upstream to downstream over the six time periods between 1964 and 2012. Figure 11 shows an example of the symbols used in box plots, as well as how they are used in a graph to make comparisons. In this type of graph, the center line marks the location of the median—the value in the data above which and below which half the instances lie. Along with the median, the two ends of the box mark the locations of the quartile divisions. These ends indicate the values of the 25th and 75th percentile of the data. These three divisions divide the distribution into four quartiles which each contain one quarter of the instances. The length of the box shows the range of the central 50 percent of the instances. This is known as the interquartile range. The "whiskers" extending from the box show the range of instances that are within 1.5 box-lengths of the interquartile range from the box. Stars indicate outliers that are more than 1.5 box-lengths but less than three box-lengths from the box. Open circles indicate extreme values that that lie more than three box-lengths from the box.[61]

[61]*Different statistics software packages and statistical graphics software packages follow different conventions in the construction of box plots. In all conventions, the ends of the box represent the values of the 25th and 75 percentile and the box itself indicates the interquartile range. The conventions differ in what is represented by the ends of the whiskers. The box plots presented in this report follow the conventions used in the SYSTAT, version 10.2 software package.*

Table 29

AMBIENT TEMPERATURES AND WATER QUALITY CRITERIA FOR TEMPERATURE FOR NONSPECIFIC WARMWATER STREAMS WITH 7Q10 FLOWS LESS THAN 200 CUBIC FEET PER SECOND[a,b]

Month	Cold Water Communities			Large Warmwater Communities[c]			Small Warmwater Communities[d]			Limited Forage Fish Communities[e]		
	Ta[f,i]	SL[g,i]	A[h,i]	Ta[f,i]	SL[g,i]	A[h,i]	Ta[f,i]	SL[g,i]	A[h,i]	Ta[f,i]	SL[g,i]	A[h,i]
January	35	47	68	33	49	76	33	49	76	37	54	78
February	36	47	68	33	50	76	34	50	76	39	54	79
March	39	51	69	36	52	76	38	52	77	43	57	80
April	47	57	70	46	55	79	48	55	79	50	63	81
May	56	63	72	60	65	82	58	65	82	59	70	84
June	62	67	72	71	75	85	66	76	84	64	77	85
July	64	67	73	75	80	86	69	81	85	69	81	86
August	63	65	73	74	79	86	67	81	84	68	79	86
September	57	60	72	65	72	84	60	73	82	63	73	85
October	49	53	70	52	61	80	50	61	80	55	63	83
November	41	48	69	39	50	77	40	49	77	46	54	80
December	37	47	69	33	49	76	35	49	76	40	54	79

[a]*The 7q10 flow is the seven-day consecutive low flow with a 10 percent annual probability of occurrence (10-year recurrence interval).*

[b]*As set forth in Section NR 102.25 of the* Wisconsin Administrative Code.

[c]*Waters with a fish and aquatic life use designation of "warmwater sportfish community" or "warmwater forage fish community" and unidirectional 7Q10 flows greater than or equal to 200 cubic feet per second.*

[d]*Waters with a fish and aquatic life use designation of "warmwater sportfish community" or "warmwater forage fish community" and unidirectional 7Q10 flows less than 200 cubic feet per second.*

[e]*Waters with a fish and aquatic life use designation of "limited forage fish community."*

[f]*Ta indicates ambient temperature.*

[g]*SL indicates sublethal temperature criteria.*

[h]*A indicates acute temperature criteria.*

[i]*The ambient temperature, sublethal water quality criterion, and acute water quality criterion specified for any calendar month shall be applied simultaneously to establish the protection needed for each identified fish and other aquatic life use. The sublethal criteria are to be applied as the mean daily maximum temperature over a calendar week. The acute criteria are to be applied as the daily maximum temperatures. The ambient temperature is used to calculate the corresponding acute and sublethal criteria and for determining effluent limitations in discharge permits under the Wisconsin Pollutant Discharge Elimination System.*

Source: Wisconsin Department of Natural Resources.

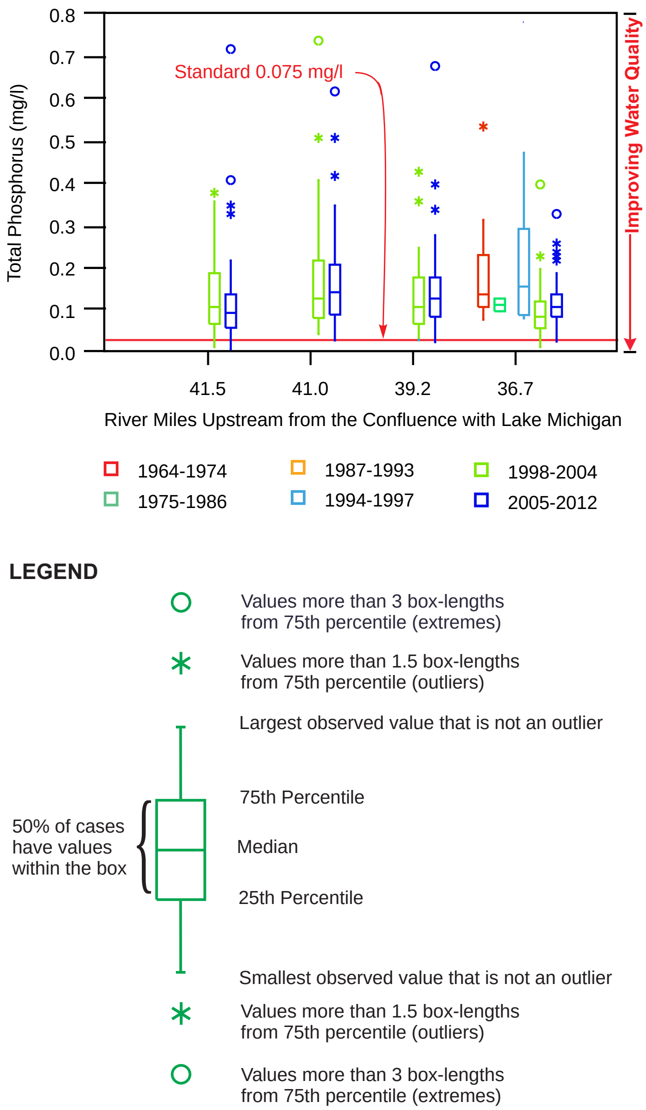
Bacterial Indicators of Safety for Human Contact

The suitability of surface water for human contact and recreational uses is assessed by examining water samples for the presence and concentrations of organisms indicating fecal contamination. A variety of disease-causing organisms can be transmitted through water contaminated with fecal material. These organisms include bacteria, such as those that cause cholera and typhoid fever; viruses, such as those that cause poliomyelitis and infectious hepatitis; and protozoa, such as *Giardia* and *Cryptosporidium*. The concentrations of two groups of bacteria are commonly examined in surface waters of the Root River watershed as indicators of fecal contamination: fecal coliform bacteria and *Escherichia coli* (*E. coli*). Under Wisconsin's water quality criteria, the suitability of surface waters for recreational uses is assessed using fecal coliform bacteria.[62] For freshwater systems, the USEPA

[62]*Under the Federal Beach Act of 2000, assessment of sanitary quality of water at Great Lakes beaches is assessed using the bacterium* Escherichia coli, *a member of the fecal coliform group of bacteria.*

Figure 11

EXAMPLE OF BOX-PLOT FIGURE SHOWING DISTRIBUTION OF WATER QUALITY CONCENTRATIONS AMONG STATIONS AND SPECIFIC TIME PERIODS FROM 1964-2012



Source: SEWRPC.

recommends using *E. coli*, one of species of fecal coliform bacteria, as an indicator of fecal contamination. All warm-blooded animals have these bacteria in their feces. Because of this, the presence of high concentrations of fecal coliform bacteria or *E. coli* in water indicates a high probability of fecal contamination. Most strains of these bacterial groups have a low probability of causing illness. Instead, they act as indicators of the possible presence of other pathogenic agents in water. While the presence of high concentrations of these indicator bacteria does not necessarily indicate the presence of pathogenic agents, they are generally found when the pathogenic agents are found.

These bacteria are not themselves pollutants of concern. Instead, they act as surrogate measures indicating the likelihood that surface waters are contaminated with fecal wastes and may contain disease-causing agents. These wastes can originate from several sources, including sanitary sewage, agricultural and barnyard wastes, and wastes from domestic pets and wild animals. Fecal pollution from different sources will carry different pathogens; however, fecal pollution from sanitary sewage generally constitutes a more serious public health risk because multiple human pathogens including bacteria, viruses, and protozoa can be present in high concentrations. Because of this, assessments of the source of waste—specifically microbial source tracking assessments that can determine whether stormwater contains fecal wastes of human origin—can provide important information for prioritizing action when high concentrations of fecal coliform bacteria or *E. coli* are detected in stormwater discharges.[63]

Figure 12 shows concentrations of fecal coliform bacteria at sampling stations along the Root River. During the period 2005-2012, concentrations of fecal coliform bacteria in the mainstem of the Root River ranged between 3 cells per 100 milliliters (cells per 100 ml) and 130,000 cells per 100 ml, with a mean value of 5,492 cells per 100 ml and a median value of 1,100 cells per 100 ml. During this period, samples of this indicator were collected at only seven sampling stations. With one exception, these stations were located within Milwaukee County. Concentrations of fecal coliform bacteria were higher at upstream sampling stations than at downstream sampling stations. The highest concentrations occurred at the sampling station at the

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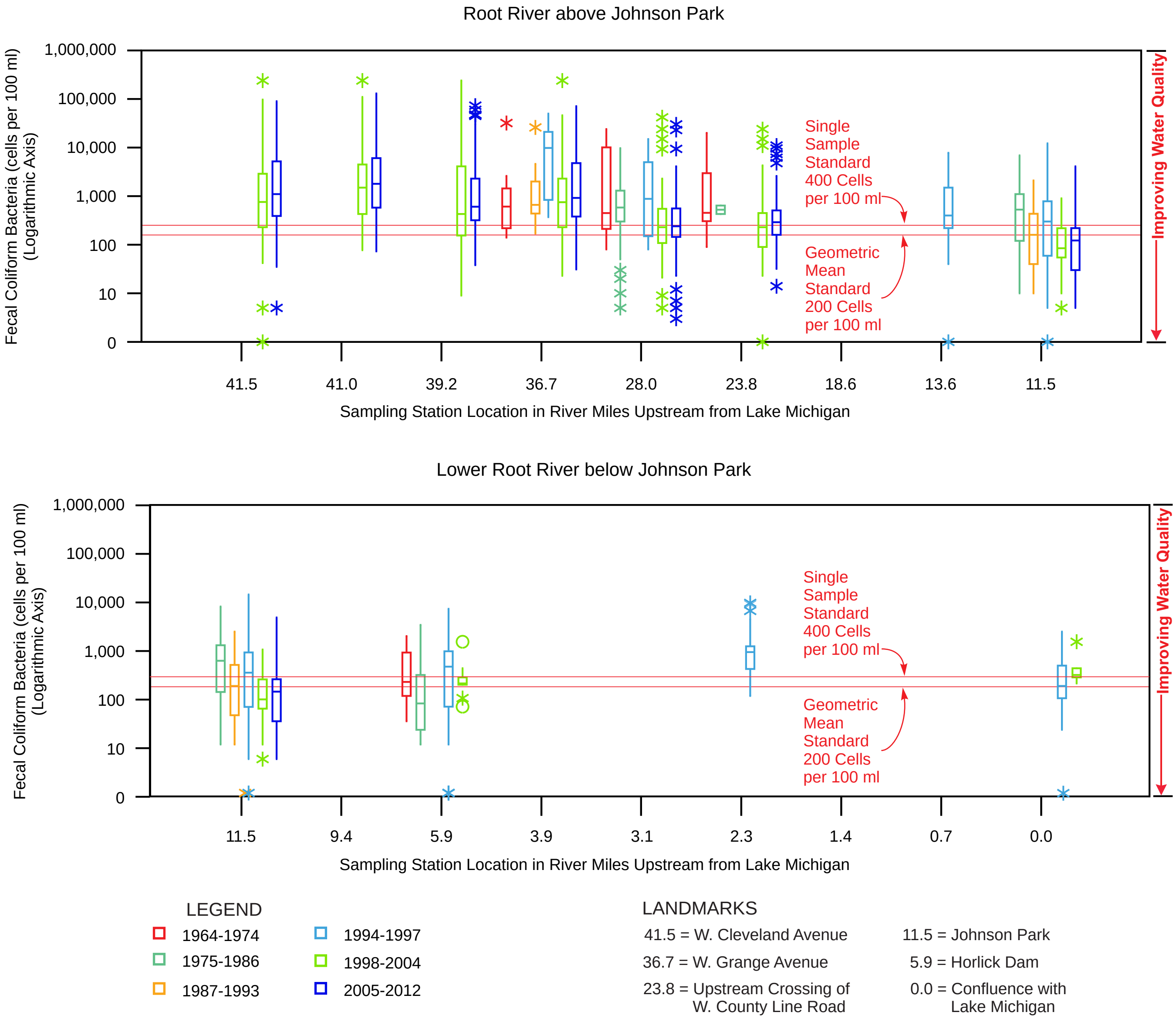
[63]*Sandra L. McLellan and Elizabeth P. Sauer,* Greater Milwaukee Watersheds Pathogen Source Identification Report: March 1, 2006 to July 28, 2009, *MMSD Contract No. M03016P02, November 2, 2009.*

Figure 12

FECAL COLIFORM BACTERIA CONCENTRATIONS AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



NOTES: See Figure 11 for description of symbols.

See Table 27for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, Milwaukee Metropolitan Sewerage District, City of Racine Health Department, and SEWRPC.

intersection of W. National Avenue and W. Oklahoma Avenue, which is located at river mile 41.0 (RM 41.0)—41.0 miles upstream from the confluence with Lake Michigan. Fecal coliform bacteria concentrations showed a trend toward decreasing from upstream to downstream in the mainstem of the Root River. While this trend was statistically significant, it accounts for a small portion of the variability in concentration.

At all stations where fecal coliform bacteria were sampled, concentrations in a substantial fraction of the samples were above the State's water quality criteria (see Figure 12). At the four stations that are located farthest upstream, concentrations in between approximately 70 percent and 85 percent of samples collected during the period 2005-2012 were above the State's single sample criterion of 400 cells per 100 ml. During the same period concentrations in approximately 85 percent to 93 percent of samples collected from these stations were above the State's geometric mean criterion of 200 cells per 100 ml. These four sampling stations are located in the Upper Root River-Headwaters and Upper Root River assessment areas, which are two of the three most highly urban assessment areas in the watershed. The numbers of samples that exceeded these criteria were somewhat lower at the next two sampling stations downstream. At these stations, concentrations in between approximately 34 percent and 37 percent of samples collected during the period 2005-2012 were above the State's single sample criterion of 400 cells per 100 ml. During the same period concentrations in approximately 57 percent to 62 percent of samples collected from these stations were above the State's geometric mean criterion of 200 cells per 100 ml. At Johnson Park (RM 11.5), the station farthest downstream where fecal coliform bacteria were sampled, concentrations in 17 percent of samples exceeded the single sample criterion and concentrations in 33 percent of samples exceeded the geometric mean criterion. These three stations are located in less urbanized areas than the four upstream (see Table 14).

At most sampling stations, trends in fecal coliform bacteria concentrations over time were not evident. The concentrations during the periods 1998-2004 and 2005-2012 were compared using analysis of variance (ANOVA) at the seven sampling stations that had recent data.[64] No statistically significant differences were detected between the mean concentrations from the two periods. Data at three sampling stations were sufficient to test for long-term trends in concentration over time. Concentrations of fecal coliform bacteria at the sampling stations at Ryan Road (RM 28.0) and Johnson Park (RM 11.5) showed statistically significant trends toward decreasing over time. At both of these stations, the trends accounted for a very small fraction of the variation in concentration. No trend was detected at the sampling station at Grange Avenue (RM 36.7).

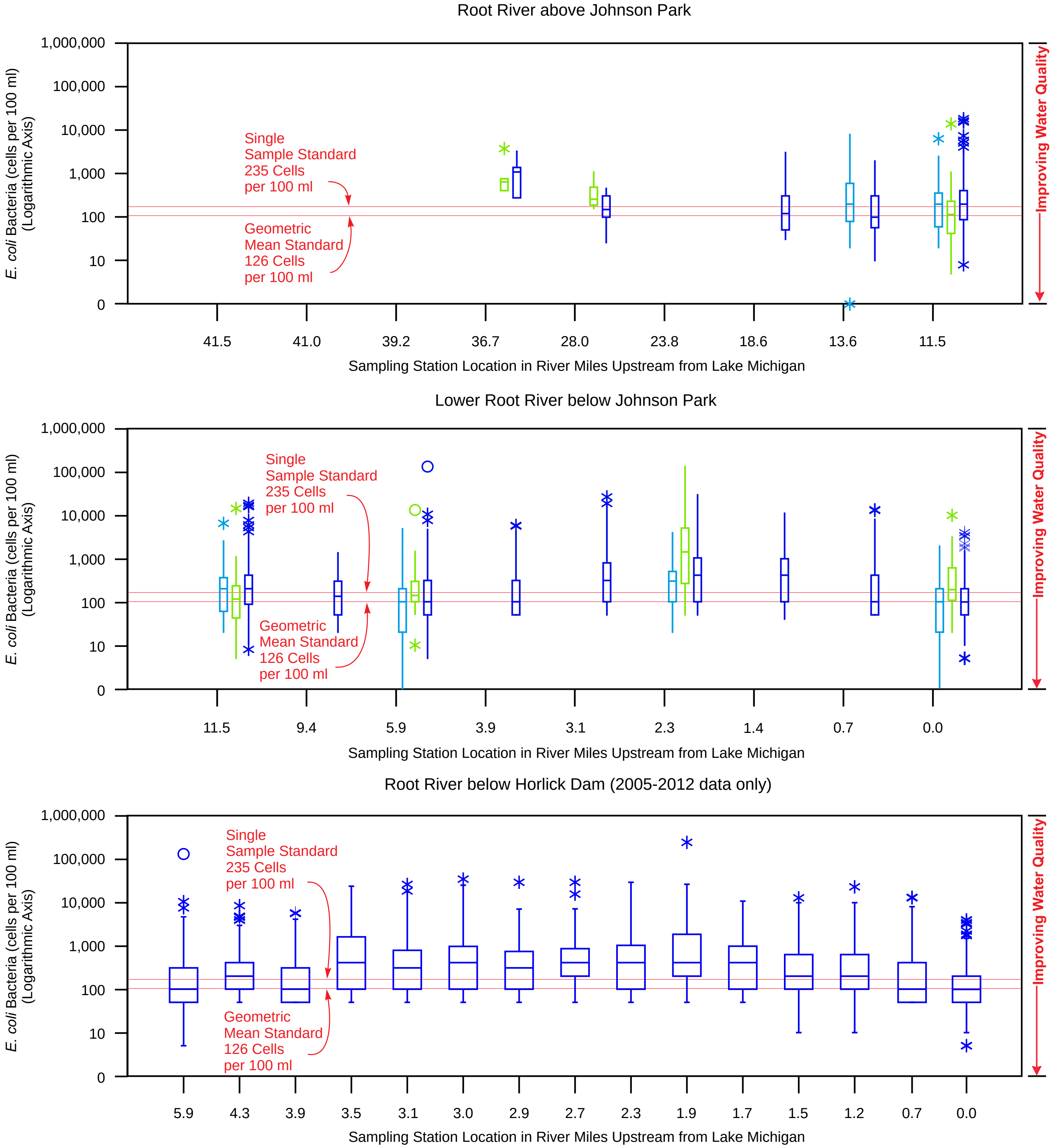
Almost all of the recent indicator bacteria data collected at sampling stations downstream from the County Line Road station (RM 23.8) consists of *E. coli* samples. As previously discussed, the USEPA recommends using this species of bacteria as an indicator of fecal contamination in freshwater systems. USEPA's recommended water quality criteria state that the geometric mean of *E. coli* concentrations is not to exceed 126 cells per 100 ml and the concentrations in single samples is not to exceed 235 cells per 100 ml.

The following evaluation relates to the period from 2005-2012, when concentrations of *E. coli* bacteria in the mainstem of the Root River ranged between less than one cell per 100 ml and 241,920 cells per 100 ml, with a mean value of 858 cells per 100 ml and a median value of 200 cells per 100 ml. Figure 13 shows concentrations of *E. coli* at sampling stations along the mainstem of the Root River. From upstream to downstream, concentrations of *E. coli* in the mainstem of the River show a complicated pattern. High concentrations were detected at the sampling station at W. Grange Avenue (RM 36.7), with a median concentration of 1,250 cells per 100 ml and a mean concentration of 1,298 cells per 100 ml. It should be noted that a small number of samples were collected at this station. Lower concentrations were detected at the next three sampling stations. Median concentrations at these stations ranged between 100 and 230 cells per 100 ml and mean concentrations ranged between 250 and 330 cells per 100 ml. Maximum concentrations detected at these stations ranged between about 400 and 2,000 cells per 100 ml. Concentrations of *E. coli* at the sampling station at Johnson Park (RM 11.5) were much more variable than those observed at stations upstream. The median at this site was 200 cells per 100 ml and was within the range observed at the three stations immediately upstream. The mean concentration at this station was 510 cells per 100 ml. The maximum concentration at this station was 18,600 cells per 100 ml. Concentrations at the next station, STH 31 (RM 9.4), were similar to those observed at the stations upstream from Johnson Park.

[64]*As part of this analysis, concentrations of fecal coliform bacteria were log-transformed in order to meet the assumptions of the statistical model.*

Figure 13

ESCHERICHIA COLI BACTERIA CONCENTRATIONS AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



LEGEND

- 1964-1974
- 1975-1986
- 1987-1993
- 1994-1997
- 1998-2004
- 2005-2012

LANDMARKS

41.5 = W. Cleveland Avenue
36.7 = W. Grange Avenue
23.8 = Upstream Crossing of W. County Line Road
11.5 = Johnson Park
5.9 = Horlick Dam
0.0 = Confluence with Lake Michigan

NOTES: See Figure 11 for description of symbols. See Table 27 for location of sample sites.

Source: Milwaukee Metropolitan Sewerage District and City of Racine Health Department.

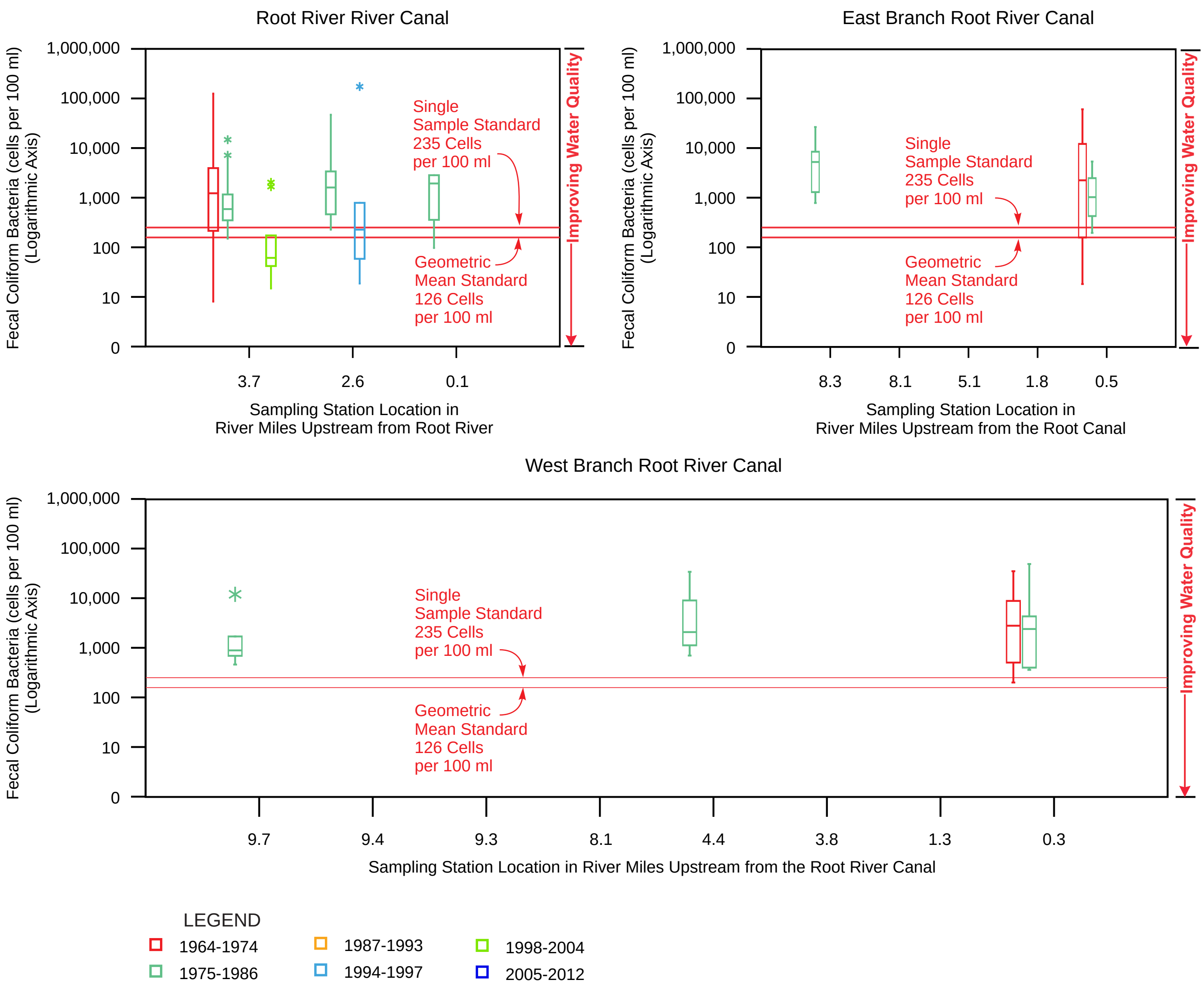
Concentrations at the station below Horlick dam (RM 5.9) also showed high variability. While the median concentration at this site was quite low, 100 cells per 100 ml, the mean concentration of 661 cells per 100 ml was the highest of any station along the mainstem of the River. The maximum concentration at this station was 129,965 cells per 100 ml. Concentrations at the next station, Lincoln Park (RM 3.9), were similar to those observed at the stations upstream from Johnson Park with median and mean concentrations of 100 cells per 100 ml and 357 cells per 100 ml, respectively. Below this station, between the station at the intersection of Spring Street and Domanik Street (RM 3.5) and Barbee Park (RM 1.7), concentrations were higher. Median concentrations of *E. coli* at these stations were between 310 cells per 100 ml and 410 cells per 100 ml. Mean concentrations in this section of the River were between 742 cells per 100 ml and 4,082 cells per 100 ml. Concentrations were highly variable within this section of the River. The highest variability with in this section was observed at the Clayton Park Boat Launch (RM 1.9). The maximum *E. coli* concentration detected at this station was 241,920 cells per 100 ml. This was about seven to 10 times higher than the maximum concentrations seen at other stations in this reach. At the Barbee Park station and the station at the confluence with Lake Michigan (RM 0.0), *E. coli* concentrations were lower. The high maximum concentrations and high variability detected at this sampling station may have been the result of an illicit discharge near this site. The City of Racine has indicated that the discharge has been remedied. Median concentrations of *E. coli* at the stations downstream from Barbee Park were between 100 cells per 100 ml and 200 cells per 100 ml. Mean concentrations in this section of the River were between 299 cells per 100 ml and 866 cells per 100 ml. The lowest concentrations in this reach were detected at the confluence with Lake Michigan (RM 0.0). The lower concentrations in this section may reflect the influence of River water mixing with water from the Lake.

At all of the stations shown in Figure 13, a substantial portion of samples exceed the water quality criteria recommended by USEPA. The fraction of samples exceeding these criteria at individual stations follows a complicated pattern from upstream to downstream. This pattern roughly parallels the pattern of concentrations along the mainstem of the River. Given that a small number of samples are available from the two stations in Milwaukee County, they are excluded from this discussion. Among the sampling stations shown in Figure 13, the fraction of samples exceeding the USEPA recommended single sample criterion of 235 cells per 100 ml ranged between 23 percent at the confluence with Lake Michigan (RM 0.0) and 62 percent at Cedar Bend Park (RM 2.3).The fraction of samples exceeding the USEPA recommended geometric mean criterion of 126 cells per 100 ml ranged between 71 percent at the confluence with Lake Michigan (RM 0.0) and 73 percent at the sampling station under the 6th Street Bridge (RM 1.4). The reach of the mainstem of the River with the highest incidence of exceedences was located approximately between the station at the intersection of Spring and Domanik Streets (RM 3.5) and the station under the 6th Street Bridge (RM 1.4). At sampling stations in this section of the River, concentrations of *E. coli* exceeded the USEPA recommended single sample criterion in about 57 to 62 percent of samples and exceeded the USEPA recommended geometric mean criterion in about 70 to 73 percent of samples. Additional discussion of how concentrations of bacteria in the Root River compare to water quality criteria is given in the section on achievement of water use objectives later in this chapter.

In the patterns described in the previous paragraphs, high concentrations of indicator bacteria and high variability in these concentrations are largely associated with the degree of urban development in the vicinity of the sampling stations. Higher concentrations, higher variability, and a larger number of exceedences of water quality standards generally occurred in more urbanized areas of the watershed. There are several potential sources of bacteria that may contribute to high concentrations and variability in urban areas. Combined sewer overflows are not an issue in this watershed. The urban portions of the watershed that are located in the MMSD service area are outside of the combined sewer area. The City of Racine completed separation of its combined sewer system into separate sanitary and storm sewer systems in the early 1980s. Discharges from storm sewer outfalls may contribute bacteria to the River. At most locations, these discharges will contain bacteria washed off of impervious surfaces on the landscape. Sources of these bacteria include wild animals and pet waste. At some locations, these discharges may also contain bacteria originating from cross-connections between the sanitary and storm sewer systems, illicit discharges into the storm sewer system, or degrading sewer system infrastructure. Fecal material from waterfowl such as gulls and geese may also be a source of bacteria to the River. Contributions from this

Figure 14

FECAL COLIFORM BACTERIA CONCENTRATIONS AT SITES ALONG THE ROOT RIVER CANAL AND ITS BRANCHES: 1964-2012



NOTES: See Figure 11 for description of symbols.

See Table 27 for location of sample sites.

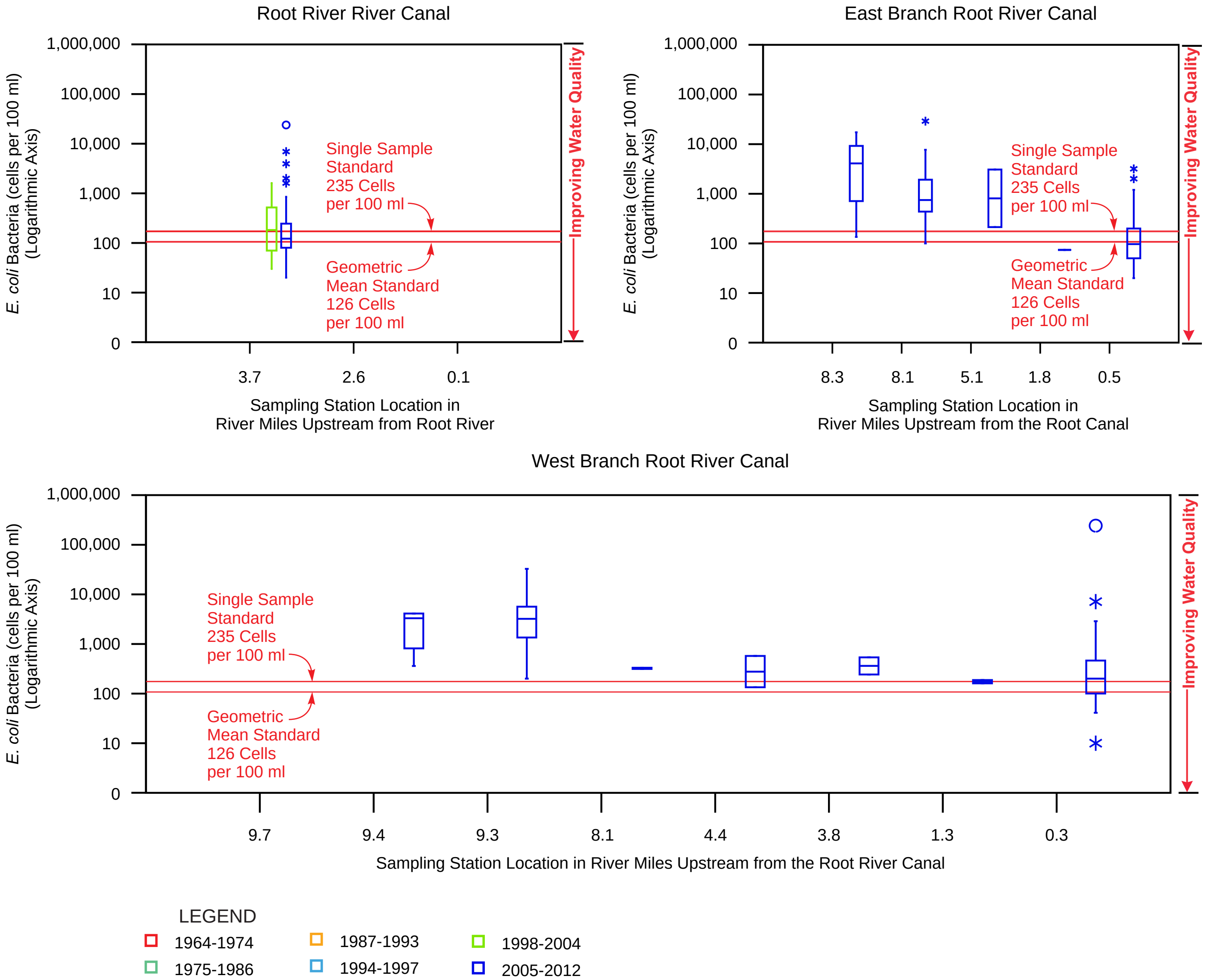
Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, and SEWRPC.

source are likely to come from two different sets of areas: areas adjacent to the River that are heavily used by these animals and impervious areas used by these animals that are directly connected to the River through the storm sewer system.

Figure 14 shows historical concentrations of fecal coliform bacteria at sampling stations along the Root River Canal and its East and West Branches. The Root River Canal and its East and West Branches were not sampled for fecal coliform bacteria during the period 2005-2012. Although limited numbers of samples were collected, especially along the East and West Branches, these data indicate that historical concentrations of fecal coliform

Figure 15

***ESCHERICHIA COLI* BACTERIA CONCENTRATIONS AT SITES ALONG THE ROOT RIVER CANAL AND ITS BRANCHES: 1964-2012**



NOTES: See Figure 11 for description of symbols.

See Table 27 for location of sample sites.

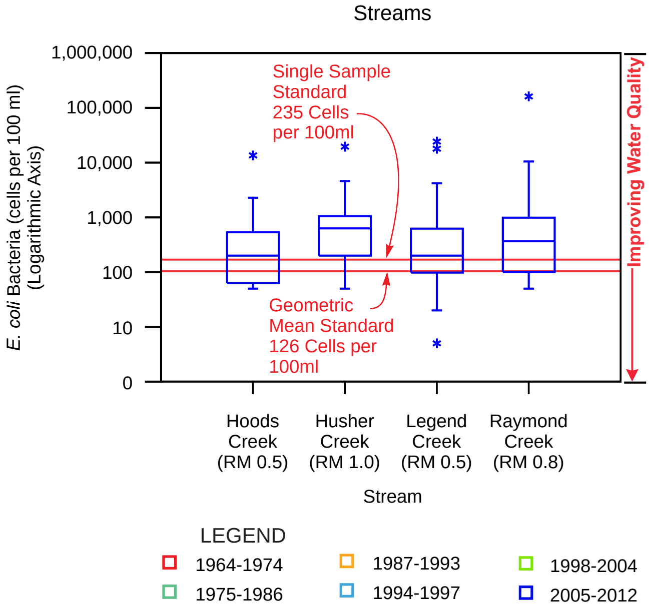
Source: City of Racine Health Department.

bacteria in these streams were high, exhibited high variability, and often exceeded water quality criteria. While these concentrations cannot be used to estimate historical concentrations of *E. coli* in these streams, they suggest that *E. coli* concentrations were also high and highly variable. This is because *E. coli* is a major constituent of the fecal coliform bacteria group.

Figure 15 shows concentrations of *E. coli* at sampling stations along the Root River Canal and its East and West Branches. During the period 2005-2012, concentrations of *E. coli* in the Root River Canal ranged between 20 cells per 100 ml and 23,820 cells per ml, with a mean value of 783 cells per 100 ml and a median value of 122 cells per 100 ml. Concentrations of *E. coli* in the East Branch of the Root River Canal ranged between 20 cells per

Figure 16

***ESCHERICHIA COLI* CONCENTRATIONS IN TRIBUTARY STREAMS IN THE ROOT RIVER WATERSHED: 2005-2012**



NOTE: See Figure 11 for description of symbols.

Source: City of Racine Health Department.

100 ml and 29,090 cells per ml, with a mean value of 1,182 cells per 100 ml and a median value of 310 cells per 100 ml. Concentrations of *E. coli* in the West Branch of the Root River Canal ranged between 10 cells per 100 ml and 241,920 cells per ml, with a mean value of 4,104 cells per 100 ml and a median value of 840 cells per 100 ml. The higher average concentrations in the East and West Branches may reflect the presence of wastewater treatment plants in upstream portions of these streams. The effluent limitations in these plants' discharge permits under the Wisconsin Pollutant Discharge Elimination System (WPDES) do not require that the effluent be disinfected.

Figure 15 also shows that concentrations of *E. coli* both the East Branch of the Root River Canal and the West Branch of the Root River Canal tend to decrease from upstream to downstream. The data are not adequate for evaluating trends over time.

Figure 16 shows concentrations of *E. coli* in four tributary streams in the Root River watershed from the period 2005-2012. Concentrations in Hoods Creek ranged between 50 cells per 100 ml and 13,540 cells per 100 ml, with a mean value of 620 cells per 100 ml and a median value of 200 cells per 100 ml. Concentrations in Husher Creek ranged between 50 cells per 100 ml and 19,560 cells per 100 ml, with a mean value of 1,094 cells per 100 ml and a median value of 628 cells per 100 ml. Concentrations in Legend Creek ranged between 5 cells per 100 ml and 24,192 cells per 100 ml, with a mean value of 1,225 cells per 100 ml and a median value of 200 cells per 100 ml. Concentrations in Raymond Creek ranged between 50 cells per 100 ml and 161,600 cells per 100 ml, with a mean value of 3,418 cells per 100 ml and a median value of 368 cells per 100 ml. In all four of these streams, concentrations of *E. coli* were frequently higher than the USEPA's recommended water quality criteria. The percentages of samples with concentrations greater than the recommended single sample criterion of 235 cells per 100 ml ranged from 41 percent in Hood's Creek to 74 percent in Husher Creek.

Effluent from the three WWTPs that discharge treated effluent into streams of the watershed constitutes a source of bacteria to those streams. The Village of Union Grove's WWTP discharges to the West Branch of the Root River Canal; the Yorkville Sewer Utility District's WWTP discharges to Ives Grove Ditch, a tributary to Hoods Creek; and a private WWTP serving Fonk's Harvest View Mobile Home Park discharges into the East Branch of the Root River Canal. As previously noted, the effluent limitations set in these plants' discharge permits under the WPDES do not require disinfection of the effluent discharged from the plants. Recently, the City of Racine Health Department collected data from two of these streams to examine the geographical extent of the impact of these discharges. On two days during June 2012, samples of *E.* coli were collected from seven sites along the West Branch of the Root River Canal, five sites along the East Branch of the Root River Canal, and one site along the Root River Canal. On each Branch of the Canal, one sample was collected immediately upstream from the outfall of the WWTP, one sample was collected immediately downstream from the outfall, and the other samples were collected at locations progressively farther downstream. The sample collected from the Root River Canal was the last sample in both series. This sampling evaluated the effects of these dischargers over an approximately 11-mile length of stream along the West Branch of the Root River Canal extending into the Root River Canal and a 10-mile length of stream along the East Branch of the Root River Canal extending into the Root River Canal downstream from the two treatment plants.

Figure 17 shows the results of these surveys. On both dates, *E. coli* concentration at the sampling site along the West Branch of the Root River Canal immediately downstream from the Union Grove WWTP was considerably higher than the concentration at the site immediately upstream from the plant. This increase did not persist down the length of the stream. On both dates, concentrations at the next site downstream were lower than the concentrations detected immediately upstream of the plant. This site is located approximately 1.2 miles downstream from the plant. While some increases in concentrations were detected along the length of the stream, they were small relative to the increase at the WWTP outfall. On both dates, the concentrations detected at the sampling site on the Root River Canal were two orders of magnitude lower than those observed immediately downstream from the treatment plant outfall.

The data from the East Branch of the Root River Canal present a slightly more complicated picture (see Figure 17). The results from the June 13, 2012, sampling from this stream were similar to those from the West Branch. *E. coli* concentration was higher immediately downstream from the outfall, although the size of this increase was less than that observed in the West Branch. This probably reflects the fact that the WWTP discharging into this stream is much smaller than the one discharging into the West Branch.[65] Concentrations at downstream sites were progressively lower, with higher concentrations being observed at the site located along the Root River Canal. On this date, the concentrations detected at the sampling site on the Root River Canal were about one-fourth of those detected immediately downstream from the WWTP outfall. A slightly different picture emerges from the results of the sampling conducted on June 27, 2012. *E. coli* concentrations immediately downstream from the outfall were lower than those detected immediately upstream from the outfall. Concentrations were slightly higher at the next sampling site, which is located about three miles downstream. Concentrations were much lower at the stations farther downstream. The cause of the high concentrations upstream from the treatment plant on this date is not clear.

The results presented in Figure 17 suggest two things about the impacts of the WWTP discharge upon concentrations of bacteria in the East and West Branches of the Root River Canal. First, these discharges clearly have a strong local effect on concentrations. In three out of four instances, discharges from the WWTPs caused an increase in the concentration of indicator bacteria immediately below the WWTP outfall. Second, this effect is localized and does not appear to affect concentrations too far downstream. On the West Branch of the Root River Canal, the length of stream over which the discharges result in elevated *E. coli* concentrations appears to be less than 1.2 miles.

Chemical Water Quality Constituents

Water Temperature

The temperature of a waterbody is a measure of the heat energy it contains. Water temperature drives numerous physical, chemical, and biological processes in aquatic systems. Processes affected by temperature include the solubility of substances in water, the rates at which chemical reactions progress, metabolic rates of organisms, the settling rates of small particles, and the toxicity of some substances. For example, the solubility of many gases in water decreases as water temperature increases. By contrast, the solubility of many solids in water increases as water temperature increases. Temperature is a major determinant of the suitability of waterbodies as habitat for fish and other aquatic organisms. Each species has a range of temperatures that it can tolerate and smaller range of temperatures that are optimal for growth and reproduction. These ranges are different for different species. As a result, very different biological communities may be found in similar waterbodies experiencing different temperature regimes.

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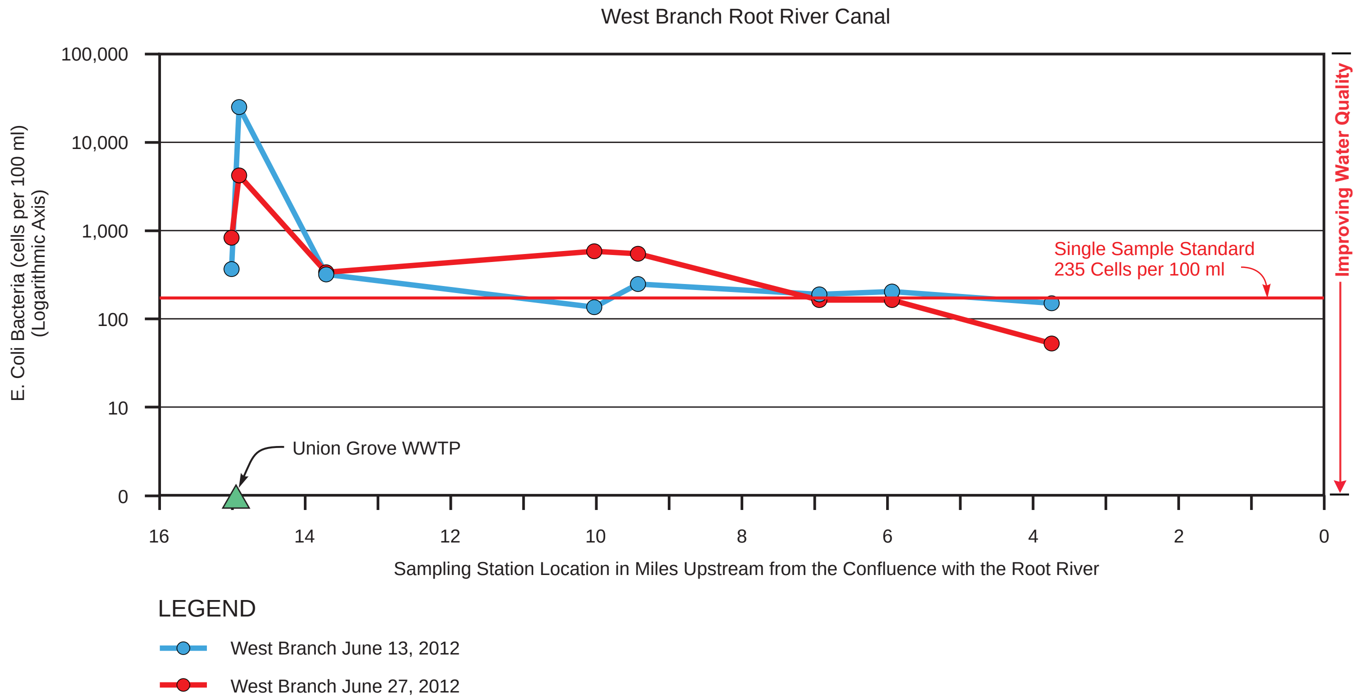
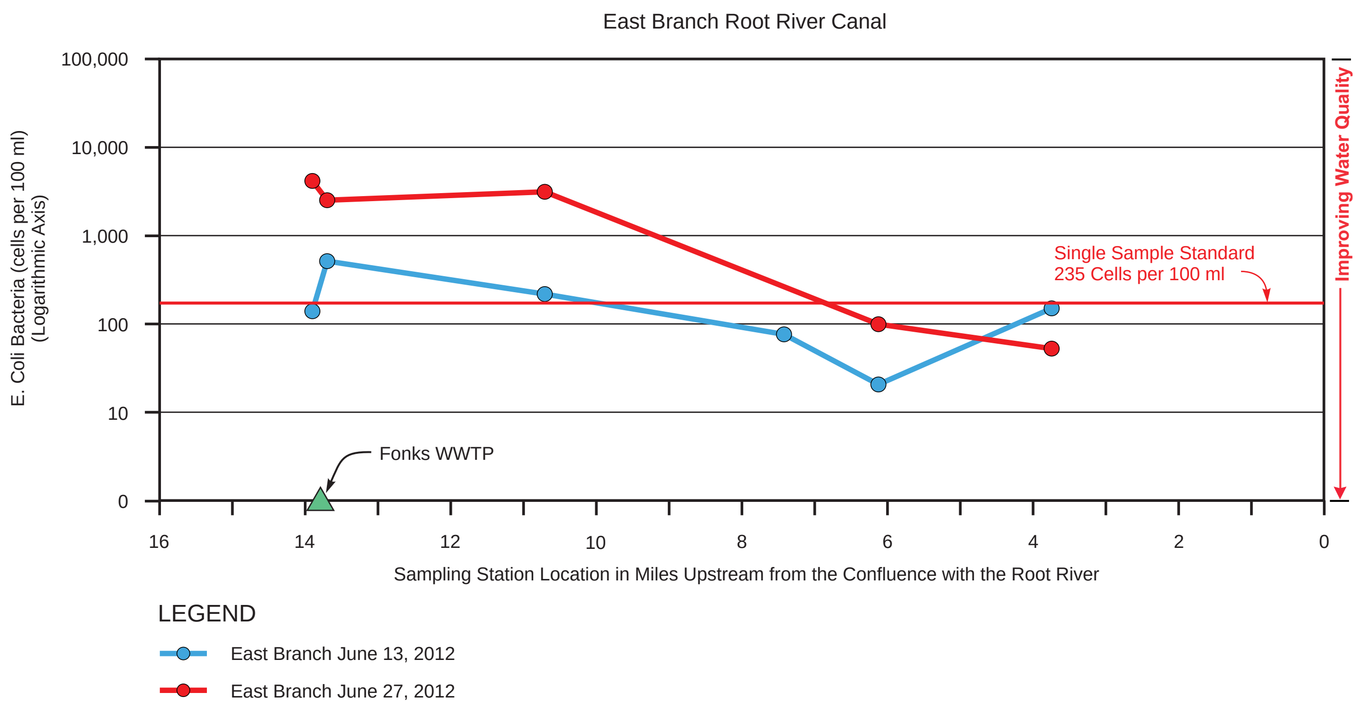
[65]*The capacity of the Union Grove WWTP is 2.0 million gallons per day, while the capacity of the Fonk's Harvest View Mobile Home Park WWTP is 0.1 million gallons per day.*

Figure 17

***ESCHERICHIA COLI* BACTERIA CONCENTRATIONS UPSTREAM AND DOWNSTREAM OF WASTEWATER TREATMENT PLANTS (WWTPs) ALONG THE EAST AND WEST BRANCHES OF THE ROOT RIVER CANAL: JUNE 2012**





Source: City of Racine Health Department.

Solar heating strongly influences water temperature and factors that affect the incidence of light on waterbodies or light penetration through waterbodies can affect temperature. The presence of suspended material or colored dissolved material in the water column can increase the absorbance of light by the waterbody, leading to heating. Water temperature follows a seasonal cycle, with lowest temperatures occurring during winter and highest occurring during summer. Water temperature can also be affected by discharges of groundwater, stormwater runoff, and discharges from point sources.

Figure 18 shows water temperatures at sampling stations at sites along the mainstem of the Root River. During the period 2005-2012, water temperatures in the mainstem of the Root River varied between -1.0 degrees Celsius (ºC) and 31.9ºC, with a median water temperature of 18ºC. Median water temperatures at individual sampling stations ranged from 13.8ºC at the station at Grange Avenue (RM 36.7) to 20.0ºC at the downstream station at Azarian Marina (RM 0.7). The median at the Grange Avenue station is unusually low and reflects the fact that this station in the only one in the upper reaches of the Root River for which sampling was conducted during the winter. When winter samples were removed from the analysis, the median water temperature at this station was 15.2ºC. This is still two to three degrees lower than the median water temperatures at other nearby sampling stations. Examination of the data showed that water temperatures at this station during the early spring were colder than those at adjacent stations. During late spring, summer, and fall, the water temperatures at this station were similar to those observed at adjacent stations. This suggests that the lower average water temperatures at this site may result from meltwater from snow piles in the parking lots of the nearby Southridge Mall. It should be noted that an inventory of recent and historical information on springs in Wisconsin conducted in 2007 by the Wisconsin Wildlife Federation does not show any springs at or upstream from this site**.**[66]

Regression analysis showed the presence of a statistically significant trend toward water temperatures increasing from upstream to downstream. On average, this trend represented an increase of about 0.07ºC per mile, or about 2.8ºC over the entire length of the river. This trend accounted for a very small portion of the variability in the data.

Figure 19 shows water temperature in the Root River Canal and its East and West Branches. During the period 2005-2012, water temperatures in the Root River Canal varied between 0.5ºC and 29.1ºC, with a median water temperature of 17.8ºC. Water temperatures in the East Branch of the Root River Canal varied between 1.0ºC and 28.5ºC, with a median water temperature of 15.8ºC. No statistically significant differences were detected between water temperatures at the sampling stations at STH 11 (RM 8.3) and Four Mile Road (RM 0.5). The other stations along the East Branch lacked sufficient data for making valid comparisons. Water temperatures in the West Branch of the Root River Canal varied between 1.2ºC and 28.0ºC, with a median water temperature of 17.4ºC. No statistically significant differences were detected between water temperatures at the sampling stations at 67th Drive (RM 9.3) and Four Mile Road (RM 0.3). The other stations along the West Branch lacked sufficient data for making valid comparisons.

Figure 20 shows water temperature at sampling stations along four tributary streams from the period 2005-2012. Water temperatures in Hoods Creek varied between 0.8ºC and 25.9ºC, with a median water temperature of 14.4ºC. Water temperatures in Husher Creek varied between 0.7ºC and 27.2ºC, with a median water temperature of 15.0ºC. Water temperatures in Legend Creek varied between 1.6ºC and 25.8ºC, with a median water temperature of 15.7ºC. Water temperatures in Raymond Creek varied between 1.3ºC and 27.4ºC, with a median water temperature of 14.7ºC.

Limited data are available from two areas of the watershed to assess daily variations in water temperature. Temperature was continuously recorded during the period from March 1, 2011, to June 14, 2011, at three locations along the West Branch of the Root River Canal that bracket the outfall from the Village of Union

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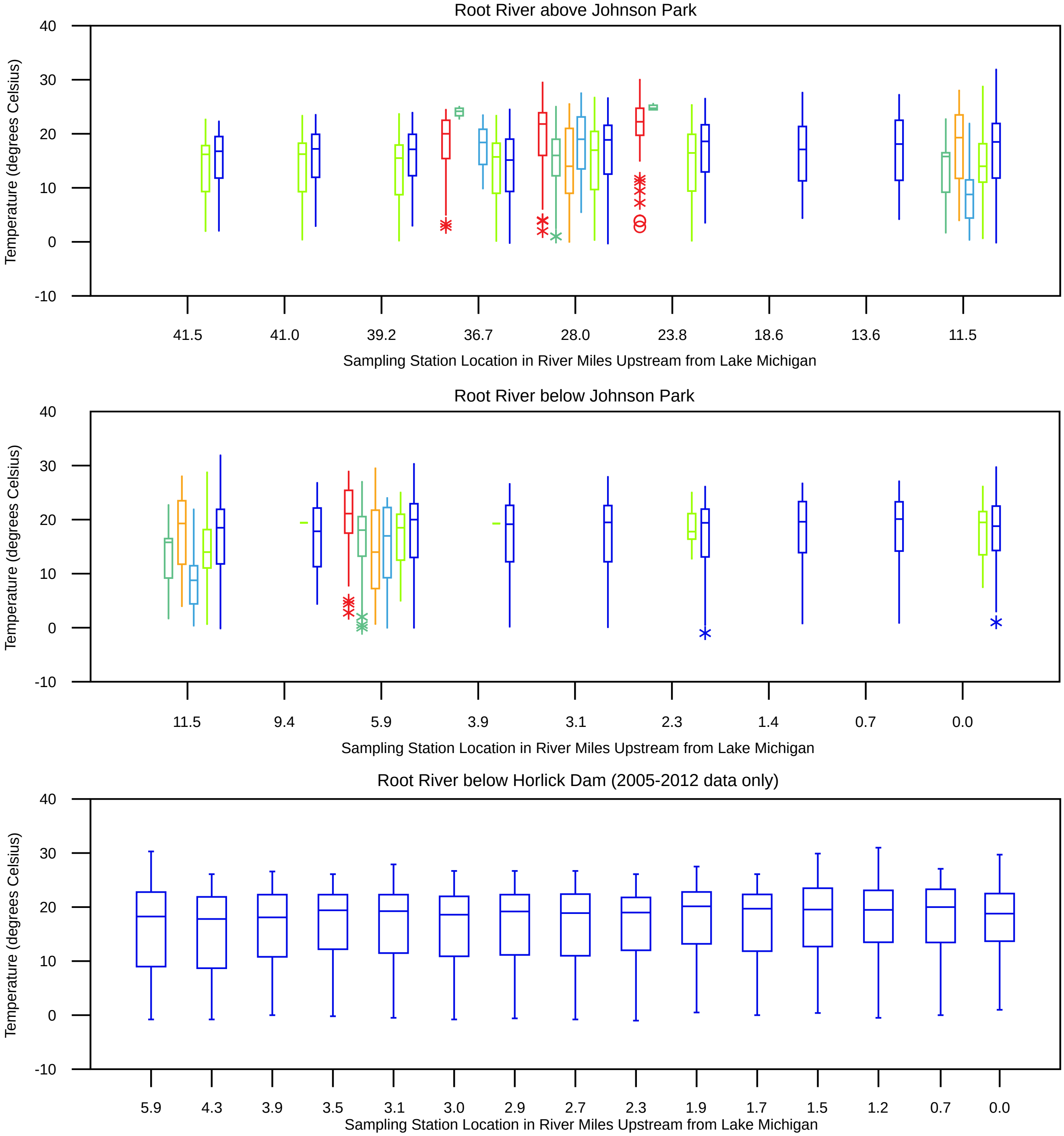
[66]*See Map 21 and Appendix A of SEWRPC Planning Report No. 52,* op. cit.

Figure 18

WATER TEMPERATURE AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



LEGEND

- 1964-1974
- 1975-1986
- 1987-1993
- 1994-1997
- 1998-2004
- 2005-2012

LANDMARKS

41.5 = W. Cleveland Avenue
36.7 = W. Grange Avenue
23.8 = Upstream Crossing of W. County Line Road
11.5 = Johnson Park
5.9 = Horlick Dam
0.0 = Confluence with Lake Michigan

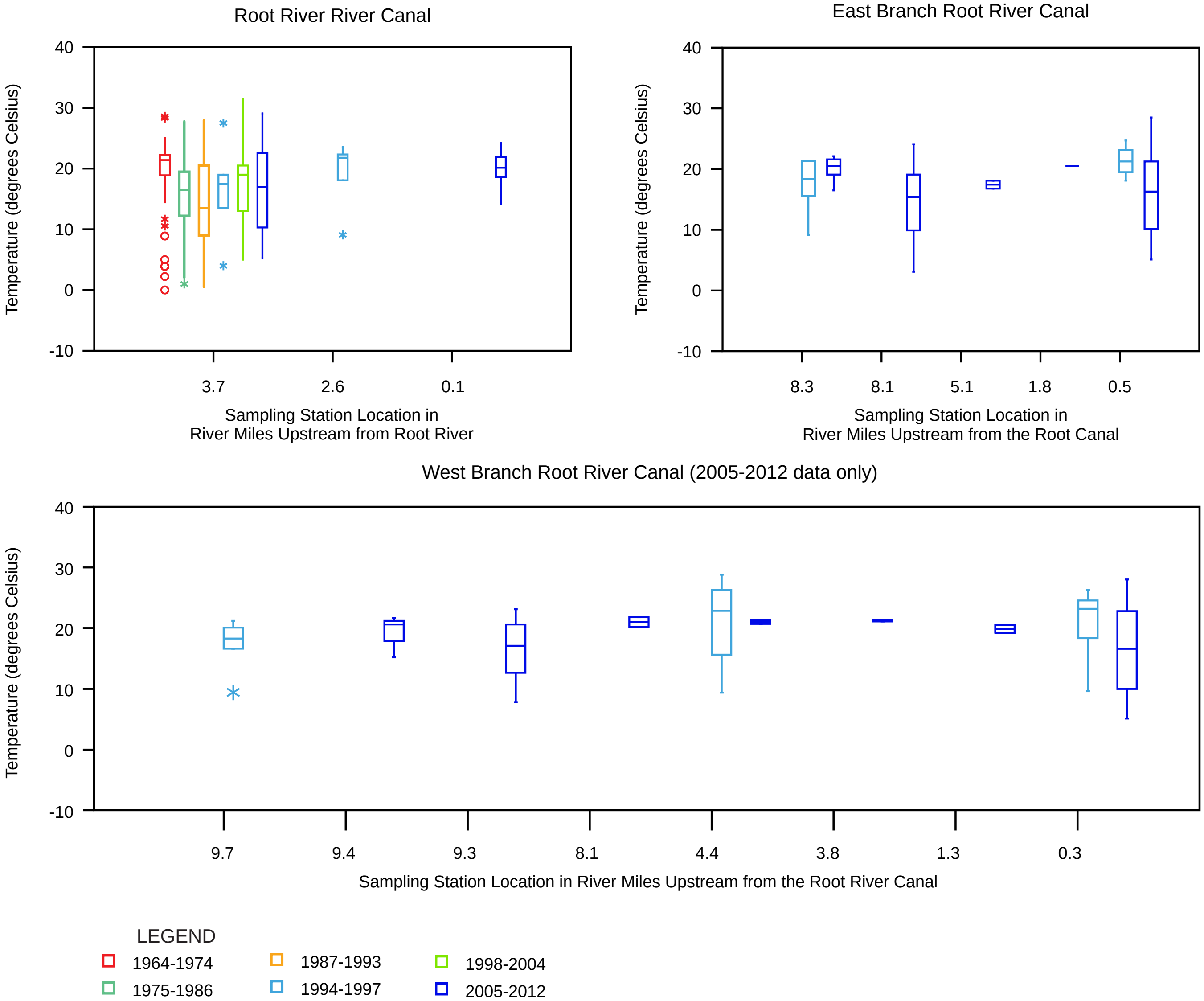
NOTES: See Figure 11 for description of symbols. See Table 27 for location of sample sites.

Wisconsin's acute and sublethal water quality criteria for temperature vary based upon month of the year. In addition, these criteria address the daily maximum temperature and the weekly mean of the daily maximum temperature. The degree of compliance with these criteria cannot be assessed from the grab samples summarized in these graphs.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, University of Wisconsin-Extension, Milwaukee Metropolitan Sewerage District, City of Racine Health Department, and SEWRPC.

Figure 19

WATER TEMPERATURE AT SITES ALONG THE ROOT RIVER CANAL AND ITS BRANCHES: 1964-2012



NOTES: See Figure 11 for description of symbols.

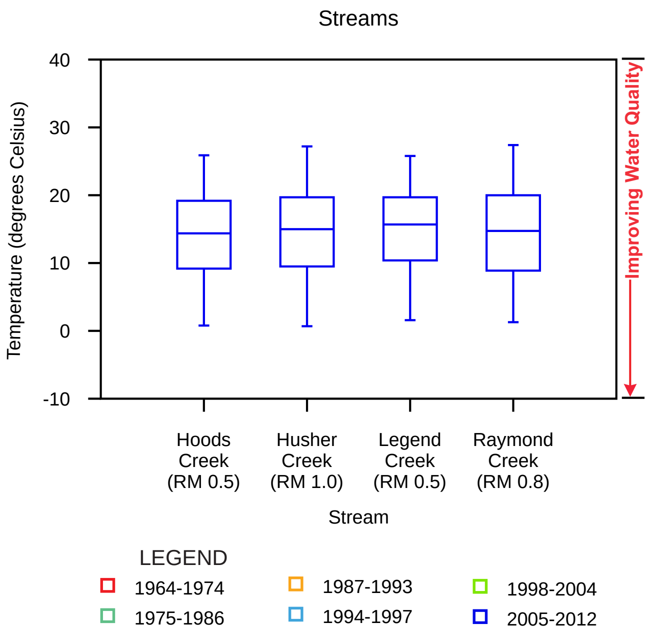
See Table 27 for location of sample sites.

Wisconsin's acute and sublethal water quality criteria for temperature vary based upon month of the year. In addition, these criteria address the daily maximum temperature and the weekly mean of the daily maximum temperature. The degree of compliance with these criteria cannot be assessed from the grab samples summarized in these graphs.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, City of Racine Health Department, and SEWRPC.

Figure 20

WATER TEMPERATURE IN TRIBUTARY STREAMS IN THE ROOT RIVER WATERSHED: 2005-2012



NOTES: See Figure 11 for description of symbols.

Wisconsin's acute and sublethal water quality criteria for temperature vary based upon month of the year. In addition, these criteria address the daily maximum temperature and the weekly mean of the daily maximum temperature. The degree of compliance with these criteria cannot be assessed from the grab samples summarized in these graphs.

Source: Wisconsin Department of Natural Resources and City of Racine Health Department.

Grove's wastewater treatment plant (WWTP).[67] One recorder was located 14 feet upstream from the outfall; another recorder was located 14 feet downstream from the outfall, and the last one was located 40 feet downstream from the outfall. The water temperatures recorded ranged between -0.2ºC and 21.3ºC at site located 14 feet upstream from the outfall, 0.9ºC and 19.8ºC at the site located 14 feet downstream from the outfall, and 1.1ºC and 19.7ºC at the site located 40 feet downstream from the outfall. The range of variation in water temperature over the course of a day was higher immediately upstream from the outfall than immediately downstream. The average range of variation in water temperature over the course of a day at the location upstream of the outfall was 3.4ºC. The average range of variation at each of the two sites downstream from the outfall was 2.1ºC. The maximum range of variation over the course of a day at the upstream site was 7.5ºC. At the sites 14 feet and 40 feet downstream from the outfall the maximum ranges of variation over the course of the day were 5.4ºC and 5.0ºC, respectively. This difference in the range of temperature variation between the site immediately upstream of the outfall and the sites immediately downstream from the outfall suggests that discharges from the WWTP are acting to reduce daily temperature variations immediately downstream from the discharge point. The data do not address how far down the stream the effects of this discharge may extend.

Daily minimum, maximum, and mean water temperatures are also available from three stations in the upper reaches of the mainstem. These stations were located at Florence Lane (RM 41.4), Beloit Road (RM 39.8), and Layton Avenue (RM 38.6). The data were collected during the months of May through September during 2010 and 2011. At the Florence Lane station, the temperatures recorded ranged between 7.8ºC and 24.7ºC. At this station, the average range of variation in water temperature over the course of a day was 1.9ºC. The maximum range of variation over the course of a day was 5.5ºC. At the Beloit Road (RM 39.8) station, the temperatures recorded ranged between 7.6ºC and 27.8ºC. At this station, the average range of variation in water temperature over the course of a day was 3.0ºC and the maximum range of variation over the course of a day was 6.3ºC. At the Layton Avenue (RM 38.6) station, the temperatures recorded ranged between 7.7ºC and 25.4ºC. At this station, the average range of variation in water temperature over the course of a day was 2.7ºC and the maximum range of variation over the course of a day was 6.3ºC.

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[67] *The recorders were placed in the stream and began recording in early December 2010; however, examination of the data record indicated that the upstream recorder was located in a frozen section of stream beginning in December 2010 and remained encased in ice through February 2011.*

Dissolved Oxygen

The concentration of dissolved oxygen in water is a major determinant of the suitability of a waterbody as habitat for fish and other aquatic organism because most aquatic organisms require oxygen in order to survive. Though tolerances vary by species, most aquatic organisms have minimum oxygen requirements.

Sources of dissolved oxygen to water include diffusion of oxygen from the atmosphere and photosynthesis by aquatic plants and suspended and benthic algae. Processes that remove dissolved oxygen from water include diffusion of oxygen to the atmosphere, respiration by aquatic organisms, and bacterial decomposition of organic material in the water column and sediment. Several factors can influence these processes, including the availability of light, the clarity of the water, the presence of aquatic plants, and the amount of water turbulence. Water temperature has a particularly strong effect for two reasons. First, as noted in the previous subsection, the solubility of most gasses in water decreases with increasing temperature. Thus as water temperature increases, the water is able to hold less oxygen. Second, the metabolic demands of organisms and the rates of oxygen-demanding processes, such as bacterial decomposition, increase with increasing temperature. As a result, the demands for oxygen in waterbodies tend to increase as water temperature increases.

Concentrations of dissolved oxygen in surface waters typically show a strong seasonal pattern. Highest concentrations usually occur during the winter. Concentrations decrease through the spring to reach a minimum during summer. Concentrations rise through the fall to reach maximum values in winter. This cycle is driven by seasonal changes in water temperature. Dissolved oxygen concentrations in some waterbodies may also show daily fluctuations in which high concentrations occur during daylight due to photosynthesis and lower concentrations occur during periods of darkness when photosynthesis ceases and respiration increases.

Supersaturation of water with dissolved oxygen occurs when the water contains a higher concentration of dissolved oxygen than is normally soluble at ambient conditions of temperature and pressure. Dissolved oxygen supersaturation can result from several causes, including the presence of waterfalls; discharge of water through dams; water temperature increases related to solar heating or discharge of industrial or power generation cooling water effluent; and high levels of photosynthesis in waterbodies with high densities of aquatic plants, phytoplankton, or benthic algae. Dissolved oxygen supersaturation can cause a number of physiological conditions that are harmful or fatal to fish and other aquatic organisms.

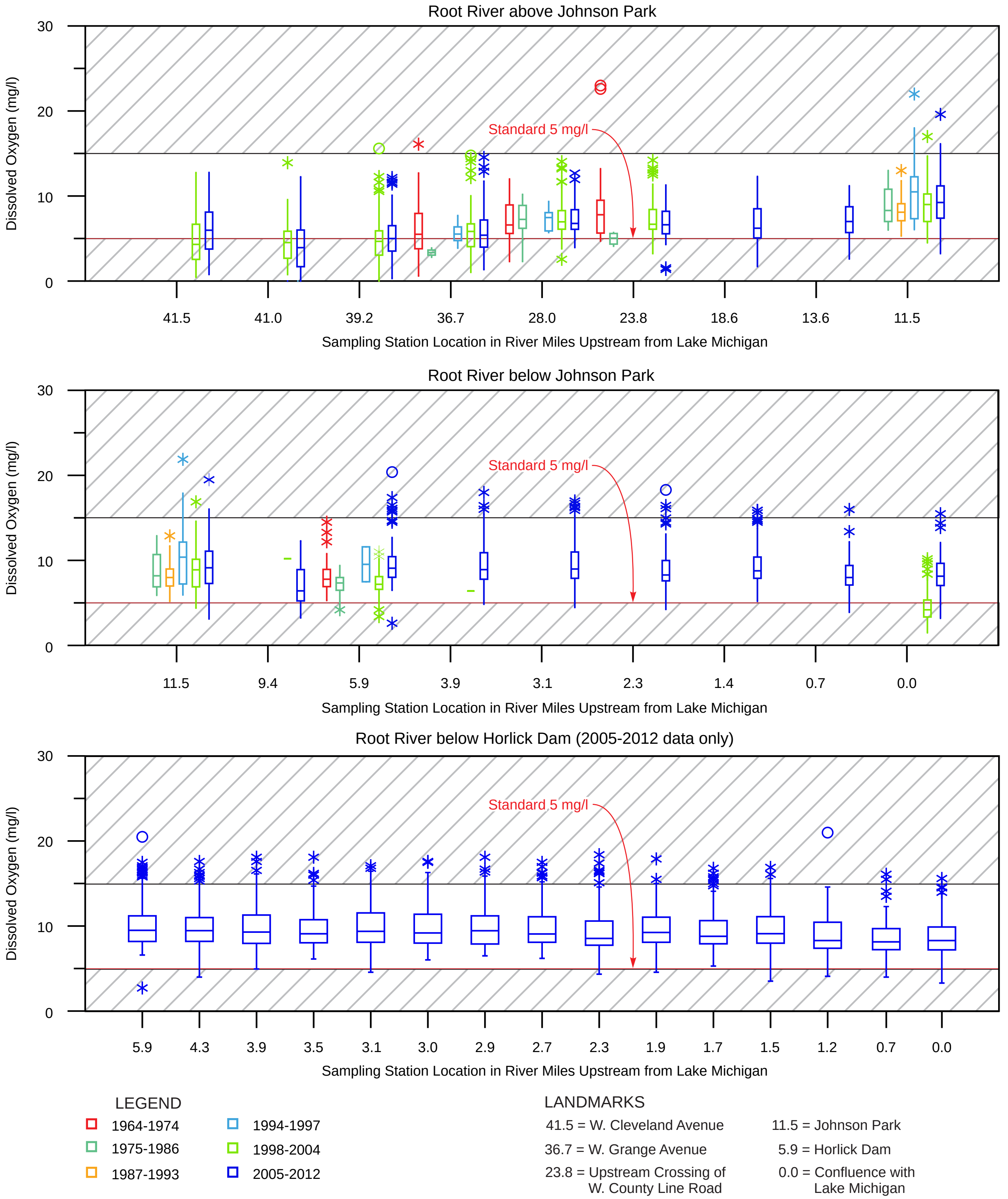
The mean concentration of dissolved oxygen at sample stations along the mainstem of the Root River for the period 2005 through early August 2012 was 8.78 milligrams per liter (mg/l). During the period 1998 through 2004, the mean concentration was 6.52 mg/l. The higher mean concentration in recent years should be interpreted with caution because it includes results from many sampling stations that were only sampled during the most recent period. Many of these stations are located in downstream sections of the River, where dissolved oxygen concentrations tend to be higher than they are in upstream sections. In addition, samples were collected at some of these downstream stations more frequently than they were at upstream stations. As a result the difference between the mean dissolved oxygen concentrations detected during these two periods may be more a reflection of changes in sampling effort than any overall change in the state of the River.

Figure 21 shows dissolved oxygen concentrations at selected sampling stations along the mainstem of the Root River. The top panel shows results from sampling stations between W. Cleveland Avenue in the City of West Allis (RM 41.5) and Johnson Park in the City of Racine (RM 11.5). The middle panel shows results from sampling stations between Johnson Park and the confluence of the Root River with Lake Michigan. These two panels show all available data going back to 1964. The bottom panel shows results from stations between Horlick dam (RM 5.9) and the confluence of the Root River with Lake Michigan for the period 2005 through early August 2012.

The four sampling stations that are farthest upstream reflect water quality conditions in the mainstem of the River in the Upper Root River-Headwaters and Upper Root River assessment areas. At these stations, low concentrations of dissolved oxygen were detected in samples collected between 2005 and 2012 (see Figure 21). At all four

Figure 21

DISSOLVED OXYGEN CONCENTRATIONS AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



NOTES: See Figure 11 for description of symbols. See Table 27 for location of sample sites.

Saturation levels of dissolved oxygen of 140 percent and higher can cause fish kills. A 15 mg/l dissolved oxygen concentration translates to a saturation of approximately 150 percent at an average water temperature of 14 degrees Celsius.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, University of Wisconsin-Extension, Milwaukee Metropolitan Sewerage District, City of Racine Health Department, and SEWRPC.

of these stations, dissolved oxygen concentration in a substantial fraction of samples was below the State's water quality criterion of 5.0 mg/l. The distributions of concentrations at these stations during the period 2005-2012 were similar to those from samples collected during the period 1998-2004. While concentrations during the more recent period were slightly higher at two of the stations (RM 41.5 and RM 39.2), they were slightly lower at the other two (RM 41.0 and RM 36.7). This suggests that dissolved oxygen conditions in this section of the River did not change much between these two periods. Examination of historical dissolved oxygen concentrations at the station at W. Grange Avenue (RM 36.7) suggests that low dissolved oxygen concentrations are a long-standing problem in this section of the River.

The next two sampling stations reflect water quality conditions in the mainstem of the River in the Middle Root River-Legend Creek (station at RM 28.0) and Middle Root River-Ryan Creek assessment areas (station at RM 23.8). Dissolved oxygen concentrations at these stations between 2005 and 2012 were higher than those upstream (see Figure 21). At both stations, dissolved oxygen concentrations in occasional samples were below the State's water quality criterion of 5.0 mg/l. The distributions of concentrations at these stations during the period 2005-2012 were similar to those from samples collected during the period 1998-2004, suggesting that dissolved oxygen conditions in this section of the River did not change much between these two periods.

The next three sampling stations (RM 18.6, RM 13.6, and RM 11.5) reflect water quality conditions in the Lower Root River-Caledonia assessment area. Dissolved oxygen concentrations at the station at S. Howell Avenue (RM 18.6) during the period 2005-2012 were slightly lower than they were at the two stations immediately upstream (see Figure 21). In addition, dissolved oxygen concentrations in about 23 percent of the samples collected at this station were below the State's water quality criterion of 5.0 mg/l. Through this section of the River, dissolved oxygen concentrations increased from upstream to downstream. This is illustrated by the fact that median concentrations of dissolved oxygen at the stations at RM 18.6, RM 13.6, and RM 11.5 during the period 2005-2012 were 6.3 mg/l, 7.4 mg/l, and 9.6 mg/l, respectively. Similarly, the percentage of samples collected that were below the 5.0 mg/l water quality criterion at these stations were 23 percent, 14 percent, and 4 percent, respectively. At the sampling station at Johnson Park (RM 11.5), dissolved oxygen concentrations during the period 2005-2012 were higher and had a slightly greater range of variation than those observed during the period 1998-2004.

The next two sampling stations reflect water quality conditions in the mainstem of the River in the Lower Root River-Johnson Park assessment area. Dissolved oxygen concentrations at the station at Four Mile Road (RM 9.4) during the period 2005-2012 were considerably lower than they were at the station immediately upstream (see Figure 21). In addition, dissolved oxygen concentrations in about 15 percent of the samples collected at this station were below the State's water quality criterion of 5.0 mg/l. Through this section of the River, dissolved oxygen concentrations increased from upstream to downstream, such that median concentrations at the sampling station below Horlick dam (RM 5.9) during the period 2005-2012 were similar to those at Johnson Park (RM 11.5). Dissolved oxygen concentrations at the station below Horlick dam during the period 2005-2012 were higher than those observed in most previous periods suggesting some improvement. It is important to note that the distribution of concentrations for the period 1994-1997 reflects a very small number of samples and may not give an accurate reflection of conditions at this station during that time period.

The last six sampling stations reflect water quality conditions in the mainstem of the River in the Lower Root River-Racine assessment area. Dissolved concentrations at the four upstream stations (RM 3.9, RM 3.1, RM 2.3, and RM 1.4) during the period 2005-2012 were similar to those observed at the station below Horlick dam (see Figure 21). During this period, dissolved oxygen concentrations at sampling stations nearest the confluence with Lake Michigan were slightly lower than those at the stations within this assessment area that are farther upstream. Examination of the lower panel of Figure 21 indicates that this decrease in dissolved oxygen concentration extends at least 1.2 miles—but no farther than 1.5 miles—upstream from the confluence with Lake Michigan. The cause of this decrease is not clear. Similar concentrations of total phosphorus were observed at these stations, as were similar levels of turbidity. Data examining concentrations of biochemical oxygen demand, chlorophyll-*a*, dissolved phosphorus, and total nitrogen are not available for this section of the River. It is possible that this reflects temperature differences between upstream and downstream portions of this section of the River. During the fall, the portion of the River that extends about 2.3 miles upstream from the confluence with Lake Michigan tends to be warmer, on average, than the two-mile portion immediately upstream by about 3ºC. This temperature difference corresponds to a difference in saturation concentration of dissolved oxygen of almost 1.0 mg/l.[68] Average temperature differences between these portions that lead to differences in saturation concentrations that are this large are only seen during the fall and winter. The differences in average temperatures in these two portions of the River during spring and summer are not great enough to produce a difference in saturation concentration that is this large. In addition, the correspondence between where the increase in average fall water temperature appears to begin and where the decrease in dissolved oxygen appears to begin is not exact. In fact, there is about a one-mile difference between these two locations. Because of this, it is unlikely that differences in water temperature account for the decrease in the concentration of dissolved oxygen in the 1.2-mile section of the River immediately upstream from the confluence with Lake Michigan.

Going from upstream to downstream, an overall pattern of dissolved oxygen concentrations in the mainstem of the Root River can be described (see Figure 21). Concentrations tend to be very low in the upper reaches, through the Upper Root River-Headwaters and Upper Root River assessment areas. Dissolved oxygen concentrations tend to be higher in reaches that run through the Middle Root River-Legend Creek and Middle Root River-Ryan Creek assessment areas. They are somewhat lower in the upstream and central portions of the Lower Root River-Caledonia assessment area, though not as low as what is observed in the headwaters. Concentrations tend to be higher in the lower portion of this reach, at the sampling station at Johnson Park. Lower concentrations are present in the upper portions of the Root River-Johnson Park assessment area. As with the previous assessment area, concentrations tend to be higher in the lower portion of this reach at the sampling station below Horlick dam. Downstream from Horlick dam, dissolved oxygen concentrations remain at about the levels observed at the dam through most of the Lower-Root River-Racine assessment area. Dissolved oxygen concentrations are slightly lower in the reach just upstream from the confluence with Lake Michigan.

Figure 21 also shows many samples in which dissolved oxygen concentrations are sufficiently high to suggest that supersaturation may be occurring. Most of these samples were collected in downstream reaches of the River, between Horlick dam and the confluence with Lake Michigan. The majority of these samples were collected during the winter and early spring months of December through March. Because water temperatures are low during these months and solubility of oxygen in water is consequently high, it is likely that some of these concentrations are below saturation levels.[69] It is also likely that some of these cases reflect supersaturation, probably cause by photosynthesis by submerged plants and algae during clear, sunny conditions.

Supersaturation of dissolved oxygen can indicate that a site is experiencing wide swings in dissolved oxygen over the course of the day. Data from in situ continuously recording dissolved oxygen data loggers show that concentration swings of this type occur during the growing season (May through September) in upper sections of the mainstem of the Root River. Figures 22 and 23 show continuous records of dissolved oxygen concentration collected at three sampling stations in the upper reaches of the River during 2010 and 2011, respectively. The figures show dissolved oxygen data that were collected at 15-minute intervals during the months of May through September. They also show continuously collected stream discharge at the USGS discharge gauge at W. Grange Avenue (RM 36.7), which is located downstream from the sites where the continuous dissolved oxygen data were collected.

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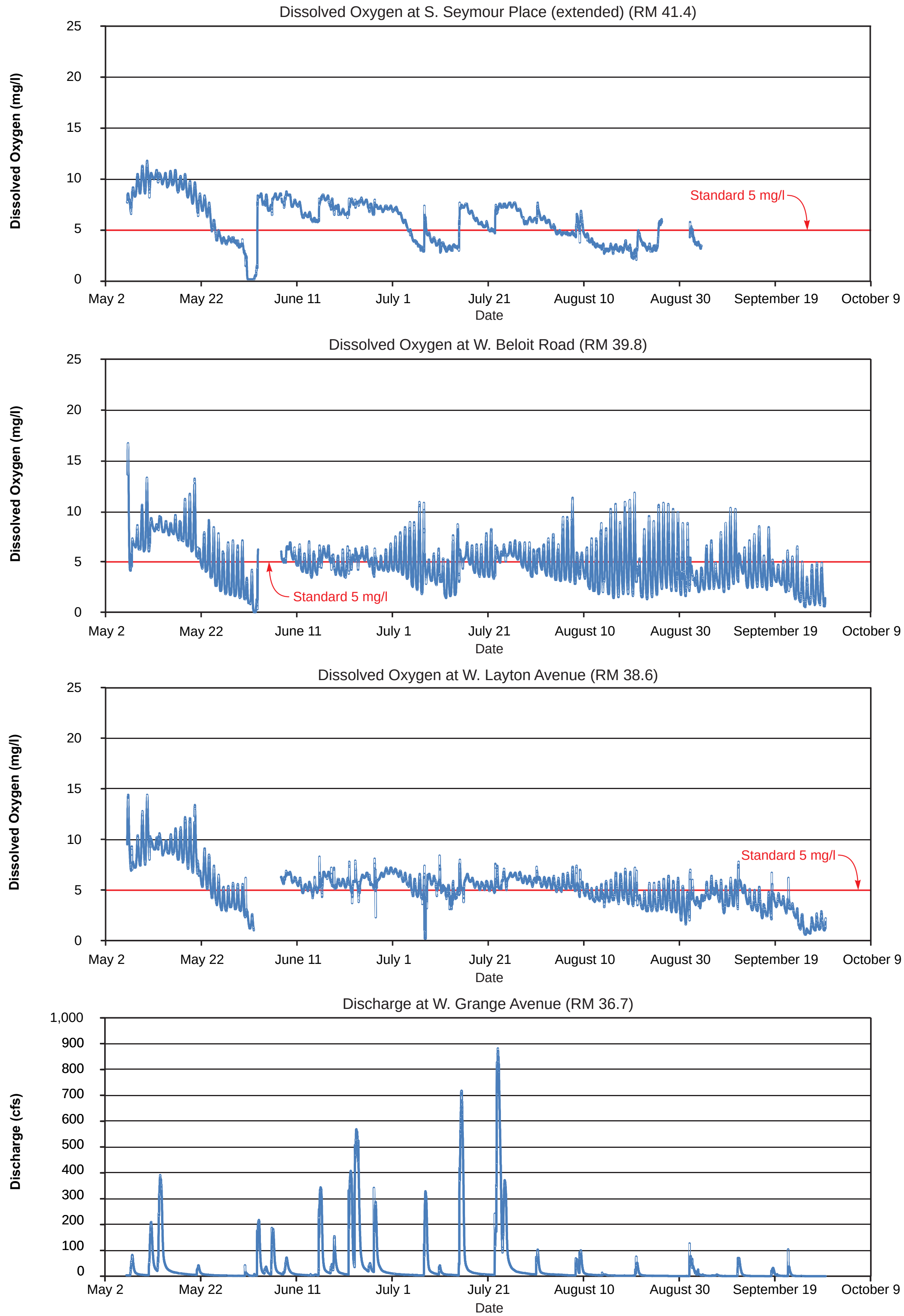
[68]*Saturation concentration is the concentration at which the water contains as much dissolve oxygen as is normally soluble under ambient conditions of temperature and pressure.*

[69]*For the purposes of this analysis the supersaturation concentration is defined based on a water temperature of 14ºC. At lower water temperatures saturation concentrations for dissolved oxygen would be higher than the concentration at a water temperature of 14ºC.*

Figure 22

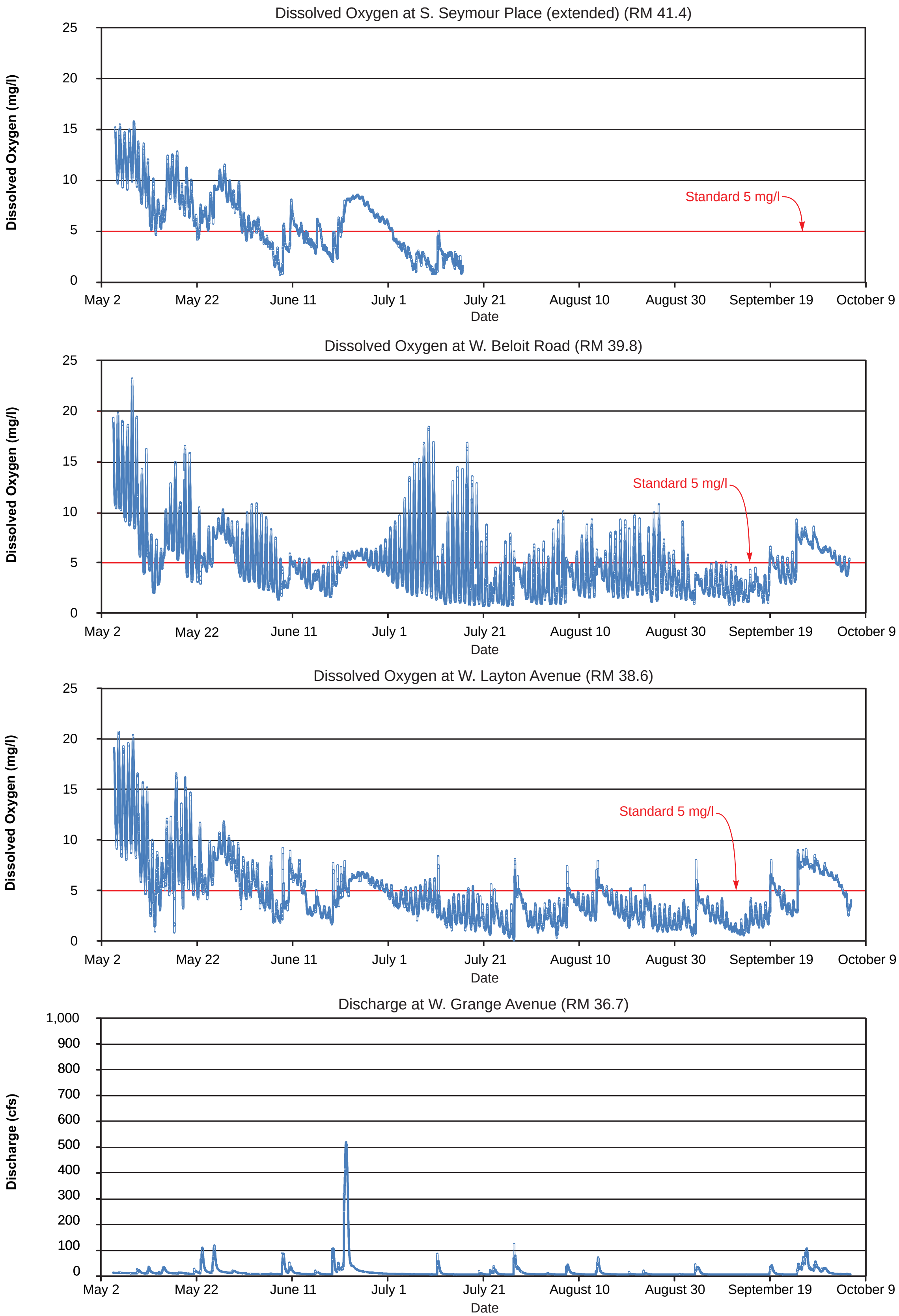
CONTINUOUSLY MONITORED DISSOLVED OXYGEN CONCENTRATIONS AT THREE LOCATIONS ALONG THE MAINSTEM OF THE ROOT RIVER: 2010



Source: U.S. Geological Survey and SEWRPC.

Figure 23

CONTINUOUSLY MONITORED DISSOLVED OXYGEN CONCENTRATIONS AT THREE LOCATIONS ALONG THE MAINSTEM OF THE ROOT RIVER: 2011



Source: U.S. Geological Survey and SEWRPC.

Table 30

MEAN CONCENTRATIONS, MEAN DAILY RANGES, AND MAXIMUM DAILY RANGES OF CONTINUOUSLY RECORDED DISSOLVED OXYGEN CONCENTRATIONS FROM THREE SAMPLING STATIONS ALONG THE ROOT RIVER: 2010 AND 2011[a]

Station	2010				2011			
	Days of Record	Mean Concentration (mg/l)	Mean Daily Range (mg/l)	Maximum Daily Range (mg/l)	Days of Record	Mean Concentration (mg/l)	Mean Daily Range (mg/l)	Maximum Daily Range (mg/l)
S. Seymour Place	112	6.02	1.22	8.20	72	6.10	2.56	6.50
W. Beloit Road	140	4.91	4.23	10.20	153	4.85	5.42	16.70
W. Layton Avenue	139	5.34	2.25	7.20	153	4.59	3.46	15.80

[a]*For the May through September growing season.*

Source: U.S. Geological Survey and SEWRPC.

Figure 22 shows that large oscillations in dissolved oxygen concentration over the course of the day occurred at the stations at W. Beloit Road (RM 39.8) and W. Layton Avenue (RM 38.6) stations during late May 2010 and at the W. Beloit Road (RM 39.8) station during early July and from mid-August into early September of the same year. During the period from mid-August into early September, the range in dissolved oxygen concentration over the day at the W. Beloit Road station increased from 2.6 mg/l on August 9 to 7.0 mg/l on August 10. The daily range continued to increase through mid-August, peaking at a maximum of 10.2 mg/l on August 20. While the daily range decreased after this date, it remained greater than 7.0 mg/l into early September.

Figure 23 shows that these large oscillations in dissolved oxygen concentration over the course of the day were more common during 2011 than they were during 2010. Periods of these oscillations occurred at the stations at W. Beloit Road (RM 39.8) and W. Layton Avenue (RM 38.6) stations during early May and mid-May and at the station at W. Beloit Road (RM 39.8) during early June, early and mid-July, and early and mid-August. Exceptionally broad fluctuations occurred at station at W. Beloit Road (RM 39.8) during early and mid-July. The range in dissolved oxygen concentration over the day at this site increased from 5.2 mg/l on July 1 to 11.4 mg/l on July 5. The daily range continued to increase over the following days, peaking at a maximum of 16.7 mg/l on July 9. By July 11 it decreased to 4.3 mg/l. The range in dissolved oxygen concentration over the day at this site increased again, reaching 9.1 mg/l on July 13 and peaking at 15.9 mg/l on July 17. Following this maximum, the daily range in dissolved oxygen concentration decreased, reaching 2.3 mg/l on July 22.

Table 30 shows mean dissolved oxygen concentrations, mean daily ranges in dissolved oxygen concentrations, and maximum daily ranges in dissolved oxygen concentrations from the growing seasons of 2010 and 2011 from the three stations with continuous data records. At all three stations, mean daily ranges and maximum daily ranges in dissolved oxygen concentration were higher in 2011 than in 2010.

As previously stated, Figures 22 and 23 also show continuously collected stream discharge at the USGS discharge gauge at W. Grange Avenue (RM 36.7). This gauge is located downstream from the sites where the continuous dissolved oxygen data were collected. The magnitude of the daily ranges in dissolved oxygen concentrations at the three upstream stations do not appear to be related to the amount of discharge at the W. Grange Avenue (RM 36.7) gauge; however, the figures show that large spikes in discharge were often accompanied by increases in the concentration of dissolved oxygen at the three upstream stations. While this was especially the case at the station at S. Seymour Place (extended) (RM 41.4), it also occurred at the stations at W. Beloit Road (RM 39.8) and W. Layton Avenue (RM 38.6).

Figure 24 shows dissolved oxygen concentrations in the Root River Canal and its West and East Branches. Dissolved oxygen concentrations in the Root River Canal were highly variable, with values at the sampling station at Six Mile Road (RM 3.7) ranging between 3.0 mg/l and 27.5 mg/l, with a median value of 10.0 mg/l. All of the samples in which dissolved oxygen concentrations were either below 5.0 mg/l or above 15.0 mg/l occurred during summer and early fall. The fact that this is being observed mostly during the growing season suggests that the variability in dissolved oxygen concentrations at this site may be driven by dense growth of benthic algae or aquatic plants at or upstream from the sampling site. When light is available, such as during sunny days, photosynthesis will result in the release of oxygen to the water, driving dissolved oxygen concentrations up. When light is not available, such as during night or cloudy days, respiration by these algae or plants will remove oxygen from the water, driving dissolved oxygen concentrations downward. The limited phosphorus data that are available from this site indicate that high concentrations of phosphorus are present in the Root River Canal during the summer. These concentrations would support the sort of algal or plant growth that would cause this sort of dynamic in dissolved oxygen concentration.

Dissolved oxygen concentrations at this station were strongly correlated with pH. This gives support to the idea that much of the variability in dissolved oxygen concentration is the result of photosynthesis and respiration. When carbon dioxide diffuses into water, it undergoes a chemical reaction with water to produce carbonic acid. Removal of carbon dioxide from water by plants and algae during photosynthesis will reduce the amount of carbonic acid in the water. This results in an increase in pH. Because oxygen is a byproduct of the photosynthetic reactions, pH and dissolved oxygen will be strongly correlated when high levels of photosynthesis are occurring. Respiration will return carbon dioxide to the water, increasing the concentration of carbonic acid and lowering the pH.

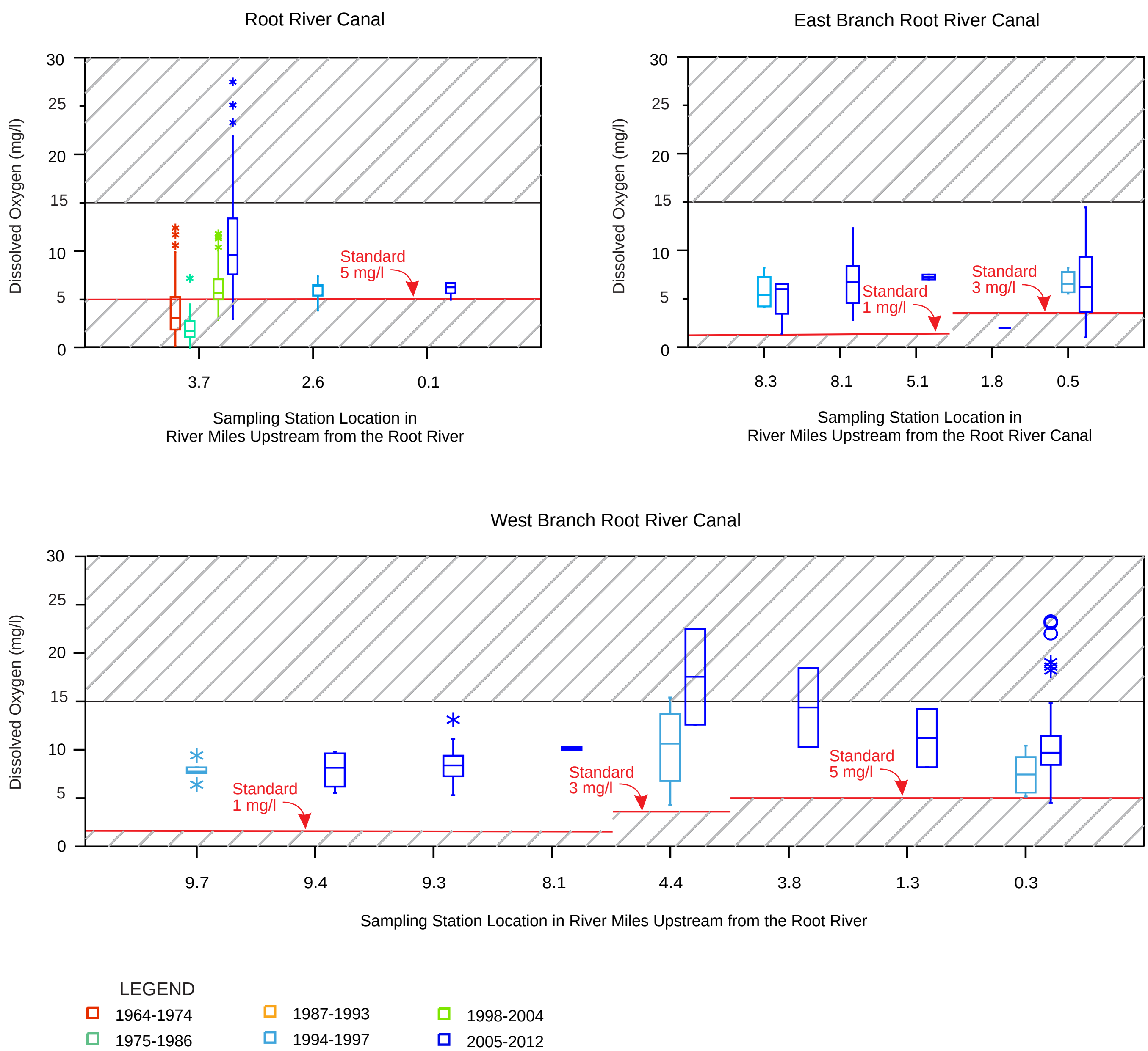
Dissolved oxygen concentrations at the in the Root River Canal sampling station at Six Mile Road (RM 3.7) during the period 2005-2012 were higher than those observed during previous periods (see Figure 24). While this suggests improvement, it should be kept in mind that the wide swings in dissolved oxygen concentrations that the data suggest are occurring during the growing season could result in the affected reaches of the Canal being uninhabitable to many species of aquatic organisms during these months. The data also suggest that dissolved oxygen concentrations may decrease from upstream to downstream along the length of the canal; however, only a small number of samples are available from the sampling station near the confluence with the Root River (RM 0.1). These data may not be representative of the concentrations in this portion of the Canal.

Figure 24 also shows dissolved oxygen concentrations in the East Branch of the Root River Canal. Dissolved oxygen concentrations in this stream ranged between 4.3 mg/l and 23.3 mg/l with a median value of 9.3 mg/l. During the period 2005-2012, concentrations at most of the sampling stations were often below 5.0 mg/l. About 20 percent of samples collected at the station at Four Mile Road (RM 0.5) were also below the applicable dissolved oxygen criterion of 3.0 mg/l. Given that only a small number of samples were collected from this stream prior to 2011, the data are not sufficient to assess whether the apparent differences in dissolved oxygen concentrations between the periods 1994-1997 and 2005-2012 represent real differences in conditions.

In the West Branch of the Root River Canal, dissolved oxygen concentrations in this stream ranged between 1.0 mg/l and 23.3 mg/l with a median value of 14.5 mg/l (see Figure 24). During the period 2005-2012, dissolved oxygen concentrations were usually above 5.0 mg/l. One sample collected at the station at Four Mile Road (RM 0.3) was below this value. Dissolved oxygen concentrations appear to increase between the stations near 67th Drive (RM 9.3) to the station at Four Mile Road (RM 0.3), with median concentrations at these stations of 8.5 mg/l and 9.8 mg/l, respectively. The distributions from the four stations located between these stations are based upon small numbers of samples and probably do not give a good representation of conditions at these stations. Dissolved oxygen concentrations higher than 15.0 mg/l were occasionally detected at the Four Mile Road station (RM 0.3), suggesting supersaturation of dissolved oxygen. This was only detected during summer and may indicate the presence of dense growth of benthic algae or aquatic plants at or upstream from the sampling site. This idea is supported by the fact that concentrations of dissolved oxygen were strongly correlated with pH at this station. Phosphorus data were not collected at this sample site on the dates when these high dissolved oxygen

Figure 24

DISSOLVED OXYGEN CONCENTRATIONS AT SITES ALONG THE ROOT RIVER CANAL AND ITS BRANCHES: 1964-2012



NOTES: See Figure 11 for description of symbols.

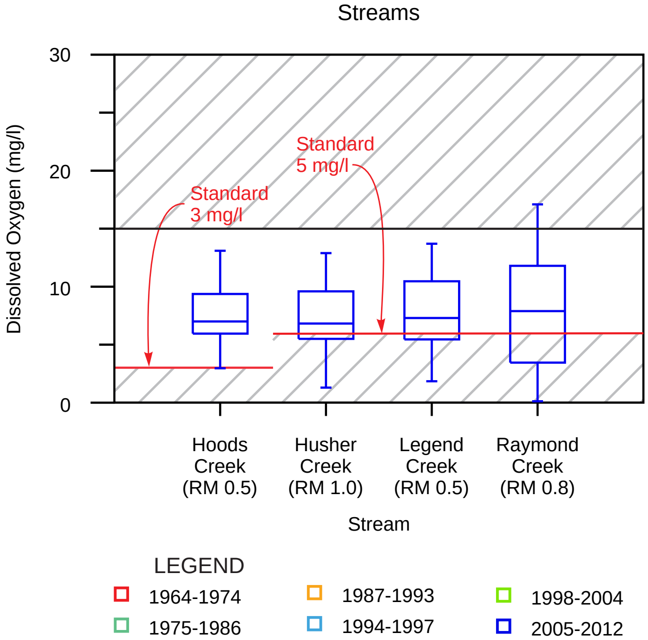
See Table 27 for location of sample sites.

Saturation levels of dissolved oxygen of 140 percent and higher can cause fish kills. A 15 mg/l dissolved oxygen concentration translates to a saturation of approximately 150 percent at an average water temperature of 14 degrees Celsius.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, City of Racine Health Department, and SEWRPC.

Figure 25

DISSOLVED OXYGEN CONCENTRATIONS IN TRIBUTARY STREAMS IN THE ROOT RIVER WATERSHED: 2005-2012



NOTES: See Figure 11 for description of symbols.

Saturation levels of dissolved oxygen of 140 percent and higher can cause fish kills. A 15 mg/l dissolved oxygen concentration translates to a saturation of approximately 150 percent at an average water temperature of 14 degrees Celsius.

Source: Wisconsin Department of Natural Resources and City of Racine Health Department.

concentrations were observed. Given that only a small number of samples were collected from this stream prior to 2011, the data are not sufficient to assess whether the apparent differences in dissolved oxygen concentrations between the periods 1994-1997 and 2005-2012 represent real differences in conditions.

The geographical distribution of occurrences of supersaturation of dissolved oxygen described in the previous paragraphs suggest that the downstream reaches of the West Branch of the Root River Canal and upstream reaches of the Root River Canal may constitute a “hotspot” for high densities of aquatic plants and algae. This hotspot extends at least as far downstream as the Six Mile Road crossing of the Root River Canal. The data do not reveal how far up the West Branch of the Root River Canal this hotspot extends. In addition, the distribution of sampling stations is too coarse to determine whether this hotspot represents a continuous stretch of stream or two or more isolated hotspots. It is certainly likely that this is being driven by high concentrations of phosphorus. The phosphorus data that are available for these two streams are consistent with this hypothesis, although there are not enough phosphorus samples to be considered definitive. Reconnaissance of these stream sections during late summer and early fall for the presence of high densities of attached photosynthetic organisms could confirm this. If it is the case, additional efforts to reduce nutrient inputs to the West Branch of the Root River Canal (especially in the Lower West Branch Root River Canal Assessment area) and upstream reaches of the Root River Canal could lead to an improvement in dissolved oxygen conditions in these streams.

Figure 25 shows dissolved oxygen concentrations for four tributary streams in the Root River watershed from the period 2005-2012. Concentrations in Hoods Creek ranged between 3.0 mg/l and 13.1 mg/l, with a median value of 7.0 mg/l. Concentrations in Husher Creek ranged between 1.3 mg/l and 12.9 mg/l, with a median value of 6.8 mg/l. Dissolved oxygen concentrations in about 20 percent of the samples collected from this stream were below the applicable water quality criterion of 5.0 mg/l. Concentrations in Legend Creek ranged between 1.8 mg/l and 13.7 mg/l, with a median value of 7.3 mg/l. Concentrations in about 18 percent of the samples collected from this stream were below the applicable water quality criterion of 5.0 mg/l. Concentrations in Raymond Creek ranged between 0.1 mg/l and 17.1 mg/l, with a median value of 7.9 mg/l. Concentrations in about 30 percent of the samples collected from this stream were below the applicable water quality criterion of 5.0 mg/l. A few samples show concentrations high enough to suggest that supersaturation of dissolved oxygen is occurring in this stream.

pH

The acidity of water is measured using the pH scale. This is defined as the negative logarithm of the hydrogen ion (H^+) concentration, which is referred to as the standard pH unit or standard units (stu). It is important to note that each unit of the scale represents a change of a factor of 10. Thus the hydrogen ion concentration associated with a pH of 6.0 stu is 10 times the hydrogen ion concentrations associated with a pH of 7.0 stu. A pH of 7.0 stu represents neutral water. Water with pH values lower than 7.0 stu has higher hydrogen ion concentrations and is more acidic, while water with pH values higher than 7.0 stu has lower hydrogen ion concentrations and is less acidic.

Many chemical and biological processes are affected by pH. The solubility and availability of many substances are influenced by pH. For example, many metals are more soluble in water with low pH than they are in water with high pH. In addition, the toxicity of many substances to fish and other aquatic organisms can be affected by pH. Different organisms are capable of tolerating different ranges of pH, with most preferring ranges between about 6.5 and 8.0 stu.

Several factors influence the pH of surface waters. Because of diffusion of carbon dioxide into water and associated chemical reactions, rainfall in areas that are not impacted by air pollution has a pH of about 5.6 stu. The pH of rainfall in areas where air quality is affected by oxides of nitrogen or sulfur tends to be lower. The mineral content of the soil and bedrock underlying a waterbody has a strong influence on the waterbody's pH. Because much of the Root River watershed is underlain by carbonate bedrock such as dolomite, pH in the waterbodies of the watershed tends to be between about 7.0 and 9.0 stu. Pollutants contained in discharges from point sources and in stormwater runoff can affect a waterbody's pH. Photosynthesis by aquatic plants, phytoplankton, and algae can cause pH variations both on a daily and seasonal basis.

Figure 26 shows the value of pH at selected sampling stations along the mainstem of the Root River. The median value of pH in the mainstem of the Root River over the period 2005-2012 was 7.95 stu. Values of pH at these stations were only rarely outside the range of 6.0 stu to 9.0 stu specified in Wisconsin's water quality criteria (see Table 28). In addition, at most sampling stations pH varied by less than $\pm$ 1.0 stu from the station's mean value. There were three exceptions to this. These occurred at the sampling stations at Johnson Park (RM 11.5), below Horlick dam (RM 5.9), and at Cedar Bend Park (RM 2.3). At each of these stations, a few samples had pH values that were lower than the station's mean by more than 1.0 stu. The lowest value observed at these stations during the period 2005-2012 was 6.0 stu. Figure 26 shows one trend in the data. First, pH in the River tends to increase from upstream to downstream. Median pH at the six sampling stations in Milwaukee County (RM 41.5 through RM 23.8) ranged from 7.39 stu to 7.80 stu. Median pH at stations downstream from this section ranged from 7.88 stu to 8.04 stu. At some sampling stations located in reaches upstream from Horlick dam, pH appears to have increased over time. Between the periods 1998-2004 and 2005-2012, the average increase in pH at these stations was about 0.15 stu. The opposite trend was seen at the stations downstream from Horlick dam for which historical data are available. Between the periods 1998-2004 and 2005-2012, pH at these stations decreased by an average of about 0.20 stu. The causes of these trends are not clear.

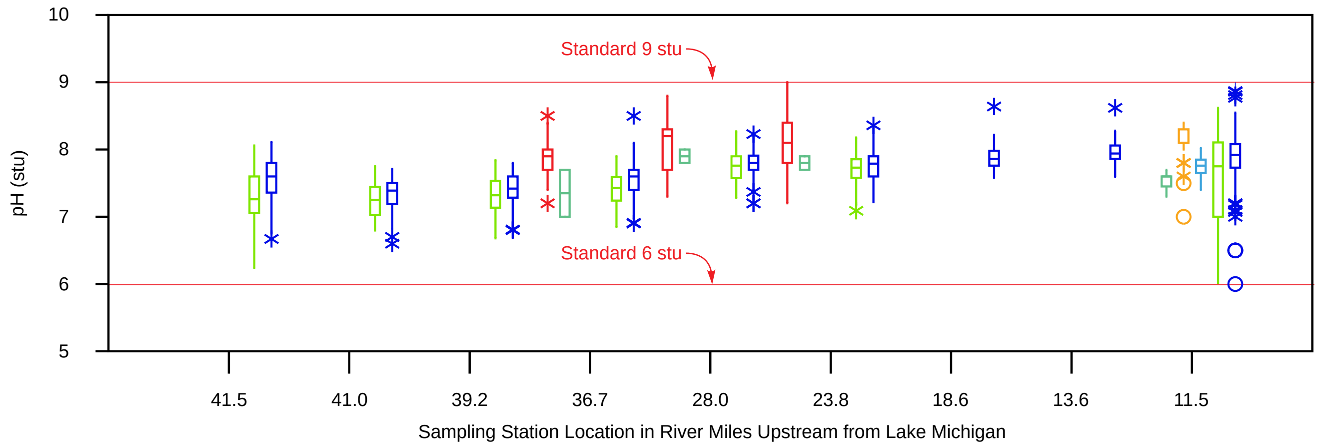
Figure 27 shows pH values in the Root River Canal and its East and West Branches. The median values of pH in the Canal and its Branches during the period 2005-2012 were 7.98 stu, 7.90 stu, and 7.81 stu, respectively. While values of pH in these streams were normally within the range of 6.0 stu to 9.0 stu specified in Wisconsin's water quality criteria (see Table 28), values in some samples collected at the station at Six Mile Road (RM 3.7) along the Root River Canal and Four Mile Road (RM 0.3) along the West Branch of the Root River Canal occasionally were greater than 9.0 stu. These exceptionally high values all occurred during early August 2011 and were associated with a high degree of supersaturation of dissolved oxygen. As previously discussed, these high levels may be indicative of high densities of aquatic plants and attached algae at or upstream from these sites. These unusually high pH levels were not detected at other stations on these two streams or at stations on the East Branch of the Root River Canal.

It should be noted that the distribution of pH values detected at the 67th Drive sampling station (RM 9.3) along the West Branch of the Root River Canal shows less variability than those from other stations with comparable numbers of samples (see Figure27). This station is immediately downstream from the outfall of the Village of Union Grove's wastewater treatment plant and water chemistry at this point in the Canal is influenced by the characteristics of the plant's effluent. The narrow range of pH values detected at this site may reflect treatment processes that maintain the value of effluent pH within a narrow range.

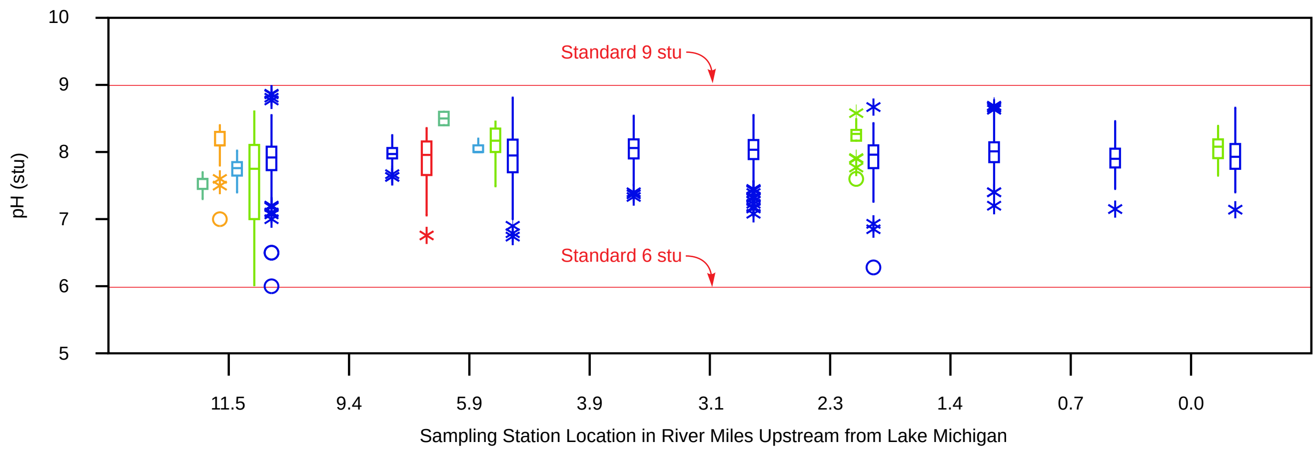
Figure 26

pH AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012

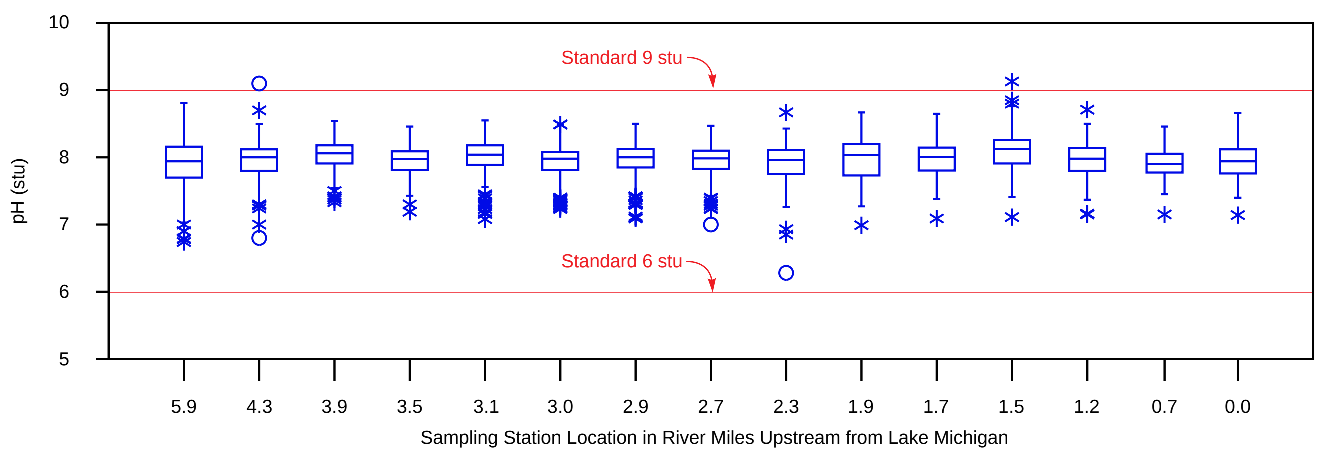
Root River above Johnson Park



Root River below Johnson Park



Root River below Horlick Dam (2005-2012 data only)



LEGEND

- 1964-1974
- 1975-1986
- 1987-1993
- 1994-1997
- 1998-2004
- 2005-2012

LANDMARKS

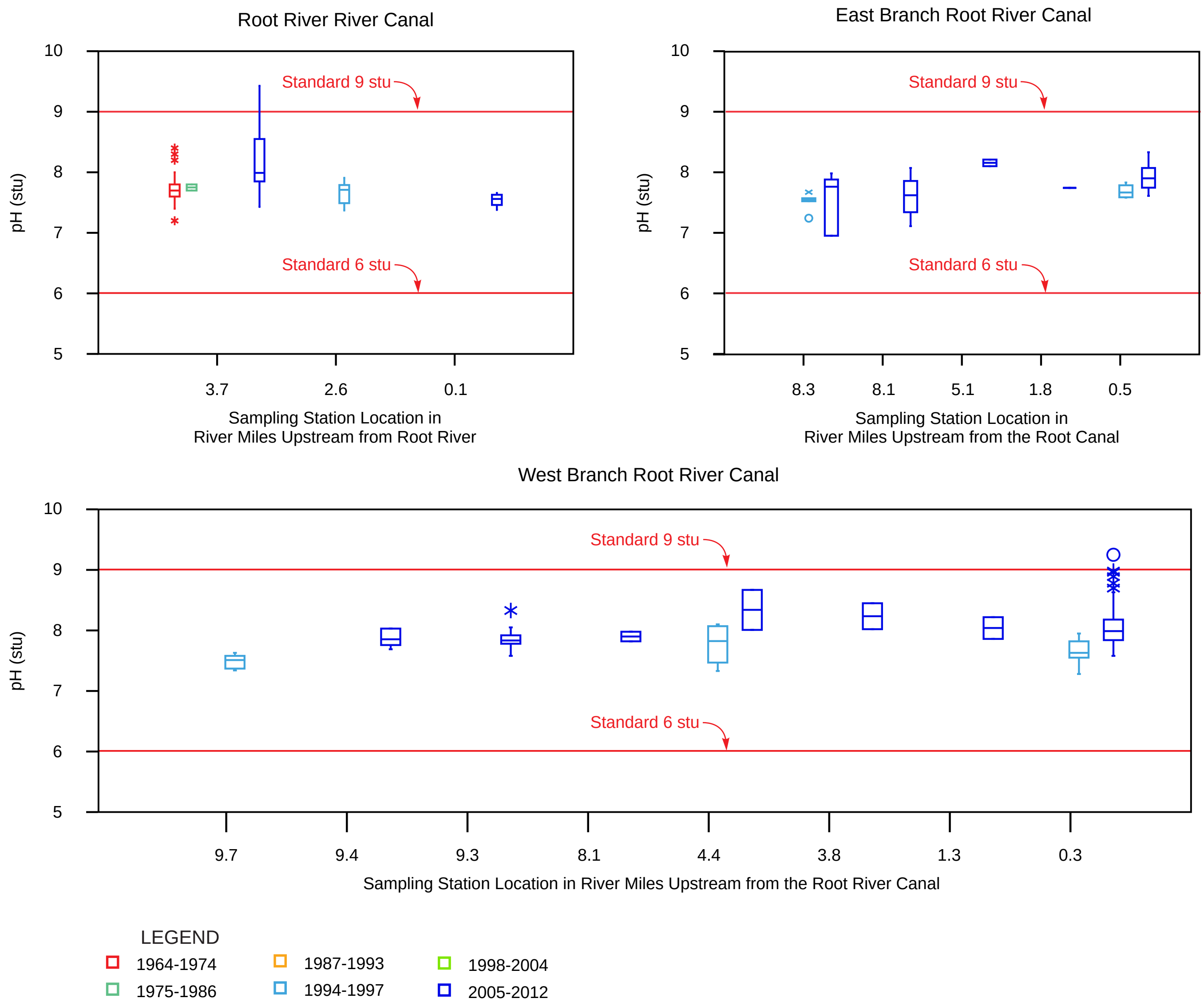
41.5 = W. Cleveland Avenue
36.7 = W. Grange Avenue
23.8 = Upstream Crossing of W. County Line Road
11.5 = Johnson Park
5.9 = Horlick Dam
0.0 = Confluence with Lake Michigan

NOTES: See Figure 11 for description of symbols. See Table 27 for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, University of Wisconsin-Extension, Milwaukee Metropolitan Sewerage District, City of Racine Health Department, and SEWRPC.

Figure 27

pH AT SITES ALONG THE ROOT RIVER CANAL AND ITS BRANCHES: 1964-2012



NOTES: See Figure 11 for description of symbols.

See Table 27 for location of sample sites.

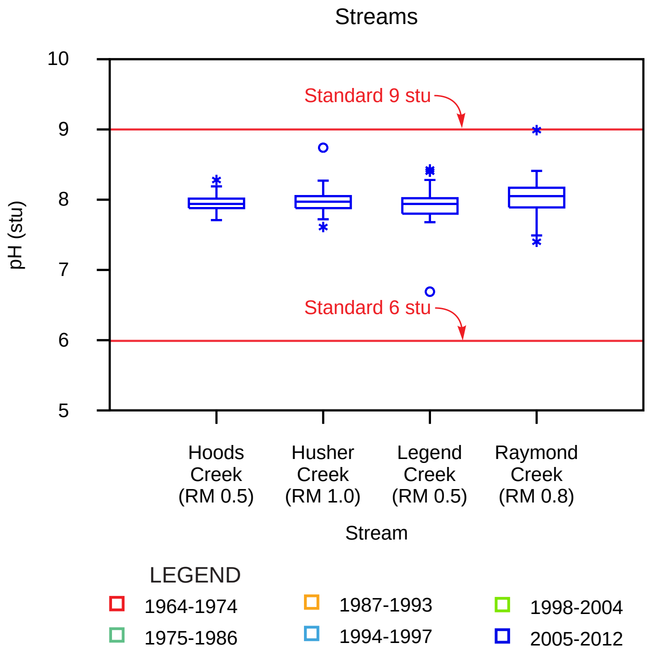
Saturation levels of dissolved oxygen of 140 percent and higher can cause fish kills. A 15 mg/l dissolved oxygen concentration translates to a saturation of approximately 150 percent at an average water temperature of 14 degrees Celsius.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, City of Racine Health Department, and SEWRPC.

Figure 28 shows pH values for four tributary streams in the Root River watershed from the period 2005-2012. All values of pH in samples collected from these streams were within the range of 6.0 stu to 9.0 stu specified in Wisconsin's water quality criteria (see Table 28). Median pH values in these streams were 7.9 stu in both Hoods and Legend Creeks, 7.96 in Husher Creek, and 8.04 in Raymond Creek.

Figure 28

pH IN TRIBUTARY STREAMS IN THE ROOT RIVER WATERSHED: 2005-2012



NOTE: See Figure 11 for description of symbols.

Source: Wisconsin Department of Natural Resources and City of Racine Health Department.

Chloride

Chlorides of commonly occurring elements are highly soluble in water and are present in some concentration in all surface waters. Chloride is not decomposed, chemically altered, or removed from the water as a result of natural processes. Natural chloride concentrations in surface water reflect the composition of the underlying bedrock and soils, and deposition from precipitation events. Waterbodies in southeastern Wisconsin typically have very low natural chloride concentrations due to the dolomite bedrock found in the Region. These rocks are rich in carbonates and contain little chloride. Because of this, the sources of chloride to surface waters in Root River watershed are largely anthropogenic, including sources such as salts used on streets, highways, and parking lots for winter snow and ice control; salts discharged from water softeners; and salts from sewage and animal wastes. Because of the high solubility of chloride in water, if chloride is present, stormwater discharges are likely to transport it to receiving waters. High concentrations of chloride can affect aquatic plant growth and pose a threat to aquatic organisms. Impacts from chloride contamination begin to manifest at a concentration of about 250 milligrams per liter and become severe at concentrations in excess of 1,000 milligrams per liter.[70]

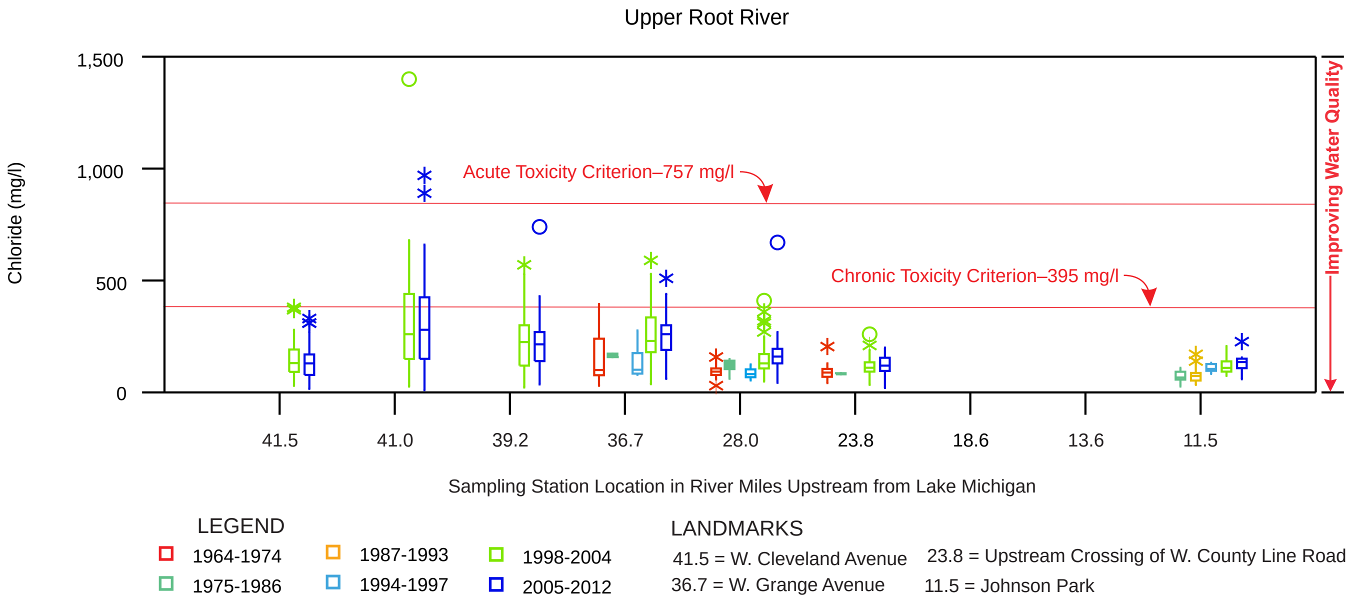
Figure 29 shows chloride concentrations at sampling stations along the River. During the period 2005-2012, chloride concentrations at sampling stations along the mainstem of the Root River ranged between 10 mg/l and 1,610 mg/l, with a mean concentration of 202 mg/l and a median concentration of 170 mg/l. During the period 2005-2012, chloride data were collected at only seven sampling stations along the mainstem of the River. Chloride concentrations increase dramatically between the two sampling stations that are farthest upstream (RM 41.5 and RM 41.0). High concentrations were also detected at the next two stations (RM 39.2 and RM 36.7). Downstream from these stations, lower concentrations were observed. At four stations, concentrations occasionally exceeded the State’s chronic toxicity criterion for fish and aquatic life of 395 mg/l. In addition, chloride concentrations at the sampling station at the intersection of W. National Avenue and W. Oklahoma Avenue (RM 41.0) exceeded the State’s acute toxicity criterion for fish and aquatic life of 757 mg/l on two occasions.

The four stations with the highest average chloride concentrations are located in the Upper Root River-Headwaters and Upper Root River assessment areas, both of which have exceptionally high percentages of urban land uses (see Table 14). The higher chloride concentrations may reflect total amount of deicing salts used on the higher density of roads associated with this predominantly urban landscape.

[70]*Frits van der Leeden, Fred L. Troise, and David Keith Todd,* The Water Encyclopedia, Second Edition, *Lewis Publishers, Inc., 1990.*

Figure 29

CHLORIDE CONCENTRATIONS AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



NOTES: See Figure 11 for description of symbols.

See Table 27 for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, Milwaukee Metropolitan Sewerage District, and SEWRPC.

Figure 29 also shows the presence of a long-term trend in chloride concentrations in the River. At those sampling stations at which data collected prior to 1998 are available, chloride concentrations have been increasing. This trend has been observed in many waterbodies in Southeastern Wisconsin.[71] In the mainstem of the Root River, this trend does not include an increase between the periods 1998-2004 and 2005-2012. At each sampling station for which chloride data were available, analysis of variance (ANOVA) found no significant differences between the mean concentrations of chloride for these two periods.[72] This suggests that the increase in chloride concentrations in the sections of the Root River upstream from Johnson Park (RM 11.5) may have slowed or stopped. An alternative explanation for this result is that the variability in chloride concentrations is high enough to mask any recent trends in chloride concentrations at these sampling stations. If chloride concentrations are not increasing, it would suggest that efforts by local governments to reduce the amount of salt applied in deicing operations are having the intended effect on chloride concentrations in the River.

It should be noted that chloride concentrations in the Root River during 2012 were higher than in previous years. Figure 30 shows this for the sampling station at the intersection of W. National Avenue and W. Oklahoma Avenue (RM 41.0). This is probably a result of the drought conditions that affected the watershed during late spring and summer of 2012. The watershed experiences abnormally dry conditions beginning in late May. These

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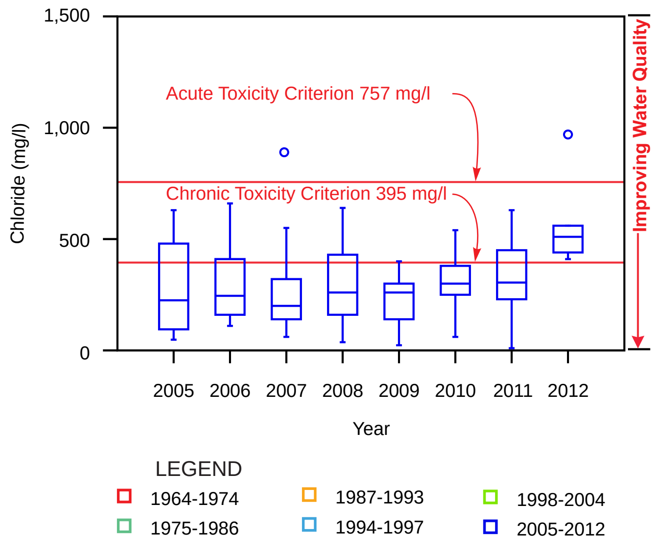
[71]*SEWRPC Technical Report No. 39*, op. cit.

[72]*In order to meet the assumptions of analysis of variance, the chloride concentrations were log-transformed.*

Figure 30

CHLORIDE CONCENTRATIONS AT THE SAMPLING STATION AT THE INTERSECTION OF W. NATIONAL AVENUE AND W. OKLAHOMA AVENUE (RM 41.0): 2005-2012



NOTE: See Figure 11 for description of symbols.

Source: Milwaukee Metropolitan Sewerage District.

conditions progressed to moderate drought by late June and extreme drought by mid-July. Extreme drought conditions persisted through early August.[73] Because of the low levels of precipitation during much of 2012, baseflow from groundwater most likely made up a larger fraction of the flow in the upper portions of the mainstem of the Root River than it would during years with normal or wet conditions. As previous discussed, chloride is highly soluble in water. When it is present in groundwater, it moves at the rate at which groundwater moves. These rates are considerably lower than the rates at which surface water flows. For example, the rates of horizontal hydraulic conductivity in the sand and gravel aquifer estimated for the areas in and around Root River watershed as part of the aquifer simulation modeling that was conducted as part of the regional water supply plan were on the order of 0.2 to 1.0 feet per day.[74] A consequence of this is that there may be a considerable time lag between chloride entering groundwater through infiltration and the same bit of chloride being discharged as baseflow into a surface waterbody. This also suggests that, with continued releases of chloride into the environment, a reservoir of chloride may accumulate in groundwater. Over time this will lead to an increase in the chloride concentration in groundwater and in water discharged from groundwater to surface waterbodies as baseflow. This is the likely explanation as to why chloride concentrations were high in the Root River during 2012—because of drought conditions the concentrations in the River were more reflective of groundwater concentrations than they would be during a normal year. Another consequence is that in the absence of additional inputs of chloride, it could take considerable time for this reservoir of chloride to move through the aquifer and into the surface water system.

These conclusions are tentative and should be interpreted with caution. Deicing operations are conducted mostly during winter months. Very few data are available for chloride in this watershed from winter months, especially from the period 2005-2012. This is due to the fact that most of the chloride data were collected by MMSD and the District does not conduct sampling during winter months. Because few data are available from the months during which deicing operations are conducted, the data presented here probably underestimate the maximum and average concentrations that actually occur in the River. In addition, the lack of winter data means that the assessment of trends cannot take winter concentrations into account.

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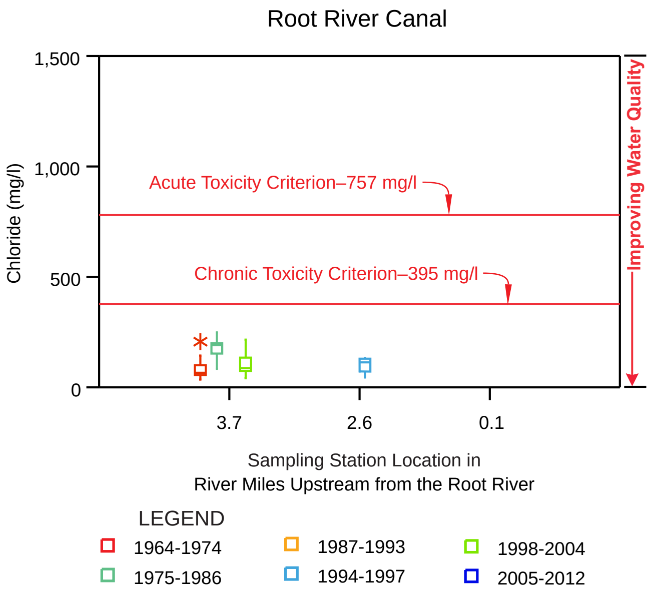
[73]*Maps showing the time course of the drought can be accessed at the National Drought Monitor at* http://www.drought.gov. *This monitor is a collaboration of the National Drought Mitigation Center at the University of Nebraska-Lincoln, the U.S. Department of Agriculture, and the National Oceanic and Atmospheric Administration.*

[74]*SEWRPC Technical Report No. 41,* A Regional Aquifer Simulation Model for Southeastern Wisconsin, *June 2005.*

Figure 31

CHLORIDE CONCENTRATIONS AT SITES ALONG THE ROOT RIVER CANAL: 1964-2012



NOTES: See Figure 11 for description of symbols.

See Table 27 for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, and SEWRPC.

Figure 31 shows chloride concentrations in samples collected along the Root River Canal. The latest chloride data were collected from this stream during 2004. During the period 1998-2004, chloride concentrations at the sampling station at Six Mile Road (RM 3.7) ranged from minimum of about 41 mg/l to a maximum of 216 mg/l with a mean concentration of 106 mg/l and a median concentration of 87 mg/l. The data from this stream are not adequate to assess spatial or temporal trends. Few historical and no recent chloride data are available for other tributary streams in the watershed, including the East and West Branches of the Root River Canal.

Specific Conductance

Specific conductance measures the ability of water to conduct an electric current. Because this ability is affected by water temperature, conductance values are corrected to a standard temperature of 25ºC (77 degrees Fahrenheit). This corrected value is referred to as specific conductance. Pure water is a poor conductor of electrical currents and exhibits low values of specific conductance.[75] The ability of water to carry a current depends upon the presence of ions in the water, and on their chemical identities, total concentration, mobility, and electrical charge. Solutions of many inorganic compounds, such as salts, are relatively good conductors. As a result, specific conductance gives a measure of the concentration of dissolved solids in water, with higher values of specific conductance indicating higher concentrations of dissolved solids.

Under certain circumstances, measurements of specific conductance may act as a useful surrogate for measurements of the concentrations of particular dissolved materials. For example, measurements of specific conductance may be able to give indications of chloride concentrations in receiving waters. Analysis of data collected by the USGS suggests that there is a linear relationship between specific conductance and chloride concentration at higher values of conductance and chloride concentration.[76] This suggests that during periods when chloride is being carried into receiving waters by discharges of stormwater or snowmelt, ambient chloride concentrations could be estimated using specific conductance. The advantage to this is that specific conductance

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[75]*For example, distilled water produced in a laboratory has a specific conductance in the range of 0.5 to 3.0 microSiemens per centimeter, a very low value.*

[76]*Steven R. Corsi, David J. Graczyk, Steven W. Geis, Nathaniel L. Booth, and Kevin D Richards, "A Fresh Look at Road Salt: Aquatic Toxicity and Water-Quality Impacts on Local, Regional, and National Scales,"* Environmental Science & Technology, *Volume 44, 2010.*

can be measured inexpensively in the field using a hand-held meter. Measurements of chloride concentrations require chemical analysis.[77]

Figure 32 shows specific conductance at sampling stations along the mainstem of the Root River. During the period 2005-2012, specific conductance at sampling stations along the mainstem ranged between 88 microSiemens per centimeter (μS/cm) and 12,000 μS/cm, with a mean value of 1,007 μS/cm. High values occurred at the four sampling stations that are farthest upstream, with the highest values being observed at the station located at the intersection of W. National Avenue and W. Oklahoma Avenue (RM 41.0). Specific conductance at these four stations also shows a high degree of variability, much higher than the variability that was observed at stations downstream. As previously noted, these four stations are located in the Upper Root River-Headwaters and Upper Root River assessment areas, both of which have exceptionally high percentages of urban land uses. The high concentrations may reflect dissolved material carried in by runoff from this highly urbanized landscape. The high variability at these stations may be a reflection of the discontinuous nature of inputs of dissolved material into the River. Runoff associated with storm events can have a major influence on the concentration of dissolved material in a stream. The first runoff from a storm transports a large pulse of salts and other dissolved materials from the watershed into the stream. This will tend to raise specific conductance. Later runoff associated with the event will be relatively dilute. This will tend to lower specific conductance.

Values of specific conductance tended to be lower and less variable at the sampling stations downstream from the Upper Root River-Headwaters and Upper Root River assessment areas. Between the sampling stations at County Line Road (RM 23.8) and the Island Park Bridge to Liberty Street (RM 3.1), values of specific conductance during the period 2005-2012 were quite consistent, with median values ranging between approximately 950 μS/cm and 1,020 μS/cm. The variability in specific conductance at these stations was considerably lower than what was seen at the upstream stations. Two factors may contribute to the lower variability at these stations. First, these stations are mostly located in less urbanized areas. Second, with the exception of the stations at County Line Road (RM 23.8) and Johnson Park (RM 11.5), sampling for specific conductance at downstream stations was conducted only in 2011 and 2012. The values observed during this short period of record may not fully represent the range of variation in these sections of the River.

Near the mouth of the River (RM 0.0), specific conductance was lower than at the other stations, with a median value of 657 μS/cm. Variability was also higher than what was observed at the stations immediately upstream. It is likely that both of these differences from upstream stations reflect the influence of Lake Michigan at this sample stations. This sampling station is located at a site where water from the River is mixing with water from the Lake. While current data are not available, historical data show that values of specific conductance in the Lake are considerably lower than those in the Root River. Data from MMSD's nearshore surveys through 2004 showed a mean value of about 341 μS/cm.[78] While the median values varied among stations, they were generally on the order of 300 μS/cm.

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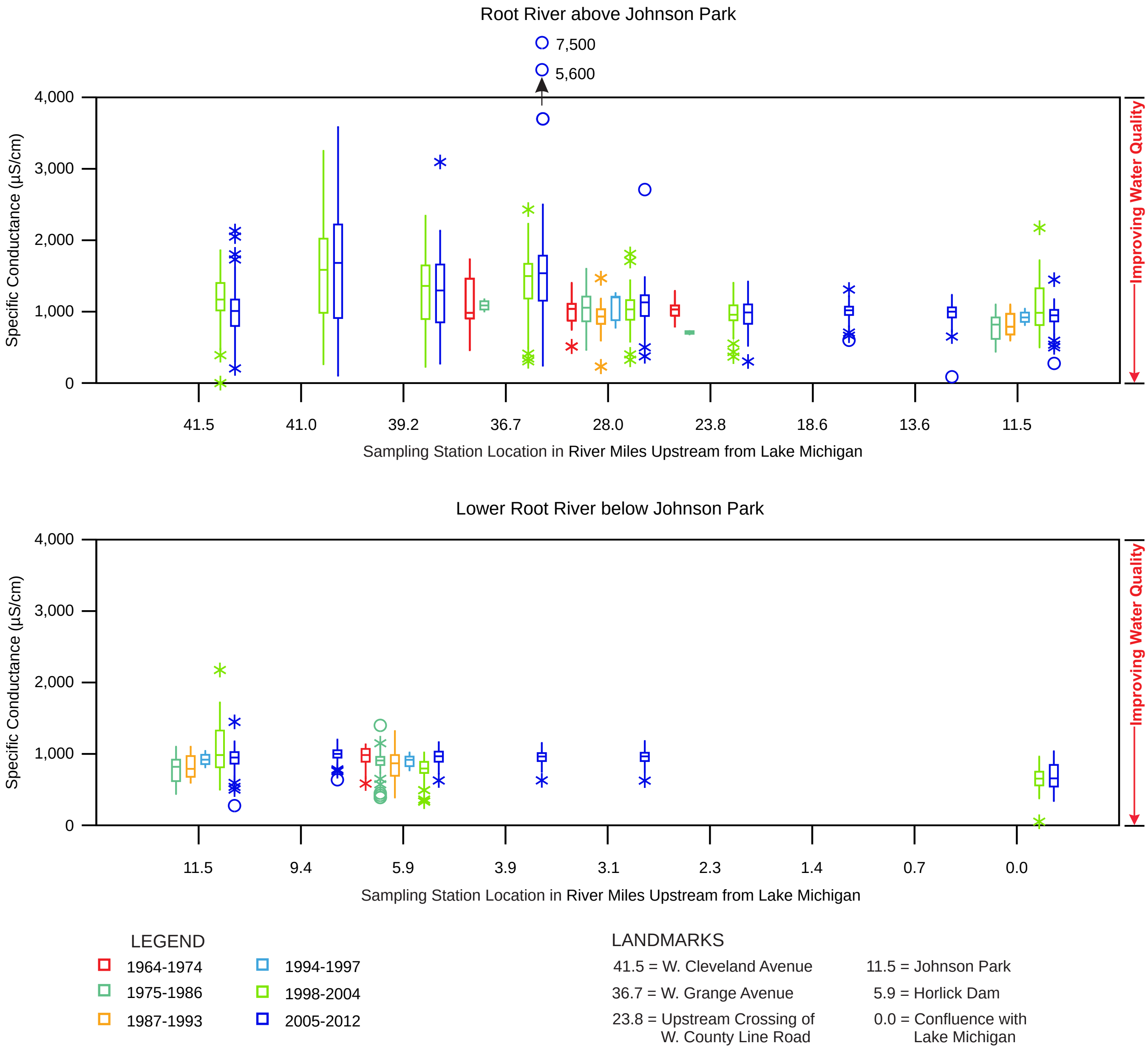
[77]*Continued collection of both conductance and chloride data could be helpful in refining this relationship. Such a refinement could potentially allow for the substitution of conductance monitoring for some chloride monitoring with a potential cost savings. It should be noted that predicted chloride concentrations from the USGS regression equation were compared to actual chloride conditions for samples from the Root River that had simultaneously collected data for specific conductance and chloride. It was found that the USGS regression equation usually predicted higher concentrations based upon specific conductance than were observed in the Root River. The average difference between predicted and observed concentrations was about 24 percent of observed concentrations. The maximum difference was about 277 percent of the observed concentration.*

[78]*SEWRPC Technical Report No. 39*, op. cit.

Figure 32

SPECIFIC CONDUCTANCE AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



NOTES: See Figure 11 for description of symbols.

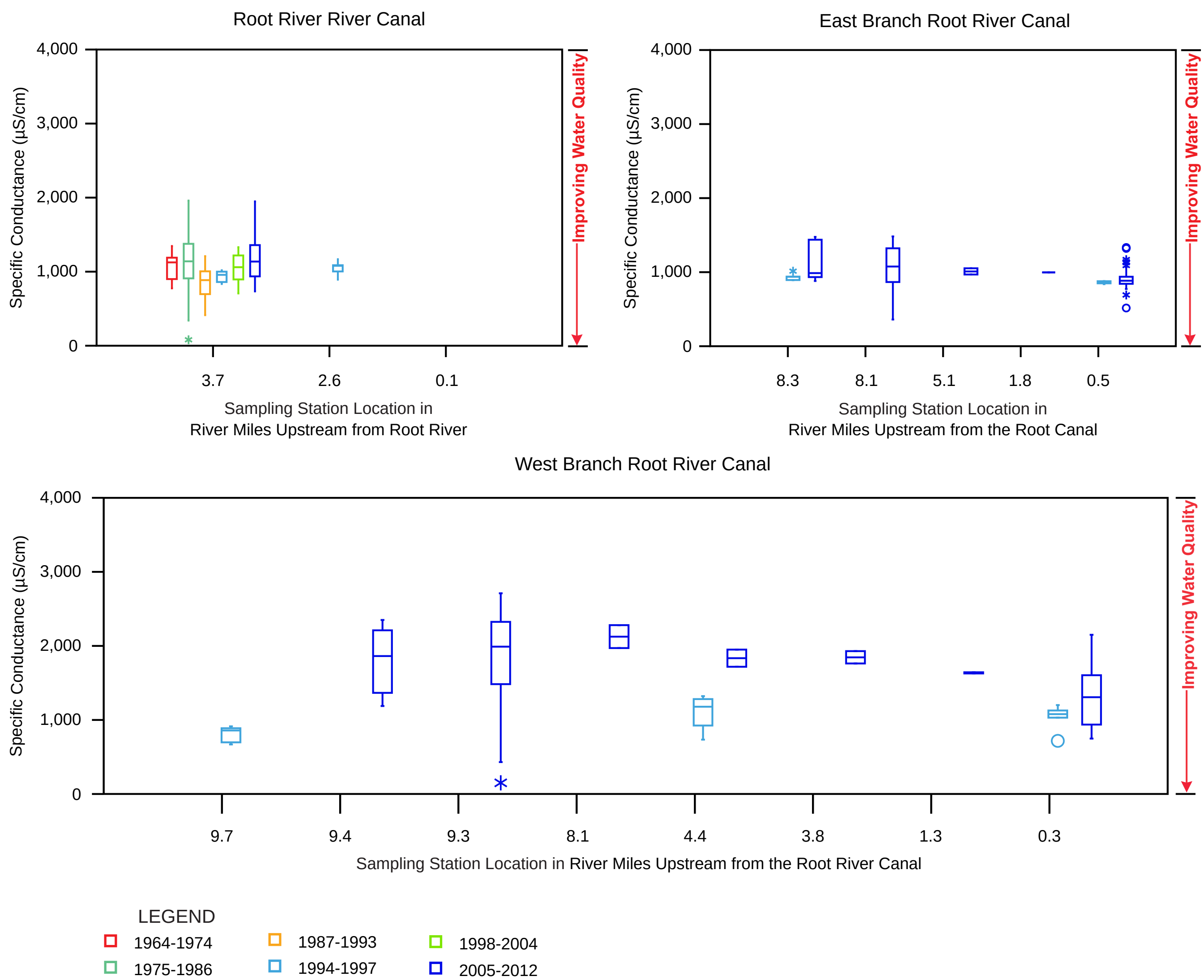
See Table 27 for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, University of Wisconsin-Extension, Milwaukee Metropolitan Sewerage District, City of Racine Health Department, and SEWRPC.

Figure 33 shows specific conductance at sampling stations along the Root River Canal and its East and West Branches. During the period 2005-2012, specific conductance in the Root River Canal ranged between 733 μS/cm and 1,950 μS/cm, with a median value of 1,137 μS/cm. Between the periods 1975-1986 and 1987-1993, values of specific conductance in samples collected from the Canal appear to have decreased. Since 1993, they have

Figure 33

SPECIFIC CONDUCTANCE AT SITES ALONG THE ROOT RIVER CANAL AND ITS BRANCHES: 1964-2012



NOTES: See Figure 11 for description of symbols.

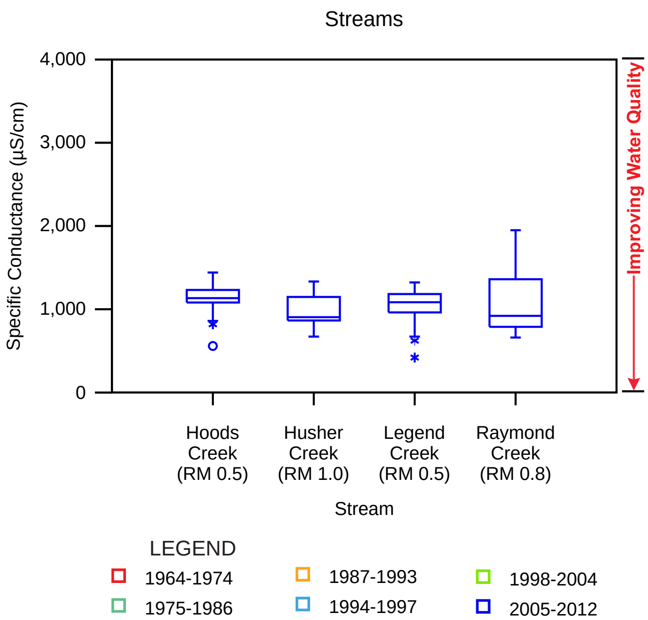
See Table 27 for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, City of Racine Health Department, and SEWRPC.

increased. During the period 2005-2012, they were at about the levels observed during the period 1987-1993. The cause of the decrease and subsequent increase is not known. During the period 2005-2012, specific conductance in the East Branch of the Root River Canal ranged between 360 μS/cm and 1,483 μS/cm, with a median value of 914 μS/cm. The values observed in upstream reaches were higher than those observed in downstream reaches, with median values of 1,076 μS/cm and 885 μS/cm at the stations at STH 11 (RM 8.1) and Four Mile Road (RM 0.5), respectively. During the period 2005-2012, specific conductance in the West Branch of the Root River Canal ranged between 151 μS/cm and 2,710 μS/cm, with a median value of 1,597 μS/cm. The values observed in

Figure 34

SPECIFIC CONDUCTANCE IN TRIBUTARY STREAMS IN THE ROOT RIVER WATERSHED: 2005-2012



NOTE: See Figure 11 for description of symbols.

Source: Wisconsin Department of Natural Resources and City of Racine Health Department.

upstream reaches were higher than those observed in downstream reaches, with median values of 1,990 µS/cm and 1,306 µS/cm at the stations at 67th Drive (RM 9.3) and Four Mile Road (RM 0.3), respectively. The specific conductance data from the East and West Branches of the Canal are not sufficient to assess time-based trends.

Figure 34 shows specific conductance values for four tributary streams in the Root River watershed from the period 2005-2012. Values in Hoods Creek ranged between 559 µS/cm and 1,441 µS/cm, with a median value of 1,135 µS/cm. Values in Husher Creek ranged between 672 µS/cm and 1,333 µS/cm, with a median value of 899 µS/cm. Values in Legend Creek ranged between 420 µS/cm and 1,323 µS/cm, with a median value of 1,084 µS/cm. Values in Raymond Creek ranged between 661 µS/cm and 1,949 µS/cm, with a median value of 936 µS/cm.

Nutrients

Nutrients are elements and compounds needed for plant and algal growth. They are often found in a variety of chemical forms, both inorganic and organic, which may vary in their availability to plants and algae. Typically, plant and algal growth and biomass in a waterbody are limited by the availability of the nutrient present in the lowest amount relative to the organisms' needs. This nutrient is referred to as the limiting nutrient. Additions of the limiting nutrient to the waterbody typically result in additional plant or algal growth. Phosphorus is usually, though not always, the limiting nutrient in freshwater systems. Under some circumstances nitrogen can act as the limiting nutrient.

Sources of nutrients to waterbodies include both sources within the waterbody and sources in the contributing watershed. Within a waterbody, mineralization of nutrients from sediment, resuspension of sediment in the bed, erosion of bed and banks, and decomposition of organic material can contribute nutrients. Nutrients can also be contributed by point and nonpoint sources within the watershed. Examples of point sources of pollution include sewage treatment plants and industrial discharges. Concentrations of some chemical forms of nutrients in discharges from points sources are subject to effluent limitations through the WPDES permit program that limit the concentrations and amounts that can be discharged. A variety of nonpoint sources can also contribute nutrients to waterbodies. Many BMPs for control of urban and rural nonpoint source pollution are designed to reduce discharges of nutrients.

Phosphorus

As noted above, phosphorus is usually, though not always, the limiting nutrient in freshwater systems. Two forms are commonly sampled in surface waters: total phosphorus and dissolved phosphorus. Total phosphorus consists of all of the phosphorus contained in material dissolved or suspended in water. Dissolved phosphorus consists of the phosphorus contained in material dissolved in water. In both these types, the phosphorus may be present in a variety of chemical forms. Because the degree of eutrophication in freshwater systems generally correlates more strongly with total phosphorus concentration than with dissolved phosphorus concentration, the State's water quality criteria are expressed in terms of total phosphorus and water quality sampling tends to focus more strongly on assessing total phosphorus concentrations than dissolved phosphorus concentrations.[79] In areas where water utilities add phosphates to municipal water for corrosion control, discharges by industrial facilities that use municipal water as noncontact cooling water may contribute phosphorus to receiving waterbodies. In rural settings, phosphorus from agricultural fertilizers or animal manure may be contributed through discharges from drain tiles or direct runoff into waterbodies. Phosphorus may also be contributed by poorly maintained or failing onsite wastewater treatment systems.

Phosphorus can be contributed to waterbodies from a variety of point and nonpoint sources. In urban settings, phosphorus from lawn fertilizers and other sources may be discharged through storm sewer systems and direct runoff into streams. It should also be noted that the State of Wisconsin has adopted a turf management standard limiting the application of lawn fertilizers containing phosphorus within the State.[80] This would be expected to reduce the amount of phosphorus discharged from urban settings. In 2010, the State also placed restrictions on the sale of some phosphorus-containing cleaning agents.[81]

Figure 35 shows total phosphorus concentrations at sampling stations along the mainstem of the Root River. During the period 2005-2012, concentrations of total phosphorus in the mainstem of the Root River ranged from below the limit of detection to 0.710 mg/l, with a mean concentration of 0.120 mg/l and a median concentration of 0.100 mg/l. Several things are evident in this figure. First, concentrations of total phosphorus vary along the length of the River. Median concentrations observed at individual stations range between 0.066 mg/l at station at STH 31 (RM 9.4) and 0.150 mg/l at the stations at Cedar Bend Park (RM 2.3), under the 6th Street Bridge (RM 1.4), and Azarian Marina (RM 0.7). Second, at those sampling stations with longer periods of records, total phosphorus concentrations have decreased over time. At some stations with periods of record that extend back into the 1960s, the decrease is dramatic. It is possible that this decrease has recently slowed or stopped. At each station with sufficient data from both periods, mean total phosphorus concentrations detected during the period 2005-2012 were compared to mean concentrations detected during the period 1998-2004 using ANOVA.[82] No statistically significant differences were detected between the mean concentrations during the two periods; however, this result should be interpreted with caution. Given the variability in total phosphorus concentrations and the relatively small number of samples collected at some stations over the two periods, it is unlikely that the statistical model would detect a slight difference.

Figure 35 also shows that total phosphorus concentrations in a high proportion of samples exceeded the State's applicable water quality criterion of 0.075 mg/l. Over the period 2005-2012, total phosphorus concentrations in about 74 percent of samples collected from the mainstem of the Root River exceeded this criterion. At individual sampling stations along the mainstem of the River, the percentage of samples in which the concentration of total phosphorus was higher than 0.075 mg/l ranged between 50 percent and 91 percent. Clearly, the concentrations of

[79]*It should be noted that MMSD's practice is to sample both total and dissolved phosphorus.*

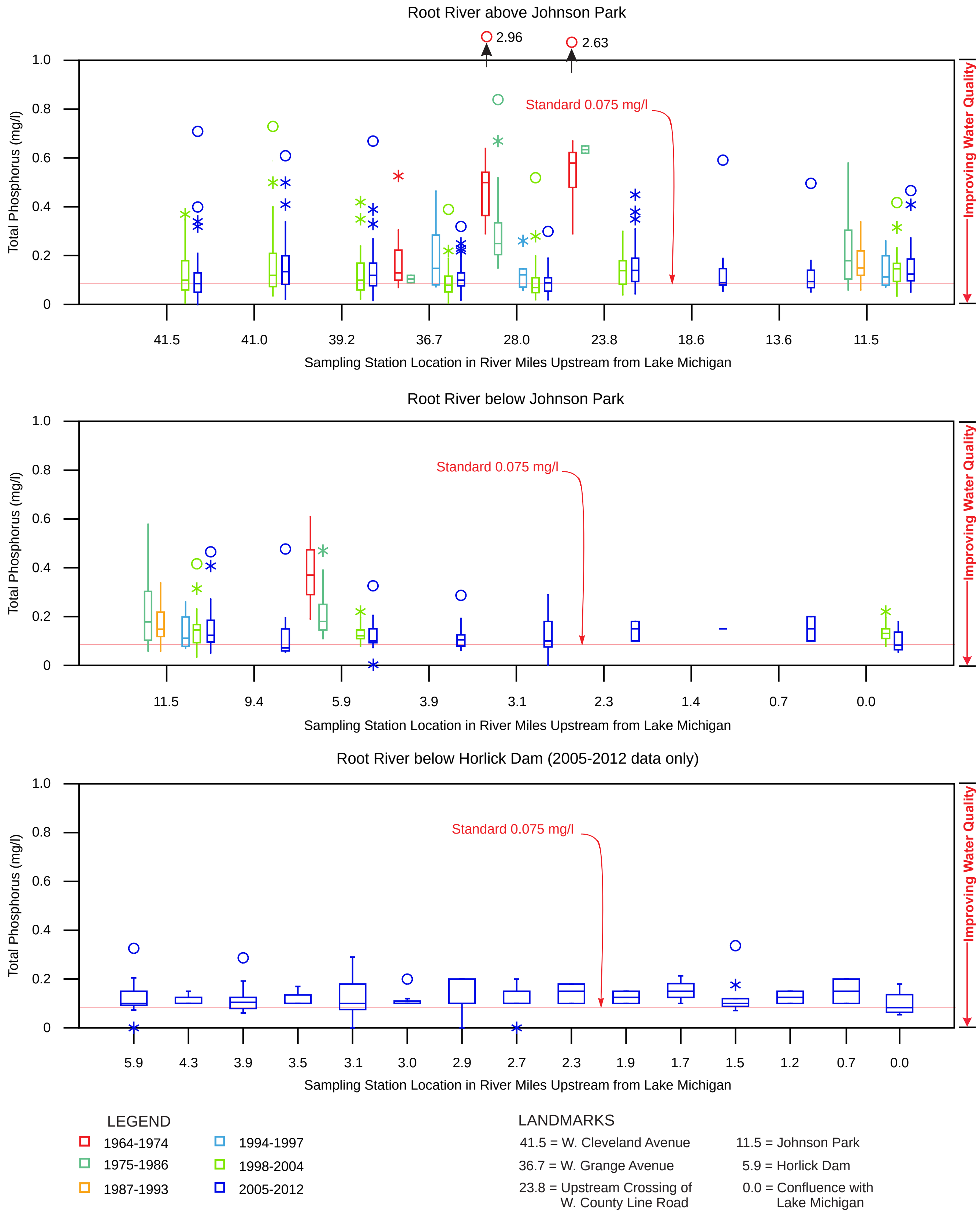
[80]*On April 14, 2009,* 2009 Wisconsin Act 9 *created Section 94.643 of the* Wisconsin Statutes *relating to restrictions on the use and sale of fertilizer containing phosphorus in urban areas throughout the State of Wisconsin.*

[81]*Section 100.28 of the* Wisconsin Statutes *bans the sale of cleaning agents for nonhousehold dishwashing machines and medical and surgical equipment that contain more than 8.7 percent phosphorus by weight. This statute also bans the sale of other cleaning agents containing more than 0.5 percent phosphorus by weight. Cleaning agents for industrial processes and cleansing dairy equipment are specifically exempted from these restrictions.*

[82]*In order to meet the assumptions of ANOVA, total phosphorus concentrations were log-transformed.*

Figure 35

TOTAL PHOSPHORUS CONCENTRATIONS AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



NOTE: See Figure 11 for description of symbols. See Table 27 for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, University of Wisconsin-Extension, Milwaukee Metropolitan Sewerage District, City of Racine Health Department, and SEWRPC.

total phosphorus are high along the entire length of the mainstem of the Root River. Additional discussion of how concentrations of total phosphorus in the Root River watershed compare to water quality criteria is given in the section on achievement of water use objectives later in this chapter.

Based on the pattern of total phosphorus concentrations, the section of the Root River below Horlick dam can be divided into three subsections. At each of the sampling stations between the station below Horlick dam (RM 5.9) and the station at W. 6th Street (RM 2.7), median total phosphorus concentration was 0.100 mg/l (see Figure 35). Higher median concentrations were observed at the stations between Cedar Bend Park (RM 2.3) and Azarian Marina (RM 0.7). At these stations median concentrations ranged between 0.109 mg/l and 0.150 mg/l. Downstream from this section, the median concentration was lower. The median concentration at the confluence with Lake Michigan (RM 0.0) was 0.080 mg/l. The lower concentration near the confluence with the Lake probably reflects mixing of River water with Lake water.

During the period 2005-2012, concentrations of dissolved phosphorus in the mainstem of the Root River ranged from below the limit of detection to 0.420 mg/l, with a mean concentration of 0.059 mg/l and a median concentration of 0.050 mg/l. During this period, data were available from only the six MMSD sampling stations and Johnson Park (RM 11.5). Median concentrations at these stations ranged between 0.045 mg/l and 0.074 mg/l. There was no discernible geographic pattern in the distribution of these median concentrations.

Figure 36 shows total phosphorus concentrations from sampling stations along the Root River Canal and its East and West Branches. Concentrations of total phosphorus in the Root River Canal during the period 2005-2012 ranged between 0.068 mg/l and 0.892 mg/l, with a mean value of 0.222 mg/l and a median value of 0.118 mg/l. Concentrations of total phosphorus in the East Branch of the Root River Canal during the period 2005-2012 ranged between 0.040 mg/l and 4.820 mg/l, with a mean value of 1.007 mg/l and a median value of 0.219 mg/l. Concentrations of total phosphorus in the West Branch of the Root River Canal during the period 2005-2012 ranged between 0.077 mg/l and 0.618 mg/l, with a mean value of 0.260 mg/l and a median value of 0.219 mg/l.

Unusually high concentrations of total phosphorus were occasionally detected at the sampling station at STH 11 (RM 8.1) along the East Branch of the Root River Canal. These unusually high concentrations were detected in three out of eight samples that were collected at this site in 2011 and 2012. Concentrations of these three samples ranged between 2.40 mg/l and 4.82 mg/l. While total phosphorus concentrations in the other sample collected at this site were high, they were within the ranges observed at other locations in the Root River Canal system. The cause of these high concentrations is not known. Possible sources include effluent discharged by the private WWTP located upstream from this site or runoff from agricultural fields upstream from this site. No rainfall was reported during the 72-hour periods prior collection of the samples containing the unusually high concentrations, so this probably is not the result of runoff events.

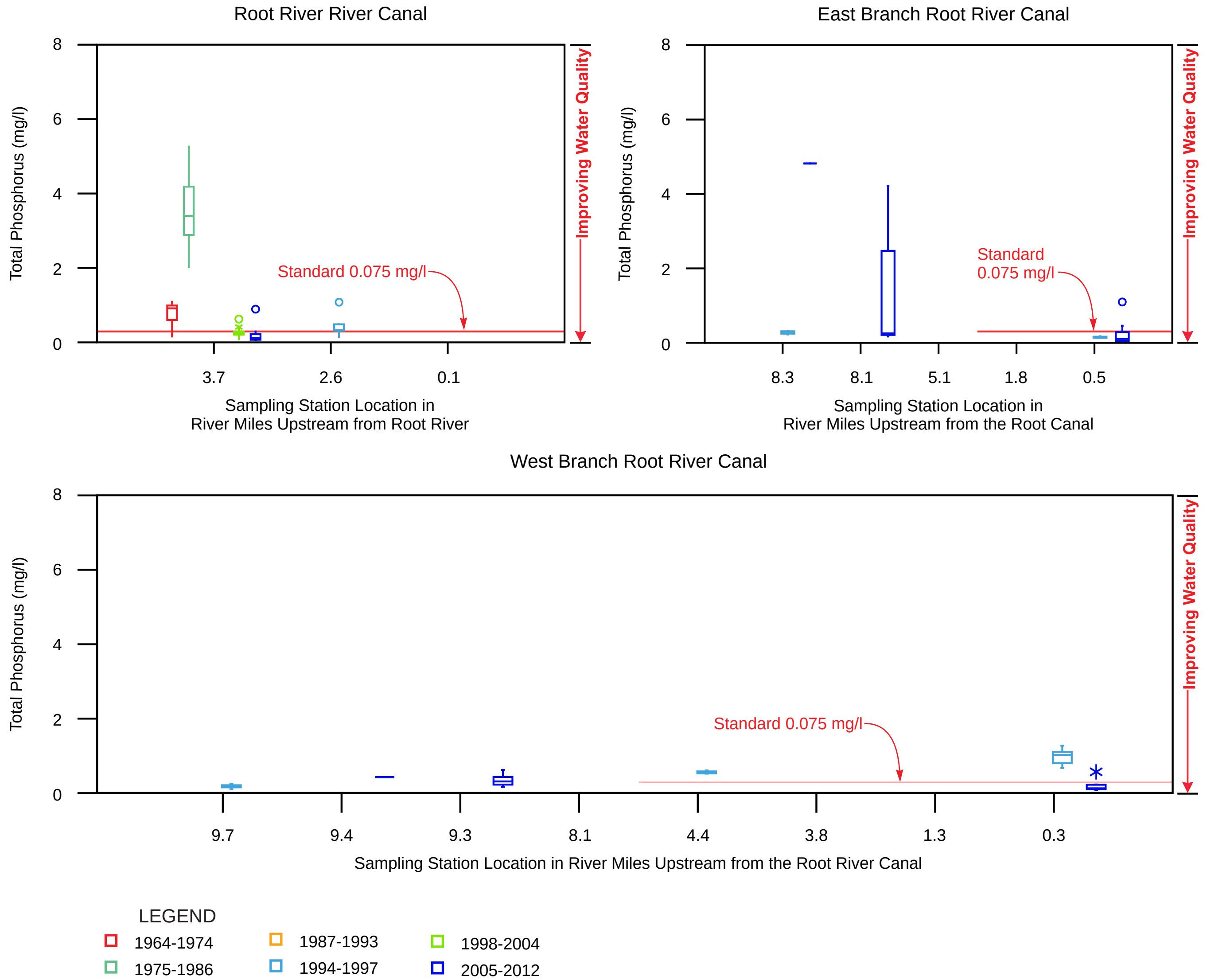
It should be noted that upstream sections of the East Branch of the Root River Canal and the West Branch of the Root River Canal are classified as limited aquatic life waters. Because of this, the State's water quality criterion for total phosphorus is not applicable to these reaches. Figure 36 shows that concentrations of total phosphorus in downstream sections of the East and West Branches and in the Root River Canal occasionally exceed the State's water quality criterion.

No data on dissolved phosphorus concentrations were available for the Root River Canal or its East and West Branches for the period 2005-2012.

Figure 37 shows concentrations of total phosphorus during the period 2005-2012 from four tributary streams in the watershed. Concentrations of total phosphorus in Hoods Creek ranged between 0.060 mg/l and 0.797 mg/l, with a mean concentration of 0.233 mg/l and a median concentration of 0.125 mg/l. Concentrations of total phosphorus in Husher Creek ranged between 0.043 mg/l and 0.376 mg/l, with a mean concentration of 0.130 mg/l and a median concentration of 0.094 mg/l. Concentrations of total phosphorus in Legend Creek ranged between 0.019 mg/l and 0.178 mg/l, with a mean concentration of 0.075 mg/l and a median concentration of 0.063 mg/l.

Figure 36

TOTAL PHOSPHORUS CONCENTRATIONS AT SITES ALONG THE ROOT RIVER CANAL AND ITS BRANCHES: 1964-2012



NOTES: See Figure 11 for description of symbols.

See Table 27 for location of sample sites.

Because of exceptionally high total phosphorus concentrations at some sampling stations in the Root River Canal system, the scales on the graphs of this figure has been extended to 8.0 mg/l.

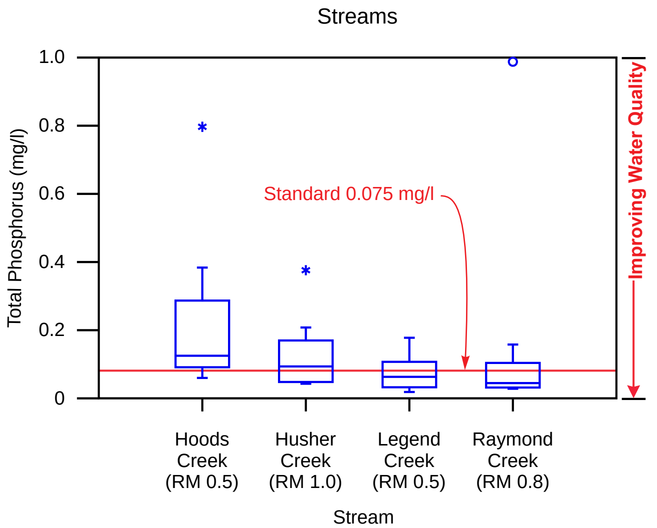
Nondesignated streams that are classified as limited aquatic life waters are specifically excluded from coverage under Wisconsin's water quality criterion for phosphorus. Because of this, no standard is shown for some sampling stations along the East and West Branches of the Root River Canal.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, City of Racine Health Department, and SEWRPC.

Concentrations of total phosphorus in Raymond Creek ranged between 0.028 mg/l and 0.980 mg/l, with a mean concentration of 0.393 mg/l and a median concentration of 0.048 mg/l. In all four of these streams, concentrations of total phosphorus in some samples exceed the State's water quality criterion of 0.075 mg/l. The percentage of samples exceeding this criterion ranges from about 37 percent in Raymond Creek to 100 percent in Hoods Creek. No total phosphorus concentration data were available during the period 2005-2012 in any other tributary streams in the Root River watershed.

Figure 37

TOTAL PHOSPHORUS CONCENTRATIONS IN TRIBUTARY STREAMS IN THE ROOT RIVER WATERSHED: 2005-2012



NOTE: See Figure 11 for description of symbols.

Source: Wisconsin Department of Natural Resources, City of Racine Health Department, and SEWRPC.

No data for dissolved phosphorus concentrations were available for any tributary streams in the Root River watershed for the period 2005-2012.

Nitrogen

A variety of nitrogen compounds that act as nutrients for plants and algae are present in surface waters. Typically, only a small number of forms of nitrogen are examined and reported in water quality sampling. Total nitrogen includes all of the nitrogen in dissolved or particulate form in the water. It does not include nitrogen gas, which is not usable as a nutrient by most organisms. Total nitrogen is a composite of several different compounds which vary in their availability to algae and aquatic plants and in their toxicity to aquatic organisms. Common inorganic constituents of total nitrogen include ammonia, nitrate, and nitrite. These are the forms that most commonly support algal and plant growth. Total nitrogen also includes a large number of nitrogen-containing organic compounds, such as amino acids, nucleic acids, and proteins that commonly occur in natural and polluted waters. These compounds are reported as organic nitrogen.

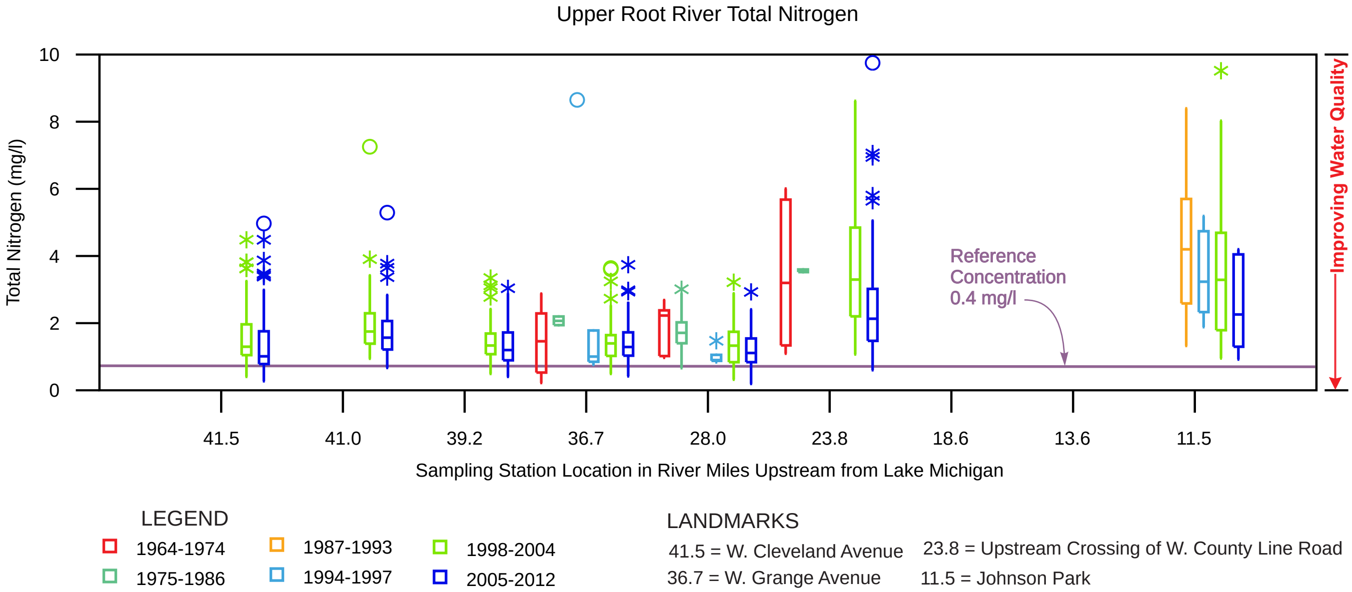
Nitrogen compounds can be contributed to waterbodies from a variety of point and nonpoint sources. In urban settings, nitrogen compounds from lawn fertilizers and other sources may be discharged through storm sewer systems and direct runoff into streams. Cross-connections between sanitary and storm sewer systems, illicit connections to storm sewer systems, and decaying sanitary and storm sewer infrastructure may contribute sanitary wastewater to waterbodies through discharges from storm sewer systems. In rural settings, nitrogen compounds from chemical fertilizers and animal manure may be contributed through discharges from drain tiles or direct runoff into waterbodies. Nitrogen compounds may also be contributed by poorly maintained or failing onsite wastewater treatment systems.

Occasionally, nitrogen acts as the limiting nutrient for algal and plant growth in freshwater systems. This usually occurs when concentrations of phosphorus are very high.

Figure 38 shows total nitrogen concentrations at sampling stations along the mainstem of the Root River. During the period 2005-2012, most of the available total nitrogen data in the watershed were collected at the six MMSD sampling stations and the sampling station at Johnson Park (RM 11.5). Data were also collected at a sampling station about 100 meters upstream from Memorial Drive in the City of Racine (RM 1.8). During the 2005-2012 period, concentrations of total nitrogen in the mainstem of the Root River ranged from 0.08 mg/l to 9.75 mg/l, with a mean concentration of 1.69 mg/l and a median concentration of 1.38 mg/l. Concentrations of total nitrogen detected at the upstream sampling stations between Cleveland Avenue (RM 41.5) and Ryan Road (RM 28.0) were lower than those detected farther downstream. During the period 2005-2012, median concentrations at the upstream stations ranged between 1.01 mg/l and 1.57 mg/l. The median concentration at County Line Road (RM 23.8) during the same period was 2.13 mg/l. Higher median concentrations were detected at sampling stations in Racine County. At the stations at Johnson Park (RM 11.5) and 100 meters upstream from Memorial Drive (RM 1.8), the median concentrations were 3.44 mg/l and 5.06 mg/l, respectively. Concentrations at these three downstream stations also showed a greater range of variation than was observed at upstream stations.

Figure 38

TOTAL NITROGEN CONCENTRATIONS AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



NOTES: See Figure 11 for description of symbols.

See Table 27 for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, Milwaukee Metropolitan Sewerage District, and SEWRPC.

At those stations that have longer periods of record, total nitrogen concentrations have decreased over time. At each station with sufficient data from both periods, mean total nitrogen concentrations detected during the period 2005-2012 were compared to mean concentrations detected during the period 1998-2004 using ANOVA.[83] Statistically significant differences were detected between the mean concentrations during the two periods at only two stations—Cleveland Avenue (RM 45.1) and County Line Road (RM 23.8).

With the exception of toxicity criteria for ammonia, the State of Wisconsin has not promulgated water quality criteria for nitrogen compounds. Figure 38 shows that the concentration of total nitrogen in most samples collected from the mainstem of the Root River was greater than a reference concentration calculated by USGS the for wadeable streams in soils with high clay content.[84] It is important to recognize that this reference value is not a water quality criterion. Instead, it represents a potential level of water quality that could be achieved in the absence of human activity.

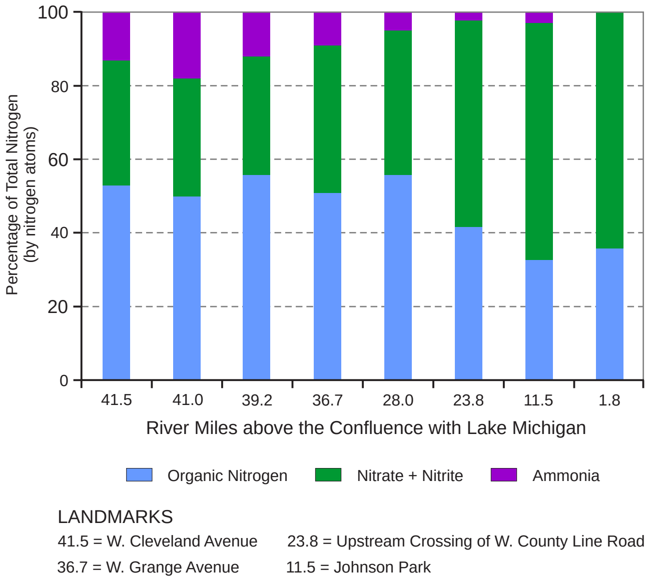
As previously described, total nitrogen consists of a variety of nitrogen-containing compounds, including ammonia, nitrates, nitrites, and organic nitrogen compounds. While the proportions of these compounds that are present in samples at any sampling station vary greatly from sample to sample, there are some trends in the

[83]*In order to meet the assumptions of ANOVA, total nitrogen concentrations were log-transformed.*

[84]*Dale M. Robertson, David J. Graczyk, Paul J. Garrison, Lizhu Wang, Gina LaLiberte, and Roger Bannerman,* Nutrient Concentrations and Their Relations to Biotic Integrity of Wadeable Streams in Wisconsin, *U.S. Geological Survey Professional Paper No. 1772, 2006.*

Figure 39

COMPOSITION OF TOTAL NITROGEN AT SAMPLING STATIONS ALONG THE MAINSTEM OF THE ROOT RIVER: 1998-2012



Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, Milwaukee Metropolitan Sewerage District, and SEWRPC.

composition of total nitrogen along the length of the mainstem of the Root River. Figure 39 shows the proportions of constituents of total nitrogen at sampling stations along the Root River. In general, the proportion of total nitrogen consisting of ammonia decreased from upstream to downstream. On average, ammonia accounted for about 15 percent of the nitrogen in total at the two stations farthest upstream (RM 41.5 and RM 41.0). At the station farthest downstream (RM 1.8), it accounted for less than 1 percent of the nitrogen in total nitrogen. Similarly, the proportion of total nitrogen consisting of organic nitrogen compounds decreased from upstream to downstream. At the two stations farthest upstream, organic nitrogen accounted for about 52 percent of the nitrogen in total nitrogen. At the station farthest downstream (RM 1.8) it accounted for about 36 percent of the nitrogen in total nitrogen. By contrast, the proportion of total nitrogen consisting of nitrate and nitrite increased from upstream to downstream.[85] On average, nitrate and nitrite accounted for about 33 percent of the nitrogen in total nitrogen at the two stations farthest upstream. At the station farthest downstream it accounted for about 64 percent.

These upstream to downstream changes in the proportions of the components of total nitrogen mask some changes in the concentrations of the components. From upstream to downstream median concentrations of ammonia decrease along the mainstem of the Root River, from about 0.260 mg/l at the sampling station at the intersection of National Avenue and Oklahoma Avenue (RM 41.0) to about 0.023 mg/l at the station 100 meters upstream from Memorial Drive (RM 1.8). Simultaneously, median concentrations of nitrate plus nitrite increased from 0.300 mg/l to 3.605 mg/l and median concentrations of organic nitrogen increased from 0.550 mg/l to 0.877 mg/l along the length of the River.

Several processes may be driving these changes in the chemical composition of total nitrogen along the length of the Root River. The relatively high concentrations of ammonia in the upstream, urban sections of the River may indicate inputs of sanitary wastewater originating from cross-connections between the sanitary and storm sewer systems, illicit discharges into the storm sewer system, or degrading sewer system infrastructure. The high concentrations of indicator bacteria that are found in this section of the River support this hypothesis. A combination of three processes probably accounts for the decrease in ammonia concentrations from upstream to downstream. First, ammonia in water will volatilize and enter the atmosphere. Second, plants and algae can assimilate ammonia, removing it from the water. Because this process requires less energy than assimilation of nitrate or nitrite, many of these organisms will preferentially assimilate ammonia over nitrate or nitrite if it is available. Third, ammonia may be oxidized through bacterial action to nitrite or nitrate. This process occurs in oxygenated waters with neutral or alkaline pH. It is likely that all three of these processes are occurring in the Root River.

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[85]*Nitrate and nitrite were sampled for, and analyzed as, combined nitrate and nitrite at the sampling stations at Johnson Park (RM 11.5) and 100 meters upstream from Memorial Drive (RM 1.8). On average at the MMSD stations, nitrite accounted for between 1 percent and 3 percent of the nitrogen in total nitrogen.*

Two processes may account for the increasing concentrations of nitrate and nitrite. First, some of the increase in nitrate and nitrite may result from the oxidation of ammonia to nitrite and nitrate through bacterial action. The decrease in ammonia along the length of the River, measured in terms of nitrogen atoms, represents approximately 7 percent of the corresponding increase in nitrate plus nitrite, measured on the same basis. Given this disparity and given that it is likely that other processes are also reducing the concentration of ammonia in the River, it is unlikely that this process accounts for more than a very small fraction of the increase in nitrate plus nitrite along the length of the River. Second, the increase in nitrate and nitrite concentration along the length of the River may reflect excess nitrate originating from fertilizer applications that wash into the River and its tributaries either through surface runoff or agricultural drainage tiles.

Most of the increase in organic nitrogen along the length of the River probably reflects decomposition of organic matter in the water column and sediment. A portion of this increase may also be due to the uptake and assimilation of inorganic forms of nitrogen by organisms in the water column. These processes result in the conversion of inorganic forms of nitrogen into organic compounds.

No data were available on the concentrations of nitrogen compounds in tributaries of the Root River for the period 2005-2012.

Suspended Materials

Suspended material in surface waters consists of particles of sand, silt, and clay; planktonic organisms; and fine organic and inorganic debris. The composition of suspended material varies with characteristics of the watershed and pollution sources.

Energy in water motions keeps particulate material suspended in water. Because the density of these particles is greater than the density of water, they will settle out of the water in the absence of water motions such as flow or mixing. The rate at which a particle settles is a function of its size, density, and shape. In general, larger and denser particles will settle more quickly than smaller and less dense particles. Flow and mixing will keep particles suspended, with stronger flow or mixing being required to keep larger or denser particles suspended. This has implications for suspended material in waterbodies. In streams, for example, higher concentrations and larger and denser particles are associated with higher water velocities—both in fast-moving sections of streams and during high flow periods. If water velocities are great enough, they may cause resuspension of sediment from the bed or erosion from the bed and banks of the stream. By contrast, deposition of suspended material may occur in slow-moving streams or during periods of low flow, with progressively smaller and lighter particles being deposited with decreasing water motions. The result of this is that concentrations of suspended material and the nature of the suspended particles in a waterbody vary, both spatially and over time.

Sources that contribute suspended material to waterbodies include sources within the waterbody and sources in the contributing watershed. Within a waterbody, resuspension of sediment in the beds of waterbodies and erosion of beds and banks can contribute suspended materials. Suspended materials can also be contributed by point and nonpoint pollution sources within the watershed. Concentrations of suspended materials in most discharges from point sources are subject to effluent limitations through the WPDES permit program that limit the concentrations and amounts of total suspended solids that can be discharged. A variety of nonpoint sources can also contribute suspended materials to waterbodies. Many BMPs for urban and rural nonpoint source pollution are geared toward reducing discharges of suspended materials.

Several different measures can be used to examine the amount of suspended materials in water. These methods differ both in the approach taken and in the characteristics actually being measured. Two measures are commonly used to assess the bulk concentration of suspended materials in water: total suspended solids (TSS) and suspended sediment concentration (SSC). Both of these are based upon weighing the amount of material retained when a sample is passed through a filter. They differ in the details of sample handling and subsampling. It is important to note that these two measures are not comparable to one another.[86] Another measure related to the amount of suspended materials in water is chlorophyll-*a* concentration, which estimates the biomass of phytoplankton suspended in the water. Finally, turbidity measures how much light is scattered in water, greater scattering being associated with higher concentrations of suspended materials.

Suspended Solids

As previously described, suspended solids consist of particles of sand, silt, and clay; planktonic organisms; and fine organic and inorganic debris suspended in the water column. High concentrations of suspended solids can cause several impacts in waterbodies. High turbidity is a result of high concentrations of suspended solids. High concentrations of suspended solids reduce the penetration of light into the water, reducing the amount of photosynthesis. In addition, suspended particles absorb more heat than water does. As a result, this can lead to an increase in the water temperature in streams. Both of these effects can lead to lower concentrations of dissolved oxygen. High concentrations of suspended solids can clog the gills of fish and other aquatic organisms, stressing them physiologically—in some cases fatally. Deposition of sediments may alter the substrate, making it unsuitable as habitat for aquatic organisms or changing channel characteristics. In addition, as a result of physical and chemical interactions, other materials may adsorb to particles suspended in water. Examples include poorly soluble organic molecules, such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and pesticides; nutrients, such as phosphate and nitrate ions; metals, such as copper and zinc ions; and microorganisms, such as bacteria and viruses. As a result, some pollutants may be carried into, or transported within, waterbodies in association with suspended material. In areas where sediment is deposited, reservoirs of these pollutants may accumulate in the sediment. The State of Wisconsin has not promulgated water quality criteria for suspended solids.

Figure 40 shows TSS concentrations from sampling stations along the mainstem of the Root River. During the period 2005-2012, TSS concentrations in the Root River ranged between 0.0 mg/l and 920.0 mg/l, with a median value of 9.1 mg/l and a mean value of 19.0 mg/l. With the exception of two samples collected at the sampling station at Johnson Park (RM 11.5), data were collected during this period only at MMSD’s six sampling stations. These stations are all located within Milwaukee County. Concentrations at all six sampling stations showed considerable variability. Median concentrations at the four upstream stations (RM 41.5, RM 41.0, RM 39.2, and RM 36.7) were below 10 mg/l. At the two downstream stations (RM 28.0 and RM 23.8), median concentrations were above 10.0 mg/l. This pattern was also present during the period 1998-2004 (see Figure 40). The pattern corresponds to differences in the degree of urban development in the assessment areas in which the sampling stations are located. The four upstream stations are located in the Upper Root River-Headwaters and Upper Root River assessment area, which are highly urbanized (see Table 14). The stations at Ryan Road (RM 28.0) and County Line Road (RM 23.8) are located in the Middle Root River-Legend Creek and Middle Root River-Ryan Creek assessment areas, respectively. These two assessment areas are much less urbanized.

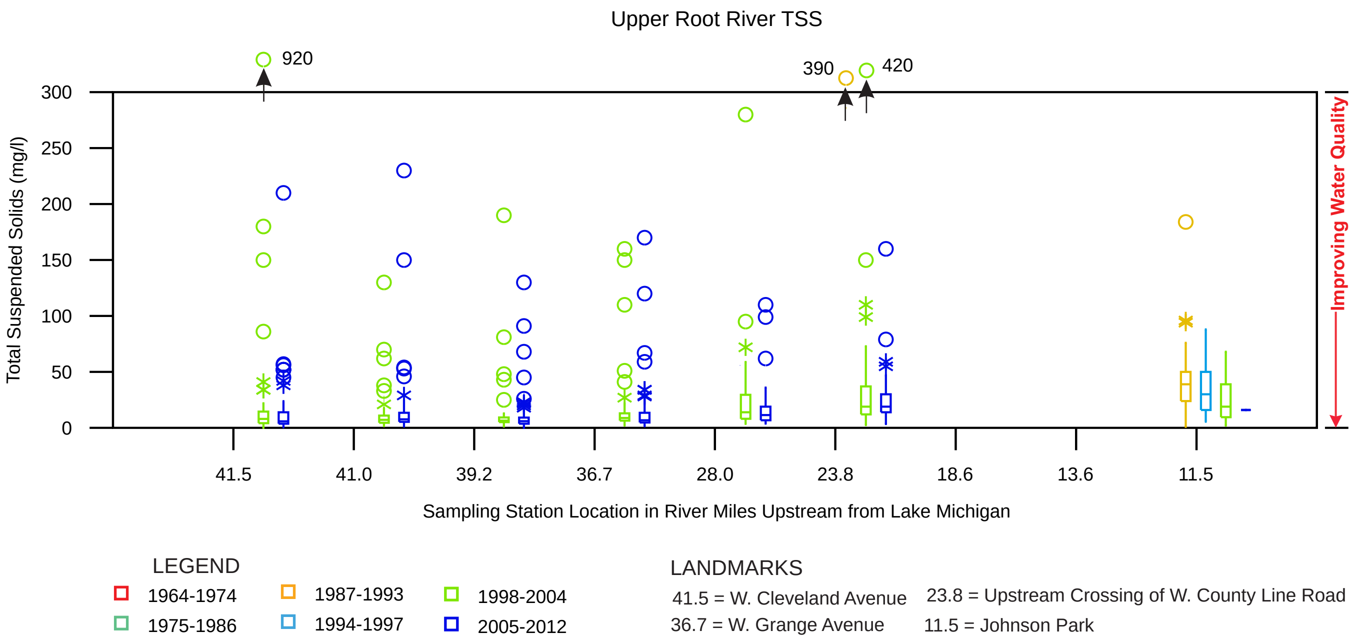
Concentrations of TSS in the mainstem of the Root River were highly correlated with measurements of turbidity. Concentrations of TSS were also positively correlated with discharge; however, there was considerable variability associated with this relationship.

No recent data for TSS were available from sampling stations along any tributary streams in the Root River watershed.

[86] *J.R. Gray, G.D. Glysson, L.M. Turcios, and G.E., Schwartz,* Comparability of Suspended-Sediment Concentration and Total Suspended Solids Data, *U.S. Geological Survey Water-Resources Investigations Report No. 00-4191, 2000.*

Figure 40

TOTAL SUSPENDED SOLIDS CONCENTRATIONS AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



NOTES: See Figure 11 for description of symbols.

See Table 27 for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, Milwaukee Metropolitan Sewerage District, and SEWRPC.

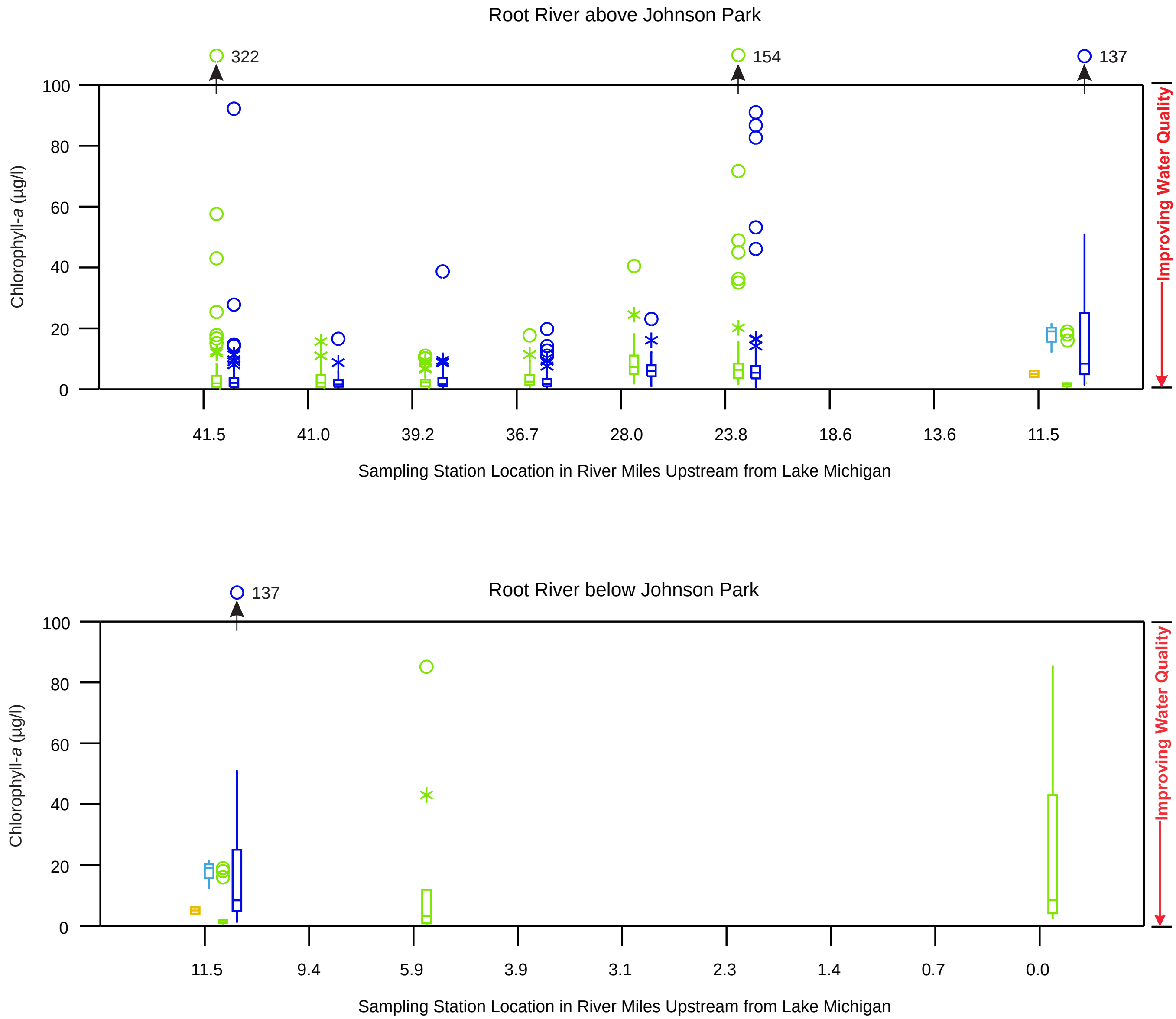
*Chlorophyll-*a

Chlorophyll-*a* is a pigment found in all photosynthetic organisms, including plants, algae, and photosynthetic bacteria. Measurements of chlorophyll-*a* are used to estimate the biomass of phytoplankton suspended in the water column. It is important to keep in mind that this is an estimate of the entire phytoplankton community. Chlorophyll-*a* concentration can vary depending on several factors other than the total biomass of phytoplankton present, including which species are present, the amount of light available, the ambient temperature, and nutrient availability. High concentrations of chlorophyll-*a* are indicative of poor water quality and are often associated with high turbidity, poor light penetration, and nutrient enrichment. The State of Wisconsin has not promulgated water quality criteria for chlorophyll-*a*.

Figure 41 shows chlorophyll-*a* concentrations at sampling stations along the mainstem of the Root River. During the period 2005-2012, chlorophyll-*a* concentrations in the Root River ranged between 0.12 micrograms per liter (μg/l) and 5,780 μg/l, with a median value of 2.88 μg/l and a mean value of 28.43 μg/l. During the period 2005-2012, concentrations detected at four stations farthest upstream (RM 41.5, RM 41.0, RM 39.2, and RM 36.7) were similar, with medians at these stations ranging between 1.57 μg/l and 2.09 μg/l. Concentrations at the next two stations during this period were higher, with medians ranging between 5.44 μg/l and 6.09 μg/l. This pattern of concentrations had been previously observed during the period 1998-2004. During the period 2005-2012, the concentration at Johnson Park was 5.27 μg/l. More variability was observed at this station than at any of the stations upstream. While no data were collected from other downstream stations during the 2005-2012 period, historical data collected at the stations below Horlick dam (RM 5.9) and at the confluence (RM 0.0) with Lake Michigan, suggest that chlorophyll-*a* concentrations in lower reaches of the River may be more variable than in upper reaches.

Figure 41

CHLOROPHYLL-*a* CONCENTRATIONS AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



LEGEND

- 1964-1974
- 1975-1986
- 1987-1993
- 1994-1997
- 1998-2004
- 2005-2012

LANDMARKS

41.5 = W. Cleveland Avenue
36.7 = W. Grange Avenue
23.8 = Upstream Crossing of W. County Line Road
11.5 = Johnson Park
5.9 = Horlick Dam
0.0 = Confluence with Lake Michigan

NOTES: See Figure 11 for description of symbols.

See Table 27 for location of sample sites.

Source: U.S. Geological Survey, Milwaukee Metropolitan Sewerage District, and SEWRPC.

It is not clear what accounts for the increase in chlorophyll-*a* concentration at the two stations in southern Milwaukee County (RM 28.0 and RM 23.8). As previously discussed, chlorophyll-*a* concentrations give a rough estimate of the biomass of phytoplankton suspended in the water column. Because phytoplankton growth responds to nutrient concentrations, the simplest explanation would be that this is a response to differences in nutrient concentrations among the sites. This does not seem to be the case. While there are differences in nutrient concentration among these sites, the pattern of the differences does not correspond well to the pattern of differences in chlorophyll-*a* concentration. This lack of correspondence is seen when chlorophyll-*a* concentrations are compared to total phosphorus, dissolved phosphorus, or total nitrogen. The higher chlorophyll-*a* concentration at RM 28.0 and RM 23.8 may reflect a response of phytoplankton growth to slightly higher water temperatures at the downstream stations. The median water temperatures measured at the times that samples were collected for chlorophyll-*a* were about 1.6^{o}C warmer at stations in southern Milwaukee County than those at the four upstream stations. Since the rates at which biological processes proceed tend to be dependent on temperature, higher water temperatures might result in faster growth of plankton in these reaches.

No recent data for chlorophyll-*a* were available from sampling stations along any tributary streams in the Root River watershed.

Turbidity

Turbidity is a measure of the clarity of water. It results from light being scattered and absorbed by particles and molecules rather than being transmitted through the water. Turbid water appears cloudy. Turbidity is caused by fine material that is suspended in the water, such as particles of silt, clay, finely divided organic and inorganic material, and planktonic organisms. Colored substances that are dissolved in the water can also contribute to turbidity. There are several ways of measuring turbidity. It is often measured using a nephelometer, which is a specialized optical device that measures the amount of light scattered when a beam of light is passed through a sample. The unit of measurement for this method is called a nephelometric turbidity unit (ntu), with low values indicating high water clarity and high values indicating low water clarity. Other methods involve measuring the depth of water through which a black and white disk remains visible. For lakes and ponds, this is often done at the site using a Secchi disk. For streams this is done using a turbidity tube. High turbidity can significantly reduce the aesthetic quality of lakes and streams, having a harmful impact on recreation. It reduces the penetration of light into the water, reducing the amount of photosynthesis. In addition, suspended particles absorb more heat than water does. As a result, high turbidity can lead to an increase in the water temperature in streams. Both of these effects can lead to lower concentrations of dissolved oxygen. Turbidity can harm fish and other aquatic life by reducing food supplies, degrading spawning beds, and affecting gill function. It can also reduce the growth of aquatic plants. The State of Wisconsin has not promulgated water quality criteria for turbidity.

Figure 42 shows turbidity at sampling stations along the mainstem of the Root River. During the period 2005-2012, turbidity at sampling stations along the mainstem of the Root River ranged between 0.4 ntu and 810 ntu with a median value of 13.1 ntu and a mean value of 21.4 ntu. The median values of turbidity at these sampling stations range between 5.1 ntu and 20.6 ntu. Median values at the four sampling stations farthest upstream and within about one mile of the confluence with Lake Michigan were less than 10 ntu. At the other stations along the mainstem they were between 10 ntu and 20 ntu. Similar patterns in turbidity appear to occur at most sampling stations. While most values of turbidity are near the median, several samples with high turbidity were detected at each station.

For those sampling stations where samples were examined for both turbidity and TSS, turbidity values were strongly correlated with TSS concentrations. No correlations were found between turbidity values and chlorophyll-*a* concentrations. This suggests that suspended solids constitute the major component contributing to turbidity, at least in the sections of the Root River that are located in Milwaukee County.[87] As was the case with TSS, higher values of turbidity were associated with higher average daily discharge. This was not a simple linear relationship and there was considerable variability associated with this tendency.

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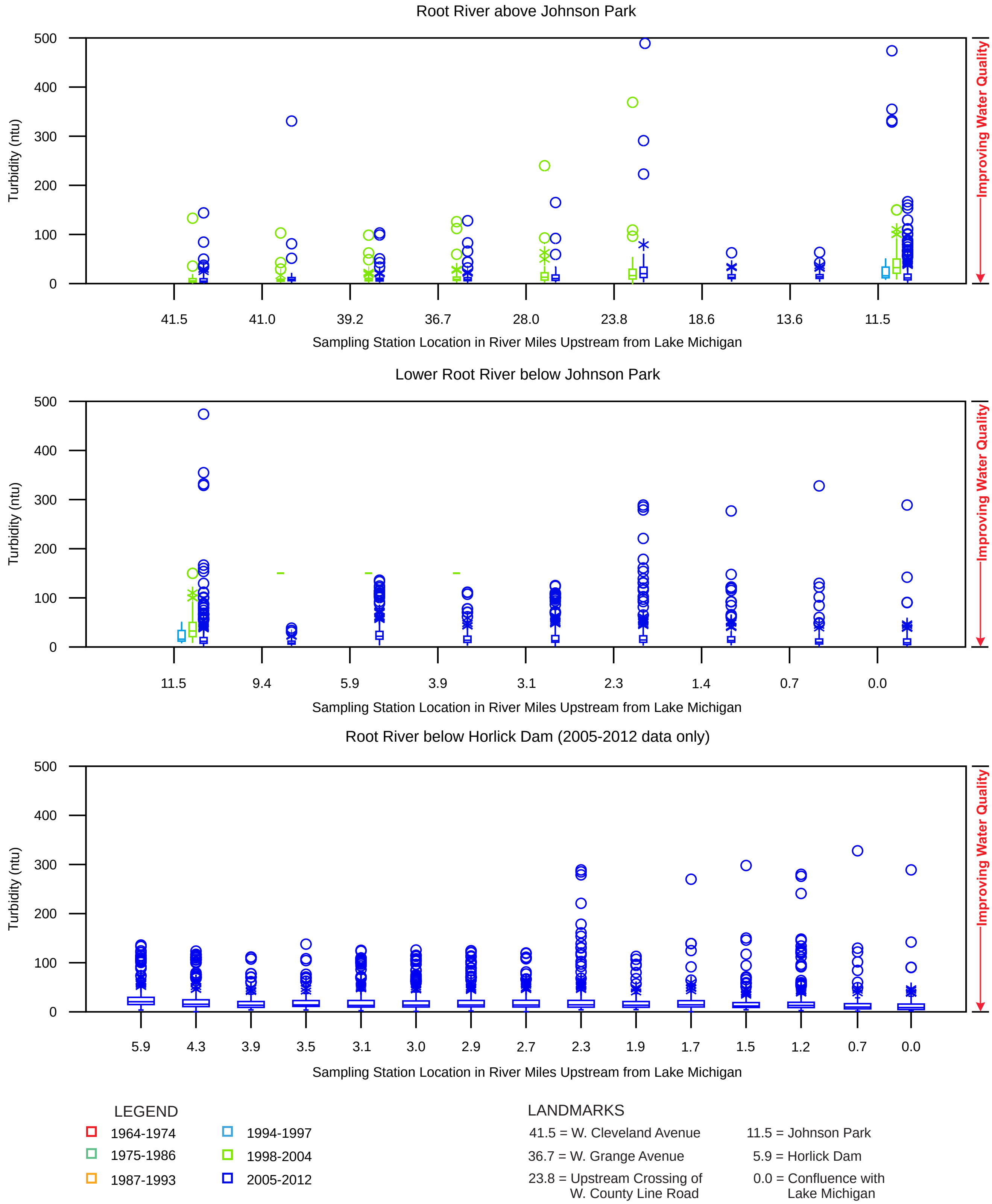
[87]*As noted in the section above on TSS, most TSS data were collected at MMSD's sampling stations.*

Figure 42

TURBIDITY AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012

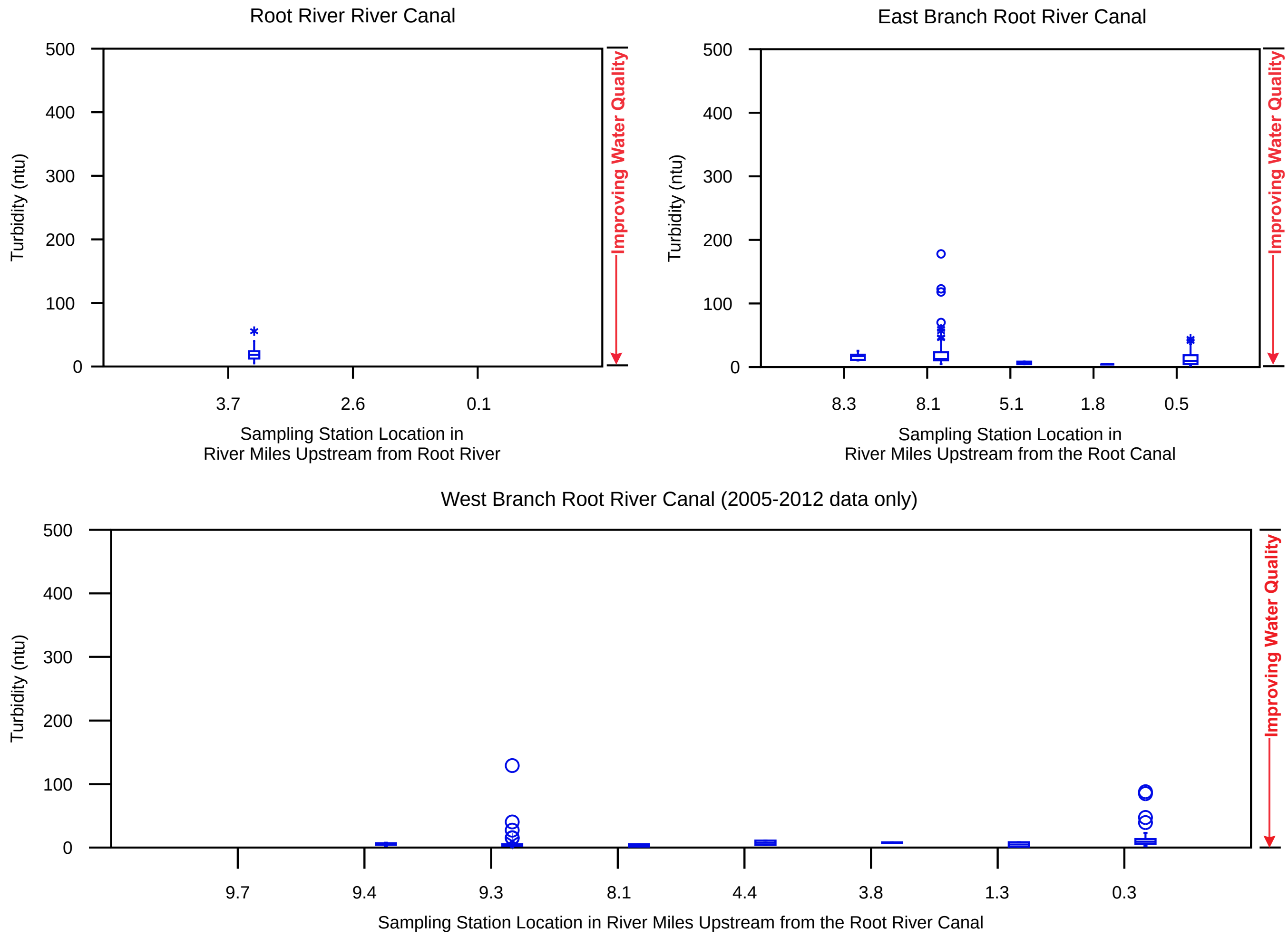


NOTES: See Figure 11 for description of symbols. See Table 27 for location of sample sites.

Source: *U.S. Geological Survey, Wisconsin Department of Natural Resources, University of Wisconsin-Extension, Milwaukee Metropolitan Sewerage District, City of Racine Health Department, and SEWRPC.*

Figure 43

TURBIDITY AT SITES ALONG THE ROOT RIVER CANAL AND ITS BRANCHES: 2005-2012



NOTES: See Figure 11 for description of symbols.

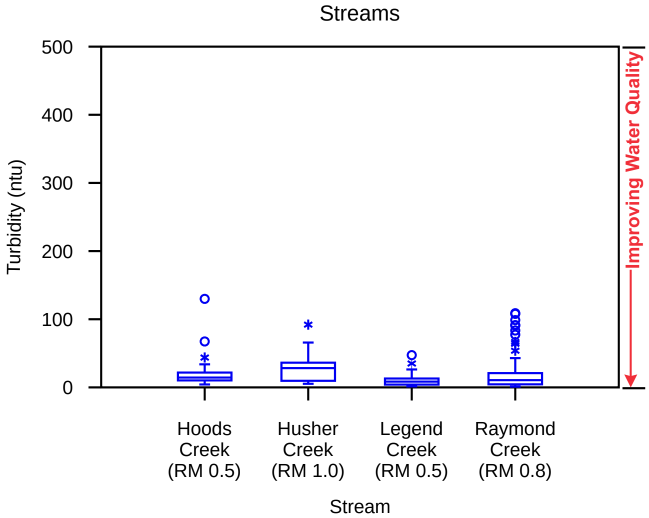
See Table 27 for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, City of Racine Health Department, and SEWRPC.

Figure 43 shows turbidity at sampling stations along the Root River Canal and its East and West Branches. Median values of turbidity in these streams were similar to those seen in the mainstem of the Root River, with values of 18.0 ntu, 11.5 ntu, and 5.9 ntu for the Canal, the East Branch, and the West Branch, respectively. Fewer high-valued outliers were detected. This partially reflects the fact that small numbers of samples were collected at some sampling stations. There was a complicated relationship between turbidity and average daily discharge at the sampling station at 6 Mile Road (RM 3.7) along the Root River Canal. Turbidity at this station showed considerable variability under conditions of low average daily discharge. Turbidity values varied between about 8.0 ntu and 40 ntu in those samples collected on days when average daily discharge was below about five cubic feet per second (cfs). This level of variability was not observed when average daily discharge was between about 20 cfs and 60 cfs. The cause of this variability during low flows is not clear. It may be the result of disturbances to streambeds or banks upstream from the sampling station.

Figure 44

TURBIDITY IN TRIBUTARY STREAMS IN THE ROOT RIVER WATERSHED: 2005-2012



NOTE: See Figure 11 for description of symbols.

Source: Wisconsin Department of Natural Resources, City of Racine Health Department, and SEWRPC.

Figure 44 shows turbidity at sampling stations along tributary streams in the Root River watershed. Median values of turbidity were 14.6 ntu, 28.3 ntu, 8.5 ntu, and 10.8 ntu for Hoods, Husher, Legend, and Raymond Creeks, respectively.

Synthesis

The 2007 RWQMPU drew several conclusions regarding water quality conditions in the streams of the Root River watershed in 2004.[88] Concentrations of dissolved oxygen were often low in upper reaches of the mainstem of the River, the lowest reaches of the mainstem of the River, and the Root River Canal. High concentrations of bacteria indicative of fecal contamination were present throughout the mainstem of the Root River and in the Root River Canal. High concentrations of total phosphorus were present in the mainstem of the Root River and in the Root River Canal and Husher Creek. Trends toward long-term increases in concentrations of chloride had been detected at some sampling stations along the mainstem of the River. Few data were available regarding water quality in tributary streams.

Sampling conducted between 2005 and mid-2012 indicates that several of these conclusions still apply. The upper portions of the mainstem of the Root River continued to experience low dissolved oxygen concentrations. High concentrations of bacteria indicative of fecal contamination were present in all of the streams in the watershed that were sampled for either fecal coliform bacteria or *E. coli*. Similarly, high concentrations of total phosphorus were present in all of the streams in the watershed that were sampled for phosphorus. These conditions do not appear to have changed much since 2004.

The results of the recent sampling also suggest that some changes in dissolved oxygen and chloride concentrations may be occurring in conditions in the streams of the watershed. At first examination, concentrations of dissolved oxygen in the reaches of the Root River between Horlick dam and the confluence with Lake Michigan appear to have improved. During the period 1998-2004, concentrations of dissolved oxygen below 5.0 mg/l were frequently observed in this reach. Between 2005 and 2012, dissolved oxygen concentrations in this reach rarely dropped below 5.0 mg/l. The recent data from several stations downstream of the dam show evidence that dissolved oxygen in this section of the River occasionally reaches concentrations in which the water is supersaturated for oxygen. This suggests that dissolved oxygen concentrations in these reaches may go through wide swings over the course of the day. While chloride data continue to show the presence of a long-term trend toward increasing chloride concentrations in the Root River, the concentrations detected in samples collected during the period 2005-2012 do not appear to be higher than the concentrations detected during the period 1998-2004. This suggests that efforts by counties and municipalities to reduce applications of chlorides in winter deicing operations may be having their intended effect.

88*SEWRPC Technical Report No. 39*, op. cit.

Since 2004, data have become available for several tributary streams that were not sampled during the period 1998-2012. For some water quality constituents the results indicate that conditions in these tributaries are similar to what is observed in the mainstem of the River. One example of this is that high concentrations of total phosphorus have been observed at most of the locations in the stream system where water quality sampling has been conducted. A second example is that high concentrations of bacteria indicative of fecal contamination have also been observed at most of the locations where water quality sampling has been conducted. It is probably reasonable to conclude that such high concentrations of bacteria and total phosphorus constitute problems throughout the watershed. Low dissolved oxygen concentrations are also a common occurrence in the tributary streams that have been sampled.

The data also give indications that there may be “hotspots” for particular water quality constituents in the stream system. Local hotspots for indicator bacteria occur downstream from WWTPs that discharge effluent into streams without disinfection, although the data indicate that the effects of these discharges probably do not extend very far downstream. It was previously suggested that the downstream reaches of the West Branch of the Root River Canal and the upstream reaches of the Root River Canal might constitute one or more hotspots for growth of aquatic plants and algae. This suggestion was based upon the incidence of supersaturation of dissolved oxygen at the sampling stations located in these reaches and is supported by the pH and total phosphorus data from the same sampling stations.

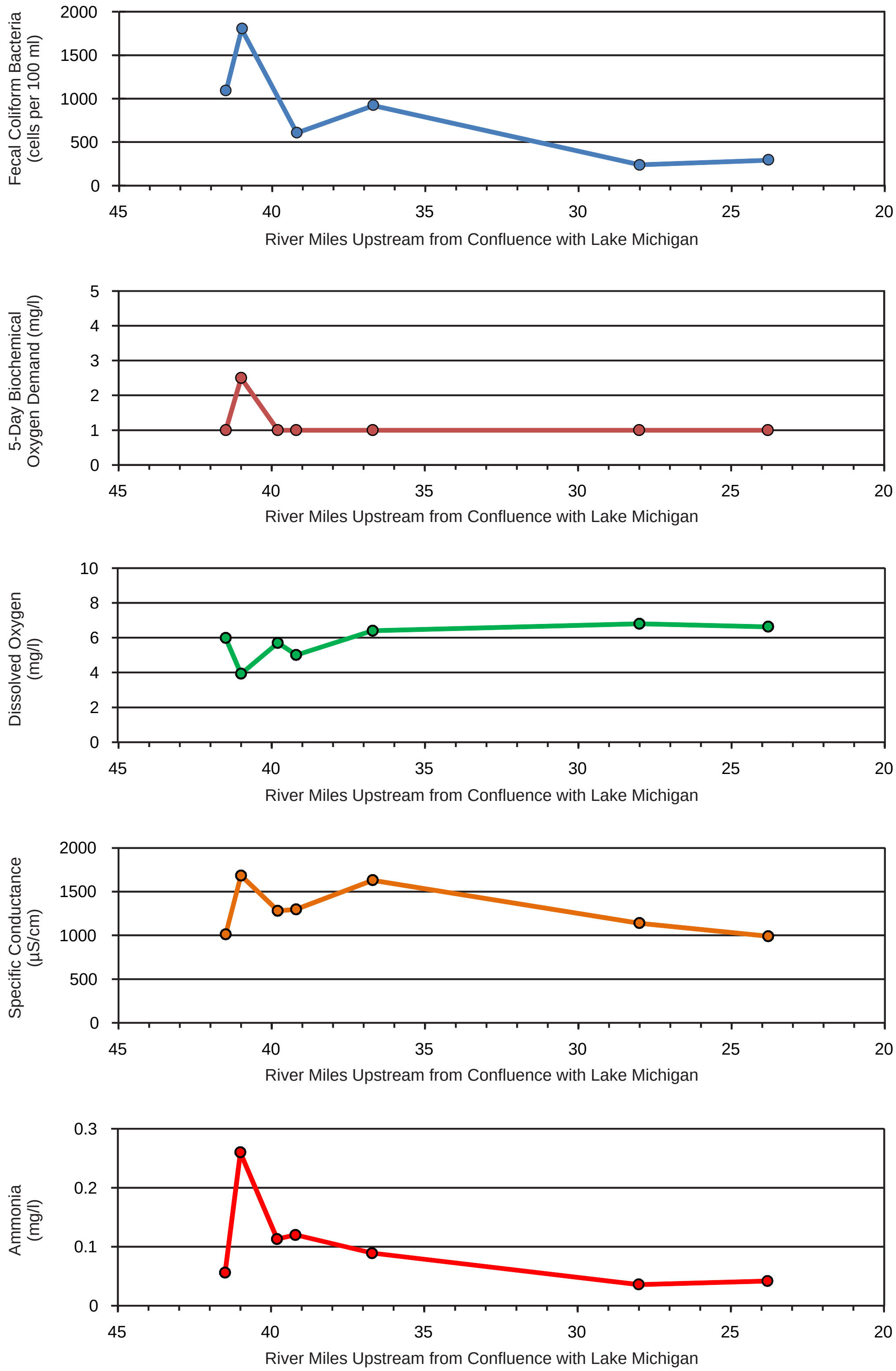
Simultaneous examination of multiple water quality constituents might reveal additional hotspots. Figure 45 shows median values of five water quality constituents—fecal coliform bacteria, five-day biochemical oxygen demand (BOD), dissolved oxygen, specific conductance, and ammonia—for sampling stations along the mainstem of the Root River in Milwaukee County. Conditions at the sampling station at the intersection of W. National Avenue and W. Oklahoma Avenue (RM 41.0) stand out as being substantially different from those at adjacent sampling stations. Median concentrations of fecal coliform bacteria, BOD, and ammonia are higher; the median value of specific conductance is higher; and the median concentration of dissolved oxygen is lower than those that are observed at either W. Cleveland Avenue (RM 41.5) or W. Cold Spring Road (RM 36.7). In addition, median concentrations of organic nitrogen, total phosphorus, and chloride were higher at this station than at adjacent stations, and the median value of pH was lower at this station than at adjacent stations (see Figures 26, 29, and 35). The combination of high bacterial concentrations, high concentrations of organic material such as BOD and ammonia, and low dissolved oxygen suggest that inputs of sanitary wastewater may be the cause of this hotspot. Possible sources include cross connections between the sanitary and stormwater sewer systems, leaking sanitary sewer lines or laterals, or illicit discharges into the storm sewer system. The source is likely to be discharging either into the mainstem of the Root River between the intersection of W. National Avenue and W. Oklahoma Avenue and W. Cleveland Avenue or into Hale Creek, which flows into the Root River between these two locations.

Figure 46 shows median values of five water quality constituents—*E. coli*, dissolved oxygen, pH, total phosphorus, and turbidity—for sampling stations along the mainstem of the Root River in Racine County between Johnson Park (RM 11.5) and the confluence with Lake Michigan (RM 0.0). The figure shows little correspondence between median concentrations of *E. coli* and median values of other water quality constituents in this section of the River. Median concentrations of *E. coli* begin to increase at Lincoln Park (RM 3.8) and remain high until Azarian Marina (RM 0.9). This pattern suggests that there may be multiple sources throughout this reach that contribute bacteria to the River. This may be the result of carp feeding on aquatic plants at or upstream of this site.

Figure 46 also shows a possible hotspot about 100 meters upstream from Memorial Drive (RM 1.8). Both the median concentration of dissolved oxygen and the median value of pH were higher at this site than at nearby sites upstream and downstream from this location. This suggests the presence of dense plant beds in the vicinity of this location. The median concentration of total phosphorus at this site was lower than the medians at nearby sites upstream and downstream from this location. This suggests that aquatic plants at this location are removing dissolved phosphorus from the water column and incorporating it into plant tissue. If the increases in median dissolved oxygen and pH at this location were caused by a persistent phytoplankton bloom, it is unlikely that total phosphorus would decrease. It is not clear what is causing the relatively high median turbidity at this location.

Figure 45

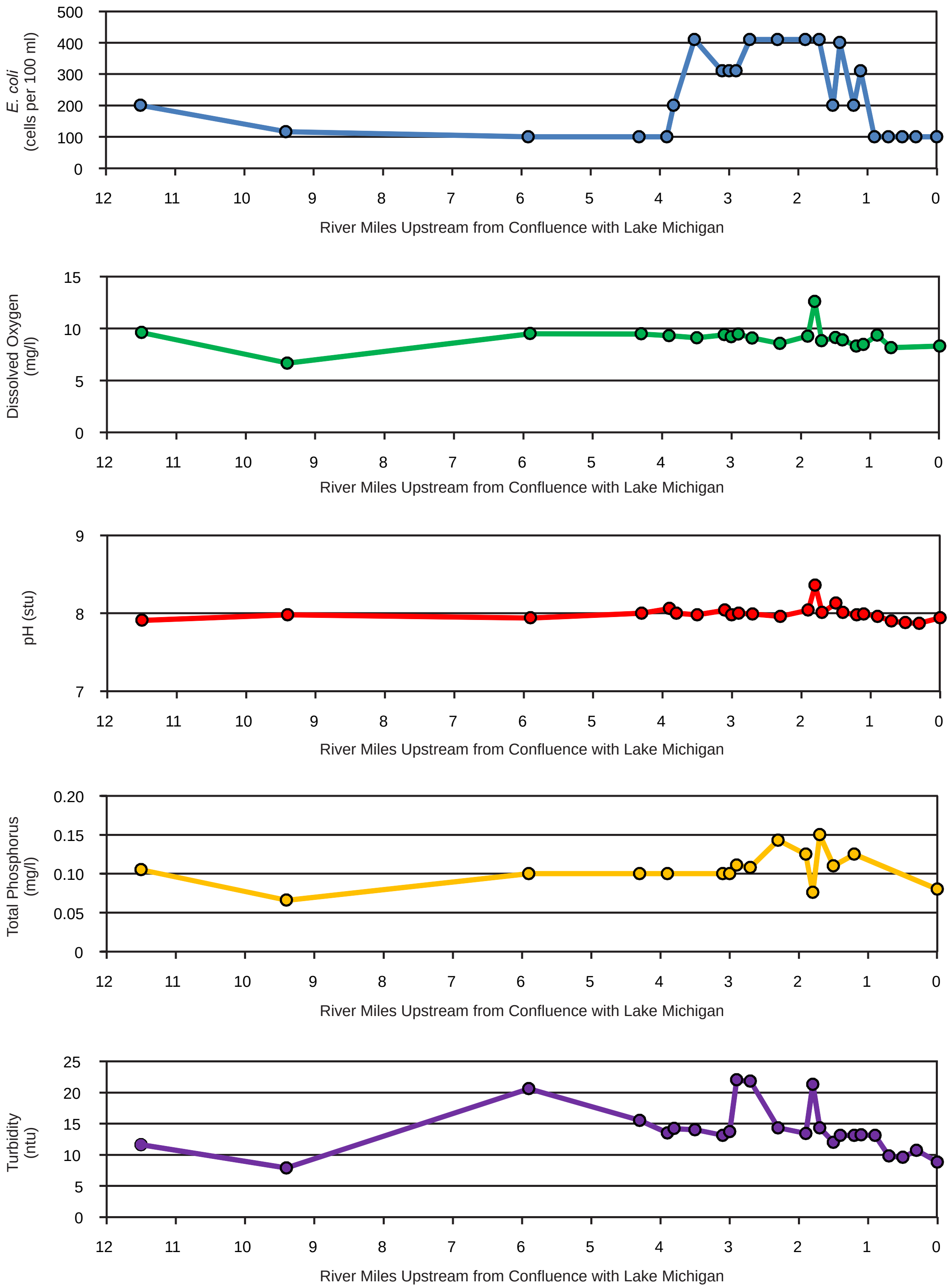
MEDIAN VALUES OF FIVE WATER QUALITY CONSTITUENTS AT SAMPLING STATIONS ALONG UPPER REACHES OF THE MAINSTEM OF THE ROOT RIVER: 1998-2012



Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, Milwaukee Metropolitan Sewerage District, and SEWRPC.

Figure 46

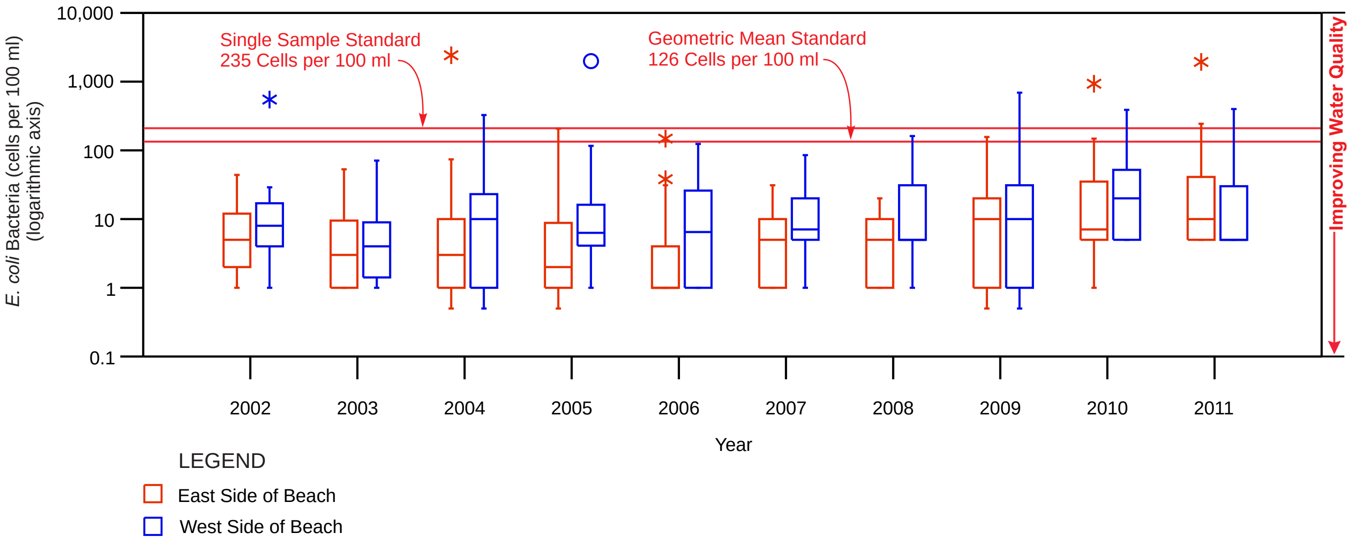
MEDIAN VALUES OF FIVE WATER QUALITY CONSTITUENTS AT SAMPLING STATIONS ALONG LOWER REACHES OF THE MAINSTEM OF THE ROOT RIVER: 2005-2012



Source: U.S. Geological Survey, University of Wisconsin-Extension, Wisconsin Department of Natural Resources, City of Racine Health Department, and SEWRPC.

Figure 47

***ESCHERICHIA COLI* BACTERIA CONCENTRATIONS AT BEACH SITES AT QUARRY LAKE: 2002-2011**



NOTE: See Figure 11 for description of symbols.

Source: Racine County, City of Racine Health Department, and SEWRPC.

Water Quality in Lakes and Ponds

While the Root River watershed contains no lakes with a surface area of 50 or more acres,[89] it does contain several smaller named lakes and ponds. Physical characteristics of lakes and ponds in the Root River watershed are given in Table 18; lakes and ponds are shown on Map 1 in Chapter I of this report.

Bacterial Indicators of Safety for Human Contact

Data on bacterial indicators of fecal contamination are available from only one lake or pond in the watershed, Quarry Lake. Figure 47 shows concentrations of *E. coli* from Quarry Lake from the swimming seasons for the period 2002-2011. Samples were collected at two sites along the beach, one on the eastern side and another on the western side. Concentrations of *E. coli* in Quarry Lake ranged between 0.5 cells per 100 ml and 2,410 cells per 100 ml, with a median concentration of five cells per 100 ml. Concentrations rarely exceeded the USEPA's recommended geometric mean criterion of 126 cells per 100 ml or single sample maximum criterion of 235 cells per 100 ml. While concentrations were generally low in samples collected from both sides of the beach, they tended to be slightly higher in samples collected on the western side. On about 48 percent of dates when samples were collected from Quarry Lake, the concentration of *E. coli* in the sample collected from the western side of the beach was higher than the concentration in the sample collected from the eastern side of the beach. By contrast, the concentration of *E. coli* in the sample collected from the eastern side of the beach was higher than the concentration in the sample collected from the western side of the beach on 24 percent of the dates that samples were collected. On the remaining dates, the concentrations in samples collected from the two sides of the beach were equal. This suggests that there may be a source of bacteria along or near the western side of the beach.

Figure 48 shows the time course of *E. coli* concentrations from both sides of the beach at Quarry Lake over the 2005 swimming season. Aside from the fact that the concentrations were usually low at both sampling sites, there appears to be little relationship between concentrations at the two sites.

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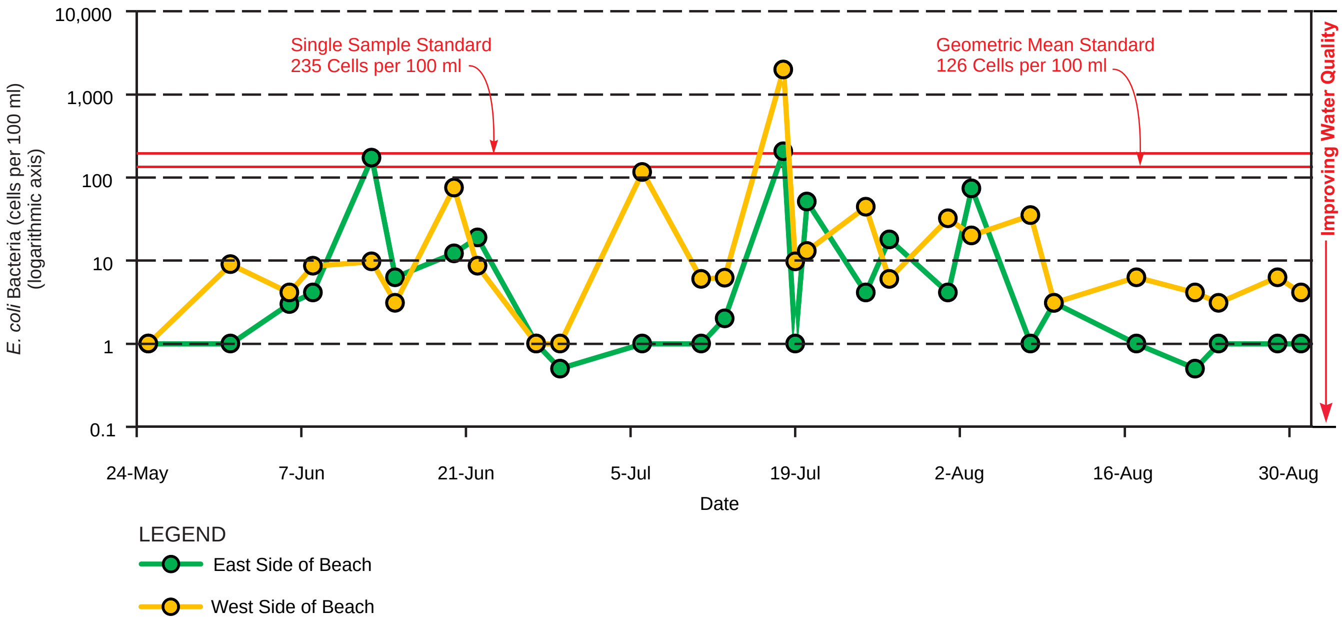
[89]*The Regional Planning Commission defines a major lake as one with a surface area of 50 acres or more.*

Figure 48

***ESCHERICHIA COLI* BACTERIA CONCENTRATIONS AT BEACH SITES AT QUARRY LAKE DURING THE 2005 SWIMMING SEASON**



Source: Racine County, City of Racine Health Department, and SEWRPC.

Chemical and Physical Water Quality Constituents

Data on water chemistry are available for relatively few lakes and ponds in the Root River watershed. Long-term data sets are available for two lakes: Scout Lake and Upper Kelly Lake. In addition, limited data are available for seven lakes and ponds. With one exception, the data sets available for these waterbodies consist of a single sample. For Lower Kelly Lake, data are available from several samples collected between 1994 and 1996.

Scout Lake

Table 31 presents summary statistics for several water quality constituents in Scout Lake. The average values and ranges of some constituents, such as dissolved oxygen and temperature, show strong seasonal associations.

Figure 49 shows water temperatures and concentrations of dissolved oxygen and total phosphorus at shallow, intermediate, and lowest depths in Scout Lake from the years 1993 through 2005. In these graphs, shallow depths are within three feet of the water surface, intermediate depths are between three and eight feet below the water surface, and lowest depths are between eight feet and 18 feet below the water surface. Most of these data were collected during the months of April through October.

The temperature data shown in Figure 49 indicate that Scout Lake is thermally stratified during much of the year. During the summer months, the average temperature of water in the lowest depths of the lake is about 15 to 16^{o}C cooler than the average temperature of water in the shallow depths. During thermal stratification, a layer of relatively warm water floats on top of a layer of cooler water. Thermal stratification is the result of differential heating of lake water and the resulting water temperature-density relationships at various depths within the water column. Water is unique among liquids in that it reaches its maximum density at about 4 ^{o}C, while it is still in the liquid state. During stratification, the top layer, or epilimnion, of the waterbody is cut off from nutrient inputs from the sediment. At the same time, the bottom layer, or hypolimnion, is cut off from the atmosphere and sunlight penetration. Over the course of the summer, water chemistry and other conditions can become different

Table 31

SUMMARY STATISTICS FOR WATER QUALITY CONSTITUENTS IN SCOUT LAKE: 1980-2005

Constituent	Spring (March-May)	Summer (June-August)	Autumn (September-November)	Winter (December-February)
Chlorophyll-*a* (μg/l)				
Samples	5	43	15	- -
Minimum	0.98	<0.01	1.50	- -
Maximum	9.42	61.00	31.60	- -
Mean	3.96	7.09	8.94	- -
Median	2.00	4.65	6.98	- -
Standard Deviation	3.65	9.56	7.66	- -
Chloride (mg/l)				
Samples	1	- -	3	- -
Minimum	255.0	- -	0.0	- -
Maximum	255.0	- -	6.0	- -
Mean	255.0	- -	3.7	- -
Median	255.0	- -	5.0	- -
Standard Deviation	- -	- -	3.2	- -
Dissolved Oxygen (mg/l)				
Samples	30	86	26	4
Minimum	0.60	0.00	0.00	6.65
Maximum	12.80	12.90	11.10	11.30
Mean	7.38	4.47	6.07	8.83
Median	7.85	4.00	6.40	8.70
Standard Deviation	4.02	3.59	3.18	0.22
pH (stu)				
Samples	4	9	5	- -
Minimum	7.10	6.70	7.30	- -
Maximum	8.80	9.70	8.70	- -
Mean	7.95	8.49	8.01	- -
Median	7.95	8.60	7.90	- -
Standard Deviation	0.98	0.87	0.57	- -
Specific Conductance (μS/cm)				
Samples	2	9	5	- -
Minimum	1,200	278	870	- -
Maximum	1,200	1,347	1,680	- -
Mean	1,200	919	1,188	- -
Median	1,200	902	937	- -
Standard Deviation	0	311	379	- -
Temperature (degrees Celsius)				
Samples	34	108	35	4
Minimum	3.9	5.6	5.6	1.0
Maximum	22.0	28.9	18.5	3.8
Mean	10.0	17.1	12.3	2.3
Median	9.2	17.7	12.2	2.3
Standard Deviation	4.7	6.9	2.9	0.6
Total Phosphorus (mg/l)				
Samples	19	59	22	5
Minimum	0.020	0.010	0.020	0.020
Maximum	0.182	0.722	2.490	6.310
Mean	0.062	0.118	0.215	1.320
Median	0.042	0.036	0.040	0.055
Standard Deviation	0.050	0.175	0.550	2.790

Table 31 (continued)

Constituent	Spring (March-May)	Summer (June-August)	Autumn (September-November)	Winter (December-February)
Secchi Depth (feet)				
Samples	11	43	14	- -
Minimum	1.50	2.00	2.50	- -
Maximum	7.55	13.10	10.00	- -
Mean	4.12	5.89	5.75	- -
Median	4.00	6.00	5.90	- -
Standard Deviation	1.75	3.12	2.31	- -

Source: Wisconsin Department of Natural Resources, Milwaukee County, and SEWRPC.

between the layers of a stratified waterbody. The extent of difference is often determined by the productivity of the waterbody and the degree of nutrient enrichment to which the waterbody has been subjected. In southeastern Wisconsin, the development of summer thermal stratification begins in mid to late spring or early summer, reaches its maximum in late summer, and breaks down and disappears in the fall.

Figure 49 shows that temperatures in the lowest layer of Scout Lake were warmer during the period 1987-1993 than they were during other periods. This is an artifact in the data. Rather than indicating an actual difference in the temperature regime, this reflects the fact that during this period a greater proportion of samples were collected during early spring and late fall when the lake was mixing and temperatures were similar at all depths.

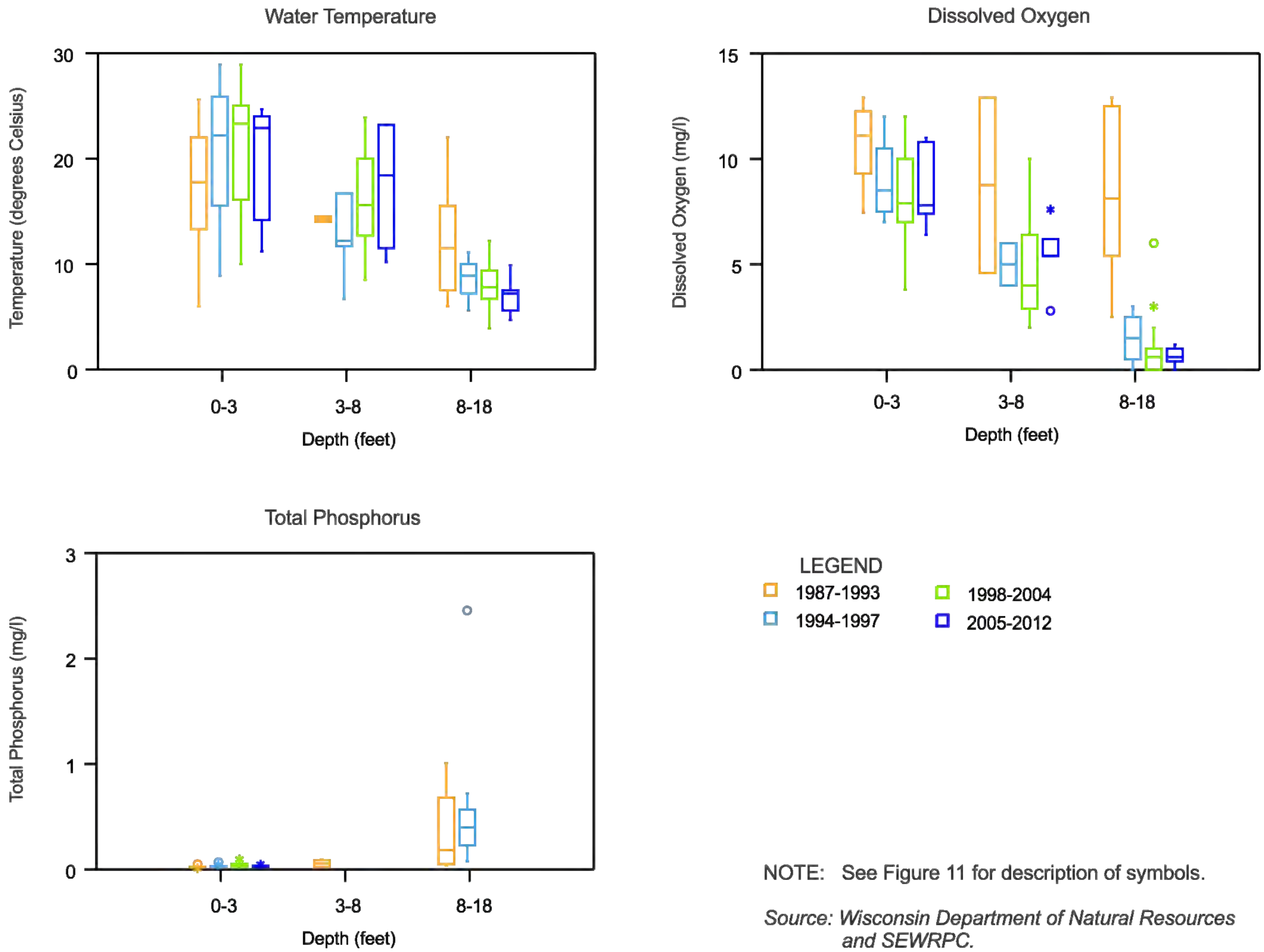
Figure 49 also shows concentrations of dissolved oxygen at shallow, intermediate, and lowest depths in Scout Lake. During most periods, dissolved oxygen concentrations were very low in the hypolimnion. Again, the higher concentrations during the period 1987-1993 are an artifact in the data and reflect samples collected during times when the Lake was mixing. During summer months, average concentrations of dissolved oxygen in the hypolimnion were about 6.75 to 7.00 mg/l lower than average concentrations in the epilimnion. The concentration of dissolved oxygen in the hypolimnion was below 1.00 mg/l in about half the samples collected during the summer months. During the same months, concentrations of total phosphorus were much higher in the hypolimnion than those in the epilimnion. During many summers examined, the hypolimnion became anoxic for a portion of the summer. The lower oxygen concentration in the hypolimnion results from depletion of available oxygen through chemical oxidation and microbial degradation of organic material in water and sediment.

Hypolimnetic anoxia is common in many of the lakes in southeastern Wisconsin during summer stratification. The lower oxygen concentrations in the hypolimnion cause fish and other aquatic organisms to move upward, nearer to the water's surface where higher dissolved oxygen concentrations are present. This migration, when combined with temperature, can select against some fish species that prefer cooler water temperatures, which generally prevail in the lower portions of a lake. When there is insufficient oxygen at these depths, these fish are susceptible to summer-kills or, alternatively, are driven into warmer portions of the lake where their condition and competitive success may be severely impaired.

In addition to these biological consequences, the lack of dissolved oxygen at depth can enhance the development of chemoclines, or chemical gradients, with an inverse relationship to the dissolved oxygen concentration. For example, the sediment-water exchange of elements such as phosphorus, iron, and manganese is increased under anoxic conditions, resulting in higher hypolimnetic concentrations of these elements. This happens because the solubility of these elements in water tends to be higher under anoxic conditions than it is under oxic conditions. Under oxic conditions, phosphorus in the sediment is often bound up in relatively insoluble iron and manganese

Figure 49

DISSOLVED OXYGEN, WATER TEMPERATURE, AND TOTAL PHOSPHORUS IN SCOUT LAKE: 1987-2012



NOTE: See Figure 11 for description of symbols.

Source: Wisconsin Department of Natural Resources and SEWRPC.

complexes. When the hypolimnion becomes anoxic, these complexes become soluble,[90] releasing phosphorus to the water. This "internal loading" can have a substantial effect on water quality, especially if these nutrients are mixed into the epilimnion through diffusion across the thermocline or during temporary changes in stratification during storm or high wind events.

The sediments in Scout Lake appear to be releasing phosphorus to the water during periods of hypolimnetic anoxia. As shown in Figure 49, over the period for which data were available for total phosphorus in both the epilimnion and hypolimnion, the median concentration of total phosphorus in the hypolimnion was about 11 times higher than the median concentration in the epilimnion.

Figure 50 shows Secchi depths from Scout Lake between 1992 and 2005. During most of the 1990s, water clarity in Scout Lake, as measured by Secchi depth, decreased. It reached minimum levels during the years 1999-2001. The variability in Secchi depth during these years was much less than had been observed in other years, despite

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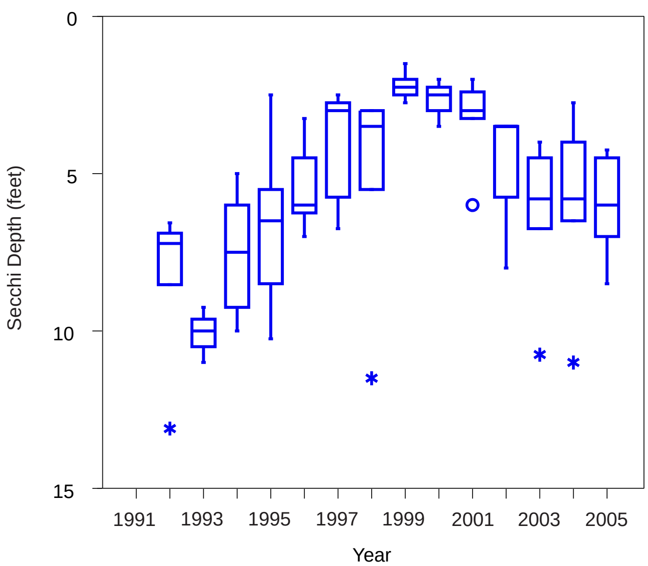
[90]*This results from a change in the oxidation state of the iron and manganese.*

Figure 50

SECCHI DEPTH IN SCOUT LAKE: 1992-2005



NOTE: See Figure 11 for description of symbols.

Source: Wisconsin Department of Natural Resources and SEWRPC.

there being similar number of samples from year to year. After 2001, Secchi depth increased, with median Secchi depth during these years being about six feet. It is not clear what caused the low Secchi depths and the reduced variability in Secchi depth during the period 1999-2001. This may have been related to changes in the management of algae and aquatic plants.

Upper Kelly Lake

Table 32 presents summary statistics for several water quality constituents in Upper Kelly Lake. For most constituents, the number of samples collected was insufficient to draw conclusions regarding seasonal patterns.

Figure 51 shows concentrations of chlorophyll-*a* and total phosphorus in Upper Kelly Lake. The median chlorophyll-*a* concentration in Upper Kelly Lake during the period 2005-2012 was 9.07 μg/l. This median concentration was similar to the one observed during the period 1994-1997. Figure 51 also shows greater variability in chlorophyll-*a* concentrations during the period 2005-2012 than during the period 1994-1997. This is a reflection of the larger number of samples collected during 2005-2012.

The median concentration of total phosphorus in Upper Kelly Lake during the period 2005-2012 was 0.054 mg/l. Figure 51 also shows greater variability in total phosphorus concentrations during the period 1994-1997 than during the period 2005-2012. This reflects the fact that samples were collected throughout the water column while the lake was stratified during the period 1994-1997, while the samples collected during the period 2005-2012 were collected from the epilimnion. The 1994-1997 samples include hypolimnetic samples with higher concentrations of total phosphorus. Based upon the limited hypolimnetic phosphorus data collected from this lake, it is likely that this lake experiences hypolimnetic anoxia during stratification.

Figure 52 shows Secchi depths in Upper Kelly Lake from the years 1994 through mid-2012. Secchi depths during the period 2005-2012 ranged between 0.00 and 14.25 feet, with a mean depth of 6.01 feet and a median depth of 5.75 feet. During early 2012, water clarity was unusually high in the Lake. This was probably the result of reduced inputs from runoff that were related to the drought conditions in 2012. When data from 2012 are excluded from the analysis, Secchi depths in Upper Kelly Lake show no evidence of any long-term trends.

Other Lakes and Ponds

Table 33 presents summary statistics for several water quality constituents in Lower Kelly Lake that were collected in the mid-1990s. While these data are old, they represent the only available water chemistry data for this lake. For most constituents, the number of samples collected was insufficient to draw conclusions regarding seasonal patterns. Concentrations of dissolved oxygen in this lake were generally low. At the same time, concentrations of total phosphorus in most samples were high.

Table 34 presents Secchi depths and concentrations of total phosphorus and chlorophyll-*a* from several lakes and ponds in the Root River watershed that have been sampled only once. For most of these waterbodies, these limited data are consistent with eutrophic conditions.

Table 32

SUMMARY STATISTICS FOR WATER QUALITY CONSTITUENTS IN UPPER KELLY LAKE: 1994-2012

Constituent	Spring (March-May)	Summer (June-August)	Autumn (September-November)	Winter (December-February)
Chlorophyll-*a* (*μ*g/l)				
Samples	- -	5	2	- -
Minimum	- -	0.47	10.90	- -
Maximum	- -	14.70	22.20	- -
Mean	- -	8.04	16.55	- -
Median	- -	9.07	16.55	- -
Standard Deviation	- -	5.21	7.99	- -
Chloride (mg/l)				
Samples	- -	- -	- -	- -
Minimum	- -	- -	- -	- -
Maximum	- -	- -	- -	- -
Mean	- -	- -	- -	- -
Median	- -	- -	- -	- -
Standard Deviation	- -	- -	- -	- -
Dissolved Oxygen (mg/l)				
Samples	- -	3	1	- -
Minimum	- -	0.07	6.40	- -
Maximum	- -	9.21	6.40	- -
Mean	- -	3.47	6.40	- -
Median	- -	1.15	6.40	- -
Standard Deviation	- -	4.99	- -	- -
pH (stu)				
Samples	- -	3	1	- -
Minimum	- -	6.45	8.40	- -
Maximum	- -	8.23	8.40	- -
Mean	- -	7.28	8.40	- -
Median	- -	7.16	8.40	- -
Standard Deviation	- -	0.90	- -	- -
Specific Conductance (*μ*S/cm)				
Samples	- -	3	- -	- -
Minimum	- -	406	- -	- -
Maximum	- -	660	- -	- -
Mean	- -	522	- -	- -
Median	- -	499	- -	- -
Standard Deviation	- -	129	- -	- -
Temperature (degrees Celsius)				
Samples	- -	3	1	- -
Minimum	- -	4.6	25.2	- -
Maximum	- -	22.9	2.52	- -
Mean	- -	14.2	25.2	- -
Median	- -	15.0	25.2	- -
Standard Deviation	- -	9.2	- -	- -
Total Phosphorus (mg/l)				
Samples	2	8	2	- -
Minimum	0.034	0.028	0.035	- -
Maximum	0.068	0.655	0.052	- -
Mean	0.051	0.136	0.044	- -
Median	0.051	0.060	0.044	- -
Standard Deviation	0.024	0.213	0.012	- -

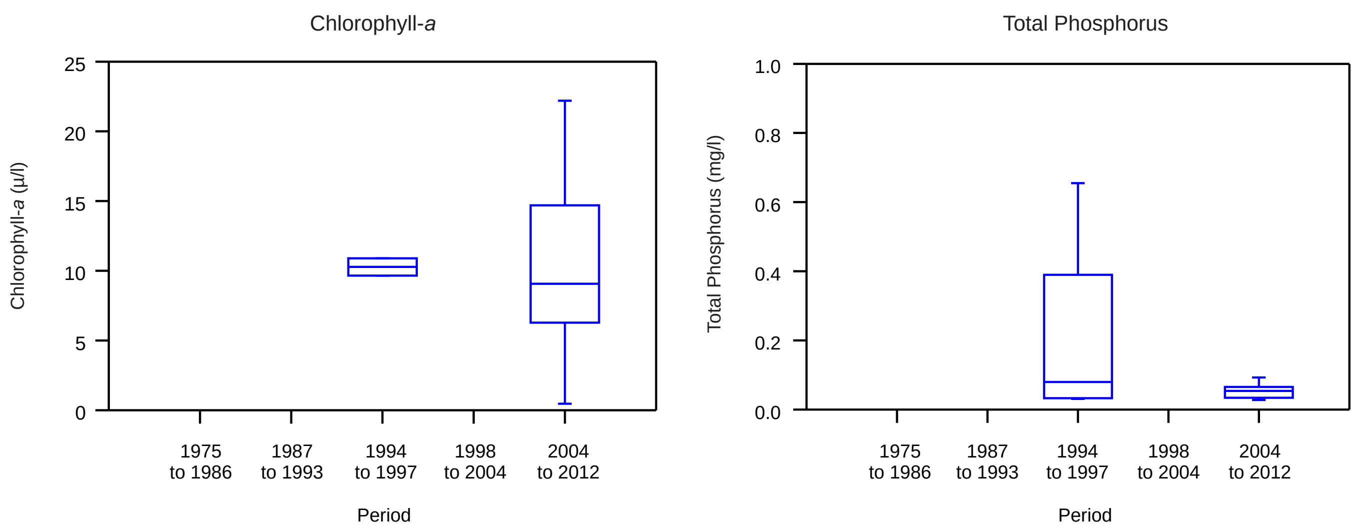
Table 32 (continued)

Constituent	Spring (March-May)	Summer (June-August)	Autumn (September-November)	Winter (December-February)
Secchi Depth (feet)				
Samples	78	143	80	1
Minimum	1.25	0.00	2.00	8.00
Maximum	14.25	9.75	11.00	8.00
Mean	5.73	5.03	5.82	8.00
Median	5.13	5.00	5.50	8.00
Standard Deviation	2.93	1.88	2.18	- -

Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 51

CHLOROPHYLL-*a* AND TOTAL PHOSPHORUS CONCENTRATIONS IN UPPER KELLY LAKE: 1975-2012



NOTE: See Figure 11 for description of symbols.

Source: Wisconsin Department of Natural Resources and SEWRPC.

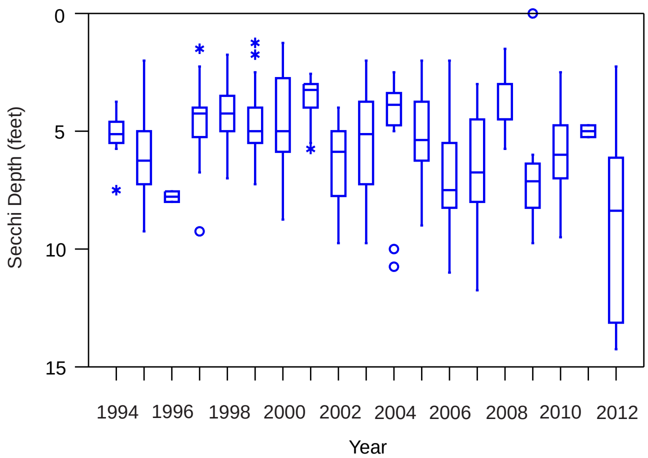
Ratings of Trophic Condition

Lakes and ponds are commonly classified according to their biological productivity—or trophic status. The trophic status of lake and ponds is often related to the degree of nutrient enrichment they have experienced. The ability of lakes and ponds to support a variety of recreational activities and healthy fish and other aquatic organisms is often correlated to the degree of nutrient enrichment which has occurred. Three terms are generally used to describe the trophic status of a lake or pond: oligotrophic, mesotrophic, and eutrophic.

Oligotrophic lakes and ponds are nutrient-poor lakes and ponds. Biological productivity in these waterbodies is low. These waterbodies characteristically support relatively few aquatic plants and often do not contain very productive fisheries. They often have high water clarity. Oligotrophic lakes and ponds may provide excellent opportunities for swimming, boating, and waterskiing. Because of the naturally fertile soils and intensive land use activities, there are relatively few oligotrophic lakes in southeastern Wisconsin.

Figure 52

SECCHI DEPTH IN UPPER KELLY LAKE: 1994-2012



NOTE: See Figure 11 for description of symbols.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Mesotrophic lakes and ponds are moderately fertile lakes and ponds. These waterbodies may support abundant aquatic plant growth and productive fisheries. Nuisance growth of algae and macrophytes are usually not exhibited by mesotrophic lakes and ponds. These waterbodies may provide opportunities for all types of recreational activities, including boating, swimming, fishing, and waterskiing. Many lakes and ponds in southeastern Wisconsin are mesotrophic.

Eutrophic lakes and ponds are nutrient-rich lakes and ponds. Biological productivity in these waterbodies is high. These waterbodies often exhibit excessive aquatic macrophyte growths and/or experience frequent algal blooms. If they are shallow, winterkills of fish may be common. While portions of such lakes and ponds are not ideal for swimming and boating, eutrophic lakes and ponds may support very productive fisheries.

The Trophic State Index assigns a numerical trophic condition rating based on Secchi-disc transparency, and total phosphorus, and chlorophyll-*a* concentrations. The original Trophic State Index developed by Carlson[91] has been modified for Wisconsin Lakes by the WDNR using data on 184 lakes throughout the State. Wisconsin Trophic State Index (WTSI) ratings below 40 indicate oligotrophic conditions.[92] WTSI ratings between 40 and 50 indicate mesotrophic conditions. WTSI rating above 50 indicate eutrophic conditions.

Figure 53 shows WTSI ratings for Scout Lake based upon Secchi depth and concentrations of total phosphorus and chlorophyll-*a*. The WTSI rating, based upon median total phosphorus concentration is 57; based upon median Secchi-disk transparency is 52; and based upon median chlorophyll-*a* concentration is 47. Wisconsin Trophic State Index ratings of between 47 and 57 would suggest that the Lake is eutrophic.

Figure 54 shows WTSI ratings for Upper Kelly Lake based upon Secchi depth and concentrations of total phosphorus and chlorophyll-*a*. The WTSI rating, based upon median total phosphorus concentration is 59; based upon median Secchi-disk transparency is 53; and based upon median chlorophyll-*a* concentration is 52. Wisconsin Trophic State Index ratings of between 52 and 59 would suggest that the Lake is eutrophic.

Achievement of Water Use Objectives

The water use objectives and the supporting water quality standards and criteria for the Root River watershed were previously discussed in this chapter. Most of the stream reaches and all of the lakes and ponds in the watershed are recommended for fish and aquatic life and full recreational uses. The exceptions to this are subject to variances under Chapter NR 104 of the *Wisconsin Administrative Code*. The East Branch of the Root River Canal from STH 20 to the confluence with the West Branch of the Root River Canal, Hoods Creek, Tess Corners Creek, the West Branch of the Root River Canal between STH 20 and CTH C, and Whitnall Park Creek

[91]*Robert E. Carlson, "A Trophic State Index for Lakes,"* Limnology and Oceanography, *Volume 22, 1977.*

[92]*R.A. Lillie, S. Graham, and P. Rasmussen, "Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes,"* Research Management Findings, *Wisconsin Department of Natural Resources Publication No. PUBL-RS-735 93, May 1993.*

Table 33

SUMMARY STATISTICS FOR WATER QUALITY CONSTITUENTS IN LOWER KELLY LAKE: 1994-1996

Constituent	Spring (March-May)	Summer (June-August)	Autumn (September-November)	Winter (December-February)
Chlorophyll-*a* (μg/l)				
Samples	- -	1	1	- -
Minimum	- -	2.72	2.66	- -
Maximum	- -	2.72	2.66	- -
Mean	- -	2.72	2.66	- -
Median	- -	2.72	2.66	- -
Standard Deviation	- -	- -	- -	- -
Chloride (mg/l)				
Samples	- -	- -	- -	- -
Minimum	- -	- -	- -	- -
Maximum	- -	- -	- -	- -
Mean	- -	- -	- -	- -
Median	- -	- -	- -	- -
Standard Deviation	- -	- -	- -	- -
Dissolved Oxygen (mg/l)				
Samples	- -	3	4	- -
Minimum	- -	0.08	0.10	- -
Maximum	- -	9.04	7.00	- -
Mean	- -	3.07	1.88	- -
Median	- -	0.08	0.20	- -
Standard Deviation	- -	5.17	3.42	- -
pH (stu)				
Samples	- -	3	4	- -
Minimum	- -	6.84	6.20	- -
Maximum	- -	8.17	8.10	- -
Mean	- -	7.39	6.88	- -
Median	- -	7.15	6.60	- -
Standard Deviation	- -	0.70	0.87	- -
Specific Conductance (μS/cm)				
Samples	- -	3	- -	- -
Minimum	- -	329	- -	- -
Maximum	- -	1,114	- -	- -
Mean	- -	749	- -	- -
Median	- -	805	- -	- -
Standard Deviation	- -	395	- -	- -
Temperature (degrees Celsius)				
Samples	- -	3	4	- -
Minimum	- -	6.6	4.8	- -
Maximum	- -	23.4	26.6	- -
Mean	- -	14.9	12.2	- -
Median	- -	14.9	8.8	- -
Standard Deviation	- -	8.4	9.9	- -
Total Phosphorus (mg/l)				
Samples	- -	3	4	- -
Minimum	- -	0.014	0.013	- -
Maximum	- -	0.565	1.095	- -
Mean	- -	0.204	0.464	- -
Median	- -	0.032	0.373	- -
Standard Deviation	- -	0.313	0.521	- -

Table 33 (continued)

Constituent	Spring (March-May)	Summer (June-August)	Autumn (September-November)	Winter (December-February)
Secchi Depth (feet)				
Samples	1	1	5	2
Minimum	7.00	7.55	4.00	5.50
Maximum	7.00	7.55	12.50	6.50
Mean	7.00	7.55	7.60	5.75
Median	7.00	7.55	8.00	8.75
Standard Deviation	- -	- -	3.49	0.35

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 34

WATER QUALITY CONSTITUENT VALUES FROM INFREQUENTLY SAMPLED LAKES AND PONDS IN THE ROOT RIVER WATERSHED

Lake	Sample Date	Secchi Depth (feet)	WTSI-SD	Total Phosphorus (mg/l)	WTSI-TP	Chlorophyll-*a*	WTSI-Chl
Boerner Botanical Garden Pond No. 2	June 16, 2004	- -	- -	0.172	68	8.00	50
Dumkes Lake	July 9, 2001	2.46	64	- -	- -	- -	- -
Koepmeir Lake	July 9, 2001	8.14	47	- -	- -	- -	- -
Monastery Lake	July 9, 2001	5.41	53	- -	- -	- -	- -
Root River Parkway Pond	July 9, 2001	5.84	52	- -	- -	- -	- -
Whitnall Park Pond	July 9, 2001	4.43	56	- -	- -	- -	- -

Source: Wisconsin Department of Natural Resources and SEWRPC.

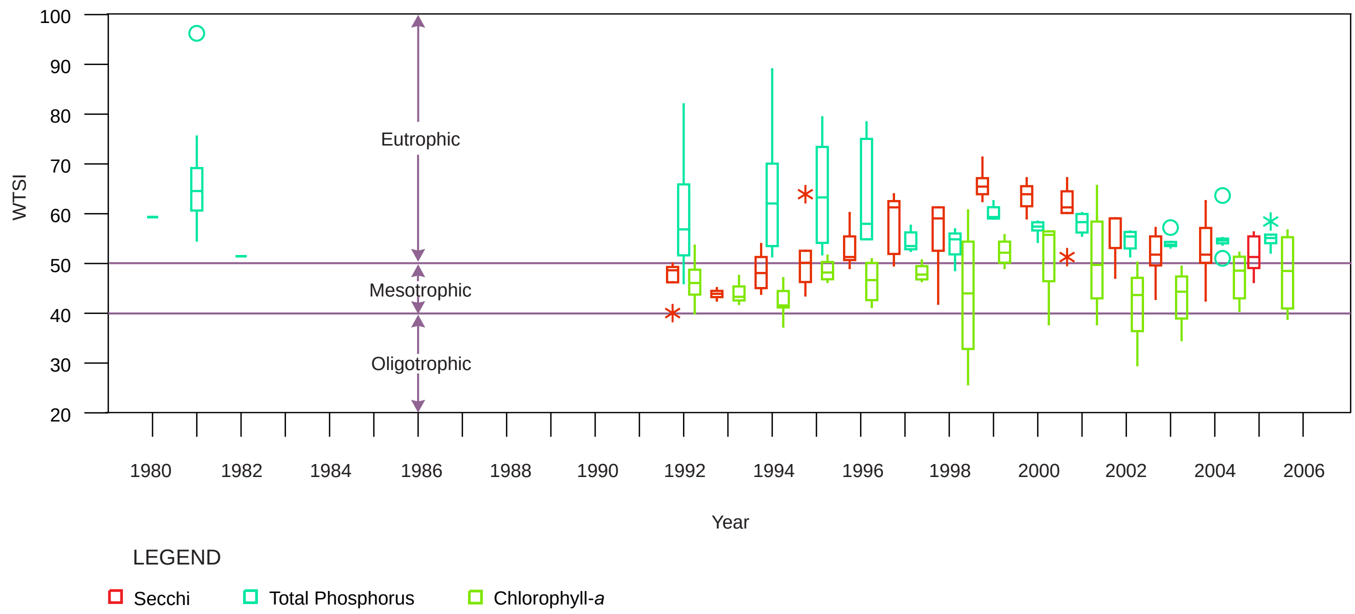
downstream from the site of the former Hales Corners sewage treatment plant to Whitnall Park Pond are recommended for limited forage fish and subject to variances under which dissolved oxygen concentrations are not to be less than 3.0 mg/l. The East Branch of the Root River, the East Branch of the Root River Canal upstream from STH 20, Ives Grove Ditch, the West Branch of the Root River Canal upstream from CTH C, Whitnall Park Creek upstream from the site of the former Hales Corners sewage treatment plant, and an unnamed tributary of the Root River from downstream from the site of the former New Berlin Memorial Hospital sewage treatment plant are recommended for limited aquatic life and are subject to variances under which dissolved oxygen concentrations are not to be less than 1.0 mg/l.

Previous Assessments of Achievement of Water Use Objectives

Based upon the available data for sampling stations in the watershed, the mainstem of the Root River and its major tributaries did not fully meet the water quality standards associated with the recommended water use objectives during and prior to 1975, the base year of the initial regional water quality management plan. Review

Figure 53

WISCONSIN TROPHIC STATE INDEX VALUES FOR SCOUT LAKE: 1980-2005

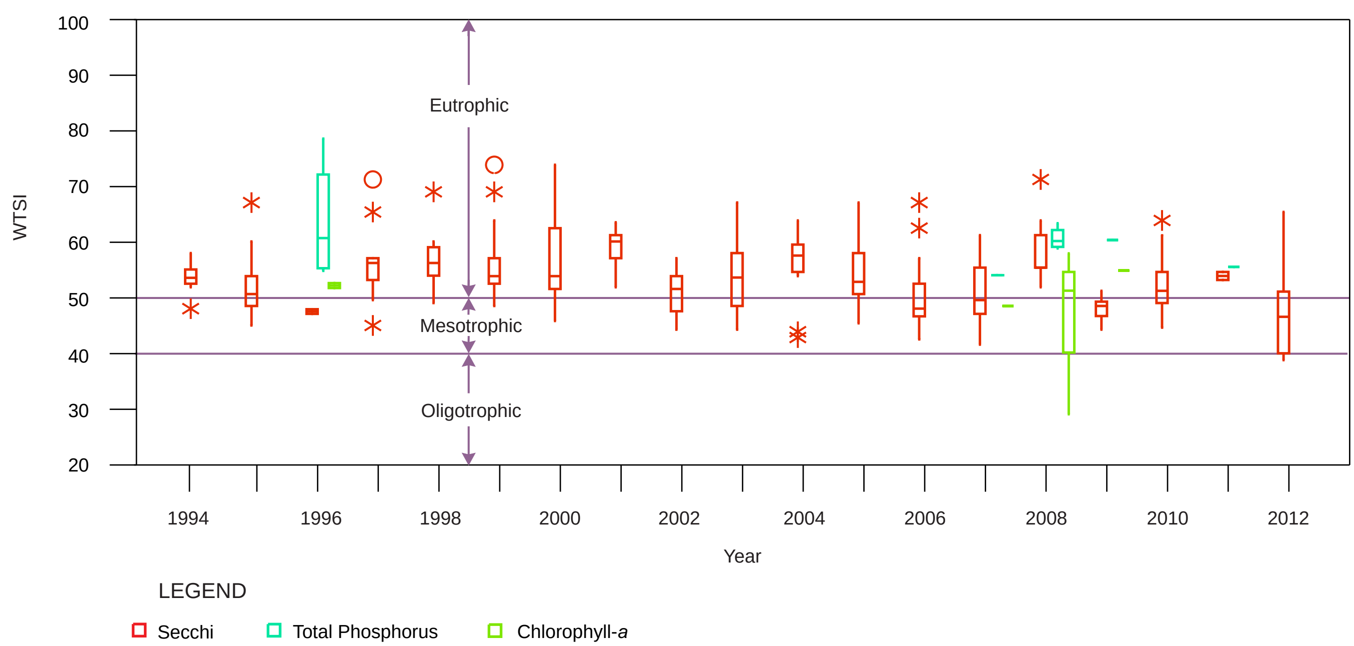


NOTE: See Figure 11 for description of symbols.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 54

WISCONSIN TROPHIC STATE INDEX VALUES FOR UPPER KELLY LAKE: 1994-2012



NOTE: See Figure 11 for description of symbols.

Source: Wisconsin Department of Natural Resources and SEWRPC.

of subsequent data indicated that as of 1995, the recommended water use objectives were only being partially achieved in the majority of the streams in the watershed.[93]

During the 1998-2004 baseline period examined in the RWQMPU, the recommended water use objectives were only partially achieved in much of the Root River watershed.[94] Based on review of data from 1998 to 2004, the RWQMPU drew the following conclusions:

- Ammonia concentrations in all samples taken along the mainstem and Husher Creek were under the acute toxicity criterion for fish and aquatic life, indicating compliance with the standard.

- Dissolved oxygen concentrations from stations along the mainstem of the Root River upstream of Grange Avenue, from the station near the mouth of the River, and from the station along the Root River Canal were commonly below the relevant standard, indicating frequent violation of the standard. Dissolved oxygen concentrations from all of the samples from Husher Creek were above the relevant standard, indicating compliance with the standard.

- Water temperatures in all samples taken from the mainstem and from Husher Creek and the Root River Canal were at or below the relevant standard, indicating compliance with the standard.

- Fecal coliform bacteria standards were commonly exceeded at stations along the mainstem of the Root River and at the station along the Root River Canal, indicating frequent violation of the standard.

- Concentrations of total phosphorus in the mainstem of the Root River, Husher Creek, and the Root River Canal commonly exceeded the recommended levels in the regional water quality management plan.[95]

Achievement of Water Use Objectives during the Period 2005 through Mid-2012

Table 35 presents a comparison of water quality constituents in the streams, lakes, and ponds of the Root River watershed to applicable water quality criteria for the period beginning in 2005 and continuing through mid-2012. This comparison examines ambient levels of five water quality constituents: water temperature and concentrations of dissolved oxygen, chloride, total phosphorus, and fecal coliform bacteria. In the case of water temperature and chloride concentration, ambient levels were compared to two applicable criteria—one which applies to acute effects to aquatic organisms and another which applies to chronic conditions. Because data regarding concentrations of fecal coliform bacteria are not available for much of the watershed, Table 35 also compares concentrations of *E. coli* to levels in the USEPA's recommended recreational water quality criteria.

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[93]*SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995.*

[94]*SEWRPC Technical Report No. 39,* op. cit.

[95]*This evaluation was conducted prior to the enactment of Wisconsin's phosphorus rule. In this evaluation, total phosphorus concentrations were compared to a planning standard of 0.10 mg/l that was recommended in the initial regional water quality management plan.*

Table 35

WATER QUALITY CHARACTERISTICS OF STREAMS, LAKES, AND PONDS IN THE ROOT RIVER WATERSHED: 2005-2012[a]

			Percent of Samples Meeting Water Quality Criteria (total number of samples indicated in parentheses)									
				Temperature		Chloride			Bacteria			
									Fecal Coliform Bacteria		*Escherichia coli*	
Stream Reach	Stream Length (miles)	Codified Water Use Objective[b]	Dissolved Oxygen	Sublethal	Acute	Chronic	Acute	Total Phosphorus	Single Sample	Geometric Mean	Single Sample	Geometric Mean
Upper Root River-Headwaters Assessment Area												
Root River above Cleveland Avenue	1.1	FAL	57.5 (73)	- -	- -	100.0 (74)	100.0 (74)	46.6 (73)	26.0 (73)	16.4 (73)	- -	- -
Root River between the intersection of W. National Avenue and W. Oklahoma Avenue and Cleveland Avenue	0.5	FAL	48.3 (263)	91.7 (22)	100.0 (184)	71.6 (76)	97.4 (76)	18.8 (80)	16.0 (75)	9.3 (75)	- -	- -
Hale Creek	1.0	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
West Branch Root River[c]	2.5	LAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Upper Root River Assessment Area												
Root River between W. Cold Spring Road and the intersection of W. National Avenue and W. Oklahoma Avenue	0.8	FAL	22.9 (376)	94.9 (39)	100.0 (282)	96.1 (76)	100.0 (76)	26.5 (83)	29.7 (74)	14.9 (74)	- -	- -
Root River between W. Grange Avenue and W. Cold Spring Road	2.5	FAL	37.2 (392)	97.4 (38)	100.0 (291)	89.9 (79)	98.7 (79)	24.4 (86)	26.8 (82)	14.6 (71)	0.0 (6)	0.0 (6)
104th Street Branch	1.0	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Wildcat Creek	1.6	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Unnamed Tributary 5 to Root River	0.8	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Unnamed Tributary 4 to Root River	1.0	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Unnamed Tributary 3 to Root River	0.4	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Whitnall Park Creek Assessment Area												
Whitnall Park Creek upstream from the former Hales Corners WWTP	0.6	LAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Whitnall Park Creek downstream from the former Hales Corners WWTP	2.4	LFF	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Upper Kelly Lake Tributary	0.8	LAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Northwest Branch Whitnall Park Creek	1.4	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
North Branch Whitnall Park Creek	0.4	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Tess Corners Creek	4.0	LFF	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

Table 35 (continued)

Stream Reach	Stream Length (miles)	Codified Water Use Objective[b]	Percent of Samples Meeting Water Quality Criteria (total number of samples indicated in parentheses)									
			Dissolved Oxygen	Temperature		Chloride		Total Phosphorus	Bacteria			
									Fecal Coliform Bacteria		*Escherichia coli*	
				Sublethal	Acute	Chronic	Acute		Single Sample	Geometric Mean	Single Sample	Geometric Mean
Whitnall Park Creek Assessment Area (continued)												
Boerner Botanical Garden Pond No. 1	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Boerner Botanical Garden Pond No. 2	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Boerner Botanical Garden Pond No. 3	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Lake Brittany	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Lower Kelly Lake	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Monastery Lake	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Shoetz Park Pond	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Upper Kelly Lake	- -	FAL	- -	- -	- -	- -	- -	12.5 (8)	- -	- -	- -	- -
Whitnall Park Pond	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Middle Root River-Dale Creek Assessment Area												
Root River between W. Drexel Avenue and W. Grange Avenue	5.8	FAL	100.0 (1)	- -	- -	- -	- -	- -	- -	- -	- -	- -
Dale Creek	1.4	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Scout Lake Creek	0.7	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Unnamed Tributary 2 to Root River	1.5	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Koepmeir Lake	- -	FAL	- -									
Root River Parkway Pond[d]	- -	FAL	- -									
Scout Lake	- -	FAL	60.0 (15)[e]	- -	- -[f]	- -	- -	0.0 (5)	- -	- -	- -	- -
East Branch Root River Assessment Area												
East Branch Root River[g]	4.0	LAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Woods Creek[h]	1.4	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Franklin High School Pond	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Mud Lake	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Middle Root River-Legend Creek Assessment Area												
Root River between W. Ryan Road and W. Drexel Avenue	2.9	FAL	93.7 (79)	- -	- -	98.7 (76)	100.0 (76)	39.0 (82)	62.5 (80)	42.5 (80)	57.1 (7)	28.6 (7)
Legend Creek	3.0	FAL	81.8 (66)	- -	- -	- -	- -	50.0 (8)	- -	- -	53.8 (65)	43.1 (65)
Tuckaway Creek	1.2	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

Table 35 (continued)

Stream Reach	Stream Length (miles)	Codified Water Use Objective[b]	Percent of Samples Meeting Water Quality Criteria (total number of samples indicated in parentheses)									
			Dissolved Oxygen	Temperature		Chloride		Total Phosphorus	Bacteria			
									Fecal Coliform Bacteria		*Escherichia coli*	
				Sublethal	Acute	Chronic	Acute		Single Sample	Geometric Mean	Single Sample	Geometric Mean
Upper West Branch Root River Canal Assessment Area												
West Branch Root River Canal above CTH C	4.4	LAL	100.0 (72)	- -	100.0 (576)[i]	- -	- -	- -[j]	- -	- -	1.4 (74)	0.0 (74)
Unnamed Tributary to West Branch Root River Canal upstream of CTH C	1.2	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Lower West Branch Root River Canal Assessment Area												
West Branch Root River Canal between STH 20 and CTH C	1.9	LFF	100.0 (2)	- -	- -	- -	- -	- -	- -	- -	50.0 (2)	0.0 (2)
West Branch Root River Canal between confluence with East Branch Root River Canal and STH 20	4.4	FAL	98.6 (70)	- -	- -	- -	- -	0.0 (10)	- -	- -	52.9 (70)	28.6 (70)
Union Grove Tributary to West Branch Root River Canal	3.4	FAL	100.0 (2)	- -	- -	- -	- -	- -	- -	- -	0.0 (2)	0.0 (2)
Yorkville Creek[k]	2.0	FAL	0.0 (2)	- -	- -	- -	- -	- -	- -	- -	50.0 (2)	0.0 (2)
50th Road Tributary to West Branch Root River Canal[l]	3.0	FAL	100.0 (2)	- -	- -	- -	- -	- -	- -	- -	0.0 (2)	0.0 (2)
Unnamed Tributary to 50th Road Tributary	1.7	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Tributary 2A to 50th Road Tributary	5.1	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Raymond Creek[m]	2.0	FAL	70.0 (66)	- -	- -	- -	- -	62.5 (8)	- -	- -	40.9 (66)	25.8 (66)
East Branch Root River Canal Assessment Area												
East Branch Root River Canal above STH 20	5.8	LAL	100.0 (72)	- -	- -	- -	- -	- -[j]	- -	- -	15.1 (73)	5.5 (73)
East Branch Root River Canal between confluence with West Branch Root River Canal and STH 20	5.1	LFF	79.1 (67)	- -	- -	- -	- -	37.5 (8)	- -	- -	80.6 (67)	65.7 (67)
Root River Canal Assessment Area												
Root River Canal	5.5	FAL	93.1 (72)	- -	- -	- -	- -	37.5 (8)	- -	- -	74.2 (66)	51.5 (66)
Unnamed Tributary to Root River Canal	3.4	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

Table 35 (continued)

Stream Reach	Stream Length (miles)	Codified Water Use Objective[b]	Percent of Samples Meeting Water Quality Criteria (total number of samples indicated in parentheses)									
			Dissolved Oxygen	Temperature		Chloride		Total Phosphorus	Bacteria			
									Fecal Coliform Bacteria		*Escherichia coli*	
				Sublethal	Acute	Chronic	Acute		Single Sample	Geometric Mean	Single Sample	Geometric Mean
Middle Root River-Ryan Creek Assessment Area												
Root River between County Line Road and W. Ryan Road	5.2	FAL	85.4 (82)	- -	- -	100.0 (76)	100.0 (76)	9.3 (75)	65.8(73)	38.4 (73)	- -	- -
Ryan Creek	6.0	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Oakwood Tributary[n]	4.5	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Oakwood Park Tributary	1.9	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Dumkes Lake	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
North Golf Course Pond No. 1	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
North Golf Course Pond No. 2	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
North Golf Course Pond No. 3	- -	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Lower Root River-Caledonia Assessment Area												
Root River between STH 38 and County Line Road	5.2	FAL	77.6 (67)	- -	- -	- -	- -	25.0 (8)	- -	- -	71.2 (66)	51.5 (66)
Root River between 5 Mile Road and STH 38	5.0	FAL	86.5 (74)	- -	- -	- -	- -	50.0 (8)	- -	- -	69.7 (66)	59.1 (66)
Root River between Johnson Park and 5 Mile Road	2.1	FAL	95.8 (238)	- -	- -[o]	100.0 (15)	100.0 (15)	25.0 (32)	83.3 (18)	66.7 (18)	63.3 (420)	47.9 (420)
Kilbournville Tributary	3.4	FAL	100.0 (1)	- -	- -	- -	- -	- -	- -	- -	- -	- -
Tributary R2 to Root River	1.4	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Husher Creek	5.2	FAL	77.6 (67)	- -	- -	- -	- -	50.0 (8)	- -	- -	25.8 (66)	12.1 (66)
Tributary R5 to Root River	0.7	FAL	- -	- -	- -	- -	- -	- -	- -	- -		
Crayfish Creek	2.7	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Caledonia Branch	1.8	FAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Hoods Creek Assessment Area												
Hoods Creek	9.3	LFF	98.5 (67)	- -	- -	- -	- -	0.0 (8)	- -	- -	59.1 (66)	39.4 (66)
Ives Grove Ditch	1.2	LAL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Lower Root River-Johnson Park Assessment Area												
Root River between Horlick Dam and Johnson Park	5.6	FAL	94.6 (223)	- -	- -[p]	- -	- -	32.0 (25)	- -	- -	72.4 (486)	60.9 (486)

Table 35 (continued)

Stream Reach	Stream Length (miles)	Codified Water Use Objective[b]	Percent of Samples Meeting Water Quality Criteria (total number of samples indicated in parentheses)										
			Dissolved Oxygen	Temperature		Chloride		Total Phosphorus	Bacteria			
									Fecal Coliform Bacteria		*Escherichia coli*	
				Sublethal	Acute	Chronic	Acute		Single Sample	Geometric Mean	Single Sample	Geometric Mean
Lower Root River-Racine Assessment Area												
Root River between Spring Street and Domanik Street and Horlick Dam	2.4	FAL	99.3 (299)	- -	- -	- -	- -	16.0 (25)	- -	- -	62.0 (724)	48.5 (724)
Root River between REC Center and Spring Street and Domanik Street	1.9	FAL	99.2 (624)	- -	- -	- -	- -	21.3 (61)	- -	- -	39.6 (1,751)	28.6 (1,751)
Root River between the confluence with Lake Michigan and the REC Center	1.6	FAL	97.9 (679)	- -	- -[q]	- -	- -	14.0 (43)	- -	- -	59.4 (1,556)	48.5 (1,556)
Quarry Lake	- -	FAL	- -	- -	- -	- -	- -	- -			97.5 (354)	94.6 (354)

[a]*In addition to providing an evaluation of water quality conditions in streams, lakes, and ponds for which water quality data are available, this table provides an overall inventory of waterbodies for which future data collection efforts might be developed.*

[b]*FAL indicates warmwater fish and aquatic life, LFF indicates limited forage fish, LAL indicates limited aquatic life. The water quality criteria that apply to these objectives are given in Tables 28 and 29.*

[c]*This stream is also known as the New Berlin Memorial Hospital Tributary*

[d]*This pond is also known as Anderson Lake.*

[e]*This represents dissolved oxygen profiles from five dates. In each case, dissolved oxygen concentrations in the epilimnion and metalimnion were above the criterion of 5.0 mg/l while concentrations in the hypolimnion were below the criterion.*

[f]*Because continuously recorded temperature data were not available for this site, daily maximum water temperatures could not be determined and the percentage of days over which the daily maximum temperature was in compliance with the acute temperature criteria could not be determined. Water temperatures in five temperature profiles were below the acute temperature criterion.*

[g]*This stream is also known as the Franklin Tributary.*

[h]*This stream is also known as Unnamed Tributary 1 to the East Branch Root River.*

[i]*Temperature in this stream reach was assessed against the State's water quality criterion for temperature for limited aquatic life waters. This criterion states that water temperature is not to exceed 86^{o}F.*

[j]*While total phosphorus data are available for this stream reach, it was not compared to the phosphorus criterion because NR 102.06 excludes limited aquatic life waters from the phosphorus criterion.*

[k]*This stream is also known as Tributary No. 3 to West Branch Root River Canal.*

[l]*This stream is also known as Unnamed Tributary No. 2 to the West Branch Root River Canal.*

[m]*This stream is also known as Tributary No. 1 to the West Branch Root River Canal.*

[n]*This stream is also known as Unnamed Creek west of 92nd Street.*

Footnotes to Table 35 (continued)

[o]Because continuously recorded temperature data were not available for this site, daily maximum water temperatures could not be determined and the percentage of days over which the daily maximum temperature was in compliance with the acute temperature criteria could not be determined. Water temperatures in two out of 195 grab samples collected in this reach exceeded the applicable acute temperature criterion, indicating that there were occasional exceedences of the criterion over the time period examined.

[p]Because continuously recorded temperature data were not available for this site, daily maximum water temperatures could not be determined and the percentage of days over which the daily maximum temperature was in compliance with the acute temperature criteria could not be determined. Water temperature in one out of 488 grab samples collected in this reach exceeded the applicable acute temperature criterion, suggesting that there were occasional exceedences of the criterion over the time period examined.

[q]Because continuously recorded temperature data were not available for this site, daily maximum water temperatures could not be determined and the percentage of days over which the daily maximum temperature was in compliance with the acute temperature criteria could not be determined. Water temperatures in five out of 1,550 grab samples collected in this reach exceeded the applicable acute temperature criterion, indicating that there were occasional exceedences of the criterion over the time period examined.

Source: SEWRPC.

During the period 2005 through mid-2012, the recommended water use objectives were only being partially achieved in much of the Root River watershed. Review of the data from this period shows the following:

- Dissolved oxygen concentrations from stations along the mainstem of the Root River in the upper nine miles upstream from W. Grange Avenue were usually below the applicable water quality criterion, indicating general noncompliance with the standard. In the approximately 37-mile-long reach downstream from W. Grange Avenue, dissolved oxygen concentrations were generally in compliance with the applicable water quality criterion. The one exception to this was that dissolved oxygen concentrations in the approximately 10-mile-long reach between County Line Road and 5 Mile Road were occasionally below the applicable water quality criterion, indicating occasional noncompliance with the standard. Dissolved oxygen concentrations in Legend Creek and in the downstream portions of the East Branch of the Root River Canal were occasionally below the applicable water quality criterion, indicating occasional noncompliance with the standard. Dissolved oxygen concentrations in Raymond Creek were often below the applicable water quality criterion, indicating frequent noncompliance with the standard. Dissolved oxygen concentrations in other tributary streams for which data were available were generally in compliance with the applicable water quality criteria. In Scout Lake, concentrations of dissolved oxygen were above the applicable water quality criterion in surface waters, but were usually below the applicable water quality criterion in samples collected from the hypolimnion.

- At those sites along the mainstem of the Root River where maximum daily water temperatures could be determined, they rarely exceeded the applicable acute criterion for temperature. Where the weekly means of maximum daily water temperatures could be determined, they rarely exceeded the applicable sublethal criterion for temperature. This indicates that, at those locations where compliance could be assessed, water temperatures complied with the applicable water quality criteria for temperature.

- Chloride concentrations at sampling stations along the mainstem of the Root River were almost always below the acute criterion, indicating compliance with this standard. Chloride concentrations between W. Cleveland Avenue and the intersection of W. National Avenue and W. Oklahoma Avenue were occasionally above the chronic criterion, indicating occasional noncompliance with the standard in this reach. It should be noted that few chloride samples were collected anywhere in the watershed during the winter deicing season. Because of this, the level of compliance with the water quality criteria for chloride during the winter deicing season is unknown.

- Concentrations of total phosphorus at sampling stations along the mainstem of the Root River, tributary streams, Scout Lake, and Upper Kelly Lake were usually above the applicable water quality criterion, indicating general noncompliance with the standard.

- In most sections of the mainstem of the Root River for which data are available, concentrations of fecal coliform bacteria were usually higher than both the geometric mean criterion and the single sample criterion, indicating general noncompliance with the standard. In addition, at those locations along the mainstem of the Root River and along tributary streams for which data are available, concentrations of *E. coli* were often higher than the USEPA's recommended geometric mean criterion and the single sample criterion. At some stations, they were usually higher than the criteria. This suggests that these locations would also not comply with the State's water quality criteria for fecal coliform bacteria.[96] Concentrations of *E. coli* in Quarry Lake during the May through September swimming season were almost always below the USEPA's recommended geometric mean criterion and the single sample criterion, suggesting that this Lake was in compliance with the standard.

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[96]E. coli *is one of the species of bacteria included in the fecal coliform bacteria group.*

Table 36

IMPAIRED WATERS WITHIN THE ROOT RIVER WATERSHED: 2012[a]

Stream	Impairment	Extent (river mile)[b]	Contributing Pollutants	Listing Date
Husher Creek	Degraded biological community	0-3.4	Total phosphorus	Proposed 2012
Root River	Low dissolved oxygen, degraded biological community	20.48-43.95	Total phosphorus	1998
	Low dissolved oxygen	20.48-43.95	Sediment, total suspended solids	1998
	Degraded biological community	5.82-26.3	Total phosphorus	Proposed 2012
	Contaminated fish tissue	0-5.82	PCBs	1998
	No identified impairment[c]	0-5.82	Total phosphorus	Proposed 2012
Root River Canal	Low dissolved oxygen	0-5.72	Sediment, total suspended solids	1998
	Low dissolved oxygen	0-5.72	Total phosphorus	1998
West Branch Root River Canal	Low dissolved oxygen	0-4.43	Sediment, total suspended solids	1998
	Low dissolved oxygen	0-4.43	Total phosphorus	1998

[a]*As listed on the State of Wisconsin's impaired waters list pursuant to Section 303(d) of the Federal Clean Water Act.*

[b]*For the Root River, river mile is the distance upstream from the confluence with Lake Michigan. For tributary streams, river mile is the distance upstream from the confluence with the waterbody the stream flows into.*

[c]*Total phosphorus concentrations in this section of the River exceed the State's water quality criterion; however, the WDNR has not documented any biological impacts.*

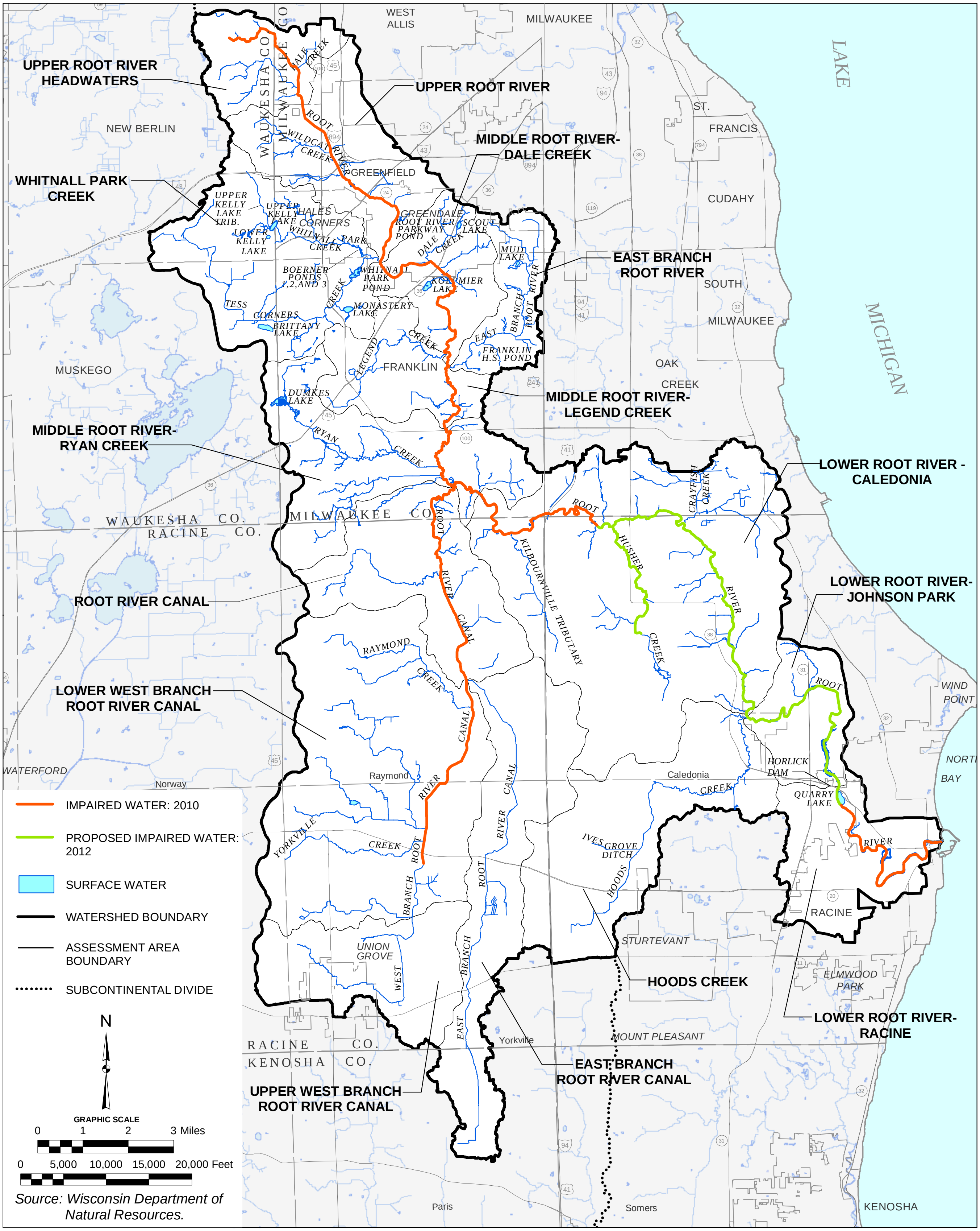
Source: Wisconsin Department of Natural Resources.

Section 303(d) of the Federal Clean Water Act requires that states periodically submit a list of impaired waters to the USEPA for approval. Wisconsin most recently submitted this list in 2012. As of December 2012, the USEPA had not approved this list. The most recently approved list was submitted by the State in 2010. Table 36 and Map 38 indicate the stream reaches in the Root River watershed that were listed as impaired as of 2010 and that are proposed to be listed as of 2012.

The entire mainstem of the Root River is either currently listed as impaired or proposed for listing. The section of the River upstream from river mile 20.48, approximately the location of the CTH V crossing, is listed as being impaired due to low concentrations of dissolved oxygen. Total phosphorus, sediment, and total suspended solids contributed by point and nonpoint source pollution are listed as contributing to this impairment. This section of the River is also listed as being impaired due to a degraded biological community. Total phosphorus contributed by point and nonpoint source pollution is listed as contributing to this impairment. The section of the River between Horlick dam and the confluence with Lake Michigan is listed as being impaired due to fish consumption advisories necessitated by high concentrations of PCBs in the tissue of fish collected in this reach. The proposed 2012 impaired waters list includes the section of the River upstream from Horlick dam to river mile 26.3, approximately the location of the W. Oakwood Road crossing. This section of the River is considered impaired due to a degraded biological community. Total phosphorus is listed as contributing to this impairment. The proposed 2012 list also includes an additional impairment in the section of the River between Horlick dam and the

Map 38

IMPAIRED WATERS WITHIN THE ROOT RIVER WATERSHED: 2012



confluence with Lake Michigan. This section is considered impaired due to the fact that total phosphorus concentrations exceed the State's water quality criteria. It should be noted that the WDNR has not documented any biological impacts resulting from this.

Portions of three tributary streams are also currently listed as impaired or proposed for listing. The entire length of the Root River Canal is listed as being impaired due to low concentrations of dissolved oxygen. Total phosphorus, sediment, and total suspended solids from nonpoint source pollution are listed as contributing to this impairment. The West Branch of the Root River Canal between STH 20 and its confluence with the East Branch of the Root River Canal is listed as being impaired due to low concentrations of dissolved oxygen. Total phosphorus, sediment, and total suspended solids contributed by nonpoint source pollution are listed as contributing to this impairment. The proposed 2012 list includes the section of Husher Creek from its confluence with the mainstem of the Root River upstream to river mile 3.4. This section of the Creek is considered impaired due to a degraded biological community. Total phosphorus is listed as contributing to this impairment.

Implications of Water Quality Relative to the Focus Issues of This Plan

As discussed in Chapter I of this report, the Root River watershed restoration plan provides targeted recommendations to address four focus issues: water quality, recreational use and access, habitat conditions, and flooding. The examination and evaluation of water quality presented in this section has several implications relative to these focus issues.

Water Quality

Dissolved oxygen concentrations constitute a critical water quality constituent for fish and aquatic life. The low concentrations of dissolved oxygen in some stream reaches and the high variability in others is likely driven by inputs of nutrients, especially phosphorus, to the surface water system. Reductions in phosphorus inputs would probably lead to improvements in conditions relative to dissolved oxygen.

Habitat

The state of water quality in the Root River watershed constitutes a limitation on the habitat available to fish and other aquatic organisms. Low concentrations of dissolved oxygen are likely to be excluding sensitive species from some stream reaches of the watershed. As discussed above, some stream reaches exhibit wide swings in dissolved oxygen concentrations that are associated with dense growth of attached algae and macrophytes. These swings in concentration are also likely to be excluding sensitive species from portions of the surface water system.

Recreation

The state of water quality places at least two limitations on recreational use of surface water resources in the Root River watershed. As noted in the preceding subsection, water quality places limits on the habitat available to fish and other aquatic organisms. Upstream from Horlick dam, this is one factor contributing to the presence of a poor quality fishery with few of the top carnivore species that constitute a high-quality recreational fishery.[97] In addition, with the exception of Quarry Lake, high concentrations of bacteria indicative of fecal contamination have been detected at all of the locations in the watershed that have been sampled for indicator bacteria. This indicates that there is a risk that waterborne disease-causing agents are present in most waterbodies in the watershed and that the water is not safe for recreational uses involving bodily contact. This constitutes a substantial limitation on the recreational use of surface waterbodies in the Root River watershed.

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[97] *Other potential factors contributing to the poor quality fishery include the barrier to fish passage represented by the dam, possible obstructions to passage at road crossings, and other unfavorable habitat conditions, all of which are addressed more fully later in this report.*

It should be noted that these implications are drawn only from the analysis and evaluation of the existing state of water quality in the watershed. The existing state of the instream and riparian habitat also has implications relative to the focus issues of water quality, recreational use and access, habitat conditions, and flooding. These will be discussed as part of the inventory of habitat conditions that is presented in subsequent sections of this chapter.

BIOLOGICAL CONDITIONS OF THE ROOT RIVER WATERSHED

Aquatic and terrestrial wildlife communities have educational and aesthetic values, perform important functions in the ecological system, and are the basis for certain recreational activities. The location, extent, and quality of fishery and wildlife areas and the types of fish and wildlife found in those areas are important determinants of the overall quality of the environment in the Root River watershed.

The Root River can be characterized as a continuum, with the River forming the backbone of a varied and diverse system of plants, aquatic organisms, and terrestrial wildlife. Some of the organisms support human recreational activities, such as fishing and hunting. Others provide visual amenities and support human activities in the watershed. The diversity and abundance of these organisms provides important insight into the past and existing conditions in the watershed.

Fisheries

The quality of streams and rivers is often assessed based on measures of the chemical or physical properties of water. However, a more comprehensive perspective includes consideration of resident biological communities as well. Guidelines to protect human health and aquatic life have been established for specific physical and chemical properties of water and have become useful yardsticks for assessing water quality. Biological communities provide additional crucial information because they live within streams for weeks to years and therefore integrate through time the effects of changes to their chemical or physical environment.[98]

In addition, biological communities are a direct measure of stream health—an indicator of the ability of a stream to support aquatic life. Thus, the condition of biological communities, integrated with key physical and chemical properties, provides a comprehensive assessment of stream health. The presence and abundance of species in a biological community are a function of the inherent requirements of each species for specific ranges of physical and chemical conditions. Therefore, when changes in land and water use in a river basin cause physical or chemical properties of streams to exceed their natural ranges, vulnerable aquatic species are eliminated, and this ultimately impairs the biological condition and stream health.[99]

The most recent biological assessment within the greater Milwaukee metropolitan area that included sites within the Root River watershed identified a strong relationship between water and aquatic community quality and amount of urban land use.[100] For example, some water quality constituents such as total phosphorus and median chloride concentrations have tended to increase with increasing urban development in several watersheds in the greater Milwaukee area. However, it is important to note that not all water quality constituents showed the same pattern in relationship with urban lands. Some showed opposite responses and some showed no patterns at all, which is similar to what SEWRPC documented for the Root River watershed in the 2007 technical report on

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[98]*D.M. Carlisle and others,* The Quality of Our Nation's Waters—Ecological Health in the Nation's Streams, *1993–2005: U.S. Geological Survey Circular 1391, 2013 (available online at:* http:// pubs.usgs.gov/circ/1391/*).*

[99]Ibid.

[100]*J.C. Thomas, M.A. Lutz, and others,* Water Quality Characteristics for Selected Sites Within the Milwaukee Metropolitan Sewerage District Planning Area, February 2004-September 2005, *U.S. Geological Survey Scientific Investigations Report 2007-5084, 2007.*

water quality conditions and sources of pollution in the greater Milwaukee River watersheds (TR No. 39).[101] However, Figures 55 and 56 show the strong negative relationship between both fisheries Index of Biotic Integrity (IBI) and macroinvertebrate Hilsenhoff Biotic Index (HBI) quality and increased levels of urbanization among the greater Milwaukee River watersheds.[102,103,104] More specifically, the highly developed upper reaches of the upper Root River watershed (at sites in the Cities of Franklin and Greenfield) have very poor fishery scores and fair macroinvertebrate scores.

Nonetheless, overall aggregate bioassessment rankings of the USGS study, which are averages of the three trophic-level rankings (fish, macroinvertebrate, and algae), show that the Root River sites in the upper portion of the Root River watershed fall within the second quartile of the streams and rivers evaluated under that study (see Table 37), indicating that that part of the watershed is only moderately degraded when compared to the other watersheds within the greater Milwaukee area shown in Table 37. The least degraded or highest-quality fish, invertebrate, and algal communities were located in less developed watersheds, including the upper portions of the Milwaukee and Menomonee Rivers.[105] The poorest biological communities were associated with the highest urbanized watersheds and include Honey Creek, Underwood Creek, and the Kinnickinnic River. This is also consistent with observations detailed in TR No. 39.[106]

The report concluded that the biological community in the Root River in Milwaukee County is limited primarily due to 1) periodic stormwater pollutant loads (associated with increased flashiness), agricultural pollutant loads, and legacy loads from now-abandoned wastewater treatment plants; 2) decreased base flows and increased water temperatures due to urbanization; and 3) habitat loss and continued fragmentation due to culverts and Horlick dam and past channelization (see Physical Conditions section below). Despite these impairments the aquatic community within the Root River has improved in some areas of the watershed (see below), which demonstrates its resilience and potential to continue to improve over time as best management practices are implemented as recommended in Chapter VI in this report.

Since publication of TR No. 39, which included a summary of the fishery quality within the Root River watershed from 1900 through 2004, there has been significant updated research related to both fisheries thermal tolerances and tools to assess fishery quality that include the *stream model*, *coolwater IBI*, and *headwater IBI* as described in the Fisheries Classification section below.[107] Therefore, the summary below can be considered an update of the

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[101]*SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee River Watersheds, *November 2007.*

[102]Ibid.

[103]*William L. Hilsenhoff, "An Improved Biotic Index of Organic Stream Pollution,* The Great Lakes Entomologist, *Volume 20, pages 31-39, 1987.*

[104]*The HBI represents the average weighted pollution tolerance values of all arthropods present in a sample. It is based upon the macroinvertebrate community's response to high loading of organic pollutants and reductions in the concentration of dissolved oxygen.*

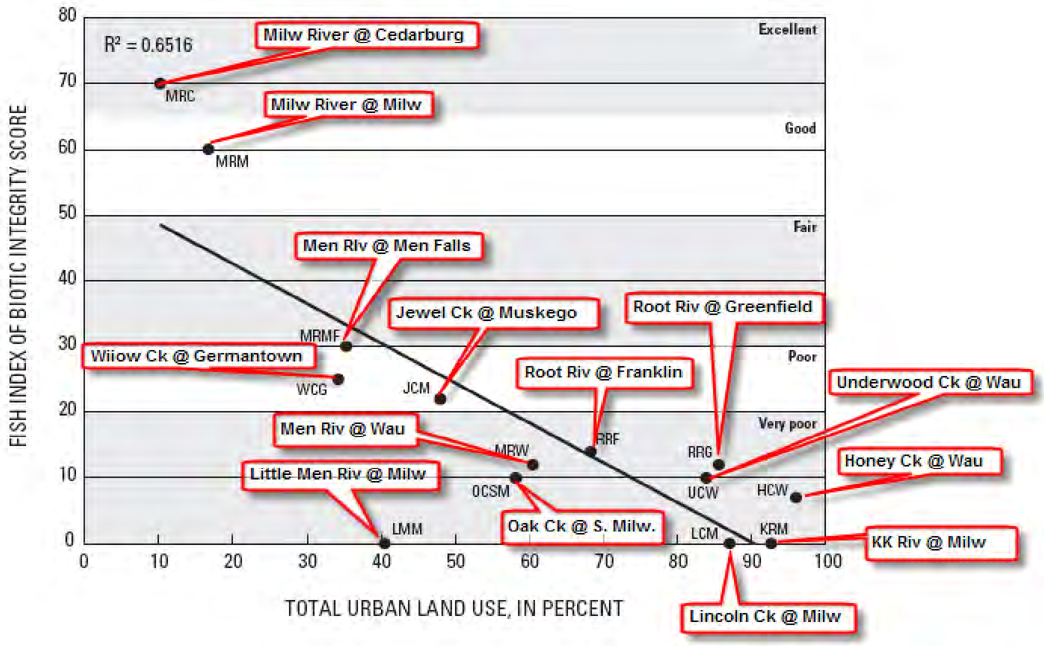
[105]Ibid.

[106]*SEWRPC Technical Report No. 39,* op. cit.

[107]*John Lyons, "Wisconsin Department of Natural Resources, An Overview of the Wisconsin Stream Model," January 2007; John Lyons, et. al., "Defining and characterizing coolwater streams and their fish assemblages in Michigan and Wisconsin, USA,"* North American Journal of Fisheries Management, *29: 1130-1151, 2009; John Lyons, "Development and validation of two fish-based indices of biotic integrity for assessing perennial coolwater streams in Wisconsin, USA," Ecological Indicators, 23:402-412, 2012; John Lyons, "A fish-based index of biotic integrity to assess intermittent headwater streams in Wisconsin, USA,"* Environmental Monitoring and Assessment, *122: 239–258, 2006.*

Figure 55

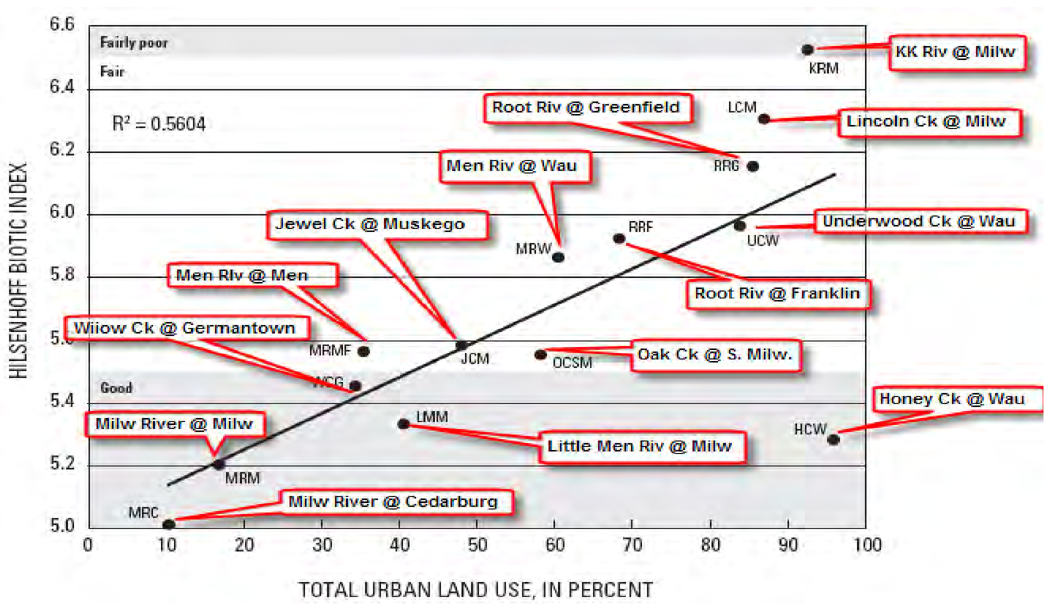
FISH INDEX OF BIOTIC INTEGRITY (IBI) SCORES COMPARED TO PERCENT URBAN LAND USE AMONG SITES IN THE GREATER MILWAUKEE WATERSHEDS



Source: *U.S. Geological Survey,* Water Quality Characteristics for Selected Sites Within the Milwaukee Metropolitan Sewerage District Planning Area, Wisconsin, February 2004-September 2005*, Scientific Investigations Report 2007-5084, 2007.*

Figure 56

A MODIFIED HILSENHOFF BIOTIC INDEX (HBI-10) COMPARED TO PERCENT URBAN LAND USE AMONG SITES IN THE GREATER MILWAUKEE WATERSHEDS



Source: *U.S. Geological Survey,* Water Quality Characteristics for Selected Sites Within the Milwaukee Metropolitan Sewerage District Planning Area, Wisconsin, February 2004-September 2005*, Scientific Investigations Report 2007-5084, 2007.*

Table 37

AVERAGE TROPHIC-LEVEL RANKINGS AND AGGREGATE BIOASSESSMENT RANKING AMONG STREAM SITES WITHIN THE GREATER MILWAUKEE WATERSHEDS: 2004-2005

Site	Average Trophic-Level Ranking: Fish[a]	Invertebrates[b]	Algae[c]	Aggregate Bioassessment Ranking
Milwaukee River near Cedarburg	1.00	1.33	2.00	1.44
Milwaukee River at Milwaukee	2.00	2.67	6.00	3.56
Jewel Creek at Muskego[d]	5.00	6.00	1.50	4.17
Menomonee River at Menomonee Falls	3.00	7.33	4.00	4.78
Willow Creek at Maple Road near Germantown	4.00	6.17	7.00	5.72
Root River near Franklin	6.00	6.67	8.50	7.06
Root River at Grange Avenue at Greenfield	7.50	11.00	7.00	8.50
Menomonee River at Wauwatosa	7.50	8.33	10.00	8.61
Oak Creek at South Milwaukee	9.50	7.33	9.50	8.78
Little Menomonee River at Milwaukee	13.00	8.33	6.50	9.28
Honey Creek at Wauwatosa	11.00	8.17	9.00	9.39
Underwood Creek at Wauwatosa	9.50	10.33	8.50	9.44
Lincoln Creek at N. 47th Street at Milwaukee	13.00	9.67	12.00	11.56
Kinnickinnic River at S. 11th Street at Milwaukee	13.00	11.67	13.50	12.72

NOTES: IBI = Index of Biotic Integrity; EPT = Ephemeroptera, Plecoptera, and Trichoptera; HBI = Hilsenhoff Biotic Index.

Fill color indicates quartile of ranking (each column is considered independently):

Quartile 1
Quartile 2
Quartile 3
Quartile 4

[a]*Averaged trophic-level rankings included only fish IBI scores.*

[b]*Averaged trophic-level rankings included Shannon index of diversity scores, percent of EPT taxa, and HBI-10 scores.*

[c]*Averaged trophic-level rankings included percent of most-sensitive diatoms and percent of sensitive diatoms.*

[d]*Located in the Fox River watershed.*

Source: U.S. Geological Survey, Water-Quality Characteristics for Selected Sites within the Milwaukee Metropolitan Sewerage District Planning Area, Wisconsin, February 2004-September 2005*, Scientific Investigations Report 2007-5084, 2007.*

fisheries IBI classification summary set forth in TR No. 39, because these new tools were not available at the time that report was completed (specifically, Map 98 and Figures 258 and 259 in Chapter IX of that report). The entire fishery dataset from TR No. 39 was re-analyzed in the section below using these new tools, including new data up to the year 2013. The warmwater IBI was the only tool available to assess the fishery within the Root River watershed at the time that TR 39 was issued, but using this index to assess coolwater streams led to an under-estimate of biotic integrity.[108] Hence, using the warmwater index for the coolwater streams within the Root River watershed in TR No. 39 resulted in these streams being misclassified as more degraded or undervalued (i.e., many sites were classified as very poor) than they would be under the new classification system, so these sites

[108]*John Lyons, et. al., "Defining and characterizing coolwater streams and their fish assemblages in Michigan and Wisconsin, USA,"* North American Journal of Fisheries Management*, 29: 1130-1151, 2009.*

needed to be updated as part of this watershed planning effort. In addition, the intermittent IBI was also used among selected sites where appropriate, which generally resulted in a higher quality/more accurate biotic integrity rating than previously reported in TR No. 39.

Fisheries Classification

In Wisconsin, high-quality warmwater systems are characterized by many native species, including cyprinids, darters, suckers, sunfish, and percids that typically dominate the fish assemblage. Pollution intolerant species (species that are particularly sensitive to water pollution and habitat degradation) are also common in such high-quality warmwater systems.[109] Pollution tolerant fish species (species that are capable of persisting under a wide range of degraded conditions) are typically present, but they do not dominate the fish fauna of these systems. Insectivores (fish that feed primarily on small invertebrates) and top carnivores (fish that feed on other fish, vertebrates, or large invertebrates) are generally common. Omnivores (fish that feed on both plant and animal material) also are generally common, but do not dominate. Simple lithophilous spawners (species that lay their eggs directly on large substrate, such as clean gravel or cobble, without building a nest or providing parental care for the eggs) are generally common.

In contrast to warmwater streams, coldwater systems are characterized by few native species, with salmonids (trout) and cottids (sculpin) dominating, and they lack many of the taxonomic groups that are important in high-quality warmwater streams.[110] An increase in fish species richness in coldwater fish assemblages often indicates environmental degradation. When degradation occurs, the small number of coldwater species is replaced by a larger number of more physiologically tolerant cool and warmwater species, which is the opposite of what tends to occur in warmwater fish assemblages (i.e., species are lost).

The warmwater and coldwater streams represent the upper and lower endpoints of a thermal continuum of fish species in temperate climates such as found in Wisconsin, but these two classifications do not adequately describe the full range of thermal variation of fisheries assemblages that exist.[111] Wisconsin also contains coolwater streams and their associated fish assemblages as well as intermittent headwater streams.[112] These systems and their associated fish assemblages are not as well understood as warmwater and coldwater fisheries, but these headwater and coolwater streams are far more numerous in terms of actual stream miles across the state of Wisconsin. For example, within Wisconsin coolwater, coldwater, and warmwater streams comprise 74.5 percent, 7.9 percent, and 17.6 percent, respectively, of the estimated total 54,033 miles of stream channel.[113] Similarly, in a separate study headwater streams were estimated to comprise 73 percent of the total amount of stream miles within the State. This demonstrates that there is definite overlap between coolwater stream and headwater stream classifications and that these constitute the major portion of streams at the State level as well as within the Root River watershed as demonstrated in the model output classifications described below and shown on Map 39.[114]

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[109]*John Lyons, "Using the Index of Biotic Integrity (IBI) to Measure Environmental Quality in Warmwater Streams of Wisconsin," United States Department of Agriculture, General Technical Report NC-149, 1992.*

[110]*John Lyons, "Development and Validation of an Index of Biotic Integrity for Coldwater Streams in Wisconsin,"* North American Journal of Fisheries Management, *Volume 16, May 1996.*

[111]*John Lyons, et. al., Defining and characterizing coolwater streams, 2009,* op. cit.

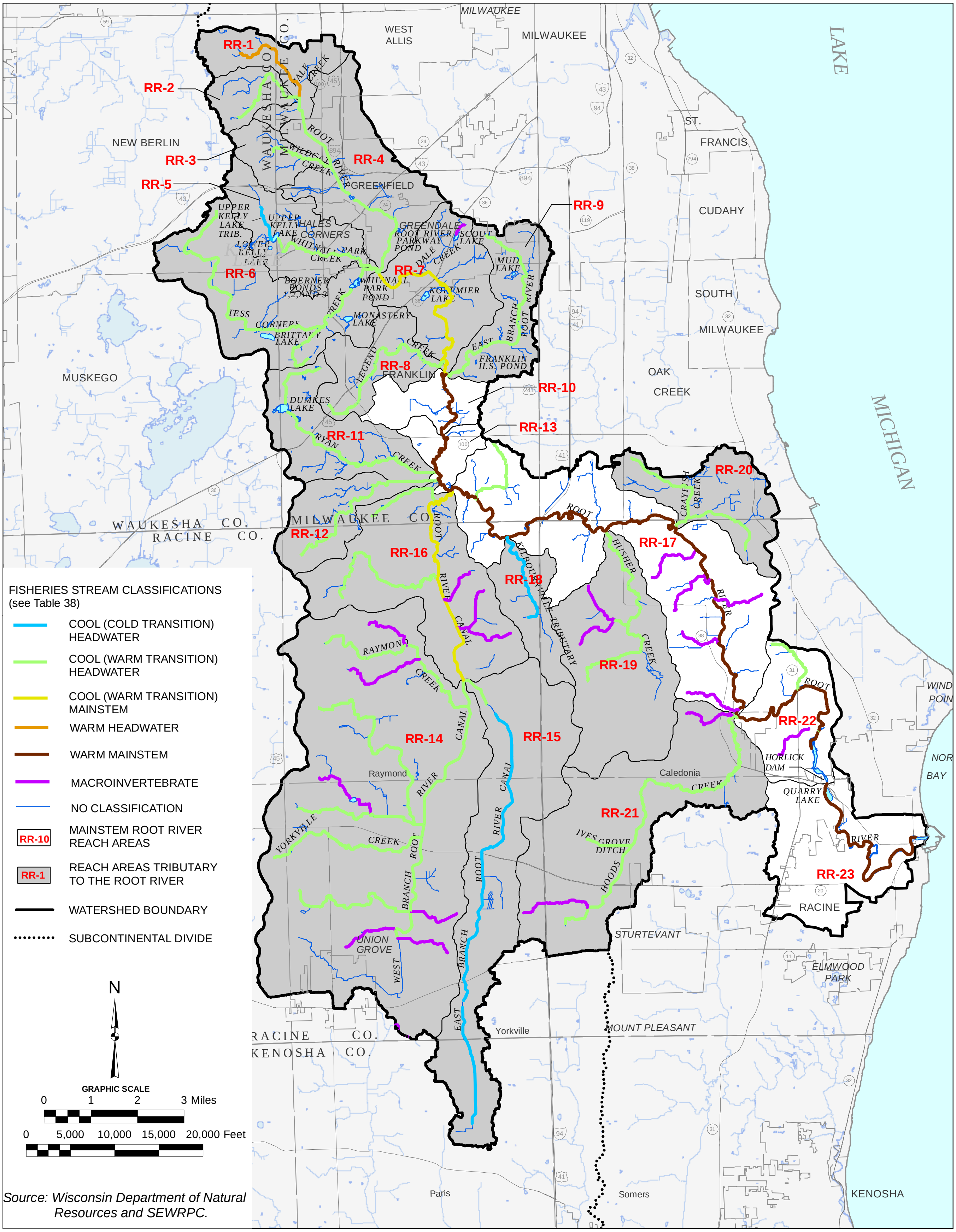
[112]*John Lyons, "A fish-based index of biotic integrity to assess intermittent headwater streams in Wisconsin, USA," Environmental Monitoring and Assessment, 122: 239–258, 2006; John Lyons, et. al., Defining and characterizing coolwater streams, 2009,* op. cit.

[113]*John Lyons, et. al., Defining and characterizing coolwater streams, 2009,* op. cit.

[114]*Headwater Fish–Lyons 2006,* op. cit.

Map 39

FISHERIES CLASSIFICATIONS WITHIN THE ROOT RIVER WATERSHED



Source: *Wisconsin Department of Natural Resources and SEWRPC.*

Headwater streams form the beginning of river systems or networks and function as a critical aquatic-terrestrial interface by which water and inorganic and organic materials enter these networks,[115] which helps to determine the nature of larger downstream waters. Given their small size, headwater streams, particularly intermittent streams that often go dry, can mistakenly be thought to have little value. However, these headwater streams are highly vulnerable to pollution, sedimentation, altered hydrology, channelization, alien species, and other human impacts, which can have significant negative consequences for streams further downstream. Therefore, "failure to provide sufficient environmental protection for small headwater streams will ultimately compromise efforts to maintain healthy river systems,"[116] so this is an important component included in the fishery and water quality recommendations in Chapter VI of this report.

Coolwater streams should not be considered useless or as having limited fisheries value compared to either coldwater or warmwater fish communities. When compared to coldwater and warmwater streams, coolwater sites are generally intermediate in species richness and fish abundance. Warmwater sites generally have higher total, native, and warmwater species and warmwater fish abundances than coolwater sites, which, in turn, have higher values than coldwater sites. In addition, the response of coolwater fish assemblages to environmental degradation differs from that of coldwater or warmwater assemblages, which is why a unique bioassessment index was developed in order to determine their biological integrity and underlying ecosystem health. As part of this development researchers found that the fish assemblage structure and composition were more variable and sensitive to water temperature in coolwater streams than they were in either coldwater or warmwater streams. Coolwater fish assemblages also overlap extensively with those of coldwater and warmwater streams, but coolwater assemblages could be divided into two separate subclasses as cold-transition and warm-transition assemblages (see Table 38). However, it is a misconception to think that only coldwater streams can support good coldwater fisheries or only warmwater streams can support good warmwater fisheries. Both coldwater and cold-transition streams are capable of supporting high abundances of coldwater fishes. For example, the greatest average abundances of brown trout occur in cold-transition streams. Similarly, warmwater and warm-transition sites are capable of supporting high abundances of warmwater fishes, although warmwater sport fish abundances are highest in warmwater sites. In summary, coolwater streams are more widespread and common than previously understood and this recognition is important and can help to improve the effectiveness of fisheries management (e.g., through fish stocking, instream and riparian habitat improvements, or fishing regulations) and environmental protection (e.g., establishment of thermal class specific regulations and/or biocriteria).

A stream model has recently been developed by the WDNR to classify stream reaches into their biotic community by fish occurrence and abundance, as well as the ecological conditions that largely determine the biotic community (i.e., stream flow and water temperature).[117] Although this model has some limitations, it does provide an objective, standardized, and ecologically meaningful framework to classify streams.[118] The proposed

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[115]*Vannote RL, Minshall GW, Cummins KW, Sedell JR, Cushing CE, "The river continuum concept,"* Can J Fisheries Aquat Sci*, 37:130–137, 1980.*

[116]*Headwater Fish–Lyons 2006,* op. cit.

[117]*John Lyons, "Patterns in the species composition of fish assemblages among Wisconsin streams,"* Environmental Biology of Fishes *Volume 45, 1996, pages 329-341.*

[118]*John Lyons, "Wisconsin Department of Natural Resources, An Overview of the Wisconsin Stream Model," January 2007.*

Table 38

PROPOSED WATER TEMPERATURE AND FLOW CRITERIA FOR DEFINING NATURAL STREAM BIOLOGICAL COMMUNITIES AND THE PROPOSED PRIMARY INDEX OF BIOTIC INTEGRITY (IBI) FOR BIOASSESSMENT

Natural Community	Maximum Daily Mean Water Temperature (˚F)	Annual 90 Percent Exceedence Flow (ft^3/s)	Primary Index of Biotic Integrity
Ephemeral	Any	0.0	N/A
Macroinvertebrate	Any	0.0-0.03	Macroinvertebrate
Cold Headwater	<69.3	0.03 -1.0	Coldwater Fish
Cold Mainstem	<69.3	>1.0	Coldwater Fish
Cool (Cold-Transition) Headwater	69.3-72.5	0.03-3.0	Headwater Fish
Cool (Cold-Transition) Mainstem	69.3-72.5	>3.0	Cool-Cold Transition Fish
Cool (Warm-Transition) Headwater	72.6-76.3	0.03-3.0	Headwater Fish
Cool (Warm-Transition) Mainstem	72.6-76.3	>3.0	Cool-Warm Transition Fish
Warm Headwater	>76.3	0.03-3.0	Headwater Fish
Warm Mainstem	>76.3	3.0-110.0	Warmwater Fish
Warm River	>76.3	>110.0	River Fish

Source: References for IBIs: Macroinvertebrate-Weigel 2003; Coldwater Fish–Lyons et al. 1996; Headwater Fish–Lyons 2006; Coolwater Fish–Lyons, 2012; Warmwater Fish–Lyons 1992; River Fish–Lyons et al. 2001.

natural community classification has 11 classes as summarized in Table 38, which have unique physical and biological characteristics as summarized below.[119] The 11 classes are associated with recommended Indices of Biotic Integrity to assess the fish communities within each classification.

- Ephemeral—Channels with water flow only after precipitation events (i.e., no base flow). No fish and few or no aquatic invertebrates are present.

- Macroinvertebrate—Very small, almost always intermittent (i.e., ceases flow for part of the year, although water may remain in the channel) streams. Few or no fish are present, but a variety of aquatic invertebrates are common, at least seasonally.

- Cold Headwater—Small, perennial streams with cold summer temperatures. Collectively, coldwater fishes are usually abundant (catch rate of greater than 100 fish per 100 meters of stream length sampled) to common (10 to100 per 100 meters), transitional fishes are common to absent, and

[119] *John Lyons, "Proposed temperature and flow criteria for natural communities for flowing waters," February 2008, updated October 2012; Weigel BM, "Development of stream macroinvertebrate models that predict watershed and local stressors in Wisconsin," J North Am Benthol Soc, 22:123–142, 2003. Coldwater Fish–Lyons et al. 1996,* op. cit.*; Headwater Fish–Lyons 2006,* op. cit.*; Coolwater Fish–Lyons, 2012,* op. cit.*; Warmwater Fish–Lyons 1992,* op. cit.*; and, John Lyons et al., "Development, validation, and application of a fish-based index of biotic integrity for Wisconsin's large warmwater rivers," Transactions of the American Fisheries Society, 130:1077-1094, 2001.*

warmwater fishes are absent. Because of the small size of the stream, trout populations consist almost exclusively of small fish (less than five inches) with larger fish absent except perhaps during spawning periods.

- Cold Mainstem—Moderate to large but still wadable perennial streams with cold summer temperatures. Coldwater fishes are abundant to common, transitional fishes are common to absent, and warmwater fishes are absent. The size of the stream is sufficient to support trout in a wide range of sizes.

- Cool (Cold-Transition) Headwater—Small, usually perennial streams with cold to cool summer temperatures. Coldwater fishes are common to uncommon (less than 10 per 100 meters), transitional fishes are abundant to common, and warmwater fishes are uncommon to absent. Headwater species are abundant to common, mainstem species are common to absent, and river species are absent.

- Cool (Cold-Transition) Mainstem—Moderate to large but still wadable perennial streams with cold to cool summer temperatures. Coldwater fishes are common to uncommon, transitional fishes are abundant to common, and warmwater fishes are uncommon to absent. Headwater species are common to absent, mainstem species are abundant to common, and river species are common to absent.

- Cool (Warm-Transition) Headwater—Small, sometimes intermittent streams with cool to warm summer temperatures. Coldwater fishes are uncommon to absent, transitional fishes are abundant to common, and warmwater fishes are common to uncommon. Headwater species are abundant to common, mainstem species are common to absent, and river species are absent.

- Cool (Warm-Transition) Mainstem—Moderate to large but still wadable perennial streams with cool to warm summer temperatures. Coldwater fishes are uncommon to absent, transitional fishes are abundant to common, and warmwater fishes are common to uncommon. Headwater species are common to absent, mainstem species are abundant to common, and river species are common to absent.

- Warm Headwater—Small, usually intermittent streams with warm summer temperatures. Coldwater fishes are absent, transitional fishes are common to uncommon, and warmwater fishes are abundant to common. Headwater species are abundant to common, mainstem species are common to absent, and river species are absent.

- Warm Mainstem—Moderate to large but still wadable perennial streams with relatively warm summer temperatures. Coldwater fishes are absent, transitional fishes are common to uncommon, and warmwater fishes are abundant to common. Headwater species are common to absent, mainstem species are abundant to common, and river species are common to absent.

- Warm Rivers—Nonwadable large to very large rivers with warm summer temperatures. Coldwater fishes are absent, transitional fishes are common to uncommon, and warmwater fishes are abundant to common. Headwater species are absent, mainstem species are common to uncommon, and river species are abundant to common.

Results of the stream model corroborate three main observations as shown on Map 39: 1) there are no coldwater streams within the Root River watershed; 2) warmwater fishery classification on the mainstem of the Root River extends for nearly 31 miles from about 4,000 feet downstream of West Drexel Avenue (i.e., upstream limit of Reach RR-10 at River Mile 30.7) to its mouth at Lake Michigan; and, 3) coolwater streams are the most common and widespread stream classification among reaches in this river system. More specifically, within the upper portion of the Root River watershed, the headwater tributaries that discharge to the mainstem reaches RR-10 and

RR-13 are classified as warm-transition coolwater streams, except for the Upper Kelly Lake Tributary within reach RR-5 that is classified as a cold-transition coolwater stream. The lower reaches of the watershed that discharge to mainstem reaches RR-17 and RR-22 are also classified as warm-transition coolwater streams, except for the East Branch of the Root River Canal and Kilbournville Tributary that are classified as cold-transition coolwater streams. These cold-transition classifications are surprising and indicate that these tributary reaches are potentially receiving more groundwater discharge than the other warm-transition tributaries in this watershed, although more information would need to be collected in order to verify these classifications.

Fisheries Assemblages

Through calculation of the Index of Biotic Integrity (IBI), data on the fish community can provide insight into the overall health of the river ecosystem in this watershed. Fish catches can also reveal trends in the populations of rare and sport fish species. The overall goal of the monitoring is to better document the current status of this biologically unique piece of river and to provide an early warning of declines in environmental quality and fisheries associated with human development in the watershed. Based on the classification output of the stream model for the Root River as described above, the appropriate warmwater, coolwater, and headwater streams Indices of Biotic Integrity were used to assess the health of each of these types of streams for the historical (pre-2000) and current (post-2000) data as shown on Maps 40 and 41, respectively.[120] Although the fish IBI is useful for assessing environmental quality and biotic integrity in streams, it is most effective when used in combination with additional data on physical habitat, water quality, macroinvertebrates, and other biota when evaluating a site.[121] Hence, supplemental data for macroinvertebrate surveys conducted by the WDNR are included on Maps 40 and 41, but a more thorough assessment and summary of these organisms can be found in the Macroinvertebrates section below.

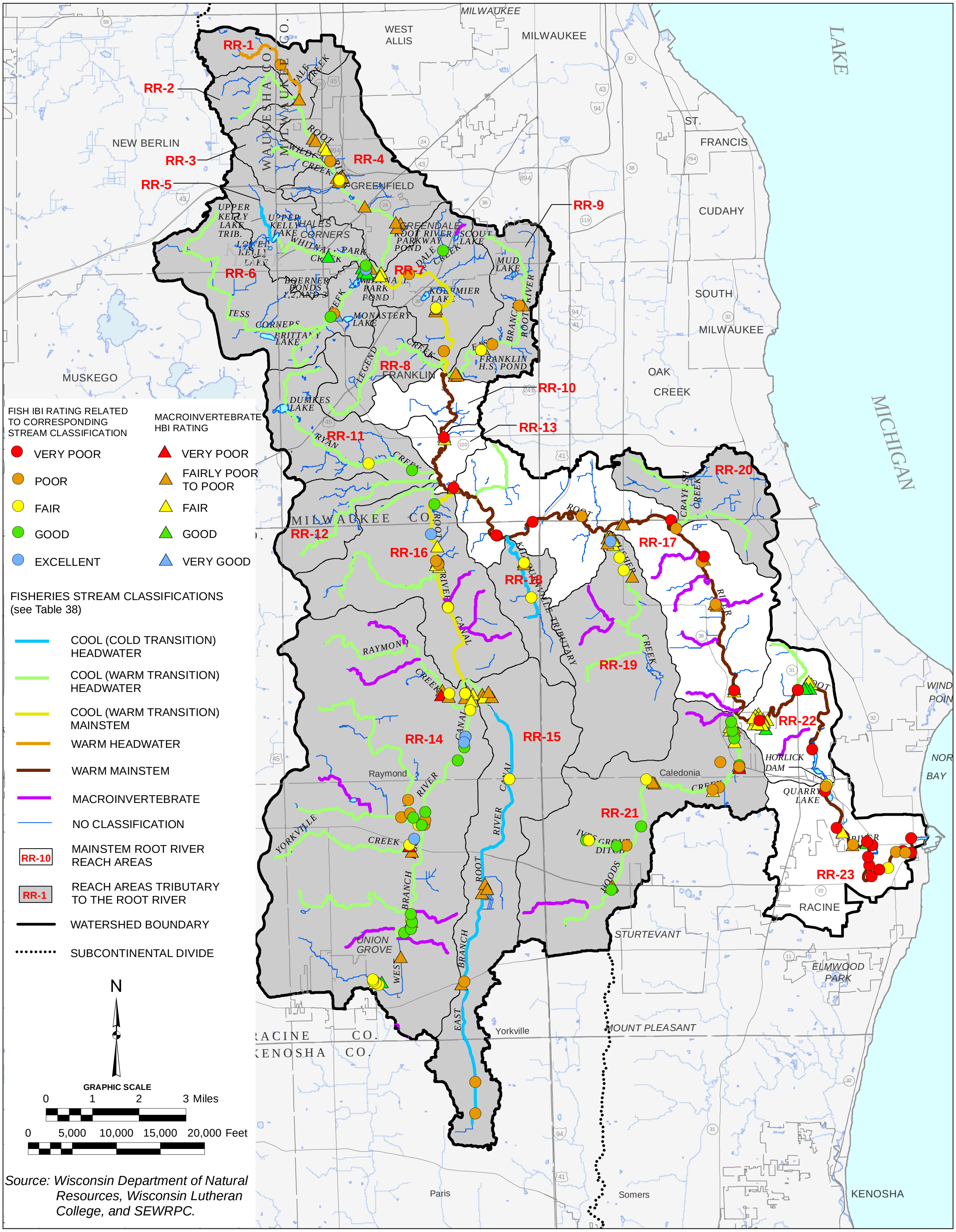
There is overlap between the coolwater and headwater stream classifications among reaches in the Root River as shown in Map 39. Although the headwater IBI is not applicable for larger perennial streams within the watershed, it was used to provide an assessment for the smaller tributaries and headwater reaches of the larger tributaries to the Root River as recommended by the stream model (see Table 38). Intermittent headwater streams are generally associated with less diverse fish assemblages than perennial coolwater stream systems. Therefore, an intermittent headwater IBI assessment will generally provide a better score when compared to the coolwater IBI assessment. Although these coolwater tributaries may not necessarily be intermittent streams, an intermittent headwater IBI was used to assess whether or not these tributaries were at least functioning as good-quality intermittent systems; the idea being that, given the high potential for fragmentation of fish passage and species extirpations, it is possible that these tributaries cannot currently function better than an intermittent headwater stream system. For example, comparison of the headwater IBI versus the coolwater IBI quality in Table 39 generally indicates that the majority of the tributaries sampled are functioning as fair and good headwater fisheries, which is valuable information and demonstrates their importance to the overall fishery in the Root River system. It is also important to note that Maps 40 and 41 show the maximum quality achieved within each subwatershed reach throughout the entire watershed for the historic and current time periods, respectively, as well as the highest quality ranking achieved by either the coolwater IBI or headwater IBI, whichever indicated better quality. Hence, Maps 40 and 41 and Table 39 show the best possible fish community quality achievable within a particular reach, as well as the highest functional stream assemblage achievable.

[120]*Note: Due to the limited comparable data available for both fisheries and macroinvertebrates within the Root River watershed, the existing conditions were combined for the years 2000 through 2013 and historical conditions included all previous years for which data were collected.*

[121]*John Lyons*, General Technical Report NC-149, op. cit.

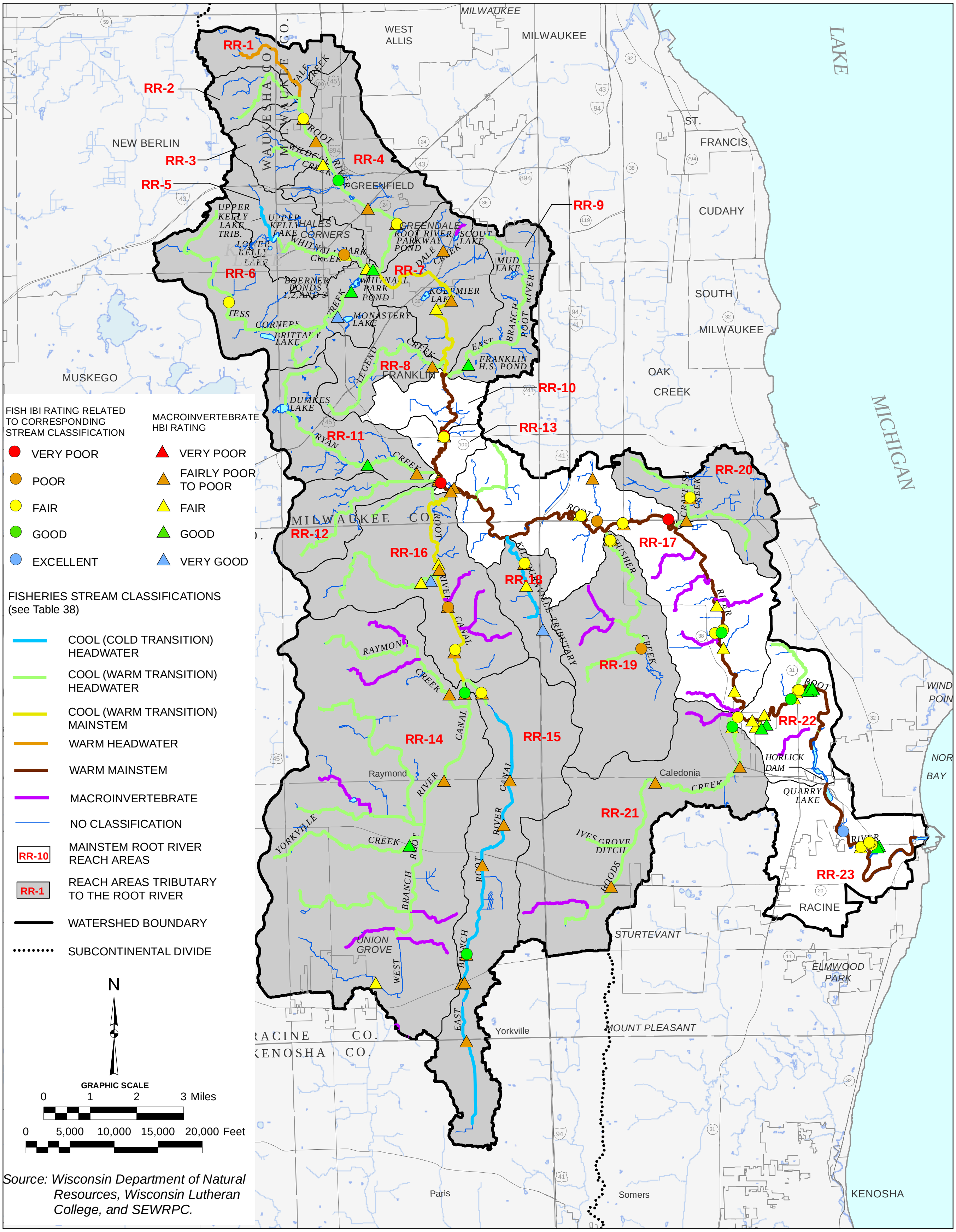
Map 40

FISHERIES AND MACROINVERTEBRATE SAMPLING LOCATIONS AND QUALITY AMONG STREAM CLASSIFICATIONS WITHIN THE ROOT RIVER WATERSHED: 1900-1999



Map 41

FISHERIES AND MACROINVERTABRATE SAMPLING LOCATIONS AND QUALITY AMONG STREAM CLASSIFICATIONS WITHIN THE ROOT RIVER WATERSHED: 2000-2011



Source: Wisconsin Department of Natural Resources, Wisconsin Lutheran College, and SEWRPC.

Table 39

FISH, INVERTEBRATE, AND HABITAT QUALITY AMONG REACHES WITHIN THE ROOT RIVER WATERSHED: 2000-2013

Stream Reach[a]		Fisheries				Invertebrates HBI	Habitat Rating
		Warmwater IBI	Cool (warm transition)	Cool (cold transition)	Headwater IBI		
Tributary Reaches							
Upper Reaches of the Watershed that Discharge to the Mainstem Reaches RR-10 and RR-13	RR-1	N/A	Fair	- -	Fair	- -	Good-Very Good
	RR-2	N/A	- -	- -	- -	- -	- -
	RR-3	N/A	- -	- -	- -	Fair	- -
	RR-4	N/A	Poor-Fair	- -	Fair-Good	Poor	Good-Very Good
	RR-5	N/A	Poor	- -	Poor	- -	Good-Very Good
	RR-6	N/A	Poor-Fair	- -	Fair-Good	Fair-Good	Poor-Fair
	RR-7	N/A	- -	- -	- -	Fairly Poor-Fair	- -
	RR-8	N/A	- -	- -	- -	Fairly Poor	- -
	RR-9	N/A	- -	- -	- -	Good	- -
	RR-11	N/A	- -	- -	- -	Good-Very Good	- -
	RR-12	N/A	- -	- -	- -	- -	- -
Lower Reaches of the Watershed that Discharge to the Mainstem Reaches RR-17 and RR-22	RR-14	N/A	Good	- -	Fair	Poor-Good	- -
	RR-15	N/A	Fair	Good	Poor-Fair	Fairly Poor	Good-Very Good
	RR-16	N/A	Poor-Fair	- -	- -	Poor-Fairly Poor	Fair
	RR-18	N/A	- -	Fair	Fair	Fairly Poor-Very Good	Fair-Very Good
	RR-19	N/A	Poor-Fair	- -	Poor-Fair	Fairly Poor	Good-Very Good
	RR-20	N/A	Fair	- -	Fair	Fairly Poor	Poor
	RR-21	N/A	Fair	- -	Good	Poor-Fair	Very Poor-Good
Mainstem Root River Reach Areas	RR-10	- -	N/A	N/A	N/A	- -	- -
	RR-13	Very Poor-Fair	N/A	N/A	N/A	Fairly Poor-Fair	Fair-Very Good
	RR-17	Very Poor-Good	N/A	N/A	N/A	Fairly Poor-Fair	Poor-Very Good
	RR-22	Fair-Good	N/A	N/A	N/A	Fair-Good	Poor-Fair
	RR-23	Fair-Excellent	N/A	N/A	N/A	Fair	Good-Very Good

NOTE: The Headwater IBI cannot exceed a Good qualitative rating. Color fills indicate the highest quality classification for fisheries (warmwater, coolwater, and headwater), invertebrates, and habitat based on QHEI achieved among each reach:

Light blue	Very Good-Excellent
Green	Good
Yellow	Fair
Orange	Fairly Poor-Poor

[a]*Mainstem and tributary stream reach areas are shown on Map 39.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Both the historical and current fish and invertebrate community data is shown on Maps 40 and 41. These data show that where multiple samples were taken there is a range in warmwater, coolwater, and headwater IBI quality throughout the entire watershed, but this is not unexpected given the range in number of years, time of collection or seasonality, and land use changes, as well as changes in temperature and precipitation that have occurred over the last hundred years during which these data were collected. Nonetheless, with the exception of the City of Racine (see below), these data generally support the conclusions summarized above that higher-quality areas are located within less developed areas compared to the more developed areas of the Root River watershed. For example, during both the historical and current time periods, the biological community data within the more urbanized upper tributary reaches of the Root River were generally of consistently lesser quality than the quality observed in the lower tributaries of the Root River that are less urbanized. Historically, the upper tributary reaches were dominated by poor to fairly poor quality community ratings versus poor to fair quality scores in the lower tributary reaches. Currently, the upper tributary reaches continue to be more degraded than the lower tributary reaches, which generally show ranges from poor to fair biological quality versus fair to good quality scores (see Table 39).

Despite significant losses of fish species in the Root River watershed since the early 1900s, comparison of the overall fish and invertebrate biological community between the historic and current time periods demonstrate that there has been a general improvement in the biotic community quality throughout the entire watershed. This is surprising and a bit counterintuitive, but it likely demonstrates that the Root River ecosystem is showing signs of recovering from the significant water quality and habitat impacts that have occurred in the past. For example, improvements in the fishery were associated with improvements in the food base or invertebrate quality throughout the Root River watershed, which shows that this community is now consistently ranked as fair to good (see Map 41 and Table 39). Since invertebrates tend to colonize or re-establish sooner after a reach has been disturbed and begins to stabilize, the high proportion of fair to good HBI scores is more evidence that the Root River watershed may be recovering/improving. For example, completion of the restoration of the Kilbournville Tributary (headwaters of reach RR-18) in 2008 associated with Wisconsin Department of Transportation (WisDOT) roadway improvements on IH 94 at CTH G in the Village of Caledonia, Racine County, led in 2011 to the highest macroinvertebrate community rating (i.e., HBI of 3.78) that has ever been recorded within the Root River watershed.[122] More specifically, within three years of construction/restoration of more than 3,500 linear feet of a naturally meandering stream channel and nearly 10 acres of reconnected floodplain as part of the wetland mitigation (see Figure 57), a very good quality invertebrate community was able to become established as shown on Map 41. This demonstrates that the stream system can respond positively to improvements in stream hydrology, habitat, and associated riparian corridors and those improvements can lead to a sustained improvement in the aquatic invertebrate community and, ultimately, the fishery. Invertebrates as a biotic indicator also tend to show a clearer relationship to habitat as compared to fish indices.[123] This also seems to be the case given that the invertebrate quality ratings are more closely associated with the habitat quality ratings than are the fish ratings. This may also be a good indication that 1) habitat and food-based organisms are improving, 2) that the fishery needs more time to recover, and 3) that continued improvements in water and habitat quality through best management practices should facilitate this positive trend.

The historic versus current comparisons also show that the greatest improvement in biological quality was observed within the lower mainstem reaches of the Root River watershed. This too was surprising, because these reaches are located within the City of Racine in one of the most highly-urbanized areas of the watershed. However, such an improvement in biological quality along with increased urban development density is the same pattern observed in the City of Milwaukee within the fishery communities of the Milwaukee River, Menomonee River, and Kinnickinnic River systems and is largely related to the connection with Lake Michigan (see Channel Obstructions or Fragmentation Section below).[124]

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[122]*SEWRPC Staff Memorandum, "Data Analysis and Recommendations Related to the Proposed Relocation of the Unnamed Tributary to the Root River for the IH 94 and CTH G Interchange Project in the Village of Caledonia, Racine County," December 15, 2008.*

[123]*Personal communications, U.S. Geological Survey staff.*

[124]*SEWRPC Memorandum Report No. 194,* Stream Habitat Conditions and Biological Assessment of the Kinnickinnic and Menomonee River Watersheds: 2000-2009*, January 2010.*

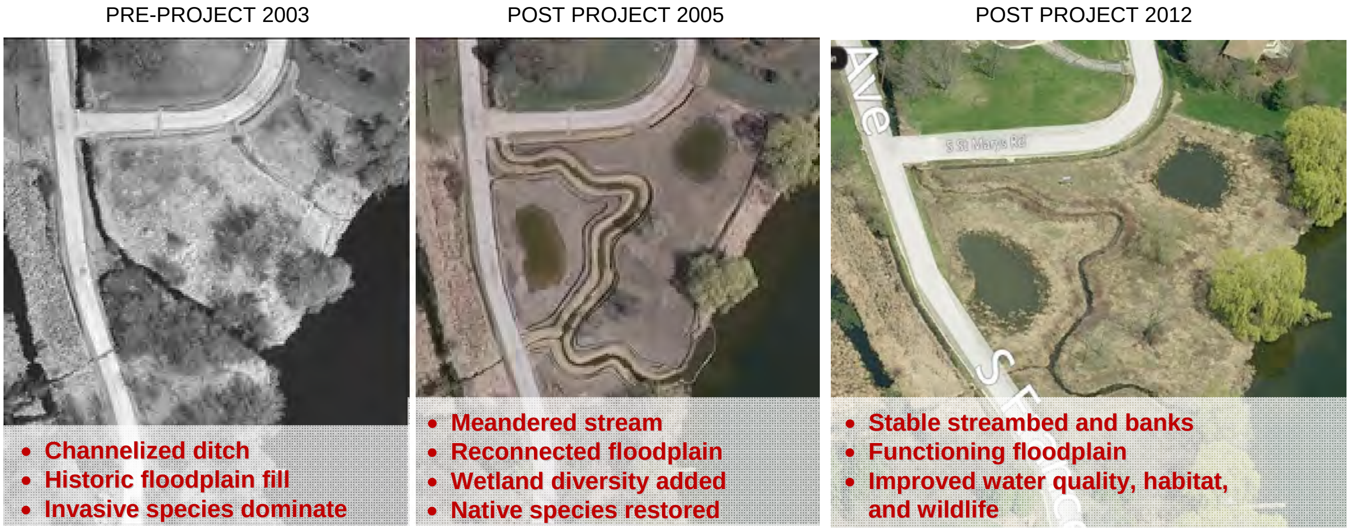
Figure 57

PRE- VERSUS POST-RESTORATION OF THE STREAM CHANNEL AND RECONNECTION OF FLOODPLAIN WITHIN THE KILBOURNVILLE TRIBUTARY TO THE ROOT RIVER FOR THE IH 94 AND CTH G INTERCHANGE PROJECT IN THE VILLAGE OF CALEDONIA, RACINE COUNTY

Source: SEWRPC and WisDOT

Figure 58

PRE- VERSUS POST-RESTORATION OF THE STREAM CHANNEL AND RECONNECTION OF THE FLOODPLAIN OF THE UPPER KELLY LAKE TRIBUTARY



Source: Microsoft (Bing Maps) and SEWRPC.

Table 39 also shows that habitat quality conditions are generally good to very good within the Root River watershed (see also Physical Characteristics within Stream Reach Areas section below). However, there are many sites within tributaries and the mainstem where habitat was only rated as poor to fair, which is not surprising given the level of channelization and agricultural and urban development and their associated water quality impacts. In one sense this demonstrates the resiliency of the River system to recover from past perturbations, but it is important to keep in mind that this is a large watershed with many miles of stream that have never been assessed for the quality of their habitat or biological community. For example, habitat ratings have never been recorded on the Upper Kelly Lake Tributary in the headwaters of reach RR-5 in the Root River watershed, but substantial improvements in the instream habitat and riparian buffer of this stream reach have been made by the Kelly Lakes Association, Inc. in partnership with the WDNR and the City New Berlin.[125] This stream channel/floodplain restoration project converted a channelized and over-widened roadside ditch into a more natural meandering stream with appropriate width and depth and pool-riffle structure (see Figure 58). In addition, the floodplain was reconnected with the new stream by the removal of historical fill (concrete, asphalt, and various soils) and construction of wetlands for protection of water quality and wildlife habitat. This project was completed within a highly urban area and demonstrates that although urban development may be generally associated with biological degradation, stream channel and riparian conditions can be improved, which can lead to a rehabilitation of habitat, water quality, and associated biological quality, and can contribute to improvement of the overall ecosystem potential of the Root River. Similar stream channel/floodplain restoration projects also have been documented to result in substantial improvements in habitat and fisheries quality within the Menomonee River watershed.[126]

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[125] *Jeffrey Thornton, Thomas Slawski, et. al., "The World Lake Vision and Ecohydrology: Case Study from Wisconsin, USA,"* Ecohydrology & Hydrology, *Volume 7: 113-124, 2007.*

[126] *SEWRPC Memorandum Report No. 194*, op. cit.

Figure 59

PRE- AND POST- PROJECT CONSTRUCTED RIPRAP STREAMBANK AND BAFFLE RETROFITS TO IMPROVE FISH AND WILDLIFE PASSAGE WITHIN THE LOW FLOW CULVERT CELL AT STH 38 IN HUSHER CREEK WITHIN THE ROOT RIVER WATERSHED: 2010-2011

Source: Wisconsin Department of Transportation and SEWRPC.

Channel Obstructions or Fragmentation

There are more than 500 potential channel obstructions in the Root River watershed. These structures are primarily associated with road and railway crossings in the form of culverts and bridges, but obstructions can also include drop structures, debris jams, and beaver dams. These obstructions can form physical and/or hydrological barriers to fisheries movements, which can severely limit the abundance and diversity of fishes within stream systems.[127] However, problem crossings can be retrofitted or replaced to improve fish and other aquatic organism passage such as what was accomplished at the STH 38 double box culvert on Husher Creek within reach RR-19 by WisDOT as shown in Figure 59.[128] Not all road or railway crossings are limiting fish passage in the Root River

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[127]*T.M. Slawski, and others, "Effects of Low-Head Dams, Urbanization, and Tributary Spatial Position on Fish Assemblage Structure within a Midwest Stream,"* North American Journal of Fisheries Management, *2008.*

[128]*SEWRPC Staff Memorandum, "Data Analysis and Recommendations Related to the Proposed Restoration of Husher Creek, Tributary to the Root River in the Village of Caledonia, Racine County," December 28, 2011.*

watershed, but many of these structures have not been assessed for fish passage and it is not known which of these structures are limiting the fishery (see Stream Crossings and Dams section below for more details). However, the Horlick dam (River Mile 6.1) is the most significant fish passage obstruction on the Root River (see Table 40). The Horlick dam has been a barrier to upstream passage for fish species native to Wisconsin much longer than the earliest recorded fish sample taken in 1900 (see Horlick Dam Impoundment Characteristics section for more details on this structure).

As summarized in TR No. 39, there has been an apparent loss of multiple fish species throughout the Root River watershed over the last 100 years. However, it is important to note that this loss of species has been disproportionately greater among reaches that are further away from a connection with Lake Michigan as shown in Table 40. For example, comparison of historical (pre-2000) versus current (post-2000) fish species abundance within the Root River generally indicates two important features: 1) historical total native fish species in the mainstem reaches downstream of Horlick dam indicated the least diverse fishery compared to the total native species in each of the upper and lower tributary reaches and mainstream reaches upstream of the dam and 2) current fish assemblages in the mainstem reaches downstream of Horlick dam contained the most diverse or greatest number of native fish species compared to observations upstream of the dam. More specifically, the mainstem reach below Horlick dam has retained 30 total native species and that number has not decreased over time, but there have potentially been 17, 18, and 3 total native species lost in the upper tributary reaches, lower tributary reaches, and the mainstream reaches upstream of Horlick dam, respectively.

Table 40 also shows that, compared to historical abundances, the upper and lower tributary reaches have lost the greatest number of intolerant (sensitive to pollution) fish species and contain the lowest proportion of coolwater species compared to the mainstem reaches of the Root River. The upper and lower tributary reaches have each lost four intolerant species and probably three to four coolwater species and the greatest number of warmwater species over time. This indicates that the urban development in the upper tributary reaches and agricultural development in the lower tributary reaches have been associated with significant negative impacts to the overall diversity and thermal tolerance of fish species in the watershed.

In contrast, the mainstem reaches upstream and downstream of Horlick dam have had a net increase of the number of intolerant species and the highest number of coolwater species. However, the reach downstream of the dam (RR-23) currently contains the highest number of intolerant species and the most diverse assemblage of coldwater and coolwater species of any other reach in the watershed. Although reach RR-23 is classified as a warmwater stream, it contains the only coldwater species found in the watershed. Most of these coldwater species are a result of the intensive stocking program that occurs as part of the WDNR steelhead facility management activities.[129] Brown trout, rainbow trout, chinook salmon, and coho salmon continue to be stocked into mainstem reach RR-23 of Root River, but this stocking would not be practicable or possible without the ability of these coldwater species to access Lake Michigan, where they spend most of their lives and only enter the River when they are ready to spawn. However, longnose sucker, which is a native coldwater species in Wisconsin, were reported to occur in reach RR-23 for the first time ever. Not much is known about their life history in Lake Michigan, but they appeared to have migrated from Lake Michigan along with white suckers, which are native coolwater species. It is probable that both these sucker species were migrating up the Root River to spawn, which is common along the northern shores of Lake Michigan, but very rare in southeastern Wisconsin shorelines. Unfortunately, these fishes were somehow trapped behind the gated section of the dam associated with the WDNR Steelhead Facility during the spring flood and suffocated (see Figure 60), which also demonstrates the unintended consequences a dam can have on native fish species even though these species were able to get past this structure.[130] Although these fishes were found dead, it is likely that some of these species actually survived to make it back into Lake Michigan and returned to spawn the following spring, and it demonstrates the co-dependency and potential of the Lake Michigan and Root River fisheries.

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[129]*SEWRPC Technical Report No. 39,* op. cit.

[130]*Personal Communication, William Wawrzyn, Fisheries Biologist, WDNR.*

Table 40

FISH SPECIES OCCURRENCE, COMPOSITION, AND TEMPERATURE PREFERENCE AMONG REACHES IN THE ROOT RIVER WATERSHED: 1900-1999 VS 2000-2013[a]

Species According to Their Relative Tolerance to Pollution	Tributary Reaches				Mainstem Reaches			
	RR-1, 2, 3, 4, 5, 6, 7 8, 9, 11, 12		RR-14, 15, 16, 18, 19, 20, 21		RR-10, 13, 17, 22		RR-23	
	Upper Reaches of the Watershed that Discharge to the Mainstem Reaches RR-10 and RR-13		Lower Reaches of the Watershed that Discharge to the Mainstem Reaches RR-17 and RR-22		Reach from About 4,000 Feet Downstream of West Drexel Avenue at River Mile 30.7 to the Horlick Dam		Reach from Horlick Dam at River Mile 6.1 to the Confluence with Lake Michigan	
	Years Sampled		Years Sampled		Years Sampled		Years Sampled	
	1900-1999	2000-2013	1900-1999	2000-2013	1900-1999	2000-2013	1900-1999	2000-2013
Intolerant								
Blackchin Shiner	- -	- -	1	- -	- -	4	- -	2
Blacknose Shiner	2	- -	2	- -	3	4	- -	2
Iowa Darter	5	- -	4	2	- -	4	- -	- -
Least Darter[b]	2	- -	2	- -	1	- -	1	- -
Longear Sunfish[c]	- -	- -	- -	- -	- -	- -	1	- -
Longnose Sucker[d]	- -	- -	- -	- -	- -	- -	- -	1
Redside Dace[b, d]	- -	- -	- -	- -	- -	- -	1	- -
Rock Bass	3	- -	3	- -	2	8	1	6
Slenderhead Darter	- -	1	- -	- -	- -	5	- -	2
Smallmouth Bass	- -	- -	- -	- -	- -	- -	- -	3
Spottail Shiner	- -	- -	- -	- -	- -	- -	1	- -
Intermediate								
Alewife[d]	- -	- -	- -	- -	- -	- -	2	3
Bigmouth Shiner	4	3	30	1	8	- -	5	- -
Black Crappie	4	- -	1	- -	2	4	3	5
Blackside Darter	- -	1	7	4	7	11	- -	4
Bluegill	10	- -	14	6	5	11	3	5
Brown Bullhead	1	- -	4	- -	1	6	1	2
Brown Trout[d]	- -	- -	- -	- -	- -	- -	4	5
Bullhead Minnow	- -	- -	1	- -	- -	- -	- -	- -
Central Stoneroller	- -	- -	1	- -	- -	- -	- -	- -
Channel Catfish	- -	- -	- -	- -	- -	7	- -	- -
Chinook Salmon[d]	- -	- -	- -	- -	- -	- -	4	1
Coho Salmon[d]	- -	- -	- -	- -	- -	- -	1	1
Common Shiner	6	- -	24	- -	8	1	5	- -
Emerald Shiner	- -	- -	- -	- -	- -	- -	2	2
Gizzard Shad	- -	- -	- -	- -	- -	- -	3	- -
Golden Redhorse	- -	- -	- -	- -	1	- -	- -	3
Grass Pickerel	4	- -	3	- -	4	- -	- -	- -
Hornyhead Chub	- -	- -	- -	- -	1	- -	- -	- -
Johnny Darter	6	2	31	7	14	16	3	4
Lake Chubsucker[b]	2	- -	1	- -	- -	- -	- -	- -
Largemouth Bass	6	4	12	4	9	8	4	5
Largescale Stoneroller	2	- -	4	- -	2	- -	1	- -
Logperch	- -	- -	1	- -	- -	- -	- -	- -
Longnose Dace	- -	- -	- -	- -	- -	- -	1	2
Mimic Shiner	- -	- -	- -	- -	- -	3	- -	2
Northern Pike	3	- -	8	6	2	10	- -	3
Orangespotted Sunfish	- -	1	- -	- -	- -	- -	- -	- -
Pumpkinseed	7	- -	6	6	3	5	3	- -
Rainbow Trout[d]	- -	- -	- -	- -	- -	- -	8	6
Redfin Shiner[c]	2	- -	2	- -	3	- -	- -	- -
River Redhorse[c]	- -	- -	- -	- -	- -	- -	- -	2
Round Goby	- -	- -	- -	- -	- -	- -	- -	1
Sand Shiner	- -	1	4	4	- -	8	2	3
Shorthead Redhorse	- -	- -	- -	- -	- -	- -	- -	2
Smelt Rainbow[d]	- -	- -	- -	- -	- -	- -	1	- -
Southern Redbelly Dace	- -	- -	1	- -	- -	- -	- -	- -
Stonecat	- -	- -	- -	- -	- -	- -	3	2
Tadpole Madtom	1	- -	- -	- -	2	- -	- -	2
Trout Perch	- -	- -	- -	- -	- -	- -	- -	2
Warmouth	6	- -	1	1	2	- -	- -	- -
White Crappie	4	- -	2	- -	6	1	1	- -
Yellow Perch	9	- -	1	- -	6	2	3	- -

NOTE: Color fills indicate water temperature preferences based upon the classifications by John Lyons, "Development and validation of two fish-based indices of biotic integrity for assessing perennial coolwater streams in Wisconsin, USA," Ecological Indicators 23, 402-412, 2012:

- Coldwater
- Coolwater
- Warmwater

Table 40 (continued)

Species According to Their Relative Tolerance to Pollution	Tributary Reaches				Mainstem Reaches			
	RR-1, 2, 3, 4, 5, 6, 7 8, 9, 11, 12		RR-14, 15, 16, 18, 19, 20, 21		RR-10, 13, 17, 22		RR-23	
	Upper Reaches of the Watershed that Discharge to the Mainstem Reaches RR-10 and RR-13		Lower Reaches of the Watershed that Discharge to the Mainstem Reaches RR-17 and RR-22		Reach from About 4,000 Feet Downstream of West Drexel Avenue at River Mile 30.7 to the Horlick Dam		Reach from Horlick Dam at River Mile 6.1 to the Confluence with Lake Michigan	
	Years Sampled		Years Sampled		Years Sampled		Years Sampled	
	1900-1999	2000-2013	1900-1999	2000-2013	1900-1999	2000-2013	1900-1999	2000-2013
Tolerant								
Black Bullhead	11	2	29	5	14	7	3	4
Bluntnose Minnow	3	- -	26	7	12	15	3	5
Brook Stickleback[d]	10	5	32	3	2	1	1	- -
Central Mudminnow	10	4	45	10	9	7	- -	- -
Common Carp	8	1	18	2	10	9	6	- -
Creek Chub	18	4	59	10	19	10	7	5
Fathead Minnow	15	5	44	5	9	6	2	- -
Golden Shiner	10	- -	13	1	10	4	6	5
Goldfish	3	- -	8	- -	2	3	6	- -
Green Sunfish	15	5	48	10	16	16	10	5
Western Blacknose Dace	5	2	2	- -	- -	- -	1	- -
White Sucker	22	6	53	9	19	16	14	6
Yellow Bullhead	4	- -	10	4	1	14	- -	6
Total Number of Species	34	16	40	21	34	31	38	36
Total Native Species	32	15	38	20	32	29	30	30
Total Introduced/Exotic Species	2	1	2	1	2	2	8	6
Total Intolerants	4	1	5	1	3	5	5	6
Total Intermediate	17	6	22	9	19	14	22	23
Total Tolerant	13	9	13	11	12	12	11	7

NOTE: Color fills indicate water temperature preferences based upon the classifications by John Lyons, "Development and validation of two fish-based indices of biotic integrity for assessing perennial coolwater streams in Wisconsin, USA," Ecological Indicators 23, 402-412, 2012:

Coldwater
Coolwater
Warmwater

[a]*Values represent the number of times each species was observed or recorded in a given time period. Historic 1900-1999 fisheries distributions are shown on Map 40 and existing fisheries distributions are shown on Map 41.*

[a]*Designated species of special concern.*

[b]*Designated threatened species.*

[c]*Denotes stenothermal species, which are fish species only capable of living or surviving within a narrow temperature range.*

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, Wisconsin Lutheran College, and SEWRPC.

Hence, it is the connection of the most downstream reach RR-23 to Lake Michigan, as well as fish stocking programs that have contributed to the highest ever recorded number of total species (36) and diverse assemblage of coldwater, coolwater, and warmwater fishes that currently exists within the Root River system. However, the fisheries data also indicate that fish species losses were much greater among both the upper and lower tributary stream reaches than the mainstream reaches upstream of the Horlick dam. Therefore, reduction of fragmentation or reconnection of stream reaches within the Root River to Lake Michigan as well as reconnection of tributary streams to the mainstem of the Root River are critical aspects to address for consideration in development of a sustainable fishery with this watershed.

Macroinvertebrates

Macroinvertebrates are animals without backbones that can be seen without a microscope. A number of different macroinvertebrate species spend all or part of their lives in aquatic environments. Major groups include mollusks, such as snails and mussels; crustaceans, such as crayfish and scud; and insects, such as mayflies, stoneflies,

Figure 60

WHITE SUCKER AND LONGNOSE SUCKER SPECIES CAUGHT IN THE GATED SECTION OF THE DAM ASSOCIATED WITH THE WDNR STEELHEAD REARING FACILITY DURING THEIR SPAWNING RUN WITHIN REACH RR-23 DOWNSTREAM OF THE HORLICK DAM ON THE ROOT RIVER: APRIL 29, 2013

These potamodromous sucker (fish that undertake regular migrations in large freshwater systems) species are commonly found migrating together during spring spawning runs and there is evidence that the Root River likely has a regular but small annual run. These spawning runs are rare along the southern shores of Lake Michigan (i.e., never observed in the Milwaukee River), but become much more common further north up the Lake Michigan shoreline. This was just one of the six or eight gated sections of the dam, which indicates that many hundreds of fishes may have perished during this spring flooding event.

Source: Wisconsin Department of Natural Resources and SEWRPC.

caddisflies, and dragonflies. The different species of macroinvertebrates found in aquatic habitats exhibit a variety of life cycles, habitat preferences, feeding modes, and environmental tolerances. Examples of the types of macroinvertebrates found in streams of the Root River watershed are shown in Figure 61.

In streams, many macroinvertebrate species utilize particulate organic matter such as leaves and twigs that enter the stream from the adjacent terrestrial environment as a source of energy and nutrients. This acts to pass much of the energy and nutrients in this material into the stream community's food web. Many macroinvertebrate species serve as food for other organisms, including fish.

Macroinvertebrates are useful indicators of water quality because they spend much of their life in the waterbody, they are not mobile, they are easily sampled, and the references needed to identify them to a useful degree of taxonomic resolution are readily available. In addition, the differences among macroinvertebrate species in habitat preferences, feeding ecology, and environmental tolerances allow the quality of water and habitat in a waterbody to be evaluated based upon the identity of the groups that are present and their relative abundances. The differences among macroinvertebrate species in feeding ecology are often represented through the classification of species into functional feeding groups based upon the organisms' principal feeding mechanisms.[131] Several groups have been described. Scrapers include herbivores and detritivores that graze microflora, microfauna, and detritus attached to mineral, organic, or plant surfaces. Shredders include detritivores and herbivores that feed

[131]*Kenneth W. Cummins, "Trophic Relations of Aquatic Insects,"* Annual Review of Entomology, *Volume 18, pages 183-206, 1973; Kenneth W. Cummins and Michael J. Klug, "Feeding Ecology of Stream Invertebrates,"* Annual Review of Ecology and Systematics, *Volume 10, pages 147-172, 1979.*

Figure 61

EXAMPLES OF MACROINVERTEBRATES FOUND IN STREAMS OF THE ROOT RIVER WATERSHED

Mayfly Larva

Isopod

Midge Larva

Giant Waterbug

Damselfly Larva

Caddisfly Larva with Case

Source: Iowa State University and the University of Wisconsin-Milwaukee.

Table 41

WATER QUALITY RATINGS FOR HILSENHOFF BIOTIC INDEX (HBI) VALUES

HBI Value	Water Quality Rating	Degree of Organic Pollution
<3.50	Excellent	None apparent
3.51-4.50	Very good	Possible slight
4.51-5.50	Good	Some
5.51-6.50	Fair	Fairly significant
6.51-7.50	Fairly poor	Significant
7.51-8.50	Poor	Very significant
8.51-10.00	Very poor	Severe

Source: W. L Hilsenhoff, "An Improved Biotic Index of Organic Stream Pollution," The Great Lakes Entomologist, *Volume 20, pages 31-39, 1987.*

primarily on coarse particulate organic matter. Collectors feed on fine particulate organic matter. This group includes filterers that remove suspended material from the water column and gatherers that utilize material deposited on the substrate.

A variety of metrics have been developed and used for evaluating water quality based upon macroinvertebrate assemblages.[132] These include metrics based on taxa richness, trophic function, relative abundance of the dominant taxa, and diversity, as well as more complicated metrics. Most of these metrics have been developed for stream systems, though some macroinvertebrate metrics are being developed for other aquatic environments, such as wetlands.[133] The Hilsenhoff Biotic Index[134] (HBI), and the percent of individuals detected consisting of members of the insect orders Ephemeroptera, Plecoptera, and Trichoptera (percent EPT-I) were used to classify the historic and existing macroinvertebrate data and to evaluate the environmental quality of the stream system using survey data from various sampling locations in the Root River watershed. Other metrics examined include the percentages of macroinvertebrates in a sample belonging to particular functional feeding groups, the number of species detected in a sample (species richness), and the percentage of macroinvertebrates detected that belong to particular taxa.

The HBI represents the average weighted pollution tolerance values of all arthropods present in a sample. It is based upon the macroinvertebrate community's response to high loading of organic pollutants and reductions in the concentration of dissolved oxygen. It is designed for use with samples collected from riffles and runs, and may not be reliable for interpreting data collected from other stream environments. For example, macroinvertebrate data from samples collected from snags tend to be more variable and give higher HBI values than data from samples collected in riffles.[135] Lower values of the HBI indicate better water quality conditions while higher values indicate worse water quality conditions. Table 41 show the values of the HBI associated with different ratings of water quality and degrees of organic pollution.

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[132]*Richard A. Lillie, Stanley W. Szczytko, and Michael A. Miller*, Macroinvertebrate Data Interpretation Manual, *Wisconsin Department of Natural Resources, PUB-Ss-965 2003, Madison, Wisconsin, 2003.*

[133]*Richard A. Lillie, "Macroinvertebrate Community Structure as a Predictor of Water Duration in Wisconsin Wetlands,"* Journal of the American Water Resources Association, *Volume 39, pages 389-400, 2003.*

[134]*William L. Hilsenhoff,* op. cit.

[135]*Lillie, Szczytko, and Miller, 2003,* op. cit.

The percent EPT-I consists of the percentage of individuals detected in a sample that are members of the insect orders Ephemeroptera, Plecoptera, and Trichoptera. These orders include mayflies, stoneflies, and caddisflies. These taxa are separated out from other aquatic taxa because they generally represent the organisms in streams and rivers that are more intolerant of organic pollution. Higher values of percent EPT indicate better water quality. Lower values indicate worse water quality. Low values of percent EPT may result from a variety of stressors including high loadings of organic pollution, low concentrations of dissolved oxygen, biologically active concentrations of toxic substances, disruption of stream flow regime, and increases in water temperature.

Between 1979 and 2011, 192 macroinvertebrate samples were collected from 70 sampling sites in streams of the Root River watershed. The majority of these, consisting of 142 samples, were collected prior to 2005. The remaining 50 samples were collected during the period 2005 to 2011. Sampling sites differed from one another with respect to how many samples were collected. There were 32 sites at which only one sample had been taken. At most of the other sites, between two and six samples were collected. There were two sites where more than six samples were collected. These are the Root River at Johnson Park, where 33 samples were collected, and Husher Creek at 7 1/2 Mile Road, where eight samples were collected.

A total of 384 macroinvertebrate taxa were identified in these samples. It should be noted that these organisms were identified to varying degrees of taxonomic resolution. In many cases, the particular species of organism was identified. In other cases, the organisms were identified to genus, subfamily, or family levels. In some instances the organism were identified only to order or class level. The majority of taxa identified, 315 taxa, were insects. These include true flies, beetles, caddisflies, mayflies, true bugs, dragonflies, and damselflies. Other groups present in samples included crustaceans, such as amphipods, crayfish, and isopods; annelid worms; nematode worms; turbellarian worms; and mollusks, consisting mostly of snails. While most taxa were found in five or fewer samples and at five or fewer sites, some were very common. The five most commonly identified taxa were the isopod *Caecidotea intermedia*, caddisflies of the genus *Cheumatopsyche*, midges of the subfamily Orthocladinae, worms of the family Tubificidae, and the caddisfly *Hydropsyche betteni*. Each of these taxa was detected at 42 or more sites and in 100 or more samples. The macroinvertebrate taxa found in samples collected from the Root River are listed in Table F-1 in Appendix F.

As shown on Map 42, the HBI scores from macroinvertebrate surveys conducted between 1979 and 2004 in streams of the Root River watershed generally ranged from poor-fairly poor to good. The HBI scores in much of the watershed during this period indicated poor to fairly poor conditions. There were four notable exceptions to this generalization. HBI scores from surveys conducted in the section of the mainstem of the Root River beginning in the downstream portion of the Lower Root River-Caledonia assessment area and continuing through the Lower Root River-Racine assessment area generally ranged from fair to good. HBI scores from downstream reaches of the Root River Canal generally indicated fair conditions. HBI scores from surveys conducted in Tess Corners Creek and Whitnall Park Creek were generally fair to good, with two samples collected from an upstream station along Tess Corners Creek indicating very good conditions. While HBI scores from lower reaches of Hoods Creek were quite variable, the overall result indicates fair conditions were present, especially near the confluence with the mainstem of the Root River.

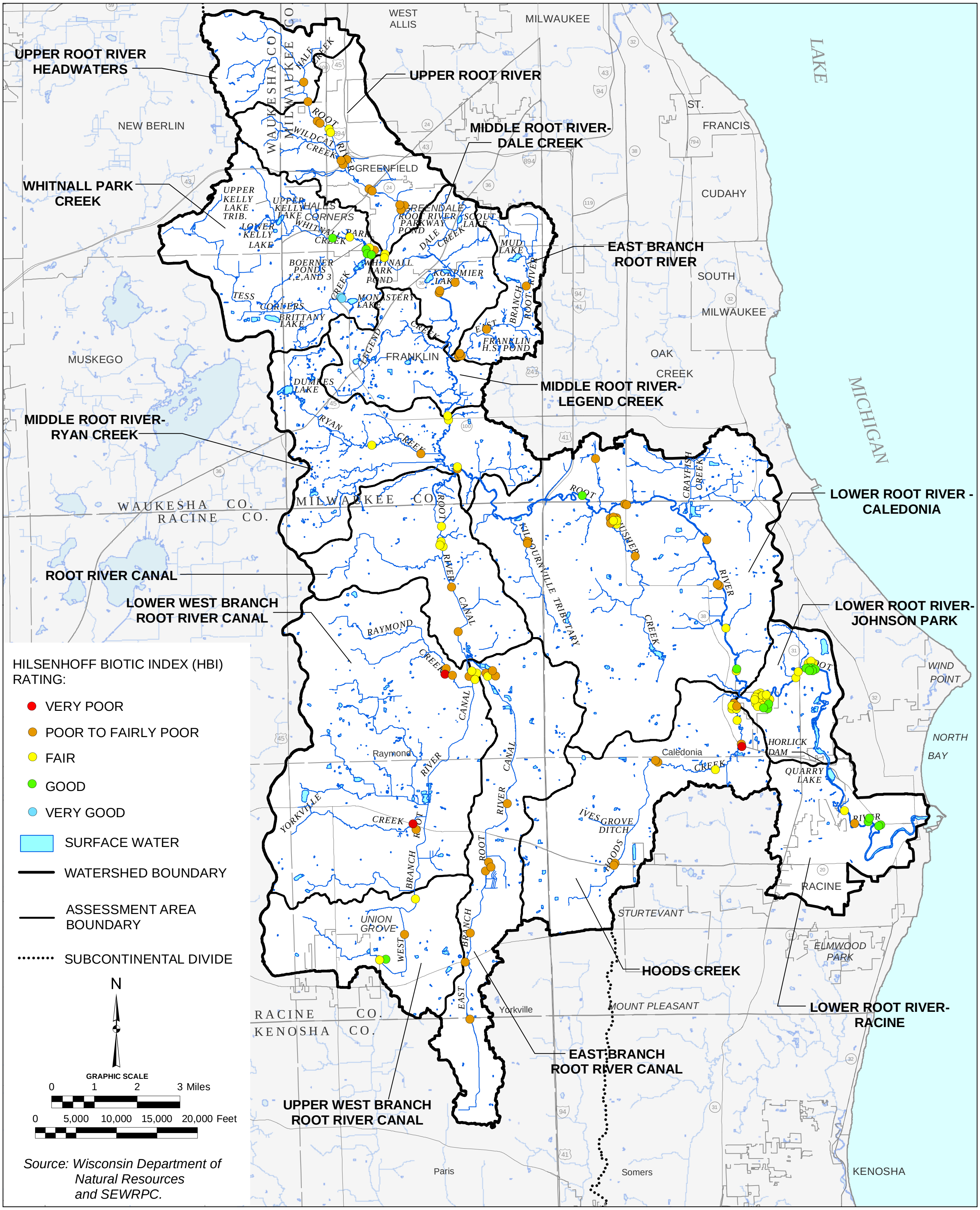
Map 43 shows HBI scores from macroinvertebrate surveys conducted between 2005 and 2011. As in the earlier period, the HBI scores in much of the watershed during this period indicated poor to fairly poor conditions. There were several exceptions to this generalization:

- HBI scores from surveys conducted in the section of the mainstem of the Root River beginning in the downstream portion of the Lower Root River-Caledonia assessment area and continuing through the Lower Root River-Racine assessment area generally ranged from fair to good.

- HBI scores from downstream reaches of the Root River Canal ranged between poor-fairly poor and fair.

Map 42

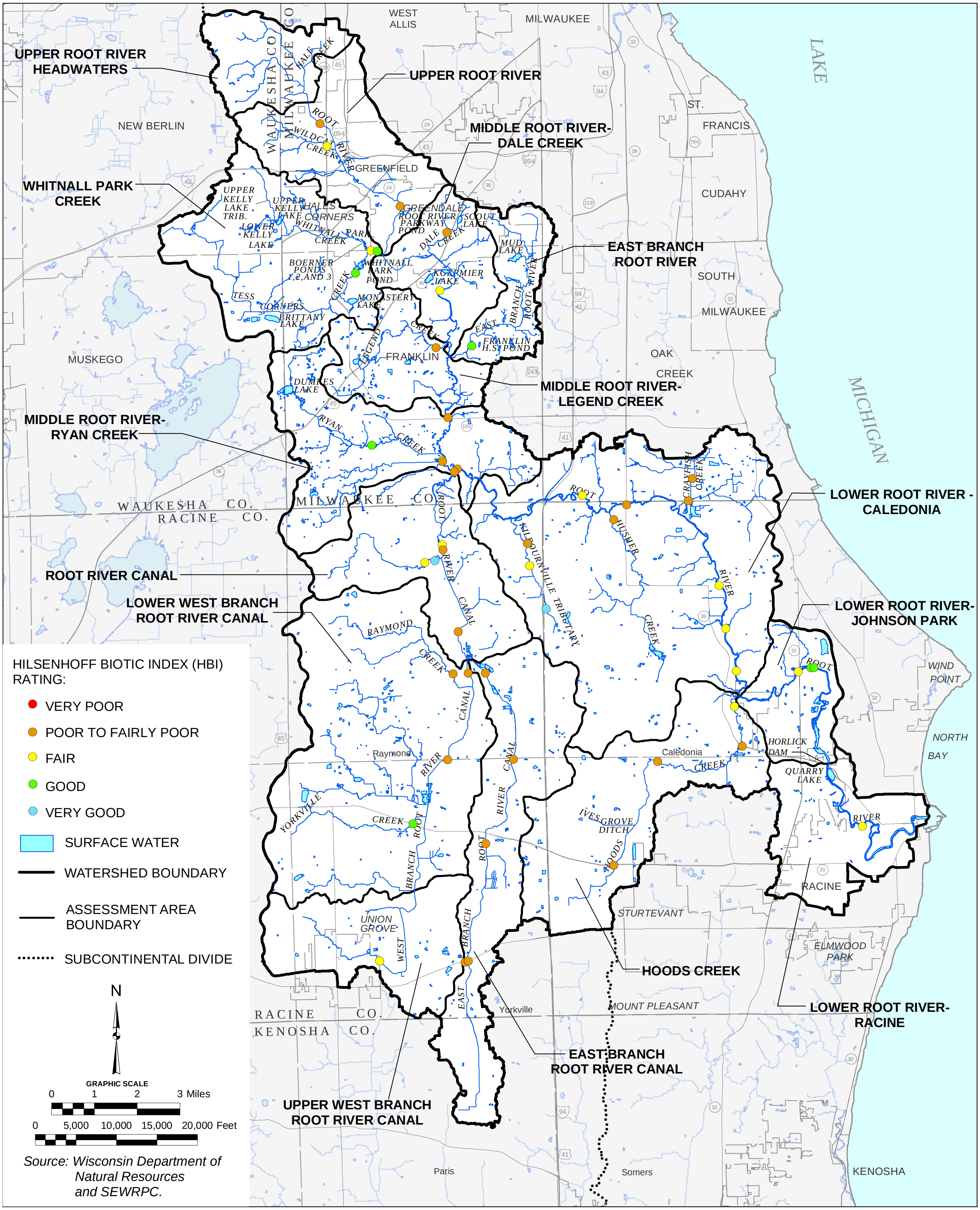
MACROINVERTEBRATE SAMPLE AND CONDITIONS WITHIN THE ROOT RIVER WATERSHED: 1979-2004



Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 43

MACROINVERTEBRATE SAMPLE AND CONDITIONS WITHIN THE ROOT RIVER WATERSHED: 2005-2011



- HBI scores from surveys conducted in Tess Corners Creek and Whitnall Park Creek were generally fair to good.

- While HBI scores from Hoods Creek generally indicated poor-fairly poor conditions, scores from samples collected near the confluence with the mainstem of the Root River indicated fair conditions.

- HBI scores from samples collected in Kilbournville Tributary ranged from poor-fairly poor in downstream reaches to very good in upstream reaches. The very good rating may be a result of the stream relocations and restoration project that WisDOT, with assistance from the SEWRPC staff, conducted along this stream at the IH 94/CTH G interchange in 2008.

- The HBI score from Yorkville Creek indicated good conditions, a marked improvement from the very poor to poor-fairly poor conditions indicted by scores from previous samples taken at the same location (see Map 42).

- The HBI score from Ryan Creek indicated good conditions, an improvement from the fair conditions indicted by scores from previous sampling at the same location (see Map 42).

- The HBI score from the East Branch Root River indicated good conditions. This suggests improvement from previous scores that indicated poor-fairly poor conditions within this section of this stream (see Map 42).

- The HBI score from Wildcat Creek indicated fair conditions. This stream had not been previously sampled for macroinvertebrates.

- HBI scores from the unnamed tributary to the Root River Canal indicated conditions ranging from fair to very good. This stream had not been previously sampled for macroinvertebrates.

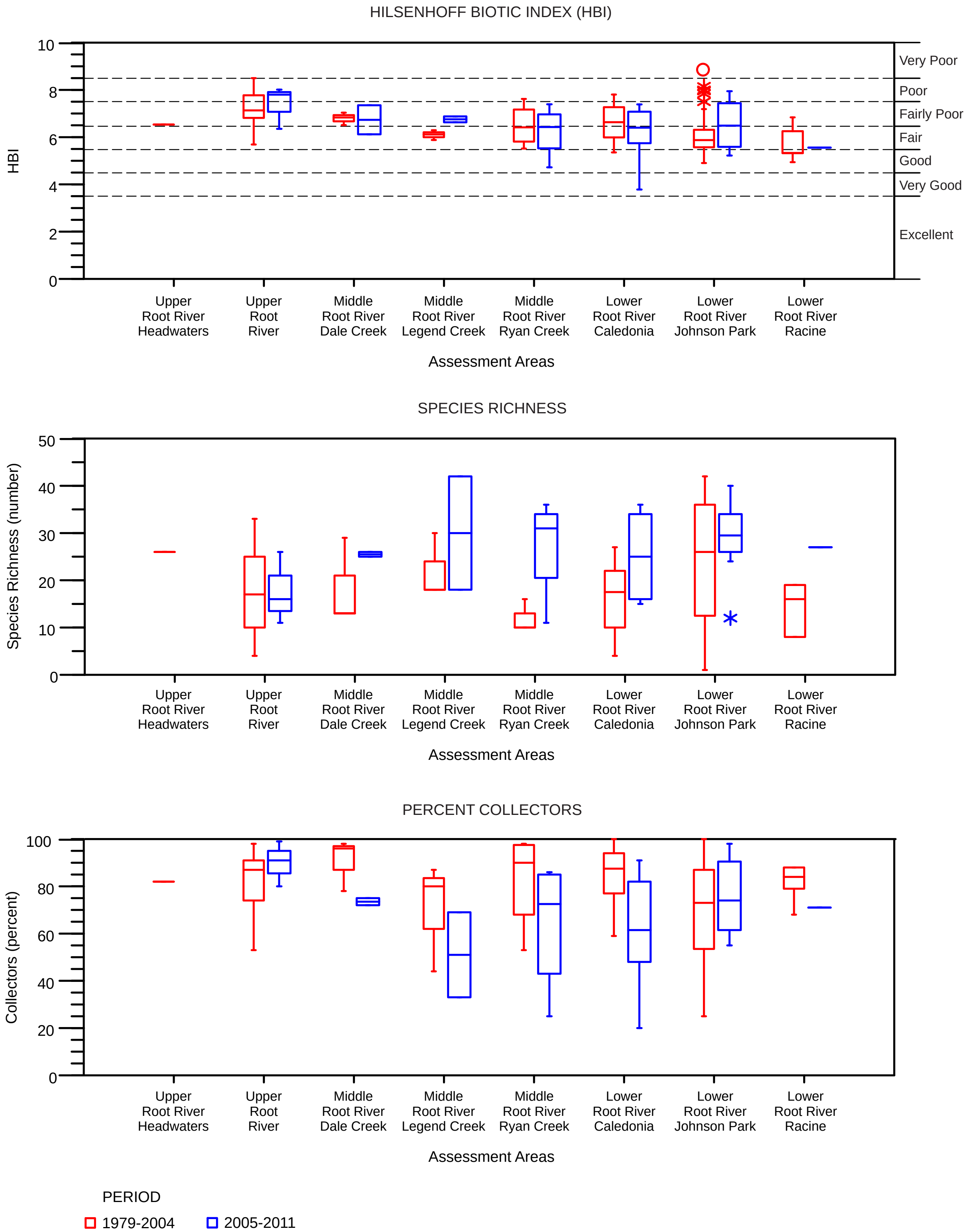
Figure 62 shows three macroinvertebrate metrics along the mainstem of the Root River by assessment area for the periods 1979-2004 and 2005-2011. The top panel shows HBI scores. Several trends are apparent in the data. During both periods, HBI scores indicate fairly poor to fair water quality conditions in most of the assessment areas. HBI scores decrease from upstream to downstream, indicating improvement in water quality conditions from upstream to downstream. In most assessment areas, the differences between the period 1979-2004 and the period 2005-2011 are slight. In the Middle Root River-Ryan Creek and Lower Root River-Caledonia assessment areas the distributions of HBI scores from the period 2005-2011 are shifted slightly downward relative to the distribution of scores from the period 1979-2004, suggesting that water quality conditions may be improving in the mainstem of the River in these assessment areas.

The middle panel of Figure 62 shows species richness, or the number of species identified in a sample, along the mainstem of the Root River by assessment area. In most assessment areas, the number of species detected in the River during the period 2005-2011 was greater than the number detected during the period 1979-2004. As with the HBI, this suggests some improvements may be occurring in water quality conditions in the River.

The lower panel of Figure 62 shows the percentage of macroinvertebrates identified that are members of the collector functional feeding group. Collectors are macroinvertebrates that feed on fine particulate organic matter, either by filtering it from the water (filterers) or gathering it from deposits on the substrate (gatherers). These species tend to be generalists in their feeding and are thought to be more tolerant of certain forms of water

Figure 62

MACROINVERTEBRATE METRICS FOR THE MAINSTEM OF THE ROOT RIVER: 1979-2011



Source: Wisconsin Department of Natural Resources and SEWRPC.

pollution.[136] In the Middle Root River-Legend Creek, Middle Root River-Ryan Creek, and Lower Root River Caledonia assessment areas, the percentages of collectors in samples collected in the period 2005-2011 decreased markedly from the percentages found in samples collected during the period 1979-2004.

Figure 63 shows HBI values for six tributary streams in the Root River watershed or the periods 1979-2004 and 2005-2011. HBI values from Hoods Creek, Tess Corners Creek, and the East Branch of the Root River Canal from the period 2005-2011 were similar to those from 1979-2004, suggesting that water quality conditions in these streams have not changed much since 2004. HBI values from the Root River Canal and the West Branch of the Root River Canal from the period 2005-2011 were higher than those from the period 1979-2004, suggesting that there may have been an increase in organic pollutants in these streams. HBI values from Kilbournville Tributary from the period 2005-2011 were markedly lower than those from the period 1979-2004, indicating an improvement in conditions in this stream. As previously noted, this may be a result of the WisDOT stream relocations and restoration along this stream at the IH 94/CTH G interchange in 2008.

One site in the watershed, the mainstem of the Root River at Johnson Park (Rive Mile 11.5), had a sufficient number of macroinvertebrate samples collected over the period 1979-2011 to allow for a site-specific examination of trends. Figure 64 shows the values of six macroinvertebrate community metrics over the periods 1979-2011 along with trend lines determined by linear regression. It should be noted that most of these metrics are highly variable. Some of this variation may reflect a number of factors such as differences in the time of year that sampling was conducted and differences among the actual locations of sampling. Despite this variability, a number of trends are apparent. HBI values at this site decreased over this period from about 6.0 to about 5.3. This corresponds to an improvement in water quality rating from fair to good. Species richness increased. At the same time there were some changes in the composition of the macroinvertebrate community. The percentage of the community that consisted of collectors decreased over this period. At the same time, the percentage of the community that consisted of shedders increased. Shredders, which are macroinvertebrates that feed on coarse particulate organic material, tend to be sensitive to riparian zone influences and land use,[137] particularly inputs of leaves from adjacent and upstream riparian areas. The presence of terrestrially applied toxicants, such as pesticides and herbicides, on leaf surfaces can affect the numbers of shredders present.[138] The percentage of macroinvertebrates at this site belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) decreased over the period. At the same time, the percentage of the macroinvertebrate community consisting of midge larvae from the family Chironomidae did not change. Overall, these metrics indicate some improvement in the macroinvertebrate community present at this site.

The macroinvertebrate sampling included 17 instances where replicate samples were taken during sampling events. In seven instances two replicate samples were collected. In 10 instances three replicate samples were collected. These replicate samples can be used to evaluate the repeatability of HBI values and ratings. For each of these sampling events, the difference between highest and lowest HBI values computed from the data was examined. These differences ranged between 0.05 and 1.66, with a mean value of 0.42 and a median value of 0.23. In 11 cases, or about two-thirds of the instances, the same water quality rating was associated with both the highest and lowest HBI values. In six cases, or about one-third of the instances, different water quality ratings

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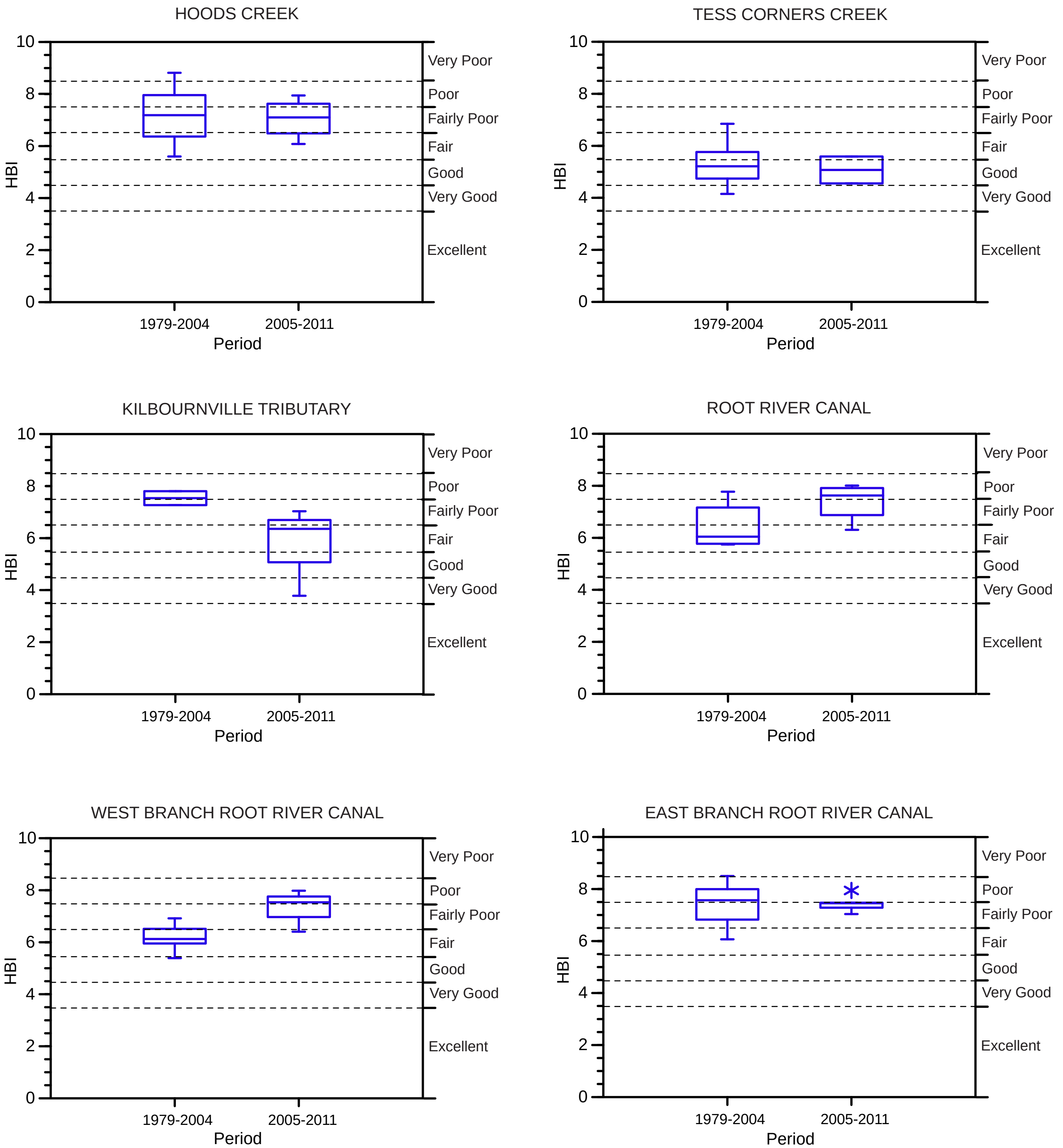
[136]*M.T. Barbour, J. Gerritsen, G.E. Griffith, R. Frydenborg, E. McCarron, J.S. White, and M.L. Bastian, "A Framework for Biological Criteria for Florida Streams Using Benthic Macroinvertebrates,"* Journal of the North American Benthological Society, *Volume 15, pages 185-211, 1996.*

[137]Ibid.

[138]*J.L. Plafkin, M.T. Barbour, K.D. Porter, S.K. Gross, and R.M Hughes*, Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish, *U.S. Environmental Protection Agency Publication EPA/444/4-89-001, 1989.*

Figure 63

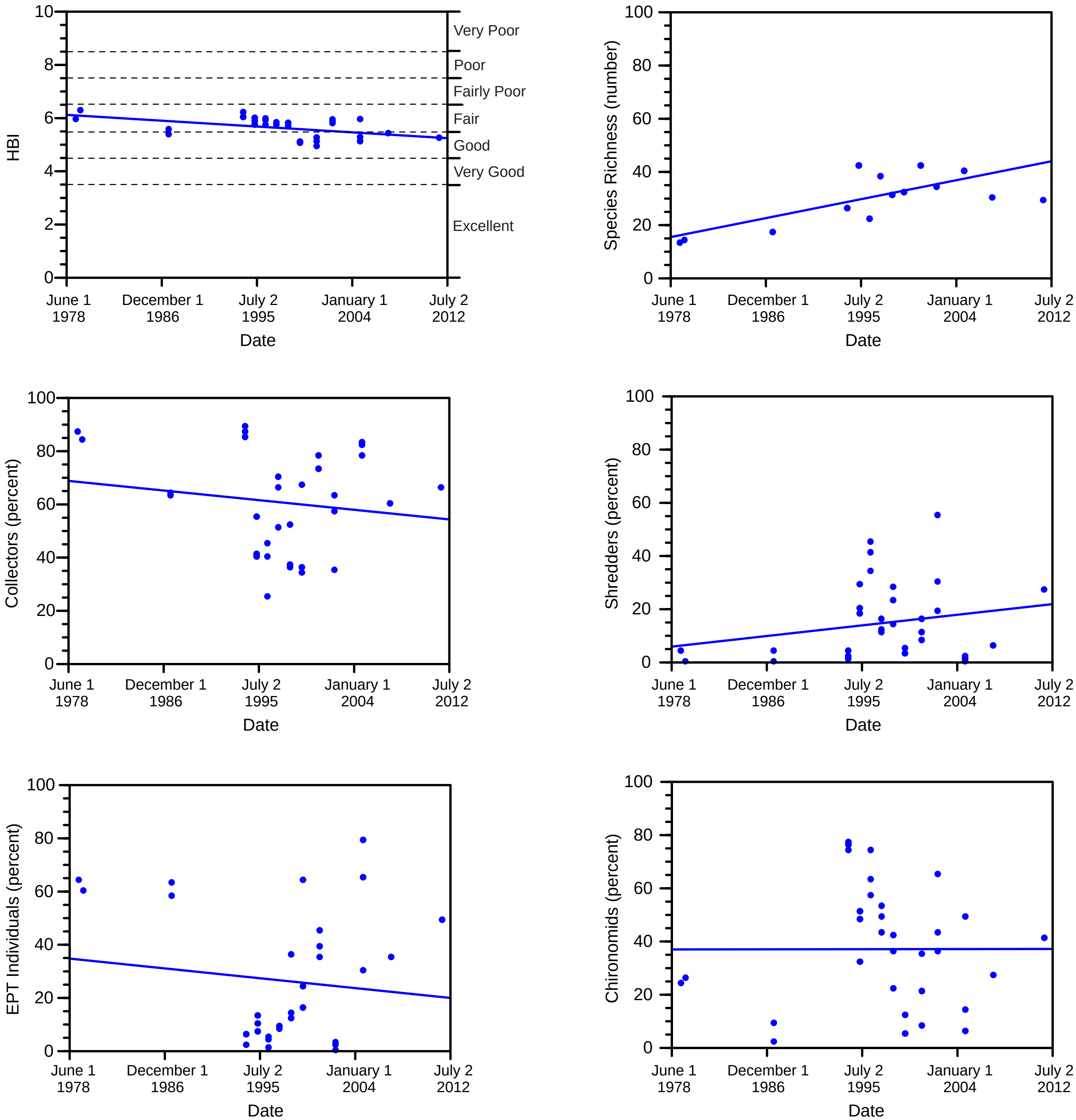
HILSENHOFF BIOTIC INDEX (HBI) VALUES FOR TRIBUTARY STREAMS IN THE ROOT RIVER WATERSHED: 1979-2004



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 64

MACROINVERTEBRATE COMMUNITY METRICS FOR THE ROOT RIVER AT JOHNSON PARK (RIVER MILE 11.5): 1979-2004



Source: Wisconsin Department of Natural Resources and SEWRPC.

were associated with the highest and lowest HBI values. In all six cases, the difference was by one rating. For example, in one instance the rating associated with one replicate sample was "good" water quality, while the rating associate with the other replicate sample was "fair" water quality. This gives an estimate of the precision of the ratings associated with single HBI values. In about two-thirds of cases, it would be expected that the rating resulting from a replicate sample would be the same rating resulting from the initial sample. In the remaining one-third of cases, it would be expected that the rating resulting from a replicate sample would be one rating higher or lower than rating resulting from the initial sample. This should be kept in mind when interpreting the ratings shown on Maps 42 and 43.

Mussels

Freshwater mussels are bivalve (two-shelled) mollusks that live in sediments of rivers, streams, lakes, and ponds. These soft-bodied animals are enclosed by two shells made mostly of calcium carbonate that are connected by a hinge. Mussels can typically be found anchored in the substrate, with only their siphons occasionally exposed. They typically favor sand, gravel, and cobble substrates. They play an important part in aquatic communities by helping stabilize river bottoms; serving as natural water filters; providing spawning habitat for fish; and serving as food for fish, birds, and some mammals. Live mussels and relict shells provide a relatively stable substrate in dynamic riverine environments for a variety of other macroinvertebrates, such as caddisflies and mayflies and for algae.

Mussels require moving water to provide food and oxygen and to remove wastes. They filter fine organic matter, such as algae and detritus, from the water. A single mussel can filter several gallons of water per day. This means that mussels can improve water quality by removing sediment and associated contaminants from water. Many mussel species grow slowly and have long life spans. In some species, individuals may survive for as long as 100 years. Most mussel species are sessile, moving only short distances their entire life. They maneuver using a muscular fleshy foot extended from the shell. Movement is often triggered by changes in water levels or other environmental conditions. During periods of stress, such as temperature extremes, drought, or exposure to pollutants, many species will burrow deep into the sediment. This can allow them to survive until the stressor has passed. Because mussels are relatively long-lived and require good physical habitat and good water quality, they serve as good indicators of environmental conditions.

Mussels form growth rings. These are dark bands that indicate a period of no growth. While current research suggests that these bands are not necessarily laid down annually, they are reasonable guides for placing individual mussels into age groups. These rings can also be used to glean information about historical water quality and disturbance.

Mussels are important, sensitive indicators of changing environmental conditions. Water quality and sediment quality are important habitat criteria for mussels. Most species of freshwater mussels prefer clean running water with high oxygen content. All species are susceptible to pollution, including pesticides, heavy metals, ammonia, and algal toxins. Because they are long-lived, mussels can be used to document changes in water quality over long periods of time. As mussels grow, heavy metals in the water and sediment accumulate in their shells. Examination of heavy metal concentrations in shells can indicate when water in a given area was first contaminated. The presence or absence of particular mussel species provides information about long-term water quality conditions. Juvenile forms of mussels are more susceptible to pollution than adult forms. Finding juveniles with few adults nearby may indicate a newly colonized area. In general, having healthy diverse populations of mussels is an indication of good water quality.

Freshwater mussels have a unique life cycle that includes a parasitic stage. Fish act as the host for this stage. Reproduction occurs when a male mussel releases sperm into the water column. This is siphoned into the female mussel to fertilize the eggs. Reproduction may be triggered by increasing water temperature and/or day length. Larvae are brooded through early development in the female's gills and development and retention of larvae within the female may last from one to 10 months. Immature mussels, known as glochidia, are generally released from the female in spring and early summer. The glochidia must attach to the gills of a fish to obtain nutrients from blood serum. Mussel species show a variety of adaptations that increase the exposure of fish to glochidia. As parasites, glochidia are dependent on fish for their nutrition at this stage in their life. Some mussels may depend on only a single fish species, whereas others are able to parasitize many different fishes. The attachment of glochidia causes no problems for the host fish. Mussels spend at least two to three weeks attached to fish. Following this they drop off the host and settle in the bed of a new stretch of a stream, river, or lake, where they may grow and stay for more than a half century. The characteristics and potential host fish species of those mussel species that have been found in the Root River watershed are shown in Table 42.

The dispersal of mussel species depends upon the transport of glochidia by host fish. The habitat preferences of freshwater mussel species and their hosts generally coincide closely.[139] Studies of peripheral populations of freshwater mussels in Nova Scotia indicate that the invasion of new habitats by mussels occurs primarily through dispersal of the host fish.[140] This dependence upon host fish for dispersal means that barriers to fish movement are also barriers to mussel dispersal and may act to restrict mussels from otherwise suitable habitats.

Mussels are considered one of the most endangered groups of animals in North America. Exploitation, changing water quality, and invasive species all are threats to these invertebrates. Siltation, chemical pollution, loss of habitat through creation of impoundments, channelization or other stream modifications, predation, and impacts from invasive species are common factors responsible for the decline of freshwater mussels. Adult mussels are eaten by muskrats, otters, and raccoons; young mussels are eaten by ducks, wading birds, and fish. Historically, freshwater mussels were used by Native Americans as food, source materials for tools, and ornamental objects. They were also important commercially in modern society beginning around the 1890s, when mussels were harvested and used in the manufacture of buttons for clothing.

Invasive species pose a significant threat to native mussel populations, zebra mussels represent a serious threat. The life cycle of these mussels is different from that of native freshwater mussels as it does not include a parasitic stage. Instead, the larvae of zebra mussels develop as planktonic organisms called veligers that drift in the current. When they become large enough they settle down on and attach to hard surface, such as the stream bottom or another object. Zebra mussels produce thousands of veligers and can reproduce several times per year. Zebra mussels are very effective at removing suspended particles, such as algae, bacteria, and detritus, from the water. They are very effective competitors for food resources. In addition, zebra mussels have the ability to attach to the shells of native mussels, smothering them. Other invasive mussels also pose threats to native mussel populations. These include the Asian clam and the quagga mussel. Both of these species also compete with native mussels for habitat and food.

Sampling has been conducted for freshwater mussels in the Root River watershed on at least two occasions: 1977 and 2012. In 1977, sampling was conducted at seven stations along the mainstem of the Root River as part of a statewide survey of unionid mussels in rivers.[141] This survey found three species: giant floater, lilliput, and white heelsplitter. More recent sampling was conducted during the summer of 2012.[142] This study sampled for mussels

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[139]*P.W. Kat, "Parasitism and the Unionacea (Bivalvia),"* Biological Review*, Volume 59, pages 189-207, 1984.*

[140]*P.W. Kat and G.M. Davis, "Molecular Genetics of Peripheral Populations of Nova Scotian Unionidae (Mollusca: Bivalvia),"* Biological Journal of the Linnean Society*, Volume 22, pages 157-185, 1984.*

[141]*Harold A. Mathiak,* A River Survey of the Unionid Mussels of Wisconsin 1973-1977*, Sand Shell Press, 1979.*

[142]*Jason M. Dare,* Mussels of the Root River: A Preliminary Qualitative Assessment*, Report to Root-Pike Watershed Initiative Network, March 14, 2013.*

Table 42

CHARACTERISTICS OF MUSSEL SPECIES THAT HAVE BEEN DETECTED IN THE ROOT RIVER

Species	Maximum Size	Habitat	Potential Host Fish Species: Occur in the Root River	Potential Host Fish Species: Not Found in the Root River
Creeper[a]	4 inches	Creeks, small streams, and occasionally large rivers in mud, sand, and gravel	Black bullhead, black crappie, blacknose dace, blackside darter, bluegill, bluntnose minnow, brook stickleback, central mudminnow, central stoneroller, channel catfish, common shiner, creek chub, fathead minnow, green sunfish, Iowa darter, johnny darter, largemouth bass, logperch, longnose dace, pumpkinseed, rock bass, sand shiner, spottail shiner, smallmouth bass, white crappie, yellow bullhead, yellow perch	Banded darter, burbot, common stoneroller, fantail darter, longear sunfish, northern redbelly dace, rainbow darter, river chub, spotfin shiner, walleye
Ellipse[b]	3 inches	Small to large streams in sand, gravel, and small cobble	Blackside darter, brook stickleback, Iowa darter, johnny darter, logperch	Fantail darter, greenside darter, mottled sculpin, orange throated darter, rainbow darter, slimy sculpin,
Fat Mucket	5 inches	Small streams to large rivers, lakes, and ponds in silt, sand, and gravel	Black crappie, bluegill, bluntnose minnow, green sunfish, common shiner, largemouth bass, pumpkin seed, rock bass, sand shiner, smallmouth bass, tadpole madtom, warmouth, white crappie, white sucker, yellow perch	Longear sunfish, sauger, striped shiner, walleye, white bass
Fluted-Shell	7 inches	Medium-sized streams to large rivers in mud, sand, and gravel	Bluegill, central stoneroller, common carp, creek chub, gizzard shad, goldfish largemouth bass, longnose dace, northern pike, pumpkinseed, river redhorse, yellow perch	Bowfin, banded darter, northern hogsucker, walleye
Fragile Papershell	6 inches	Small streams to large rivers in silt, sand, and gravel	- -[c]	Freshwater drum
Giant Floater	10 inches	Small streams to large rivers, lakes, ponds in silt, sand, and gravel	Black crappie, blacknose shiner, bluegill, bluntnose minnow, central stoneroller, common shiner, green sunfish, Iowa darter, johnny darter, largemouth bass, yellow perch	Brook silverside, rainbow darter, striped shiner
Liliput	1.5 inches	Rivers, ponds, and lakes in mud, sand, and gravel	Bluegill, green sunfish, orange spotted sunfish, warmouth, white crappie	- -
Spike	5.5 inches	Small streams to large rivers, occasionally lakes in silt, sand, and gravel	Black crappie, gizzard shad, rock bass, white crappie, yellow perch	Banded sculpin, flathead catfish
Three Ridge	8 inches	Small streams to large rivers in sand and gravel, sometimes in compacted mud	Black crappie, bluegill, green sunfish, largemouth bass, northern pike, pumpkinseed, rock bass, warmouth, white crappie, yellow perch	Flathead catfish, sauger, shortnose gar, white bass

Table 42 (continued)

Species	Maximum Size	Habitat	Potential Host Fish Species: Occur in the Root River	Potential Host Fish Species: Not Found in the Root River
Wabash Pigtoe	4 inches	Creeks, small steams, and large rivers in mud, sand and gravel	Black crappie, bluegill, common shiner, creek chub, white crappie	Silver shiner
White Heelsplitter	8 inches	Small streams to large rivers, ponds and lakes in mud, sand, and gravel	Common carp, gizzard shad, green sunfish, largemouth bass, orange spotted sunfish, river redhorse, white crappie	Banded killifish, longnose gar, walleye

[a]*Creeper glochidia have also been reported to mature into juvenile mussels without parasitizing a host.*

[b]*This species is considered a threatened species in Wisconsin.*

[c]*The only known fish host for fragile papershell glochidia are freshwater drum, which have not been reported as being present in the Root River watershed.*

Source: D.C. Allen, B.E. Sietman, D.E. Kelner, M.C, Hove, J.E. Kurth, J.M. Davis, and D.J. Hornbach, "Early Life-History and Conservation Status of Venustaconcha ellipsiformis (Bivalia, *Unionidae*), *in Minnesota,"* American Midland Naturalist, *Volume 157, pages 74-91, 2007; K. Hillegass and M. Hove, "Suitable Fish Hosts for Glochidia of Three Freshwater Mussels: Strange Floater, Ellipse, and Snuffbox,"* Triannual Unionie Report, *Volume 13, page 25, 1997; M. Hove, "Suitable Fish Hosts of the Lilliput,* Toxolasma parvus,*"* Triannual Unionid Report, *Volume 8, page 9, 1995; M. Hove, R. Engelking, M. Peteler, E.M. Peterson, A.R. Kapuscinski, L.A. Sovell, and E.R. Evers, "Suitable Fish Hosts for Glochidia of Four Freshwater Mussels,"* Conservation and Management of Freshwater Mussels II: Proceedings of a UMRCC Symposium, *1997; M. Hove and A.R. Kapuscinski, "Ecological Relationships Between Six Rare Minnesota Mussels and Their Host Fishes," Final Report to the Minnesota Department of Natural Resources, 1998; R. Howells, "New Fish Hosts for Nine Freshwater Mussels (Bivalvia: Unionidae) in Texas,"* Texas Journal of Science*, Volume 49, pages 255-258, 1997; R. Klocek, J. Bland, and L. Barghusen,* A Field Guide to the Freshwater Mussels of Chicago Wilderness, *Chicago Wilderness, 2008; R. Mulcrone,* Incorporating Habitat Characteristics and Fish Hosts to Predict Freshwater Mussel (Bivalvia: Unionidae) Distributions in the Lake Erie Drainage, Southeastern Michigan, *Ph.D. Dissertation, University of Michigan, 2004; S. O'Dee and G. Watters, "New or Confirmed Host Identifications for Ten Freshwater Mussels,"* Proceedings of the Conservation, Captive Care ,and Propagation of Freshwater Mussels Symposium*, pages 77-82, 2000; F.A. Riusech and M.C. Barnhart, "Host Suitability and Utilization in* Venustaconcha ellipsiformis *and* Venustaconcha pleasii *(Bivalvia: Unionidae) from the Ozark Plateaus,* Proceedings of the Conservation, Captive Care ,and Propagation of Freshwater Mussels Symposium*, pages 83-91, 2000; R. Trdan, "Reproductive Biology of* Lampsilis radiate siliquoidea *(Pelecypoda: Unionidae),"* American Midland Naturalist, *Volume 106, pages 243-248, 1982; R. Trdan and W. Hoeh, "Eurytopic Host Use by Two Congeneric Species of Freshwater Mussel (Pelecypoda: Unionidae: Anodonta),"* American Midland Naturalist, *Volume 108, pages 381-388, 1982; E. van Snik Gray, W. Lellis, J. Cole, and C. Johnson, "Hosts of* Pyganodon cataracta *(Easter Floater) and* Strophitus undulates *(Squawfoot) from the Upper Susquehanna River Basin, Pennsylvania,"* Triannual Unionid Report, *Volume 18, page 6, 1999; G. T. Watters, "An Annotated Bibliography of the Reproduction and Propagation of the Unionoidea (Primarily of North America)." Ohio Biological Survey Miscellaneous Contributions No. 1, 1994; G.T. Watters,* A Guide to the Freshwater Mussels of Ohio, *Ohio Department of Natural Resources, 1995; G.T. Watters, S. O'Dee, and S. Chordas, "New Potential hosts for:* Strophitus undulatus-*Ohio River Drainage;* Strophitus undulates-*Susquehanna River Drainage;* Alasimidonta undulate- *Susquehanna River Drainage;* Actinonaias ligamentina-*Ohio River Drainage; and* Lasmigona costata-*Ohio River Drainage,"* Triannual Unionid Report, *Volume 15, pages 27-29, 1998; and J.L. Weiss and J.B. Layzer, "Infestations of Glochidia on Fishes in the Barren River, Kentucky,"* American Malacological Bulletin, *Volume 11, pages 153-159, 1995.*

at 16 sites along a 35-mile section of the mainstem of the Root River between the Root River Environmental Education Community Center (REC Center) in the City of Racine and W. Grange Avenue in the Village of Greendale. These sites are shown on Map 44. Sampling was not conducted in tributary streams. The surveys at these sites consisted of timed qualitative searches of all likely mussel habitat at a site. Each survey began at the base of a riffle or run section of river and proceeded upstream until 30 minutes after the last new mussel species was found. In addition, both shorelines adjacent to the stream section surveyed were examined to locate dead mussel shells which had drifted onto the shore during high water or had been left in middens by mammals feeding on mussels.

The results of the 2012 survey are shown in Table 43. The surveys detected live mussels from seven native species. The surveys also found dead shells from four additional native species. The nonnative zebra mussel was also detected. The four most common species were creeper, fat mucket, giant floater, and white heelsplitter. Live individuals of creeper and fat mucket were found at 10 sites; live giant floaters were found at 13 sites, and live white heelsplitters were found at 14 sites. By contrast, fragile papershells, three ridges, and wabash pigtoes were rarer. Live fragile papershells were found at three sites; live wabash pigtoes were found at two sites; and live three ridges were found at one site.

As previously noted, the survey found dead shells from four species; which no live individuals were found. Two of these species, spike and lilliput, were found at multiple sites. Ellipse and fluted-shell were found at one site each. The surveys conducted in 1977 found live individuals of one of these species, lilliput. It should be noted that mussel shells can take years to decades to deteriorate. Because of this, the presence in or along a river of dead shells from a mussel species does not necessarily mean that live individuals of that species are currently present in the river.

There are some patterns in the distribution of mussels along the length of the Root River. The greatest abundance and diversity of live mussels was found in two zones. The first zone consists of a five-mile reach between CTH V and 7 Mile Road. The second zone consists of a one-mile reach between Riverside Drive in the City of Racine and the REC Center. While the number of live mussels found at the sites in the reaches varied from site to site, the average number of live mussels found in these sections was slightly greater than 100 per site. The numbers of live mussels found at sites outside these sections tended to be lower, averaging 27 per site. Horlick dam might act as a barrier restricting the distribution of a few mussel species. Live individuals and dead shells of the three ridges were found only at sites upstream from the dam. By contrast, live fragile papershell and dead shells from ellipse and fluted shell were found only at sites downstream from the dam.

Prior to 2006, harvesting of freshwater mussels was allowed in Wisconsin, and rules were in place that allowed each individual to harvest up to 50 pounds of mussels per day. Under those rules threatened and endangered species could not be harvested. This was problematic because even experts had difficulty identifying individual mussel species. Since 2006, it is illegal to harvest mussels from inland waters in the State. The law does allow dead shells from species that are not threatened or endangered to be collected.

Currently, the WDNR Bureau of Natural Heritage Conservation[143] is working with citizen scientists to create a new mussel monitoring program to update the data on mussel distribution statewide. Researchers are enlisting the help of volunteers by contracting with schools, nature centers, and interested individuals, and are providing training to conduct stream surveys under the auspices of the Mussel Monitoring Program of Wisconsin.

[143] *This was formerly the Bureau of Endangered Resources.*

Map 44

FRESHWATER MUSSEL SAMPLING SITES WITHIN THE ROOT RIVER WATERSHED: 2012

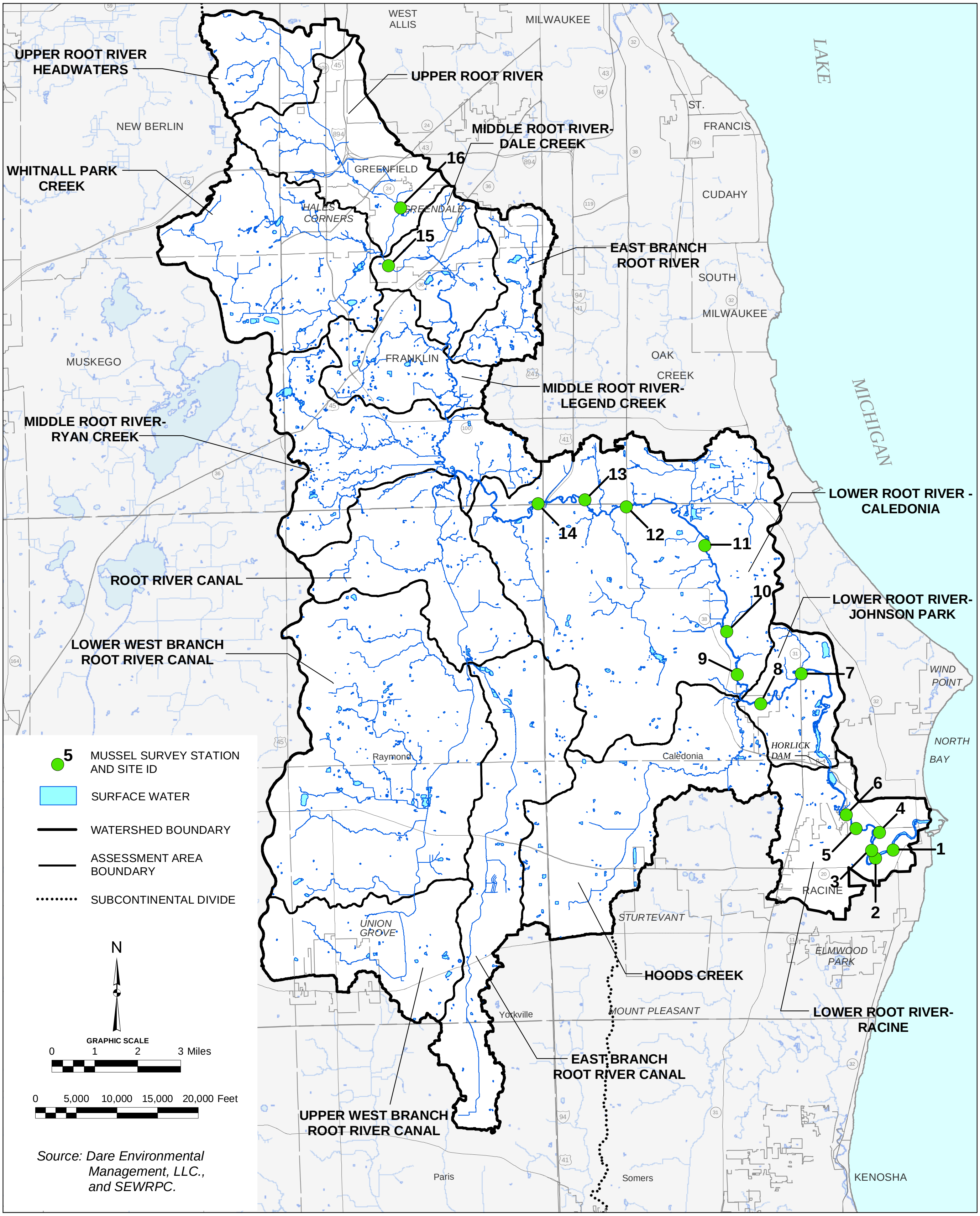


Table 43

LIVE MUSSELS FOUND AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 2012

Sample Site[a]	Location	White Heelsplitter (*Lasmigona complanata*)	Creeper (*Strophitus undulatus*)	Spike (*Elliptio dilatata*)	Giant Floater (*Pyganodon grandis*)	Three Ridge (*Amblema plicata*)	Ellipse (*Venustachoncha ellipsiformis*)[b]	Fat Mucket (*Lampsilis siliquoidea*)	Wabash Pigtoe (*Fusconaia flava*)	Fluted-Shell (*Lasmigona costata)*	Liliput (*Toxolasma parvus*)	Fragile Papershell (*Leptodea fragilis*)	Zebra Mussel *(Dreissena polymorpha*)	Total Live Mussels
1	REC Center	28	8	- -[c]	19	- -	- -	3	- -[c]	- -	- -	2	13	73
2	Clayton Park	57	49	- -[c]	39	- -	- -	32	- -[c]	- -[c]	- -[c]	4	6	187
3	Riverside Drive	18	28	- -[c]	5	- -	- -[c]	7	- -[c]	- -	- -	2	- -	60
4	Liberty Street	- -[c]	- -	- -	- -[c]	- -	- -	- -	- -	- -	- -	- -	- -	0
5	Upstream of Steelhead Facility	18	29	- -	10	- -	- -	6	- -	- -	- -	- -	- -	63
6	Colonial Park	3	9	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	12
7	STH 31 and 4 Mile Road	24	- -	- -	17	- -	- -	1	2	- -	- -	- -	- -	44
8	Johnson Park	21	- -[c]	- -[c]	16	- -	- -	2	- -[c]	- -	- -[c]	- -	- -	39
9	4 Mile Road	9	7	- -[c]	4	- -[c]	- -	7	- -[c]	- -	- -	- -	- -	27
10	5 Mile Road	9	3	- -	4	- -	- -	- -[c]	- -	- -	- -	- -	- -	16
11	7 Mile Road	39	38	- -[c]	29	2	- -	11	1	- -	- -[c]	- -	- -	120
12	STH 38	43	9	- -[c]	29	- -[c]	- -	5	- -[c]	- -	- -	- -	- -	86
13	CTH V	37	40	- -	33	- -	- -	9	- -	- -	- -[c]	- -	- -	119
14	W. County Line Road	20	- -	- -[c]	9	- -[c]	- -	- -[c]	- -	- -	- -	- -	- -	29
15	Whitnall Park	10	- -	- -	29	- -	- -	- -	- -	- -	- -	- -	- -	39
16	W. Grange Avenue	- -[c]	- -	- -	- -	--	- -	- -	- -	- -	- -	- -	- -	0
- -	Total Live Mussels	336	220	0	243	2	0	83	3	0	0	8	19	914

[a]*See Map 44.*

[b]*This species is considered threatened in the State of Wisconsin.*

[c]*While no live individuals of this species were found at this site, dead shells were found.*

Source: Dare Environmental Management, LLC.

Volunteers wade in the water and walk stream banks looking for live and dead mussels. Live mussels are identified and photographed before they are returned to the stream. Empty shells and dead specimens are collected along with information and photos that are sent to the mussel monitoring program at the WDNR central office.

Other Wildlife

Although a quantitative field inventory of amphibians, reptiles, birds, and mammals was not conducted as a part of this study, it is possible, by polling naturalists and wildlife managers familiar with the area, to compile lists of amphibians, reptiles, birds, and mammals which may be expected to be found in the area under existing conditions. The technique used in compiling the wildlife data involved obtaining lists of those amphibians, reptiles, birds, and mammals known to exist, or known to have existed, in the Root River watershed area, associating these lists with the historical and remaining habitat areas in the area as inventoried, and projecting the appropriate amphibian, reptile, bird, and mammal species into the watershed area. The net result of the application of this technique is a listing of those species which were probably once present in the watershed area, those species which may be expected to still be present under currently prevailing conditions, and those species which may be expected to be lost or gained as a result of urbanization within the area. The results of these inventories are presented in Appendix F. It is important to note that this inventory was conducted on a countywide basis for each of the aforementioned major groups of organisms. Some of the organisms listed as occurring in Kenosha, Milwaukee, Racine, and Waukesha Counties may only infrequently occur within the Root River watershed.

A variety of mammals, ranging in size from large animals like the white-tailed deer, to small animals like the meadow vole, are likely to be found in the Root River watershed. Figure 65 shows some of the common mammals of the watershed. Muskrat, white-tailed deer, gray squirrel, and cottontail rabbit are among the mammals reported to occur in the area. Table F-2 in Appendix F lists the mammals whose ranges historically extended into the watershed area.

A large number of birds, ranging in size from large game birds to small songbirds, are found in the Root River watershed area. Table F-3 in Appendix F lists those birds that normally occur in this watershed. Each bird is classified as to whether it breeds within the area, visits the area only during the annual migration periods, winters in the area, or is resident in the area. Figure 66 shows several birds that breed in the Root River watershed. Among the birds that the watershed supports are significant populations of waterfowl, including mallards and Canada geese. Larger numbers of various waterfowl likely move through the watershed areas during the annual migrations when most of the regional species may also be present. Many game birds, songbirds, waders, and raptors also reside in or visit the watershed.

Amphibians and reptiles are vital components of the ecological communities of the Root River watershed area. Figure 67 shows some of the amphibians that can be found in the watershed. Examples of amphibians native to the area include frogs, toads, and salamanders. Figure 68 shows some of the reptiles that can be found in the watershed. Turtles and snakes are examples of reptiles common to the Root River area. Table F-4 in Appendix F lists the amphibian and reptile species normally expected to be present in the Root River area under present conditions. Most amphibians and reptiles have specific habitat requirements that are adversely affected by agricultural disturbances and advancing urban development.

Endangered and threatened species and species of special concern present within the Root River watershed area include 57 species of plants, 12 species of birds, 10 species of fish, five species of reptiles, one species of amphibian, and 10 species of invertebrates based upon Wisconsin Department of Natural Resources records dating back to the late 1800s (see Table 25).[144]

[144]*The barn owl, Bewick's wren, Blanding's turtle and Butler garter snake have been proposed for delisting. As of July 3, 2013, the State Natural Resources Board and Governor Scott Walker have approved the proposed delisting, and the proposal is being reviewed by the Wisconsin Legislature.*

Figure 65

EXAMPLES OF MAMMALS FOUND IN THE ROOT RIVER WATERSHED

Little Brown Bat

Muskrat

White-tailed Deer

Gray Squirrel

Red Fox

Source: Wisconsin Department of Natural Resources and Donna Pelikan Boxhorn.

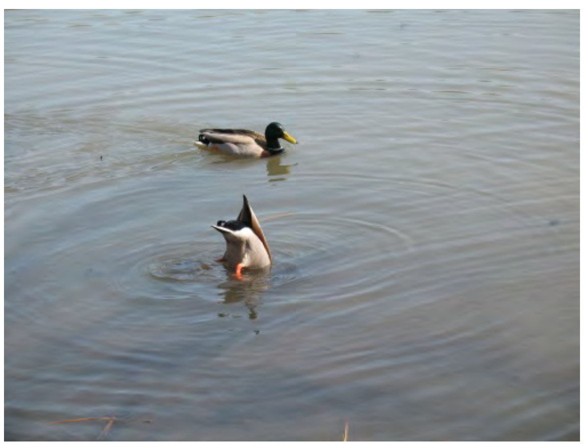
Figure 66

EXAMPLES OF BIRDS FOUND IN THE ROOT RIVER WATERSHED

Ring-Billed Gull

Rose-Breasted Grosbeak

Killdeer



Mallard

Purple Martin

Great Blue Heron

Source: Wisconsin Department of Natural Resources and Donna Pelikan Boxhorn.

Figure 67

EXAMPLES OF AMPHIBIANS FOUND IN THE ROOT RIVER WATERSHED

American Toad

Four-Toed Salamander

Bull Frog

Bull Frog with Tadpoles

Central Newt

Green Frog

Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 68

EXAMPLES OF REPTILES FOUND IN THE ROOT RIVER WATERSHED

Common Garter Snake

Blanding’s Turtle

Snapping Turtle

Musk Turtle

Fox Snake

Source: Wisconsin Department of Natural Resources, Donna Pelikan Boxhorn, and SEWRPC.

Figure 69

COMMON CARP *(Cyprinus carpio)*

Source: Minnesota Department of Natural Resources.

The diversity and abundance of wildlife species originally native to the watershed, along with their habitat, have undergone significant change since European settlement of the area. This change is a direct result of the conversion of land by the settlers from its natural state to human uses. This conversion began with the clearing of the forests and prairies and the draining of wetlands for agricultural purposes, and has continued with the development of urban land in some areas. Successive cultural uses and attendant management practices have been superimposed on these land use changes. These practices have also affected the wildlife and wildlife habitat. In urban areas, cultural management practices that affect wildlife and their habitat include the use of fertilizers, herbicides, and pesticides; road salting for snow and ice control; heavy motor vehicle traffic that produces disruptive noise levels and air pollution and non-point source water pollution; and the introduction of domestic pets.

Exotic and Invasive Species

A noticeable feature of the waterbodies and riparian areas on the post-European-settlement landscape of southeastern Wisconsin is the large number of nonnative species of plants and animals that have become established and capable of reproducing in local habitats. Where their introduction has caused, or is likely to cause, economic or environmental harm or harm to human health, exotic species may be considered invasive. Typically, populations of exotic invasive species can grow rapidly, due to both the high reproductive capacities of these organisms and the absence of predators, parasites, pathogens, and competitors from their new habitat. Once established in a waterbody, these species can rarely be eliminated. In addition, many of these species are capable of readily dispersing to other waterbodies. In many cases, this dispersal is aided by direct or indirect human intervention.

The presence of an exotic invasive species in an aquatic habitat can produce alterations in physical and biological characteristics of that habitat. Many of these species are capable of producing dense populations, which can crowd out native species. Feeding by some of these species can have marked impacts on water clarity. Many of these species are strong competitors for nutrients, space, and other resources, allowing them to displace native species from habitats.

Several different exotic invasive species have been found in waterbodies, wetlands, and riparian areas of the Root River watershed. These are described and, to the extent that data are available, the extent of their presence is inventoried below.

Descriptions of Aquatic Invasive Species

Aquatic invasive species pose threats to the integrity of watersheds in Wisconsin. Several aquatic invasive species are present in the Root River watershed. Except as noted below, the following species are either known to be present or have historically been present in the watershed.

Common Carp

The common carp (*Cyprinus carpio*) (see Figure 69), a native of Asia, is an aggressive exotic fish species that was deliberately introduced into Wisconsin waters in the last decades of the 19th century. By 1885 it was well established in the State.[145] Tolerant of a wide range of ecological conditions, the common carp is most abundant in large, shallow lakes. It prefers warm waters with abundant vegetation and can survive in polluted waters with low concentrations of dissolved oxygen and high temperatures. It is not usually found in clean, cold waters.

Carp populations can produce a number of changes in waterbodies. Through their feeding activity they destroy aquatic vegetation and resuspend sediment. This can lead to increases in temperature and decreases in light penetration and dissolved oxygen concentration. In addition, the resuspension of sediment may transfer nutrients to the water column, leading to increased algal growth. These changes may reduce the suitability of the waterbody as habitat for other, more desirable, fish and wildlife species. The common carp has been implicated in the loss of certain types of waterfowl from waterbodies because the fish destroys important aquatic vegetation, such as wild rice and wild celery, which these birds rely on for food. The carp may also outcompete certain native fish species, such as black bass, largemouth bass, and pike for food and spawning areas.

It should be noted that four other nonindigenous species of carp—bighead carp (*Hypophthalmichtys nobilis*), black carp (*Mylopharyngodon piceus*), grass carp (*Ctenopharyngodon idella*), and silver carp (*Hypophthalmichtys molirix*)—may pose risks to Lake Michigan and its tributary waters, including the Root River. All of these species are native to eastern China. Each has high reproductive capacity and is capable of rapid population growth. Individuals in each of these species are capable of consuming large amounts of food and can grow to large size. Each species is capable of migrating distances in excess of several hundred miles in large river systems. None of these species have been detected in waterbodies of the Root River watershed.

Figure 70

CURLY-LEAF POND WEED (*Potamogeton crispus)*

Source: Elizabeth J. Czarapata, Wisconsin Department of Natural Resources.

Curly-Leaf Pondweed

Curly-leaf pondweed (*Potamogeton crispus)* (see Figure 70) is an aquatic plant native to Europe and Asia that has invaded lakes in much of the United States. It was accidentally introduced into North American waters during the introduction of the common carp in the late 19th century. By 1950 it had spread throughout much of the United States.

Several features of the biology of curly-leaf pondweed contribute to its status as a nuisance species. This species has fairly broad environmental tolerances. It can grow in clear to turbid water and tolerates alkaline and brackish water.[146] It is tolerant of low light levels and well-adapted to cold water. This allows it to grow slowly under the

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[145]*George C. Becker,* Fishes of Wisconsin, *University of Wisconsin Press, Madison, Wisconsin, 1983.*

[146]*R.L. Stuckey, "Distributional History of* Potamogeton crispus *(Curly Pondweed) in North America,"* Bartonia, *Volume 46, 1979, pp. 22-42.*

Figure 71

EURASIAN WATER MILFOIL (*Myriophyllum spicatum*)

Source: Elizabeth J. Czarapata, Wisconsin Department of Natural Resources.

ice during winter while other aquatic plants are dormant. It grows up early in the spring, often being the first plant to appear following ice out. It forms dense surface mats, which can interfere with recreational uses of a waterbody and limit the growth of native aquatic plants. Curly-leaf pondweed typically dies back in the middle of the summer. Prior to this die back, it forms propagules called turions consisting of hardened stem tips that disperse by water movement. Transfer of turions and transfer of plant fragments by boats can contribute to the spread of this plant between waterbodies.

The mid-summer die back of curly-leaf pondweed causes several problems. This die back creates a sudden loss of habitat for fish and macroinvertebrates that can adversely impact their populations. Decomposition of dying pondweed can reduce dissolved oxygen concentrations in the waterbody and release nutrients which contribute to algal blooms and reduced water clarity. Rafts of dying pondweed can accumulate on shore, reducing aesthetic enjoyment of the waterbody.

Control of curly-leaf pondweed is usually accomplished through adjustment of water levels, manual harvesting, mechanical harvesting, herbicide application, or some combination thereof.

Eurasian Water Milfoil

Eurasian water milfoil (*Myriophyllum spicatum*) (see Figure 71) is an aquatic plant originally native to Europe, Asia, and North Africa that has invaded waterbodies in much of North America. It was first observed in a pond in the District of Columbia in 1942. Since then it has spread to waterbodies in most states and several Canadian provinces. The species most likely reached eastern North America through the aquarium trade when aquarium owners released the contents of aquaria into local waterbodies. Its spread has been facilitated by plant fragments clinging to boats moving between waterbodies. The waters of southeastern Wisconsin are heavily infested with this plant.

Several features of the biology of Eurasian water milfoil contribute to its status as a nuisance species. It is a perennial herbaceous submerged plant that forms systems of roots and runners in the sediment. Its shoot system can form dense branches at the surface. It begins growth in the early spring, before other aquatic plants have begun to grow. This, along with its tendency to form dense stands, allows it to shade out other vegetation. It can tolerate a wide range of conditions, including broad ranges of temperature, alkalinity, and lake trophic status. This species is mostly propagated vegetatively, through the growth of underground runners from the root system and through the growth of stem fragments into adult plants. Because of the latter method of propagation, shearing of plants by harvesting or boat propellers can facilitate its spread.

The presence of large populations of Eurasian water milfoil can cause several problems in waterbodies. This species often outcompetes native aquatic plant species and dominates the plant communities in lakes and ponds. This leads to reductions in the abundance and diversity of native aquatic plants.[147] Dense stands of Eurasian water

[147] *J.D. Madsen, J.W. Sutherland, J.A. Bloomefield, L.W. Eichler, and C.W. Boylan, "The Decline of Native Vegetation Under Dense Eurasian Watermilfoil Canopies,"* Journal of Aquatic Plant Management, *Volume 28, 1991, pp. 94-99.*

milfoil can impede water circulation. This can lead to reductions in the concentration of dissolved oxygen, especially as organic material decays. Eurasian water milfoil provides relatively poor habitat for wildlife and other aquatic organisms. It provides less nutritional value to waterfowl, supports lower diversity and abundance of macroinvertebrates, supports lower fish abundance, and promotes lower rates of fish growth than native plant species. Finally, thick mats of this plant can limit boating, fishing, swimming, and aesthetic enjoyment of waterbodies, leading to increased costs for aquatic plant management.[148]

Figure 72

FLOWERING RUSH (*Butomus umbellatus)*

Source: W.A. Smith, Wisconsin Department of Natural Resources.

Control of Eurasian water milfoil is usually accomplished through manual harvesting, mechanical harvesting, herbicide application, or some combination thereof. Biological control has been attempted using a native milfoil weevil, *Euhrychiopsis lecontei*, as a control agent. This insect appears to be widely distributed among lakes in Wisconsin.[149] The use of this species as a biological control agent for Eurasian water milfoil has had mixed results. In some instances, decreases in the biomass or abundance of Eurasian water milfoil have been associated with the presence of these weevils within infested lakes.[150] In other lakes that contain this weevil, no such decrease was detected. Similarly, augmentation of natural weevil populations has sometimes resulted in decreases in Eurasian water milfoil biomass or abundance in some lakes, but not in others. The reasons for the failure of this weevil to control Eurasian water milfoil populations in some lakes is not well understood, but has been attributed to a variety of factors, including: predation upon the weevils by fish, lack of suitable overwintering habitat, low reproduction rates by weevils when present at low densities, and hybridization between Eurasian water milfoil and native milfoil species.

Flowering Rush

Flowering rush (*Butomus umbellatus)* (see Figure 72) is an aquatic plant native to Europe that has invaded waterbodies in North America. It was most likely introduced into North America as a garden ornamental. Since its introduction flowering rush has spread through the northern tier of states and several Canadian provinces.

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[148]*C.S. Smith and J.W. Barko, "The Ecology of Eurasian Watermilfoil,"* Journal of Aquatic Plant Management, *Volume 28, 1990, pp. 55-64.*

[149]*L.L. Jester, M.A. Bozek, D.R. Helsel, and S.P. Sheldon,* "Euhrychiopsis lecontei *Distribution, Abundance, and Experimental Augmentations for Eurasian Watermilfoil Control in Wisconsin Lakes,"* Journal of Aquatic Plant Management, *Volume 38, 2000, pp. 88-97.*

[150]*R.M. Newman, "Invited Review Biological Control of Eurasian Watermilfoil by Aquatic Insects: Basic Insights from an Applied Problem,"* Archiv fur Hydrobiologie, *Volume 159, 2004, pp. 145-184.*

Figure 73

GOLDFISH (*Carassius auratus*)

Source: B. Albert, U.S. Geological Survey.

Several features of the biology of flowering rush contribute to its status as a nuisance species. Flowering rush grows well in wet places. It can form dense stands of plants. It is sensitive to water level changes and can invade areas not occupied by other plants, especially when lowering of water levels expose new sites. Long-distance dispersal of flowering rush most likely occurs through escape from cultivation. Local dispersal is aided by this plant's ability to grow from fragments of existing plants. Because of this, the spread of flowering rush can be facilitated by plant fragments clinging to boats moving between waterways.

Several impacts are associated with the presence of flowering rush in waterbodies. Flowering rush may be capable of aggressively displacing native vegetation,[151] including outcompeting cattails and willows.[152] This can lead to declines in native fish and wildlife. In addition, the dense stands formed by this species can interfere with boating and other recreational uses.

Flowering rush is controlled through manual means and mechanical means. Cutting flowering rush below the water surface is an effective method of control. Cutting will not kill the plant, but it will decrease the abundance. Multiple cuts may be required throughout the summer as flowering rush grows back from the root. All cut plant parts must be removed from the water. Hand digging can be used to remove isolated plants that are located downstream of larger infestations. Extreme care must be taken to remove all root fragments. Any disturbance to the root system will cause small reproductive structures on the roots to break off and spread to other areas of the waterbody. It is very difficult to kill flowering rush with herbicides.

Goldfish

The goldfish (*Carassius auratus*) (see Figure 73) a native of East Asia, is a common ornamental and aquarium fish. While it was intentionally released into waters of the United States as early as the late 17th century,[153] the first reported introductions into Wisconsin waters occurred in the 1850s.[154] This species has been described as being more tolerant of aquatic pollution than most native North American fish species.[155] Typical habitats include quiet backwaters of streams and pools, especially those with submerged vegetation. This species is tolerant of high turbidity, wide temperature fluctuations, low concentrations of dissolved oxygen, and a wide range of pH. Adults can also tolerate high salinity.

Foraging activities by goldfish can cause high levels of turbidity in waterbodies, leading to declines in aquatic vegetation. Goldfish compete with native fishes for food and space and can disturb sportfish habitats.

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[151]*R.J. Staniforth and K.A. Frego, "Flowering Rush (*Butomus umbellatus*) in the Canadian Prairies,"* The Canadian Field-Naturalist, *Volume 94, 1980, pp. 333-336.*

[152]*L.C. Anderson, C.D. Zeiz, and S.F. Alam, "Phytogeography and Possible Origin of* Butomus umbellatus *in North America,"* Bulletin of the Torrey Botanical Club, *Volume 101, 1974, pp. 292-296.*

[153]*W.R. Courtney, Jr., J.R. Stauffer, Jr., "The Introduced Fish Problem and the Aquarium Fish Industry,"* Journal of the World Aquaculture Society, *Volume 21, 1990, pp. 145-159.*

[154]*G.C. Becker, 1983,* op. cit.

[155]*H.W. Robison and T.M. Buchanan,* Fishes of Arkansas, *University of Arkansas Press, Fayetteville, Arkansas, 1988.*

Figure 74

RUSTY CRAYFISH (*Orconectes rusticus)*

Source: Wisconsin Department of Natural Resources.

Rusty Crayfish

The rusty crayfish (*Orconectes rusticus*) (see Figure 74) is a crustacean originally native to streams of the Ohio River Basin in Ohio, Kentucky, and Tennessee. It was introduced into Wisconsin in about 1960[156] and has since spread throughout the State. Its spread and introduction into waterbodies was probably facilitated by anglers using this crayfish as bait.

Several features of the biology of the rusty crayfish contribute to its status as a nuisance species. It feeds on aquatic macrophytes, benthic macroinvertebrates, detritus, fish eggs, and small fish. This species has a higher rate of metabolism than similarly sized crayfish species.[157] As a result of this metabolic difference, the rusty crayfish can have a high impact on other biota in waterbodies into which it has been introduced. For example, through their feeding activities, rusty crayfish can reduce the abundance and diversity of both aquatic macrophytes and benthic macroinvertebrates. The rusty crayfish exhibits highly aggressive behavior toward individuals of other crayfish species. In addition, it is less susceptible to predation by fish than some other native crayfish species. As a result of these characteristics, rusty crayfish tend to displace native crayfish when they are introduced into waterbodies in Wisconsin.[158] While some research in lakes indicates that fisheries management leading to restoration of healthy populations of bass and sunfish may reduce the nuisance impacts of rusty crayfish,[159] the best method of control appears to be preventing their introduction into waterbodies.

Zebra Mussel

The zebra mussel (*Dreissena polymorpha*) (see Figure 75) is a mollusk originally native to the Caspian Sea region of Eurasia which has invaded waters of the Great Lakes region. They were first detected in Lake St. Clair near Detroit in 1988 and have spread to all of the Great Lakes, many inland lakes in the Great Lakes basin, and the Mississippi and Ohio Rivers.

Several features of the biology of the zebra mussel contribute to its status as a nuisance species. Adult zebra mussels colonize solid substrates in waters with concentrations of dissolved calcium greater than about 15 mg/l.

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[156]*G.M. Capelli and J.J. Magnusson, "Morphoedaphic and Biogeographic Analyses of Crayfish Distribution in Northern Wisconsin,"* Journal of Crustacean Biology, *Volume 3, 1983, pp. 548-564.*

[157]*W.T. Momot, "Further Range Extensions of the Crayfish* Orconectes rusticus *in the Lake Superior Basin of Northwestern Ontario,"* Canadian Field-Naturalist, *Volume 106, 1992, pp. 397-399.*

[158]*G.M. Capelli and B.J. Munjal, "Aggressive Interactions and Resource Competition in Relation to Species Displacement Among Crayfish of the Genus* Orconectes,*"* Journal of Crustacean Biology, *Volume 2, 1982, pp. 486-492.*

[159]*See for example: C.L. Hein, B.M. Roth, A.R. Ives, and M.J. Vander Zanden, "Fish Predation and Trapping for Rusty Crayfish (*Orconectes rusticus*) Control: A Whole-lake Experiment*, Canadian Journal of Fisheries and Aquatic Sciences, *Volume 63, 2006, pp. 383-393; and C.L. Hein, M.J. Vander Zanden, and J.J. Magnusson, "Intensive Trapping and Increased Fish Predation Cause Massive Decline of an Invasive Crayfish,"* Freshwater Biology, *Volume 52, 2007, pp. 1134-1146.*

These colonies can be very dense, with beds of zebra mussels containing up to 100,000 individuals per square meter.[160] Colonies of zebra mussels are able to grow by a few individuals colonizing small areas of hard substrate and others settling down upon them. Female zebra mussels can produce large numbers of eggs which hatch to produce planktonic larvae. These larvae can be carried considerable distances by water currents and can be transported between waterbodies in boats, ballast water, or live wells before settling down on hard substrate to grow into adults. Zebra mussels feed by filtering suspended particles from the water column. Large adults have been observed to remove particles from over 1.5 liters of water per day.[161] These mollusks do not necessarily ingest all of the particles they remove from the water. When particles are present in high concentrations or consist of unpalatable materials, they can be ejected in a mucilaginous secretion called pseudofeces. This results in suspended materials being removed from the water column and transferred to the sediment.

Figure 75

ZEBRA MUSSEL (*Dreissena polymorpha)*

Source: Wisconsin Lakes Partnership.

The presence of large infestations of zebra mussels can produce several impacts in waterbodies. Because these mollusks remove suspended material from the water column, water clarity and light penetration tend to increase in waterbodies containing large numbers of zebra mussels. In some instances the increase in light penetration can be enough to favor the presence of aquatic macrophytes over phytoplankton. Even when the change is not dramatic, phytoplankton production and biomass and zooplankton biomass tend to decrease and macrophyte biomass tends to increase in waterbodies with large infestations. These food web changes may result in less energy being available to support higher trophic levels, such as fish. The transfer of organic material to the sediment in pseudo-feces can result in increases in macroinvertebrate densities and diversity. Since some waterfowl feed on zebra mussels, the density of water fowl may increase in lakes with large zebra mussel populations. Because these mollusks can accumulate organic pollutants in their tissues at concentrations hundreds of thousands of times the ambient concentration in the environment, feeding on zebra mussels by waterfowl can lead to pollutants being passed up the food chain. Finally, the diversity and density of native mussel species tends to decline in water-bodies experiencing zebra mussel infestation. This occurs both from competition between zebra mussels and native mussels for suspended food particles and from the tendency of zebra mussels to smother native mussels living in soft sediment by attaching to their shells and forming colonies.

A second species of Dreissenid mussel, the quagga mussel (*Dreissena bugensis*), has recently invaded Lake Michigan. It has not been reported to be present in the Root River watershed.

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[160]*F.L. Snyder, M.B. Hilgendorf, and D.W. Garton, "Zebra Mussels in North America: The Invasion and Its Implications," Ohio Sea Grant, Ohio State University, Columbus Ohio, 1997; accessed at:* http://www.sg.ohio-state.edu/f-search.html.

[161]*Jin Lei, Barry S. Payne, and Shiao Y. Wang, "Filtration Dynamics of the Zebra Mussel,* Dreissena polymorpha," Canadian Journal of Fisheries and Aquatic Sciences, *Volume 53, 1996, pp. 29-37.*

Figure 76

COMMON BUCKTHORN (*Rhamnus cathartica)*

Source: Wisconsin Department of Natural Resources.

Figure 77

GLOSSY BUCKTHORN (*Rhamnus frangula)*

Source: Wisconsin Department of Natural Resources.

Descriptions of Riparian Invasive Plant Species

Invasive plant species pose threats to the integrity of riparian areas in Wisconsin. Several invasive plant species are present in the Root River watershed. Except as noted below the following species are either known to be present or have historically been present in the watershed.

Buckthorn

Common buckthorn (*Rhamnus cathartica*) (see Figure 76) and glossy buckthorn (*Ramnus frangula*) (see Figure 77) are large shrubs that have invaded a number of habitats in Wisconsin. Common buckthorn invades oak forests, riparian woods, savannas, prairies, old fields, and roadsides. Glossy buckthorn invades a number of wetland habitats. Both species were imported as ornamental shrubs from Europe. They were being planted in hedgerows in Wisconsin as early as 1849. They can form dense, even-aged stands that reduce the amount of light available to understory species and prevent the regeneration of native trees.

Several features of the biology of common and glossy buckthorn contribute to their status as nuisance plants. Both species have broad environmental and habitat tolerances. They tend to produce leaves earlier in the spring and retain them longer in the fall than many native species. This gives them a longer growing season. They exhibit rapid growth rates. They resprout vigorously after being cut. They are prolific seed producers. Their seeds are capable of dispersing over long distances, with dispersal being aided by birds. Buckthorn seeds can remain viable in soil for up to five years.

Control of buckthorn is accomplished by manual removal, controlled burning, herbicide application, and cutting followed by herbicide application. Small buckthorn seedlings can be pulled from the ground and will not resprout. Larger infestations of seedlings can be controlled through foliar application of herbicides. Controlled burning can also be used for management in grasslands and savannas. Larger plants are controlled by cutting followed by herbicide application to the stump. Follow up control of seedlings that emerge after initial control efforts is important in controlling buckthorn. In wetlands with artificially lowered water tables, restoring the water to its historical levels will often kill glossy buckthorns.

Common Reed Grass

Common reed grass (*Phragmites australis)* (see Figure 78) is a large grass that has invaded moist habitats throughout the United States. Invaded habitats include lake shores, river banks, and road sides. It also is common in disturbed areas. This species is distributed throughout much of the world, with native strains being present in

Figure 78

COMMON REED GRASS (*Phragmites australis)*

Source: Elizabeth J. Czarapata, Wisconsin Department of Natural Resources.

New England for at least 4,000 years. The invasive strains of this species are thought to have originated in Europe and to have been accidentally introduced to North America, most likely as ballast material during the late 18th or early 19th century.

Several features of the biology of common reed grass contribute to its status as a nuisance species. This plant has an extensive rhizome system that can be as much as six feet under the ground's surface. This rhizome sends up numerous erect stems. These stems can be between six and 20 feet tall. Common reed grass is propagated by seeds and by fragments of the rhizome. Under wet conditions, stem fragments can also form root and shoot systems to propagate the plant. This plant can tolerate dry conditions and both alkaline and acid soil conditions.

After invading a site, common reed grass can establish a monoculture, shading out and choking out other vegetation. These monocultures have poor value as habitat for wildlife. The presence of this plant can also alter the hydrology and nutrient cycling at a site. Finally, dense stands of this plant increase the potential for fires.

Control of common reed grass is accomplished through treatment with herbicide. Following treatment with herbicide, additional control may be accomplished through mowing or prescribed burning.

Garlic Mustard

Garlic mustard (*Alliaria petiolata*) (see Figure 79) is a plant originally native to Europe that has invaded upland and floodplain forests and savannas, and disturbed areas. It was intentionally introduced into North America as a culinary herb and medicinal plant in the 1860s. Since then it has spread through much of the northeastern United States.

Several features of the biology of garlic mustard contribute to its status as a nuisance plant. Individual plants are capable of producing thousands of seeds which can scatter up to several meters from the parent plant. Long distance dispersal of these seeds is aided by humans and wildlife. These seeds can accumulate in the soil to form a seed bank that can persist and remain viable for years. Garlic mustard also secretes antifungal chemicals into the soil. These chemicals disrupt the association between native plants and symbiotic mycorrhizal fungi. This suppresses the growth of the native plants. As a result of this and other competitive interactions, the abundance and diversity of native herbaceous plants decreases at sites invaded by garlic mustard. This alters the suitability of the habitat for native animal species.

Control of garlic mustard can be very difficult once it has become established at a site. Control methods include hand-pulling of plants, cutting plants at their base prior to flowering, burning of plants, and herbicide application. Removal of garlic mustard from a site may require repeated application of control efforts over five to 10 years.

Honeysuckle

The exotic bush honeysuckles are a group of plant species native to Europe and Asia that are invading a variety of habitats in Wisconsin. They were introduced into North America beginning in the mid-18th century for use as landscape ornamentals and cover for wildlife. The major exotic bush honeysuckle species include Amur honeysuckle, tatarian honeysuckle, Morrow's honeysuckle, and bella honeysuckle. In addition, several other species and hybrids of species have escaped from cultivation.

The exotic bush honeysuckles grow as dense, stout, upright deciduous shrubs with shallow roots. They reach heights of three to 10 feet. They are easily distinguished from native honeysuckle species of the genus Lonicera, such as grape honeysuckle, yellow honeysuckle, or red honeysuckle. The native species are woody vine-like twining species.

Several features of the biology of the exotic bush honeysuckles contribute to their status as nuisance plant species. They can occupy a broad variety of habitats, including forest edge, roadsides, pastures, abandoned fields, bogs, fens, and lake shores. Their distribution is aided by birds, which consume their ripened fruit and disperse the seeds over long distances. They begin leaf development one to two weeks before native shrubs and trees. This early leafing can act to exclude spring ephemeral wildflowers that have evolved to bloom before trees and shrubs leaf out. The vigorous growth of exotic bush honeysuckles inhibits the growth of native shrub and ground cover species. Through shading and depletion of soil moisture and nutrients they may exclude native species from habitats that they have invaded.

Exotic bush honeysuckles can be controlled through mechanical or chemical means. Because their roots are fairly shallow, smaller plants can be pulled or dug out of the ground. Chemical control can be accomplished by cutting the plants at the base and treating the cut immediately with herbicide. Two cuts per year are recommended—one in early spring and another in early fall. Chemical control may also be accomplished through foliar spraying. Both mechanical and chemical control methods must be repeated for three to five years in order to stop new plants from emerging from the seed bank.

Figure 79

GARLIC MUSTARD (*Allaria petiolata)*

Source: Wisconsin Department of Natural Resources.

Japanese Knotweed

Japanese knotweed (*Polygonum cuspidatum*)[162] (see Figure 80) is an invasive perennial plant that grows to heights a high as 10 feet in large clones that can cover several acres. It was introduced into North America in the late 19th century. Since then it has spread through much of the continent. It grows in a variety of habitats, in many soil types, and in a range of moisture conditions. Of particular concern is its tendency to invade wetland riparian areas. It often forms an impenetrable wall of stems that crowds out native vegetation and leaves streambanks vulnerable to erosion when the plant dies in winter.

Several features of the biology of Japanese knotweed contribute to its status as a nuisance plant. It is a frequent colonizer of temperate riparian ecosystems, roadsides, and disturbed environments. It forms thick, dense colonies that completely crowd out any other herbaceous species. This species can tolerate a wide range of soil types, pH,

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[162]*It is also referred to as* Fallopia japonica.

Figure 80

JAPANESE KNOTWEED (*Polygonum cuspidatum)*

Source: Elizabeth J. Czarapata, Wisconsin Department of Natural Resources.

Figure 81

PURPLE LOOSESTRIFE (*Lythrum salicaria)*

Source: S. Kelly Kearns, Wisconsin Department of Natural Resources.

and salinity. It spreads by extensive networks of underground rhizomes. These rhizomes can be located six feet beneath the ground and can be up to 60 feet long. They can become strong enough to damage pavement and penetrate building foundations. The plant is also resilient to cutting, vigorously re-sprouting from the roots.

Japanese knotweed is controlled through herbicide application.

Purple Loosestrife

Purple loosestrife (*Lythrum salicaria*) (see Figure 81) is a plant originally native to Europe that has invaded wetlands and other habitats in northeastern North America. It was intentionally introduced into the United States in the early 19th century for use as a medicinal plant and garden ornamental. Since its introduction, it has spread throughout much of the northeastern United States and portions of Canada. Its spread into the Great Lakes area has been favored by its cultivation and sale as an ornamental and by the construction of inland waterways and canals in the 1880s. While it was first detected in Wisconsin in the 1930s, it remained uncommon in the State until the 1970s.

Several features of the biology of purple loosestrife contribute to its status as a nuisance plant. It is a hardy perennial. While it prefers moist soils, it can grow in a wide variety of soil types and textures. In a mature plant, 30 to 50 erect stems arise from persistent root stock. Mature plants can be very prolific, producing over 2.5 million seeds per plant per year. These seeds are very small and can be transported by water currents and animals. The seeds remain viable for several years and form a persistent seed bank that can maintain and regenerate the population. This plant can also propagate itself vegetatively.

Purple loosestrife is controlled by manual removal and herbicide application. While no North American herbivores or pathogens are known to suppress purple loosestrife, biological control can be accomplished using some of the plant's natural insect enemies from Europe. The control agents include two leaf beetle species, a root-mining weevil species, and a flower-eating weevil species. Research has shown that these insects are dependent on purple loosestrife and are not a threat to other plants. While this biological control technique rarely results in elimination of purple loosestrife, it can effectively decrease purple loosestrife's size and seed output. This can allow native plants to reduce purple loosestrife numbers naturally through enhanced competition. The technique is typically best done in some combination with occasional use of more traditional control methods such as digging and herbicide use.

Figure 82

REED CANARY GRASS (*Phalaris arundinaceae)*

Source: Wisconsin Department of Natural Resources.

Reed Canary Grass

Reed canary grass (*Phalaris arundinacea*) (see Figure 82) is a tall, perennial grass that forms extensive single-species stands in wet open areas. It is widely distributed through Europe, Asia, northern Africa, and North America. It is a common invasive species of wetlands in North America. It can invade most types of wetlands. Invasions are often associated with disturbances, such as ditching of wetlands, steam channelization, sedimentation, or deforestation. Wetlands dominated by reed canary grass harbor few other plant species and constitute poor habitat for most wildlife species.

Several features of the biology of reed canary grass contribute to its status as a nuisance plant. It is one of the first grasses to sprout in the spring. It forms a thick rhizome that dominates the subsurface soil. Established stands can tolerate extended periods of inundation. It is propagated through both its rhizome and seeds. It can form large seed banks in the soil.

Once established at a site, reed canary grass can be difficult to eradicate. No single control method is universally applicable. In natural communities, mechanical control practices are recommended. In buffer areas and in severely disturbed sites, chemical and mechanical controls may be used. If herbicide is used, care should be taken to prevent contact with nontarget species. Any control technique to reduce or eliminate reed canary grass should be followed by planting native species adapted to the site. It should be noted that, while herbicide kills reed canary grass, seeds in the seed bank may germinate and recolonize the site. Several herbicidal applications may be necessary to inhibit seed bank recolonization. After the first application of herbicide has killed living plants, disturbance of the soil can encourage seed bank germination. When this occurs, the site can again be treated with herbicide to deplete the seed bank.

Teasel

Common teasel (*Dipsacus fullonum*) (see Figure 83) and cut-leaf teasel (*Dipsacus laciniatus*) (see Figure 84) are European plants that can form extensive monocultures which exclude native vegetation in a variety of habitats including prairies, savannas, seeps, and sedge meadows. These species were introduced into North America during the 18th century for use in raising the nap of cloth. Currently, teasels are grown as horticultural plants and for use in dried flower arrangements. The teasel population has expanded rapidly over the last 30 years. This has been accompanied by a rapid expansion of the range of these species in several Midwestern states, including southern Wisconsin.

Several features of the biology of common teasel and cut-leaf teasel contribute to their status as nuisance plants. Teasel grows in sunny open habitats, ranging from wet conditions to dry conditions. Teasel produces large numbers of seeds. A single plant can produce over 2,000 seeds. These seeds have high germination rates, with up to 80 percent of the seeds germinating. Seeds may remain viable for at least two years. Immature seed heads of cut-leaved teasel are capable of producing viable seed. While teasel seeds typically do not disperse over long

Figure 83

COMMON TEASEL (*Dipsacus fullonum)*

Source: Stephen Solheim, University of Wisconsin-Whitewater.

Figure 84

CUT-LEAF TEASEL (*Dipsacus laciniatus)*

Source: Wisconsin Department of Natural Resources.

distances, highway mowing equipment can spread the seed. As a result, movement of teasel has been documented along highway systems. Seeds may also be dispersed by water.

Teasel is controlled by manual removal and herbicide action. Individual plant rosettes can be removed using a dandelion digger; however, removal of the entire taproot is essential to eliminate re-sprouting. Flowering stalks may be cut down once the plant has initiated flowering, but plants may send up new flowering stalks if cut prematurely. It has been shown that seeds will continue to develop and mature on stalks even after they have been cut. To prevent seed dispersal, the cut stalks should be bagged and removed. Foliar applications of herbicide can be effective when mechanical control is not feasible.

Wild Parsnip

Wild parsnip (*Pastinaca sativa*) (see Figure 85) is a plant native to Eurasia that has invaded open habitats in North America. It was introduced for cultivation as a food source in the 18th century and was recorded as being present in Wisconsin by 1894. This plant readily moves into disturbed habitats and along road sides. From there it can spread into woodland openings, prairies, and drainages. It can encroach on a wide range of habitats and displace native vegetation.

Figure 85

WILD PARSNIP (*Pastinaca sativa)*

Source: Wisconsin Department of Natural Resources.

Several features of the biology of wild parsnip contribute to its status as a nuisance plant. It typically grows in sunny areas and tolerates wet to dry soil types. Like many other nonnative invasive plants, wild parsnip can tolerate a wide range of growing conditions and habitats including prairies, savannas and fens. It is also commonly found along roadsides, pastures and open agricultural fields. Wild parsnip slowly invades an area in waves following initial infestation. Once the population builds, it spreads rapidly. This species is an aggressive weed that frequently invades and modifies a variety of open habitats. Sap from this plant can cause a photo-dermatitis, a light sensitive reaction on skin. When sap from broken stalks, leaves, or flowers contacts skin and is exposed to sunlight, a skin rash will develop within 24 to 48 hours. Symptoms range from slightly reddened skin to large blisters.

Wild parsnip is controlled by manual removal and herbicide action. Cutting roots one to two inches below the soil surface and removing cut material can be effective. Larger infestations are controlled through herbicide treatments. Burning alone tends to be an ineffective treatment.

Infestations of Invasive Species in the Root River Watershed

Several exotic invasive species have been found in waterbodies, wetlands, and riparian areas of the Root River watershed. Table 44 lists waterbodies in the watershed in which aquatic invasive species have been detected. It shows that six aquatic invasive species—common carp, goldfish, Eurasian water milfoil, curly leaf pondweed, rusty crayfish, and zebra mussel—have been detected in waterbodies within the watershed.

Common carp has long been reported as being present in streams of the Root River watershed (see Table 44). The comprehensive plan for the watershed that was written in the 1960s indicated that "rough" fish, such as carp, drum, and suckers, are caught at times in nearly all parts of the perennial stream network."[163] Most recently, carp were detected at sampling stations along both the mainstem of the Root River and the Root River Canal during fishery surveys conducted by the WDNR in 2011. Carp were also detected at sampling stations along the mainstem of the Root River during WDNR fishery surveys conducted in 2001 and 2003.

Goldfish has been reported as being present in the Root River (see Table 44) at sampling stations along the mainstem of the River during fishery surveys conducted by the WDNR in 2001 and 2003. It was not detected in the 2011 surveys.

Eurasian water milfoil has been reported as being present in three lakes in watershed, Lower Kelly Lake, Upper Kelly Lake, and Scout Lake (see Table 44). Aquatic plant surveys were conducted in Lower Kelly Lake in 1997 and 2005.[164] In 1997, Eurasian water milfoil was detected at 25 percent of the sampling sites examined in the Lake. It was not detected in the 2005 survey. Aquatic plant surveys conducted in Upper Kelly Lake in 1997 and

[163]*SEWRPC Planning Report No. 9,* A Comprehensive Plan for the Root River Watershed, *July 1966.*

[164]*SEWRPC Memorandum Report No. 135, 2nd Edition,* A Lake Protection Plan for the Kelly Lakes, Milwaukee and Waukesha Counties, Wisconsin, *April 2007.*

Table 44

AQUATIC INVASIVE SPECIES IN WATERBODIES OF THE ROOT RIVER WATERSHED: 2012

Waterbody	Species Reported Present
Hoods Creek	Rusty Crayfish
Lower Kelly Lake	Eurasian Water Milfoil
Quarry Lake	Zebra Mussel
Root River	Common Carp, Goldfish, Rusty Crayfish
Root River Canal	Common Carp, Rusty Crayfish
Ryan Creek	Rusty Crayfish
Scout Lake	Curly-Leaf Pondweed, Eurasian Water Milfoil
Upper Kelly Lake	Curly-Leaf Pondweed, Eurasian Water Milfoil
West Branch Root River Canal	Rusty Crayfish

Source: *Wisconsin Department of Natural Resources, Milwaukee County, Great Lakes Indian Fish and Wildlife Commission, and SEWRPC.*

2005 showed that Eurasian water milfoil was present. In both of these surveys it was detected at 50 percent of the sampling sites examined in the Lake.[165] Aquatic plant surveys conducted in 2004 detected the presence of Eurasian water milfoil in Scout Lake.[166] While the extent of coverage by this plant was not given, nuisance plants covered about 25 percent to 50 percent of the surface area of the Lake.

Curly-leaf pondweed has been reported as being present in two lakes, Scout Lake and Upper Kelly Lake (see Table 44). Aquatic plant surveys conducted in 2004 detected that it was present in Scout Lake.[167] While the extent of coverage by this plant was not given, nuisance plants covered about 25 percent to 50 percent of the surface area of the Lake. Aquatic plant surveys conducted in Upper Kelly Lake in 1997 and 2005 showed that curly-leaf pondweed was present. [168] In the 1997 survey, it was detected at 35 percent of the sampling sites examined in the Lake. In the 2005 survey, it was detected at about 39 percent of the sampling sites examined. Curly-leaf pondweed has also been reported as being present in an unnamed pond just east of IH 94 in the Town of Yorkville.

Rusty crayfish has been reported as being present in the mainstem of the Root River and several tributary streams including Hoods Creek, the Root River Canal, Ryan Creek, and the West Branch of the Root River Canal (see Table 44). According to data available on the website of the Great Lakes Indian Fish and Wildlife Commission, this crayfish was first detected in the watershed in 1982. It was also found to be present in samples collected in 1987, 2002, and 2005.

Zebra mussel has been reported as being present at one site in the Root River watershed: Quarry Lake (see Table 44). According to data available on the website of the Great Lakes Indian Fish and Wildlife Commission, this mollusk has been present in the Lake since at least 1994.

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[165]*SEWRPC Memorandum Report No. 135,* op. cit.

[166]*Milwaukee County Environmental Services Division,* Milwaukee County Park & Lagoon Management Plan, *June 2005.*

[167]*Milwaukee County Environmental Services Division, 2005,* op. cit.

[168]*SEWRPC Memorandum Report No. 135,* op. cit.

Southeastern Wisconsin Invasive Species Consortium Road Side Surveys

In 2011 and 2012, the Southeastern Wisconsin Invasive Species Consortium (SEWISC) conducted road side surveys of several invasive plant species in eight counties in southeastern Wisconsin. The counties in which these surveys were conducted include the four counties that contain the Root River watershed. The surveys conducted in 2011 located and mapped all populations of fours species—common reed grass, common teasel, cut-leaf teasel, and Japanese knotweed—that were visible from any divided road, highway, freeway, or expressway in the eight counties. The surveys also located and mapped populations that were visible from any public road or bike path that passes through or skirts a primary environmental corridor, a secondary environmental corridor, or an isolated natural resource area. The two teasel species were mapped as teasel. The surveys conducted in 2012 added to and corrected the results from the 2011 surveys. In addition, the 2012 surveys located and mapped populations of wild parsnip.

The surveys also estimated the sizes of the populations that were mapped. Populations were categorized as small, moderate, or large infestations based on the estimated number of stems present and the effort that would be needed to control the infestation. A small infestation consists of one to 50 stems in a discrete cluster. Control of a small infestation can be accomplished in no more than 30 minutes using hand clippers and herbicide in a spray bottle. A moderate infestation consists of 20 to 1,000 stems. Control of a moderate infestation would require 30 minutes to four hours of effort using equipment carried by shoulder straps. A large infestation consists of more than 1,000 stems. Control of a large infestation would require more than four hours of effort using steered equipment.

Infestations of common reed grass, Japanese knotweed, teasel, and wild parsnip detected in the Root River watershed by the SEWISC surveys are shown on Map 45 and are summarized in Table 45. The 2011 and 2012 surveys found 312 infestations within the watershed. It should be noted that because these infestations had to be visible from a roadway in order to be detected, this number probably underestimates the number of infestations that were present in the watershed in 2011 and 2012.

The SEWISC surveys found that Japanese knotweed was relatively uncommon in the Root River watershed. Three infestations were found, one each in the Lower Root River-Johnson Park, Lower Root River-Racine, and Upper Root River assessment areas (see Map 45 and Table 45).

The SEWISC surveys found 115 sites with infestations of common reed grass in the Root River watershed (see Map 45 and Table 45). About 40 percent of these sites contained small infestations and another 40 percent of sites contained moderate infestations. The largest numbers of infestations were found in the Lower Root River-Caledonia, Hoods Creek, and East Branch Root River Canal assessment areas. Many of these infestations were located along IH 94. About 62 percent of the infestations detected in the watershed were found in these three assessment areas. By contrast, the SEWISC surveys detected no infestations of common reed grass in the Lower Root River-Racine and Upper West Branch Root River Canal assessment areas. In each of the other assessment areas, the SEWISC surveys detected fewer than 10 infestations.

A second recent set of data regarding infestations of common reed grass is available for portions of the Root River watershed. In 2010 and 2011, researchers from the Michigan Tech Research Institute at Michigan Technological University, the U.S. Geological Survey's Great Lakes Science Center, Boston College, and the U.S. Fish and Wildlife Service use synthetic aperture radar to distinguish between common reed grass and other types of wetland vegetation at sites within 10 kilometers of Great Lake lakeshores along the entire U.S. shoreline of the Great Lakes. This technique is able to detect infestations of common reed grass that cover areas equal to or greater than one-half acre. This study detected no infestations of common reed grass of one-half acre or greater area in the portions of the Root River watershed within 10 kilometers of the shore of Lake Michigan. This study also identified wetland areas that are sensitive to invasion by common reed grass.[169]

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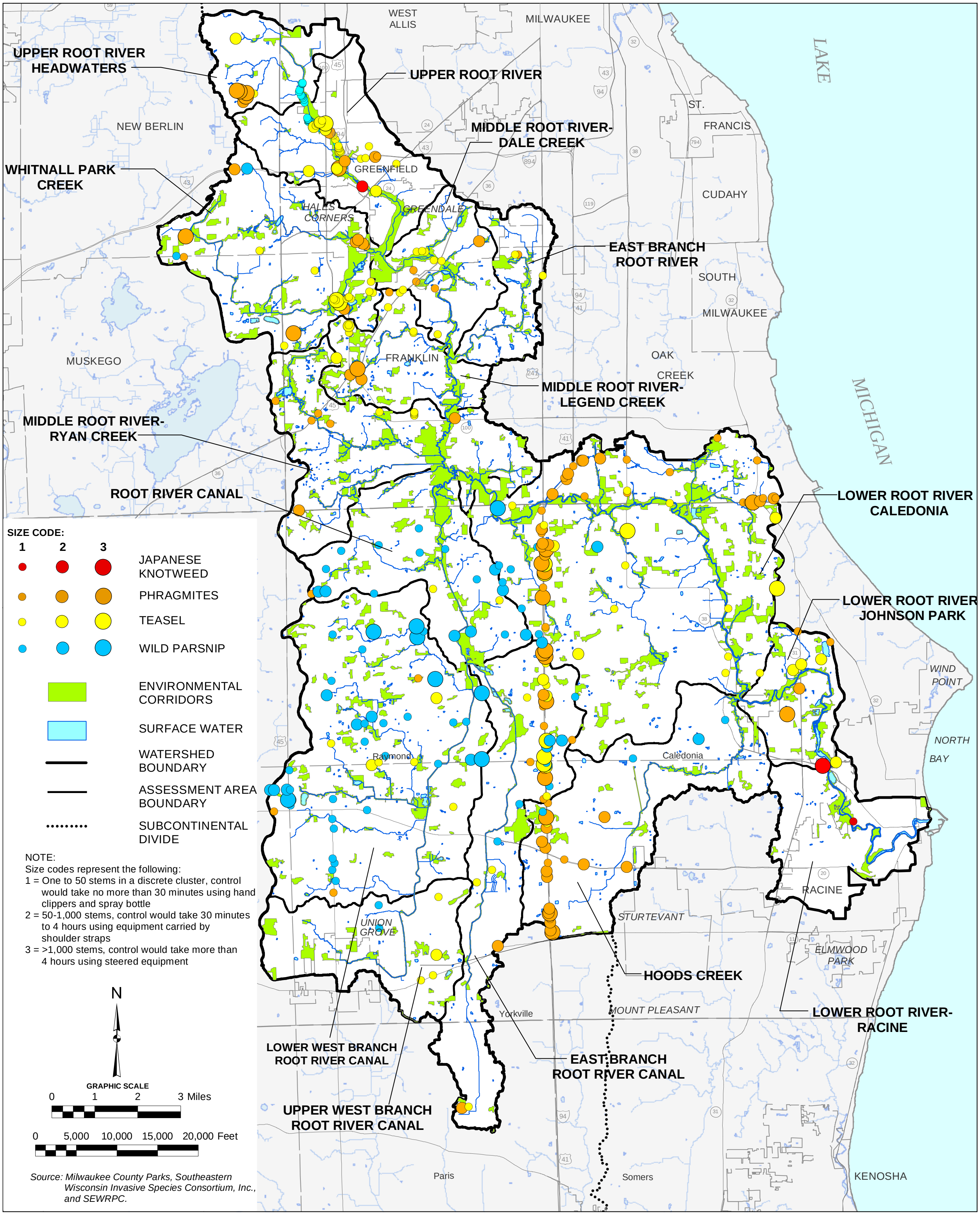
[169]*As of July 2014, these analyses were still under review by USGS and the results were not available.*

Map 45

INFESTATIONS OF JAPANESE KNOTWEED, PHRAGMITES, TEASEL, AND WILD PARSNIP WITHIN THE ROOT RIVER WATERSHED AS DETECTED IN ROADSIDE SURVEYS: 2011-2012



Source: Milwaukee County Parks, Southeastern Wisconsin Invasive Species Consortium, Inc., and SEWRPC.

Table 45

INFESTATIONS OF FIVE INVASIVE PLANT SPECIES IN THE ROOT RIVER WATERSHED AS DETECTED BY ROADSIDE SURVEYS: 2011-2012

Assessment Area	Japanese Knotweed (*Polygonum cuspidatum*)				Common Reed Grass (*Phragmites australis*)				Common Teasel (*Dipacus sylvestris*) and Cut-leaf Teasel (*Dipacus laciniatus*)				Wild Parsnip (*Pastinica sativa*)				Total
	Infestation Size[a]				Infestation Size[a]				Infestation Size[a]				Infestation Size[a]				
	Small	Moderate	Large	Total	Small	Moderate	Large	Total	Small	Moderate	Large	Total	Small	Moderate	Large	Total	Total
Upper Root River-Headwaters	0	0	0	0	0	1	4	5	1	2	0	3	0	0	0	0	8
Upper Root River	0	1	0	1	1	3	1	5	15	6	1	22	0	0	0	0	28
Whitnall Park Creek	0	0	0	0	2	5	2	9	12	0	2	14	1	1	0	2	25
Middle Root River-Dale Creek	0	0	0	0	4	1	0	5	7	0	0	7	0	0	0	0	12
East Branch Root River	0	0	0	0	1	0	0	1	2	0	0	2	0	0	0	0	3
Middle Root River-Legend Creek	0	0	0	0	1	2	1	4	6	1	0	7	0	0	0	0	11
Upper West Branch Root River Canal	0	0	0	0	0	0	0	0	4	0	0	4	2	0	0	2	6
Lower West Branch Root River Canal	0	0	0	0	3	0	0	3	5	2	0	7	23	8	7	38	48
East Branch Root River Canal	0	0	0	0	5	5	3	13	8	3	3	14	6	4	0	10	37
Middle Branch Root River-Ryan Creek	0	0	0	0	5	2	0	7	7	1	0	8	0	0	0	0	15
Root River Canal	0	0	0	0	1	0	0	1	2	0	0	2	9	7	0	16	19
Lower Root River-Caledonia	0	0	0	0	18	13	7	38	11	3	4	18	6	2	1	9	65
Hoods Creek	0	0	0	0	4	13	3	20	1	0	0	1	3	1	0	4	25
Lower Root River-Johnson Park	0	0	1	1	2	1	1	4	0	4	0	4	0	0	0	0	9
Lower Root River-Racine	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	1	1	1	3	47	46	22	115	81	22	10	113	50	23	8	81	312

[a]Small infestations consist of one to 50 stems in a discrete cluster. Control of a small infestation can be accomplished within 30 minutes using hand clippers and a spray bottle. Moderate infestations consist of 50-1,000 stems. Control of a moderate infestation can be accomplished within 30 minutes to four hours using equipment carried by shoulder straps. Large infestations consist of more than 1,000 stems. Control of a large infestation would take more than four hours using steered equipment.

Source: Southeastern Invasive Species Consortium and SEWRPC.

The SEWISC surveys found 113 sites with infestations of teasel in the Root River watershed (see Map 45 and Table 45). About 72 percent of these sites contained small infestations. The largest numbers of infestations were found in the Upper Root River, Lower Root River-Caledonia, Whitnall Park Creek, and East Branch Root River Canal assessment areas. About 59 percent of the infestations detected in the watershed were found in these four assessment areas. By contrast, the SEWISC surveys detected no infestations of teasel in the Lower Root River-Racine assessment area. In each of the other assessment areas, the SEWISC surveys detected fewer than 10 infestations.

The SEWISC surveys found 81 sites with infestations of wild parsnip in the Root River watershed (see Map 45 and Table 45). About 62 percent of these sites contained small infestations. The largest numbers of infestations were found in the Lower West Branch Root River Canal, Root River Canal, and East Branch Root River Canal assessment areas. About 79 percent of the infestations detected in the watershed were found in these four assessment areas. By contrast, the SEWISC surveys detected no infestations of wild parsnip in the Upper Root River-Headwaters, Upper Root River, Middle Root River-Dale Creek, East Branch Root River, Middle Root River-Legend Creek, Middle Root River-Ryan Creek, Lower Root River-Johnson Park, and Lower Root River-Racine assessment areas. In each of the other assessment areas, the SEWISC surveys detected fewer than 10 infestations.

WDNR Reed Canary Grass Assessment

In 2008, the WDNR conducted a landscape-level assessment and mapping of wetlands in Wisconsin dominated by reed canary grass.[170] This assessment was conducted using remote sensing near infrared images collected by the Landsat-5 and Landsat-7 satellites during mid-October during the years 1999 through 2003. Images taken in mid-October allow reed canary grass to be distinguished from other vegetation because reed canary grass enters senescence later in the fall than most other wetland species. This technique utilized pixels with 30-meter resolution and mapped and classified wetlands using a minimum 0.5-acre mapping unit.[171] The study also included field visits to 269 sites to confirm the assessment made from the satellite imagery. Overall accuracy of classifications for the satellite image that includes the Root River watershed was found to be about 83 percent.

Based upon satellite imagery, wetland areas were classified into two groups. In one group, reed canary grass represented more than 50 percent of the ground cover. The study considered those wetland areas to be dominated by reed canary grass. In the other group, reed canary grass represented less than 50 percent of the ground cover.

Wetlands dominated by reed canary grass in the Root River watershed are shown on Map 46. The results are summarized by assessment area in Table 46. The assessment identified 5,849 acres of wetland in the Root River watershed, of which 619 acres, or about 11 percent, had ground cover that was dominated by reed canary grass. In most of the assessment areas, wetlands in which reed canary grass represented more than 50 percent of ground cover constituted 12 percent or less of the wetland areas in the assessment area. There were two exceptions to this generalization. In the East Branch of the Root River Canal assessment area, wetland areas dominated by reed canary grass represented about 22 percent of the wetland areas identified. Similarly, in the Lower West Branch of the Root River Canal assessment area, wetland areas dominated by reed canary grass represented about 19 percent of the wetland areas identified.

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[170]*Brynda K. Hatch and Thomas W. Bernthal,* Mapping of Wisconsin Wetlands Dominated by Reed Canary Grass, *Phalaris arundinaceae* L: A Landscape Level Assessment, *Final Report to U.S. Environmental Protection Agency Region V, Wetland Grant N096544501-0, Wisconsin Department of Natural Resources Publication PUB WT-900-2008, October 2008.*

[171]*Wetlands mapped by this technique may not completely correspond to wetlands mapped in the SEWRPC land use analyses shown on Map 34.*

Map 46

EXTENT OF REED CANARY GRASS COVER IN WETLANDS WITHIN THE ROOT RIVER WATERSHED: 1999-2003

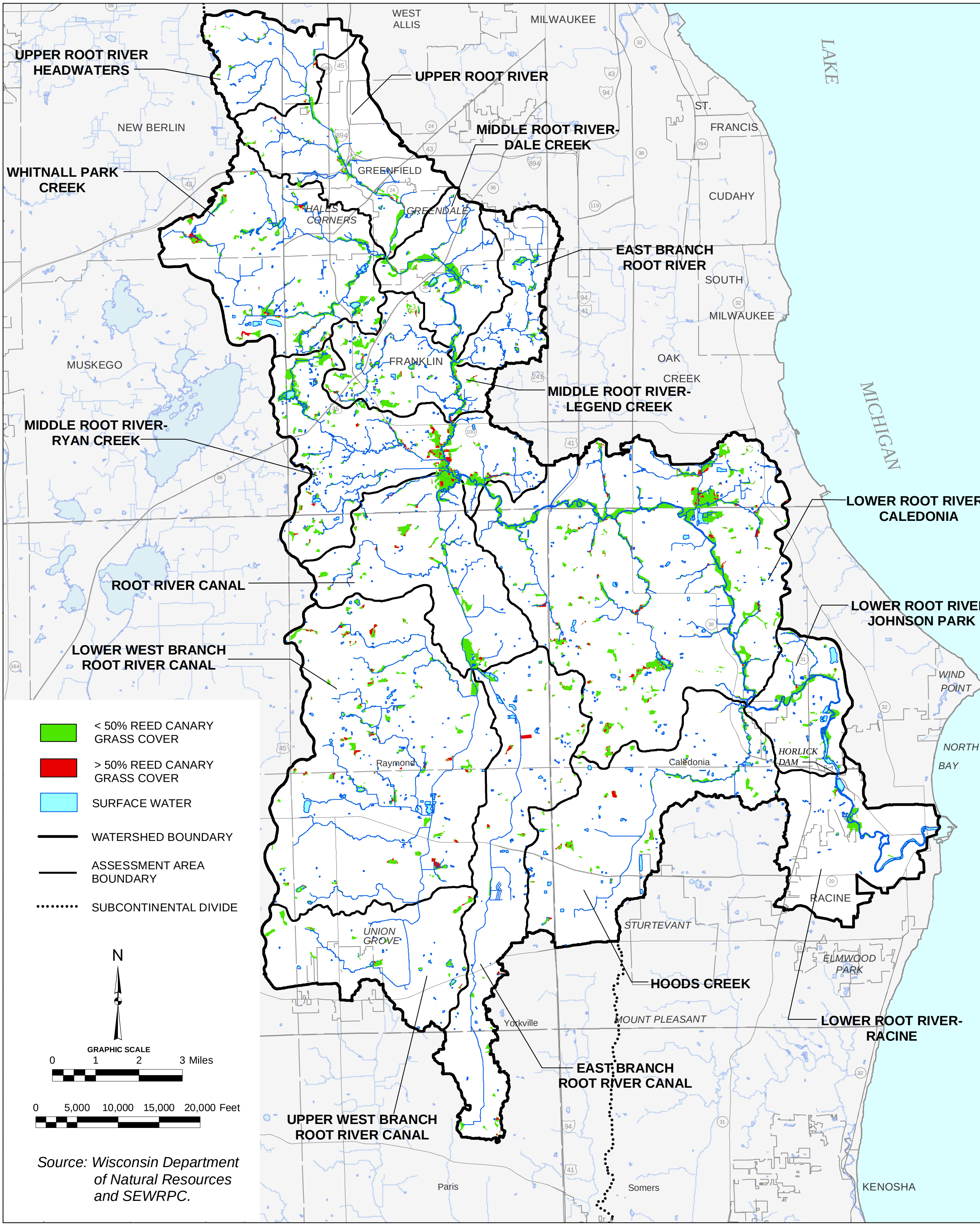

Table 46

LANDSCAPE LEVEL ASSESSMENT OF WETLANDS DOMINATED BY REED CANARY GRASS IN THE ROOT RIVER WATERSHED: 1999-2003

Assessment Area	Wetland Area Containing Less than 50 percent Reed Canary Grass (acres)		Wetland Area Containing More than 50 percent Reed Canary Grass (acres)		Total Wetland Area Assessed (acres)	
	Acres	Percent	Acres	Percent	Acres	Percent
Upper Root River-Headwaters	54.3	90.0	6.1	10.0	60.4	100.0
Upper Root River	203.0	93.0	15.3	7.0	218.3	100.0
Whitnall Park Creek	499.9	88.6	64.5	11.4	564.4	100.0
Middle Root River-Dale Creek	302.9	97.9	6.5	2.1	309.5	100.0
East Branch Root River	75.7	96.2	3.0	3.8	78.7	100.0
Middle Root River-Legend Creek	307.8	91.8	27.4	8.2	335.2	100.0
Upper West Branch Root River Canal	102.1	92.5	8.3	7.5	110.4	100.0
Lower West Branch Root River Canal	402.0	81.0	94.2	19.0	496.2	100.0
East Branch Root River Canal	124.3	77.7	35.7	22.3	160.0	100.0
Middle Root River-Ryan Creek	692.5	87.9	105.0	12.1	797.5	100.0
Root River Canal	388.8	91.7	35.4	8.3	424.2	100.0
Lower Root River-Caledonia	1,553.5	89.4	183.9	10.6	1,737.4	100.0
Hoods Creek	199.9	89.9	22.5	10.1	222.4	100.0
Lower Root River-Johnson Park	237.1	96.3	9.2	3.7	246.3	100.0
Lower Root River-Racine	86.2	97.7	2.0	2.3	88.2	100.0
Total	5,230.0	89.4	619.0	10.6	5,849.0	100.0

Source: Wisconsin Department of Natural Resources and SEWRPC.

The study also drew some general conclusions on a Statewide basis. While domination by reed canary grass was mostly associated with emergent plant wetlands, the amount of reed canary grass dominated acres found in forested wetlands and in lowland shrub wetlands was larger than expected. Reed canary grass dominated wetlands occurred throughout the State, but they were more common in areas where agricultural land uses were the predominant land use. The report described the southeast quarter of the State as having a "pattern of smaller reed canary grass wetlands surrounded by a matrix of agricultural land."[172]

This technique has several limitations.[173] Due to the nature and spectral characteristics of woody vegetation, the classification procedure may not be effective in areas with forest cover. The pixel size is too large and the resolution too coarse for discerning transitional gradients between reed canary grass and other vegetation. In general, these gradients span only a few feet. Finally, because other invasive species also constitute nuisances in and ecological threats to wetlands, an absence of reed canary grass cannot be interpreted as a finding of good wetland condition.

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[172]*Hatch and Bernthal, 2008,* op. cit.

[173]*Thomas W. Bernthal and Kevin G. Willis,* Using Landsat 7 Imagery to Map Invasive Reed Canary Grass (*Phalaris arundinaceae*)*:* A Landscape Level Wetland Monitoring Methodology, *Final Report to U.S. Environmental Protection Agency Region V, Wisconsin Department of Natural Resources Publication PUB-SS-992 2004, March 2004.*

Milwaukee County Parks Department Invasive Plant Surveys

Since 2009, Milwaukee County Parks Department staff has conducted surveys of invasive plant species in County parks and natural areas. These surveys mapped locations of populations of invasive plant species within lands managed by the Parks Department. The plants species mapped in these surveys include species considered prohibited and restricted under the classification established pursuant to Chapter NR 40, “Invasive Species Identification, Classification and Control,” of the *Wisconsin Administrative Code*, as well as species that are regarded as invasive but not currently classified as prohibited or restricted.

The Parks Department surveys located and mapped 729 infestations of invasive plant species in Milwaukee County parks and natural areas (see Table 47). The surveys mapped 26 invasive plant species (see Maps 47 through 50). County Parks Department staff also reported that five additional species—common buckthorn and four species of exotic bush honeysuckle—were commonly found throughout the park system. Because they were so common, infestations of these five species were not mapped. They may represent the most common invasive plant species in the portion of the park system located in the Root River watershed.

Map 47 shows locations of infestations of herbaceous invasive plant species within those Milwaukee County parks and natural areas located in the Root River watershed. The surveys found 174 infestations of 15 herbaceous invasive plant species.[174] These totals do not include infestations of garlic mustard or dame’s rocket, which are shown on separate maps (see below). While garlic mustard and dame’s rocket were the most common herbaceous invasive plant species found in the park system (see Maps 48 and 49), several other herbaceous species accounted for 10 or more infestations. These species include burdock, common reed grass, forget-me-not, narrow leaf cattail, reed canary grass, teasel, wild chervil, and yellow iris. Several areas within the park system have multiple sites containing infestations of herbaceous invasive plant species. The section of the Root River Parkway located between S. 108th Street and W. Morgan Avenue has numerous infestations consisting of common reed grass, narrow-leaf cattail, reed canary grass, teasel, and wild chervil. Kulwicki Park contains several infestations consisting of common reed grass, teasel, wild chervil, and wild parsnip. Scout Lake Park contains several infestations consisting of burdock, narrow-leaf cattail, and purple loosestrife. The sections of the Root River Parkway located immediately to the northwest and southeast of W. Loomis Road (STH 36) have numerous infestations consisting of burdock, common reed grass, forget-me-not, Japanese knotweed, teasel, and yellow iris. Most of the infestations in the section of the parkway located immediately southeast of W. Loomis Road consist of yellow iris. Grobschmidt Park contains numerous infestations consisting of burdock, common reed grass, narrow-leaf cattail, and wild parsnip.

Map 48 shows locations of infestations of garlic mustard within those Milwaukee County parks and natural areas located in the Root River watershed. The surveys found 377 infestations of this species. Garlic mustard was the most common invasive species that was mapped in the surveys, accounting for almost 52 percent of the mapped infestations. Several areas within the park system have multiple sites containing infestations of garlic mustard. These areas include Greenfield Park, the section of the Root River Parkway between S. 124th Street and W. Oklahoma Avenue, the section of the Root River Parkway between W. Layton Avenue and W. Grange Avenue, Scout Lake Park, Whitnall Park—especially along Whitnall Park Creek, Hales Corners Park, and Grobschmidt Park—especially around Mud Lake, and the section of the Root River Parkway along the Milwaukee-Racine county line east of IH 94.

Map 49 shows locations of infestations of dame’s rocket within those Milwaukee County parks and natural areas located in the Root River watershed. Dame’s rocket is a short-lived European perennial that was introduced into North America as an ornamental plant in the 17th century. It has since escaped cultivation and become naturalized. It lacks natural predators and diseases in North America and competes with native species for water, light, and nutrients, often forming dense monocultures. The surveys found 111 infestations of this

[174] *It should be noted that common teasel and cut-leaf teasel are shown on the map as teasel.*

Table 47

INFESTATIONS OF INVASIVE PLANT SPECIES IN MILWAUKEE COUNTY PARKS AND NATURAL AREAS LOCATED IN THE ROOT RIVER WATERSHED BY ASSESSMENT AREA: 2009-2013

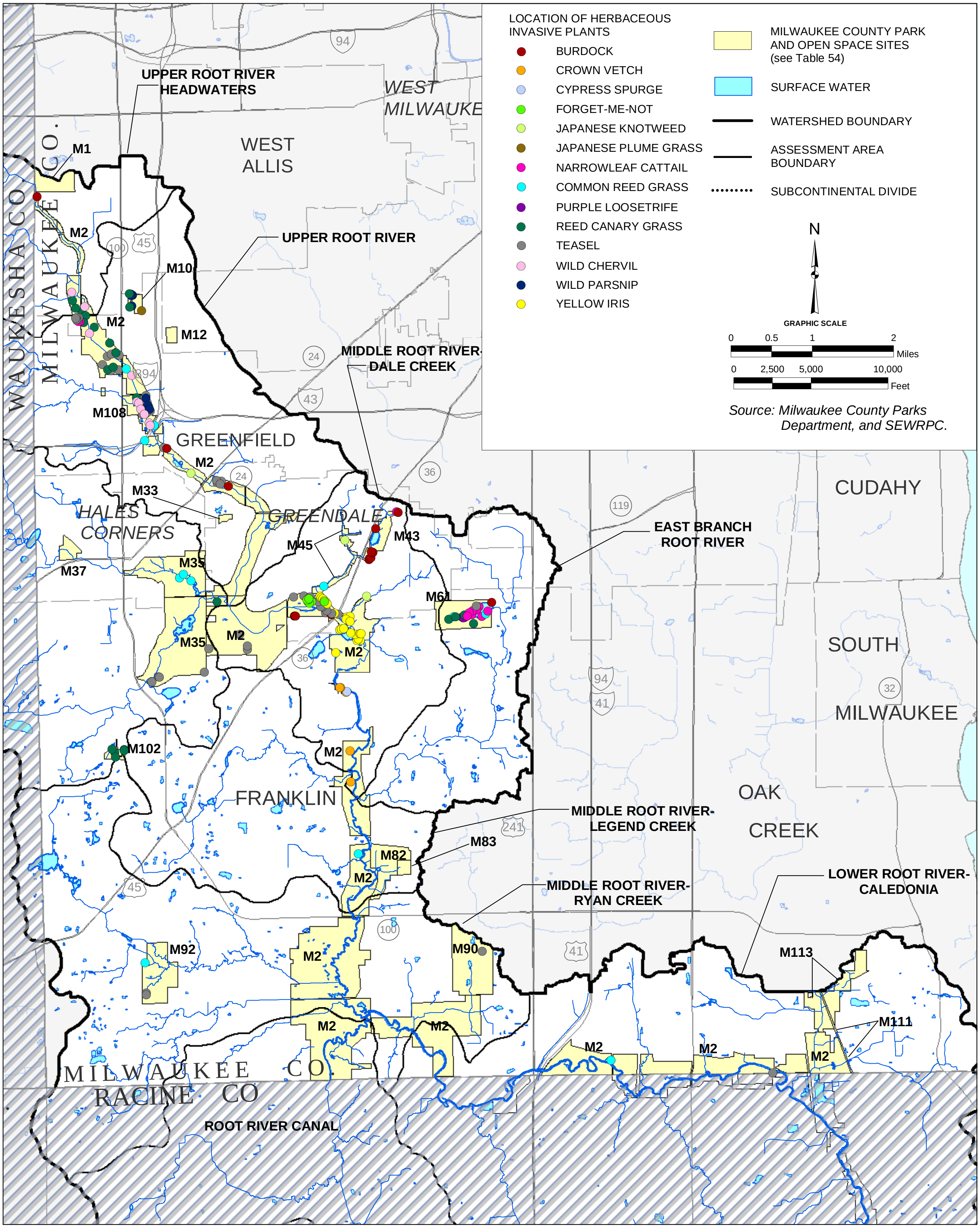
Species	Growth Habit	Upper Root River Headwaters	Upper Root River	Whitnall Park Creek	Middle Root River-Dale Creek	East Branch Root River	Middle Root River-Legend Creek	Middle Root River-Ryan Creek	Root River Canal	Lower Root River-Caledonia	Total
Black Alder (*Alnus glutinosa*)	Woody	2	4	5	0	0	0	0	0	0	11
Black Locust (*Robinia pseudoacacia*)	Woody	0	4	0	0	0	0	0	0	0	4
Burdock (*Arctium minus*)	Herbaceous	1	2	0	13	1	0	0	0	0	17
Common Reed Grass (*Phragmites australis*)	Herbaceous	0	3	3	1	3	1	1	0	1	13
Crown Vetch (*Coronilla varia*)	Herbaceous	0	0	0	5	0	0	0	0	0	5
Cypress Spurge (*Euphorbia cyparissias*)	Herbaceous	0	0	0	1	0	0	0	0	0	1
Dames Rocket (*Hesperis matronalis*)	Herbaceous	1	52	34	16	0	3	1	0	4	111
Forget-Me-Not (*Myosotis sylvatica*)	Herbaceous	0	0	0	10	0	0	0	0	0	10
Garlic Mustard (*Allaria petiolata*)	Herbaceous	84	52	67	102	20	1	2	0	49	377
Glossy Buckthorn (*Frangula alnus*)	Woody	1	0	0	0	0	0	0	0	0	1
Japanese Barberry (*Berberis thunbergii*)	Woody	0	0	0	1	2	0	31	0	2	36
Japanese Knotweed (*Polygonum cuspidatum*)	Herbaceous	0	1	0	2	0	0	0	0	0	3
Japanese Plume Grass (*Miscanthus sacchariflorus*)	Herbaceous	0	1	0	0	0	0	0	0	0	1
Multiflora Rose (*Rosa multiflora*)	Woody	3	1	1	0	0	0	0	0	2	7
Narrowleaf Cattail (*Typha angustifolia*)	Herbaceous	0	2	0	2	8	0	0	0	0	12
Oriental Bittersweet(*Celastrus orbiculatus*)	Woody	0	0	1	0	0	0	2	0	0	3
Purple Loosestrife (*Lythrum salicaria*)	Herbaceous	0	0	0	0	3	0	0	0	0	3
Reed Canary Grass (*Phalaris arundinacea*)	Herbaceous	3	10	6	0	4	0	0	0	0	23
Teasel[a] (*Dipacus sylvestris and D. laciniatus*)	Herbaceous	0	24	5	13	1	0	3	0	1	47
Tree of Heaven (*Ailanthus altissima*)	Woody	0	1	0	0	0	0	0	0	0	1
White Poplar (*Populus alba*)	Woody	0	0	0	0	1	0	0	0	0	1
Wild Chervil (*Anthriscus sylvestris*)	Herbaceous	2	8	0	0	0	0	0	0	0	10
Wild Parsnip (*Pastinaca sativa*)	Herbaceous	0	7	0	0	0	0	0	0	0	7
Winged Burning Bush (*Euonymus alatus*)	Woody	0	0	1	2	0	0	0	0	0	3
Yellow Iris (*Iris pseudacorus*)	Herbaceous	0	0	0	22	0	0	0	0	0	22
Total	- -	97	172	123	190	43	5	40	0	59	729

[a]*Teasel includes both common teasel and cut-leaf teasel.*

Source: Milwaukee County Parks Department and SEWRPC.

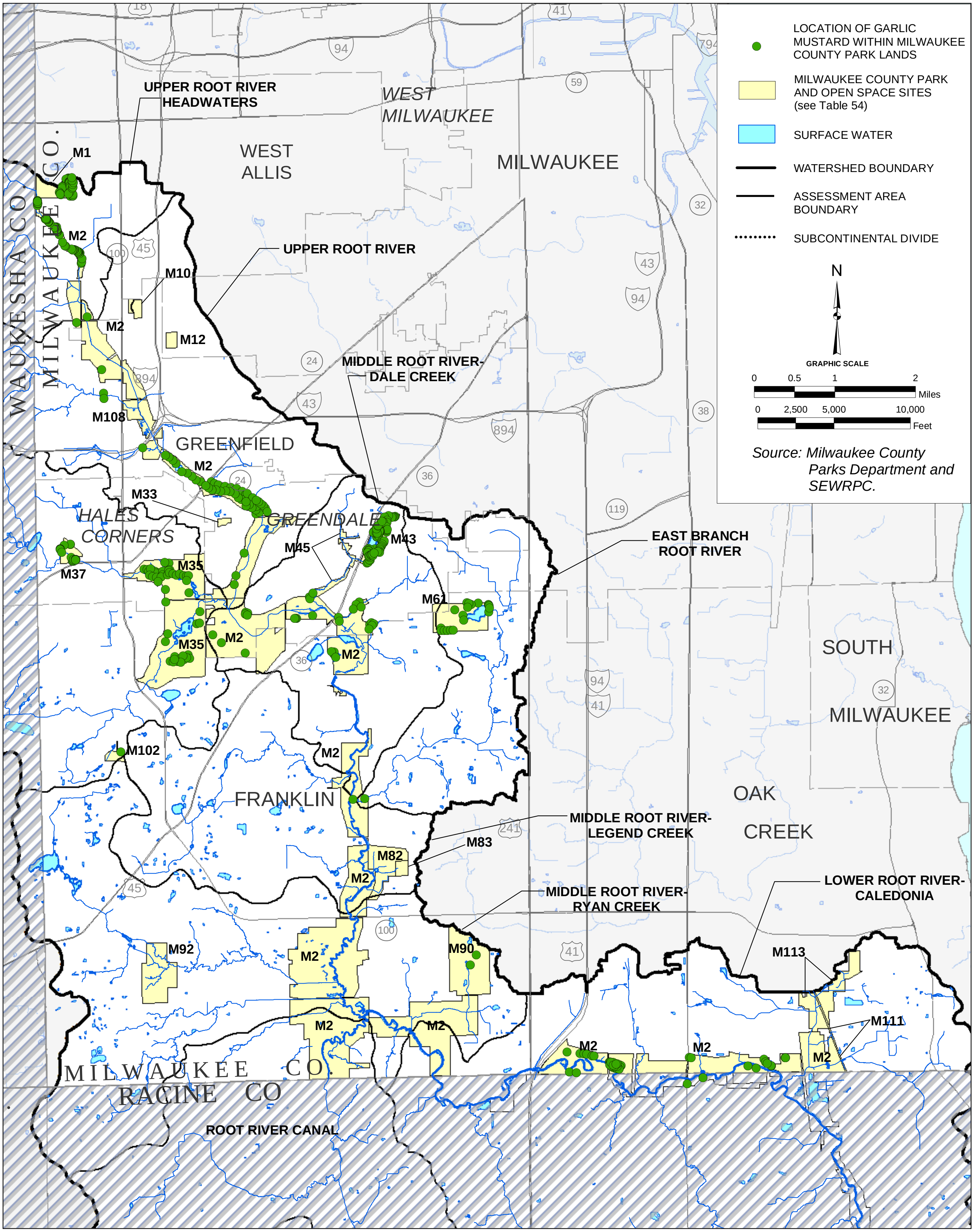
Map 47

INFESTATIONS OF HERBACEOUS INVASIVE PLANT SPECIES WITHIN MILWAUKEE COUNTY PARKS LOCATED IN THE ROOT RIVER WATERSHED: 2009-2013



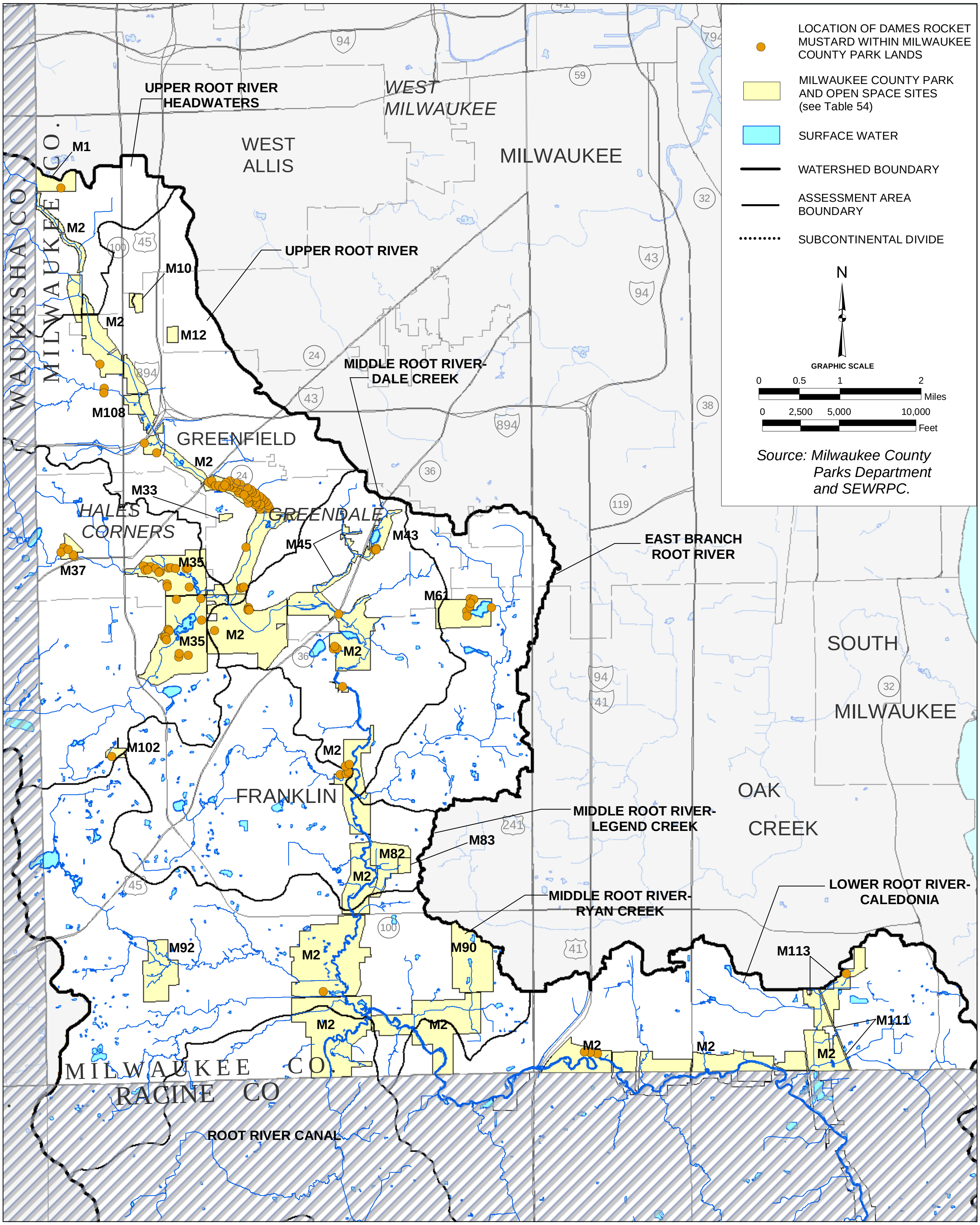
Map 48

INFESTATIONS OF GARLIC MUSTARD WITHIN MILWAUKEE COUNTY PARKS LOCATED IN THE ROOT RIVER WATERSHED: 2009-2013



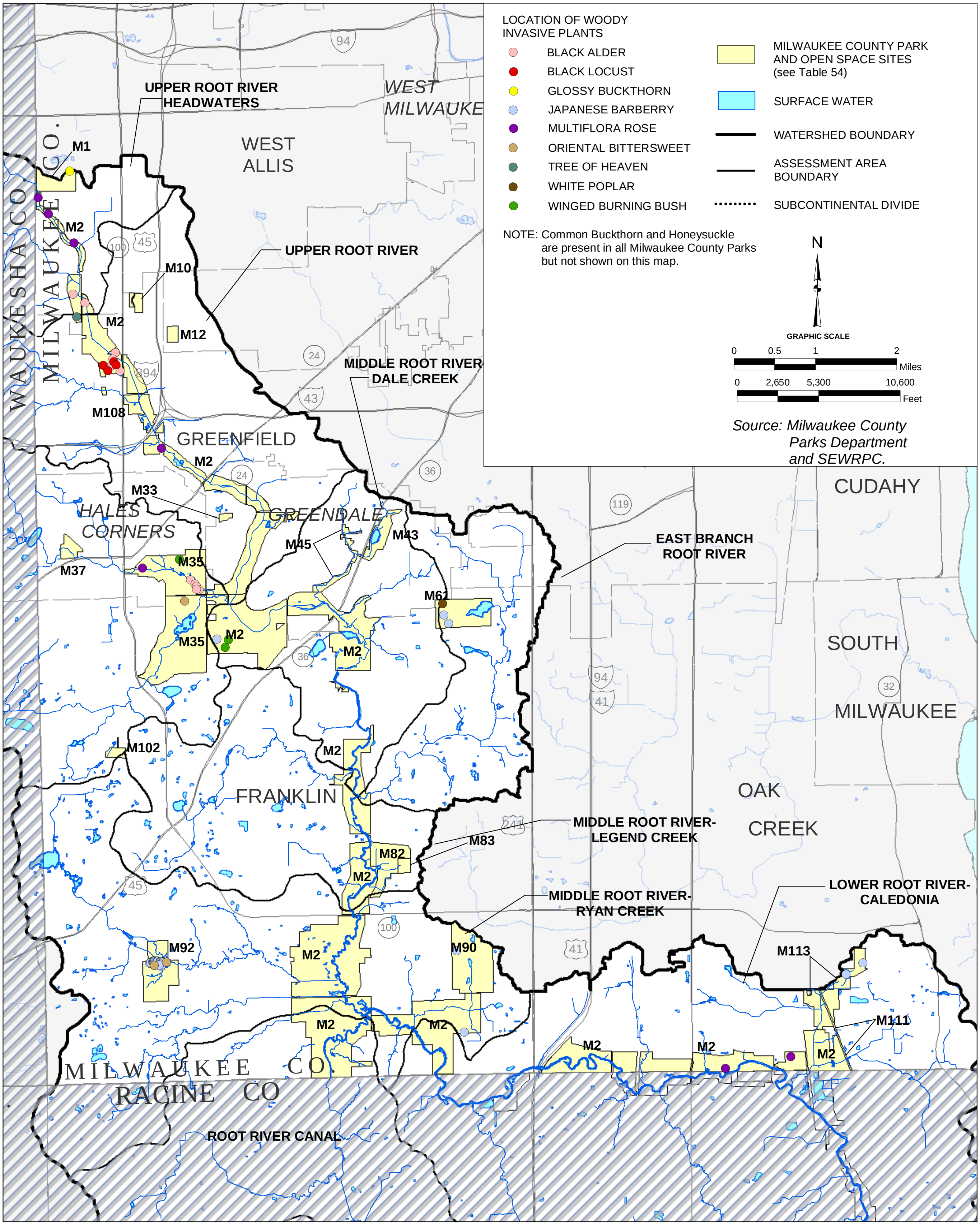
Map 49

INFESTATIONS OF DAMES ROCKET WITHIN MILWAUKEE COUNTY PARKS
LOCATED IN THE ROOT RIVER WATERSHED: 2009-2013



Map 50

INFESTATIONS OF WOODY INVASIVE PLANT SPECIES WITHIN MILWAUKEE COUNTY PARKS LOCATED IN THE ROOT RIVER WATERSHED: 2009-2013



species. Dame's rocket was the second most common invasive species that was mapped in the surveys, accounting for about 15 percent of the mapped infestations. Several areas within the park system have multiple sites containing infestations of dame's rocket. These areas include the section of the Root River Parkway between W. Forest Home Avenue (STH 24) and W. Grange Avenue, Whitnall Park—especially along Whitnall Park Creek, Hales Corners Park, and Grobschmidt Park—especially around Mud Lake, and the section of the Root River Parkway immediately south of W. Drexel Avenue.

Map 50 shows locations of infestations of woody invasive plant species within those Milwaukee County parks and natural areas located in the Root River watershed. The surveys found 67 infestations of nine woody invasive plant species. In addition to the infestations of woody invasive plant species shown on Map 50, Milwaukee County Parks staff reported that common buckthorn and four species of exotic bush honeysuckle—Amur honeysuckle, tatarian honeysuckle, Morrow's honeysuckle, and bella honeysuckle—were commonly found in Milwaukee County parks and natural areas in the Root River watershed. Japanese barberry was the most common woody invasive plant species mapped in the surveys. The surveys mapped 36 locations with infestations of this species. Several areas within the park system have multiple sites containing infestations of woody invasive plant species. The section of the Root River Parkway located between S. 124th Street and W. Cleveland Avenue contains at least three infestations consisting of multiflora rose. The section of the Root River Parkway located near W. Beloit Road contains several infestations consisting of black alder and black locust. Whitnall Park contains several infestations of black alder along Whitnall Park Creek. Other woody invasive plant species found in Whitnall Park include Japanese barberry, multiflora rose, oriental bittersweet, and winged burning bush. Grobschmidt Park contains infestations of Japanese barberry and white poplar. Franklin Park contains several infestations of Japanese barberry and oriental bittersweet.

Table 47 shows the number of infestations of invasive plant species in each of the assessment areas located wholly or partially in Milwaukee County by species. Most assessment areas contain numerous infestations. There are two exceptions to this generalization. No infestations were reported in the Root River Canal assessment area and only five infestations were reported in the Middle Root River-Legend Creek assessment area. The fact that numbers of infestations detected in the assessment areas are substantially lower than the numbers detected in other assessment areas in the County should be interpreted with caution. The differences among assessment areas may partially reflect differences in the amount of effort expended in surveying invasive species.

Other Invasive Species

Several other invasive species are known to be present in Root River watershed. These species include common buckthorn, garlic mustard, glossy buckthorn, and purple loosestrife. No recent mapping or survey data for the species were available.

PHYSICAL CONDITIONS

Root River Watershed Drainage Network

Water from rainfall and snowmelt generally flows into streams by one of two pathways: 1) either directly flowing over land as surface water runoff or 2) infiltrating into the soil, recharging the groundwater, and eventually reaching streams as baseflow. Ephemeral, or intermittent, streams generally flow only during the wet season or during large rainfall events. Perennial streams that flow year-round are primarily sustained by groundwater during dry periods. The surface water stream network within the Root River watershed is shown on Map 22. As discussed above, for the inventory and assessment of physical and biological stream conditions, the Root River watershed was divided into 23 stream reach areas (five mainstem reaches and 18 tributary reaches) which are derived from combinations of multiple subbasins. These stream reach areas form the basis for the summary statistics within this section (see Table 48).

Viewed from above, the network of water channels that form a river system typically displays a branch-like pattern as shown in Figure 86. A stream channel that flows into a larger channel is called a tributary of that channel. The entire area drained by a single river system is termed a drainage basin, or watershed. Stream size

Table 48

PHYSICAL CONDITIONS ALONG REACHES WITHIN THE ROOT RIVER WATERSHED: 2005-2013

				Streambank Conditions					Obstructions				Inputs		
Reach and Principal Streams	Area (acres)	Total Stream Length (miles)	Slope of Streambed (percent slope)[a]	Stream Length Assessed (miles)	Total Length of Eroding Bank (feet)[b]	Percent of Banks Eroding	Total Length of Protected Bank (feet)[c]	Percent of Banks Protected	Stream Crossings Total Number (number per mile)[d]	Dams/Drop Structures (total number)	Large Woody Debris Total Number (number per mile)	Trash and Debris	Stormwater Outlet Pipes Total Number (number per mile)	Drain Tile Outlets Total Number (number per mile)	Tributary Inlets
Mainstem Reaches															
RR-10	1,758														
Root River Mainstem		2.07	0.08	2.07	1,533	7.0	50	0.2	2 (1.0)	- -	8 (3.9)	- -	2 (1.0)	- -	8
Tuckaway Creek		1.62	- -	- -	- -	- -		- -	4 (2.5)	1	- -	- -	- -	- -	- -
RR-13	1,153														
Root River Mainstem		2.47	0.04	2.47	2,264	8.7	80	0.3	2 (0.8)	- -	14 (5.7)	- -	2 (0.8)	- -	- -
RR-17	12,707														
Root River Mainstem		14.50	0.04	14.50	12,133	7.9	- -	- -	14 (1.0)	- -	34 (2.3)	45	8 (0.6)	7 (0.5)	38
RR-22	3,589														
Root River Mainstem		5.65	0.05	2.1	720	3.2	- -	- -	3 (1.4)	1	- -	17	- -	1 (0.5)	1
RR-23	5,699														
Root River Mainstem		6.58	0.18	6.58	8,250	11.9	14,750	21.2	23 (3.5)	1	- -	- -	73 (11)	- -	- -
Tributary Reaches															
RR-1	2,340														
Root River Headwaters		3.36	0.30	1.96	4,656	22.5	3,050	14.7	28 (8.3)	0	7 (3.6)	- -	10 (5.1)	- -	6
Hale Creek		0.93	0.06	0.93	180	1.8	535	5.4	2 (2.2)	0	5 (5.4)	- -	23 (29.1)	- -	3
RR-2	1,237														
West Branch Root River		2.75	- -	- -	- -	- -	- -	- -	23 (8.4)	- -	- -	- -	- -	- -	- -
S. 130th Street Tributary		1.56	- -	- -	- -	- -	- -	- -	21 (13.5)	- -	- -	- -	- -	- -	- -
RR-3	1,239														
Wildcat Creek		2.50	0.85	0.30	150	4.4	- -	- -	13 (5.2)	0	1 (3.3)	- -	- -	- -	- -
RR-4	5,443														
Root River Headwaters		4.93	0.09	4.93	9,630	18.5	966	1.9	12 (2.4)	0	15 (3.0)	- -	33 (6.5)	- -	15
104th Street Ditch		0.37	0.79	0.28	60	2.0	40	1.4	3 (8.1)	0	1 (3.6)	- -	1 (3.6)	- -	0
RR-5	3,318														
Whitnall Park Creek		3.17	0.62	3.17	145	0.4	2,290	6.8	39 (12.3)	2	11 (3.5)	- -	11 (3.5)	- -	2
North Branch Whitnall Park Creek		0.39	0.19	0.39	20	0.5	- -	- -	1 (2.6)	1	0 (0.0)	- -	2 (5.1)	- -	0
NW Branch Whitnall Park Creek		1.66	0.77	- -	- -	- -	- -	- -	9 (5.4)	- -	- -	- -	- -	- -	- -
Upper Kelly Lake Tributary		1.67	- -	- -	- -	- -	- -	- -	8 (4.8)	- -	- -	- -	- -	- -	- -
RR-6	6,271														
Tess Corners Creek		9.18	0.37	0.78	1,210	14.7	- -	- -	29 (3.2)	1	7 (9.0)	- -	- -	- -	3
RR-7	4,137														
Root River Headwaters		5.42	0.06	5.42	1,960	3.4	48	0.1	5 (0.9)	- -	46 (8.5)	- -	5 (0.9)	- -	18
Dale Creek		2.02	1.01	0.84	- -	- -	- -	- -	7 (3.5)	- -	1 (1.2)	- -	1 (1.2)	- -	- -
Scout Lake Creek		0.86	- -	- -	- -	- -	- -	- -	4 (4.7)	- -	- -	- -	- -	- -	- -
RR-8	2,557														
Legend Creek		5.59	0.40	- -	- -	- -	- -	- -	29 (5.2)	- -	- -	- -	- -	- -	- -
RR-9	3,137														
East Branch Root River		5.98	0.27	4.73	4,990	10.0	500	1.0	21 (3.5)	- -	89 (18.8)	- -	32 (6.8)		25

Table 48 (continued)

Reach and Principal Streams	Area (acres)	Total Stream Length (miles)	Slope of Streambed (percent slope)[a]	Streambank Conditions: Stream Length Assessed (miles)	Streambank Conditions: Total Length of Eroding Bank (feet)[b]	Streambank Conditions: Percent of Banks Eroding	Streambank Conditions: Total Length of Protected Bank (feet)[c]	Streambank Conditions: Percent of Banks Protected	Obstructions: Stream Crossings Total Number (number per mile)[d]	Obstructions: Dams/Drop Structures (total number)	Obstructions: Large Woody Debris Total Number (number per mile)	Obstructions: Trash and Debris	Inputs: Stormwater Outlet Pipes Total Number (number per mile)	Inputs: Drain Tile Outlets Total Number (number per mile)	Inputs: Tributary Inlets
Tributary Reaches (continued)															
RR-11	3,850														
Ryan Creek		7.36	- -	- -	- -	- -	- -	- -	11 (1.5)	- -	- -	- -	- -	- -	- -
RR-12	2,457														
Oakwood Tributary		4.60	- -	- -	- -	- -	- -	- -	9 (1.8)	- -	- -	- -	- -	- -	- -
RR-14	25,320														
West Branch Root River Canal		12.21	0.04	- -	- -	- -	- -	- -	25 (2.0)	- -	- -	- -	- -	- -	- -
Union Grove Tributary		3.74	- -	- -	- -	- -	- -	- -	7 (1.9)	- -	- -	- -	- -	- -	- -
Yorkville Creek		4.32	0.39	- -	- -	- -	- -	- -	6 (1.4)	- -	- -	- -	- -	- -	- -
50th Road Tributary		3.77	- -	- -	- -	- -	- -	- -	15 (4.0)	- -	- -	- -	- -	- -	- -
Tributary 2A		5.68	0.28	- -	- -	- -	- -	- -	16 (2.8)	- -	- -	- -	- -	- -	- -
Unnamed Tributary		2.37	0.63	- -	- -	- -	- -	- -	2 (0.8)	- -	- -	- -	- -	- -	- -
Raymond Creek		5.57	0.36	- -	- -	- -	- -	- -	17 (3.1)	- -	- -	- -	- -	- -	- -
RR-15	9,997														
East Branch Root River Canal		12.35	0.14	- -	- -	- -	- -	- -	24 (1.9)	- -	- -	- -	- -	- -	- -
RR-16	7,724														
Root River Canal		5.83	0.02	- -	- -	- -	- -	- -	4 (0.7)	- -	- -	- -	- -	- -	- -
Unnamed Tributary		4.93	- -	- -	- -	- -	- -	- -	10 (2.0)	- -	- -	- -	- -	- -	- -
RR-18	2,053														
Kilbournville Tributary		3.94	- -	- -	- -	- -	- -	- -	7 (1.8)	- -	- -	- -	- -	- -	- -
RR-19	6,921														
Husher Creek		5.64	0.21	- -	- -	- -	- -	- -	14 (2.5)	- -	- -	- -	- -	- -	- -
RR-20	3,382														
Crayfish Creek		2.85	0.09	- -	- -	- -	- -	- -	12 (4.2)	- -	- -	- -	- -	- -	- -
N. Branch Crayfish Creek		1.01	- -	- -	- -	- -	- -	- -	11 (10.9)	- -	- -	- -	- -	- -	1
RR-21	10,267														
Hoods Creek		9.91	0.19	8.10	7,775	9.1	- -	- -	23 (2.3)	1	58 (7.2)	34	8 (1.0)	41 (5)	12
Ives Grove Ditch		1.12	0.09	- -	- -	- -	- -	- -	3 (2.7)	- -	- -	- -	- -	- -	- -
Sorenson Ditch		0.44	- -	- -	- -	- -	- -	- -	1 (2.2)	- -	- -	- -	- -	- -	- -

NOTE: This table is a compilation of data collected for several different studies. GIS data was provided by DTM Consulting (documented in "Root River Sediment Transport Study-Desktop GIS Application," September 2007) for the Root River Sediment Transport Planning Study (2007) which focuses on the Root River and some of its tributaries within Milwaukee County. GIS data was also provided by AECOM for the report they prepared for the City of Racine Root River Outfall and Streambank Erosion Assessment (2013). SEWRPC staff completed a stream survey in the summer of 2013, collecting data for Hoods Creek and filling in the data gap between the two aforementioned studies. Several hydraulic models were also used to calculate streambed slopes and numbers of road crossings. Methodologies for data collection for each of these studies are different, and, thus, the results are not always directly comparable.

[a] *The slopes of streambed segments in this table are calculated from channel invert elevations used in the most current hydraulic models available to SEWRPC staff at the time of this report.*

[b] *Length of eroding banks are derived from GIS data from the following studies; The Root River Sediment Transport Planning Study (2007) for Reach Areas RR-1, RR-3, RR-4, RR-5, RR-6, RR-7, RR-9, RR-10, and RR-13; SEWRPC's 2013 stream survey for Reach Areas RR-17, RR-21, and portions of RR-22; and the City of Racine Root River Outfall and Streambank Erosion Assessment (2013) for Reach Area RR-23.*

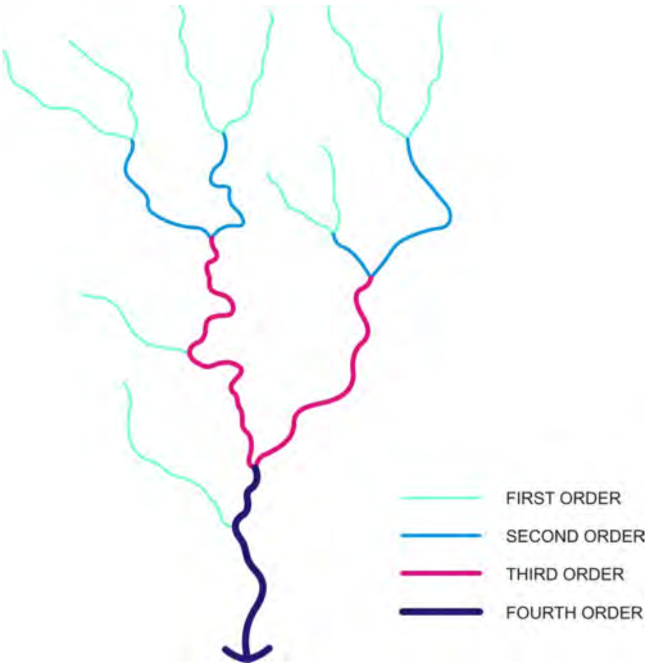
[c] *Length of protected banks was only assessed for certain stream segments surveyed for the Root River Sediment Transport Planning Study.*

[d] *The number of stream crossings reported in this table include data obtained from one of four studies: the Root River Sediment Transport Planning Study (2007), the City of Racine Root River Outfall and Streambank Erosion Assessment (2013),the most current hydraulic model available, or SEWRPC's 2013 survey. Findings from the study which had the most extensive area surveyed were reported in this table. Streams or portions of streams that were not included in the aforementioned studies were examined using digital orthophotography to generate a more accurate count of stream crossings.*

Source: SEWRPC.

Figure 86

TYPICAL STREAM NETWORK PATTERNS BASED ON HORTON'S CLASSIFICATION SYSTEM



Source: Oliver S. Owen and others, Natural Resource Conservation: Management for a Sustainable Future*, and SEWRPC.*

increases in the downstream direction as more and more tributary segments enter the main channel. A classification system based on the position of a stream within the network of tributaries, called a stream order, was developed by Robert E. Horton and later modified by Arthur Strahler. In general, the lower stream order numbers correspond to the smallest headwater tributaries and are shown as Order 1, or first-order, streams as represented in Figure 86. Second-order streams (Order 2) are those that have only first-order streams as tributaries, and so on (see Figure 86). As water travels from headwater streams toward the mouth of larger rivers, streams gradually increase their width and depth and the amount of water they convey also increases. It is important to note that over 80 percent of the total length of Earth's rivers and streams are headwater streams (first-and second-order) and the Root River watershed shows the same type of pattern.

To better understand stream systems and what shapes their conditions, it is important to understand the effects of both spatial and temporal scales. Streams can be theoretically subdivided into a continuum of habitat sensitivity to disturbance and recovery time as shown in Figure 87.[175] Microhabitats, such as a handful-sized patch of gravel, are most susceptible to disturbance; river systems and watersheds are least susceptible. Furthermore, events that affect smaller-scale habitat characteristics may not affect larger-scale system characteristics, whereas large disturbances can directly influence both large- and smaller-scale features of streams. For example, on a small special scale, deposition at one habitat site may be accompanied by scouring at another site nearby, but the reach or segment containing the habitat sites does not appear to change significantly. In contrast, a large-scale disturbance, such as a debris flood, is initiated at the sector level and reflected in all lower levels of the hierarchy (reach, habitat, microhabitat). Similarly, on a temporal scale, siltation of microhabitats may disturb the biotic community over the short term. However, if the disturbance is of limited scope and intensity, the system may recover quickly to pre-disturbance levels.[176]

Physical Characteristics within Stream Reach Areas

Physical conditions presented in this section derive from three studies conducted on various portions of the Root River watershed. These three studies include: 1) the Root River Sediment-Transport Planning Study[177] and the

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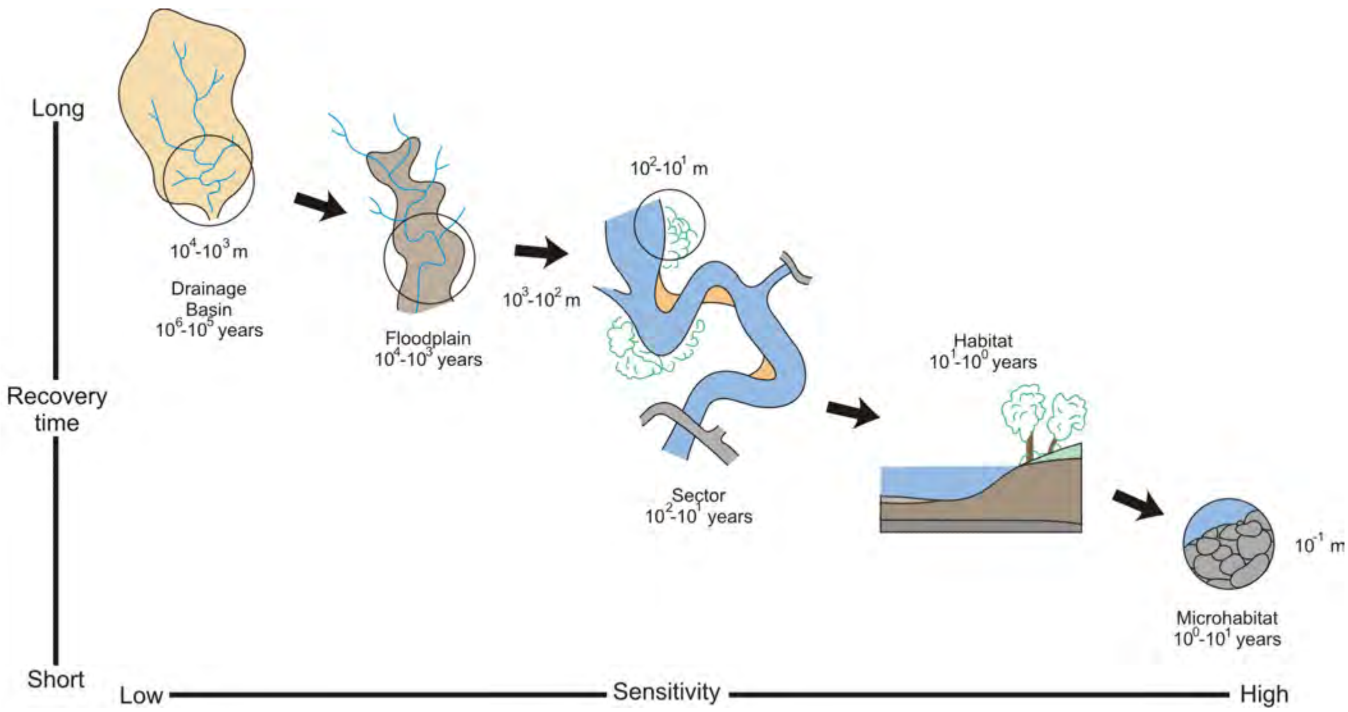
[175]*C.A. Frissell, et al., "A Hierarchical Framework for Stream Classification: Viewing Streams in a Watershed Context,"* Journal of Environmental Management*, Volume 10, 1986, pages 199-214.*

[176]*G.J. Niemi, et al., "An Overview of Case Studies on Recovery of Aquatic Systems From Disturbance,"* Journal of Environmental Management*, Volume 14, 1990, pages 571-587.*

[177]*Mussetter Engineering, Inc., Root River Sediment-Transport Planning Study,* Report to the Milwaukee Metropolitan Sewerage District*, September 2007.*

Figure 87

RELATION BETWEEN RECOVERY TIME AND SENSITIVITY TO DISTURBANCE FOR DIFFERENT HIERARCHICAL SPATIAL SCALES ASSOCIATED WITH STREAM SYSTEMS



Source: C.A. Frissell and others, "A Hierarchical Framework for Stream Habitat Classification: Viewing Streams in a Watershed Context," Environmental Management*, Vol. 10, and SEWRPC.*

accompanying Root River Sediment Transport Study-Desktop GIS Application,[178] 2) the Root River Outfall and Streambank Erosion Assessment,[179] and 3) field inventories conducted by SEWRPC staff along the mainstem of the Root River in stream reach areas RR-17 and RR-22, and along Hoods Creek within stream reach RR-21. Inventories and geographic information system (GIS) data were provided by Mussetter Engineering, Inc. and DTM Consulting from the Root River Sediment-Transport study, which focused on the mainstem of the Root River and some of its tributaries within Milwaukee County, including Hale Creek, Wildcat Creek, Whitnall Park Creek, Tess Corners Creek, Dale Creek, Legend Creek, East Branch Root River, Ryan Creek, and Crayfish Creek (see Appendix G for the full report). Inventories and GIS data were also provided by AECOM for the report they prepared for the City of Racine Root River Outfall and Streambank Assessment, which focused on the mainstem of the Root River within the City of Racine (see Appendix H for the full report). Field inventories conducted by SEWRPC staff were conducted to bridge the gaps in data between the studies discussed above. The full extent of streams studied in the three reports is shown on Map 51 and summary statistics for all studies can be found in Table 48.

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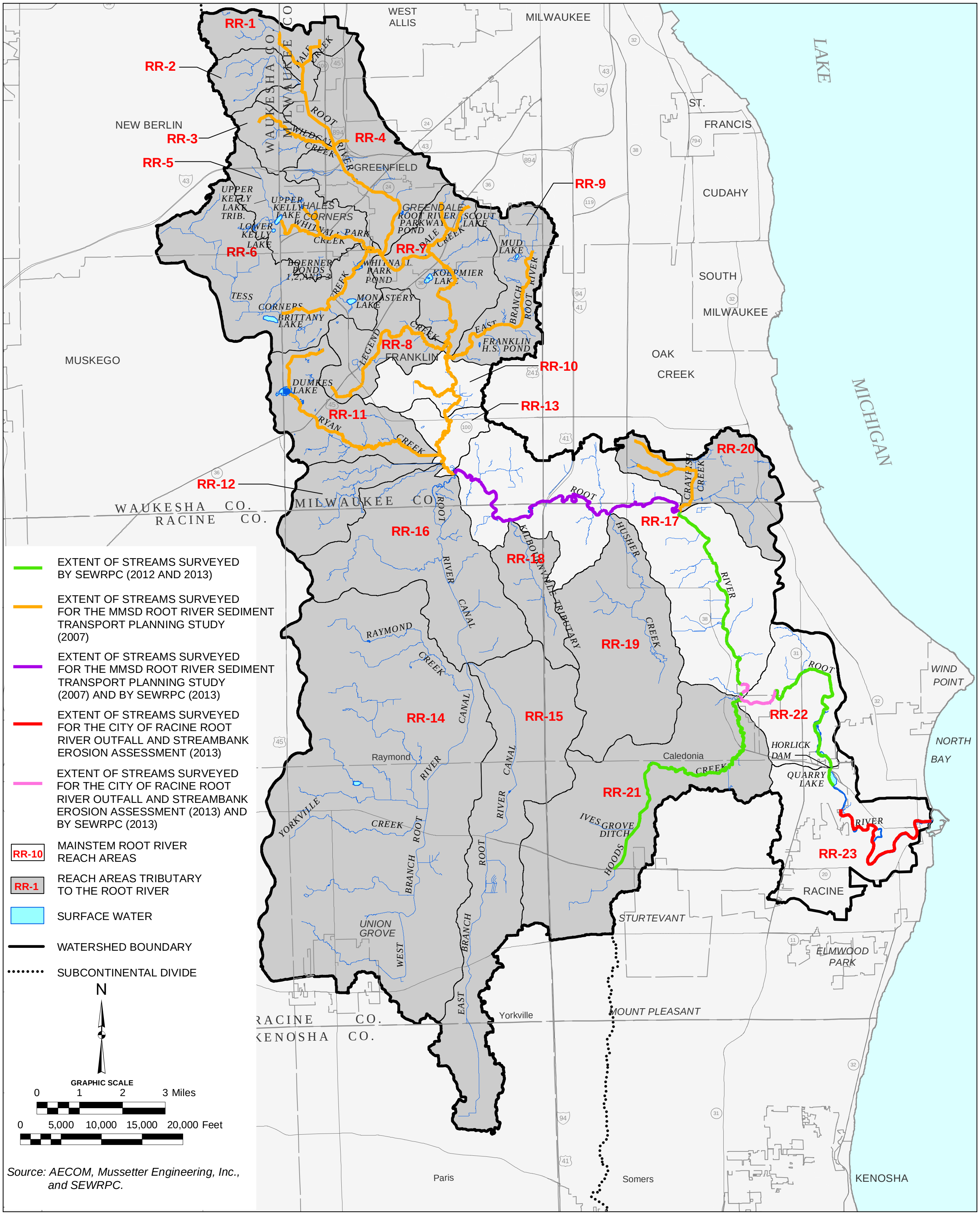
[178]*DTM Consulting, Root River Sediment Transport Study-Desktop GIS Application*, Report to the Milwaukee Metropolitan Sewerage District, *September 2007*.

[179]*AECOM, Root River Streambank Erosion and Outfall Assessment*, Report to the City of Racine, December 2013.

Map 51

EXTENT OF STREAM REACHES SURVEYED FOR RECENT STUDIES WITHIN THE ROOT RIVER WATERSHED: 2005-2013



Source: AECOM, Mussetter Engineering, Inc., and SEWRPC.

Field inventories were conducted by SEWRPC staff from June 2013 through August 2013 to quantitatively and qualitatively characterize the physical characteristics of the Root River and Hoods Creek. Both quantitative and qualitative measures were largely based upon the WDNR Baseline Monitoring protocols for instream fisheries habitat assessment.[180] A total of 201 cross-section surveys were obtained throughout stream reach areas RR-17, RR-21, and RR-22, and the number of transects ranged from 7 to 12 transects per mile, depending on the reach sampled as shown in Tables I-1 and I-2 in Appendix I. An additional 256 maximum water depths were recorded in pool habitats to assess number and quality in order to supplement information between cross-sections where the full complement of data was collected. Physical parameters that were measured include water and sediment depth, substrate composition, undercut bank, bank slope, channel width, bankfull width, and bankfull depth. The remaining cover parameters were each qualitatively estimated as none, low, moderate, and high percent abundances based upon categories as defined in the Qualitative Habitat Evaluation Index (QHEI) methodology.[181]

Slope and Sinuosity

Stream characteristics, such as slope, length, and sinuosity are determined by a combination of geological history (i.e., glaciation) and human intervention (i.e., lake or pond impoundments or channelization). Based upon this information, as well as subbasin boundaries separating the mainstem Root River and its tributaries, the Root River watershed was divided into 5 distinct mainstem stream reach areas and 18 distinct tributary stream reach areas (see Map 22 and Figures 88 and 89). In addition, stream reaches surveyed by SEWRPC staff were further distinguished based upon the stream characteristics discussed above for ease of analysis (see Maps I-1 and I-14 in Appendix I).

Healthy streams naturally meander across a landscape over time. Sinuosity is a measure of how much a stream meanders and is defined by a ratio of channel length between two points on a channel to a straight-line distance between the same two points. Sinuosity or channel pattern can range from a straight to a winding pattern, or meandering. Channelized streams (i.e., streams that have been straightened) typically have low sinuosity (i.e., a number closer to one). Much of the loss in sinuosity in channelized streams within the Root River watershed most likely occurred in the late part of the 19th and early part of the 20th century from ditching or channel straightening to accommodate agricultural development. Other channelized streams within the watershed were ditched to accommodate highway development.

A stream is a transport system for water and sediment and it is continually eroding and depositing sediments, which causes the stream to migrate. When the amount of sediment load coming into a stream is equal to what is being transported downstream—and stream widths, depths, and length remain consistent over time—it is common to refer to that stream as being in a state of "dynamic equilibrium." These streams retain their physical dimensions (equilibrium), but those physical features shift, or migrate, over time (dynamic). For example, it is not uncommon for a low-gradient stream in Southeastern Wisconsin to migrate more than one foot within a single year.

The longitudinal slope of a channel is the ratio of elevation change between two points on the channel to the length of the channel between the same two points. Slope is an indicator of stream energy or power. The lower the slope, the lower the energy, and the slower the water flows. Stream slopes within mountainous stream systems are

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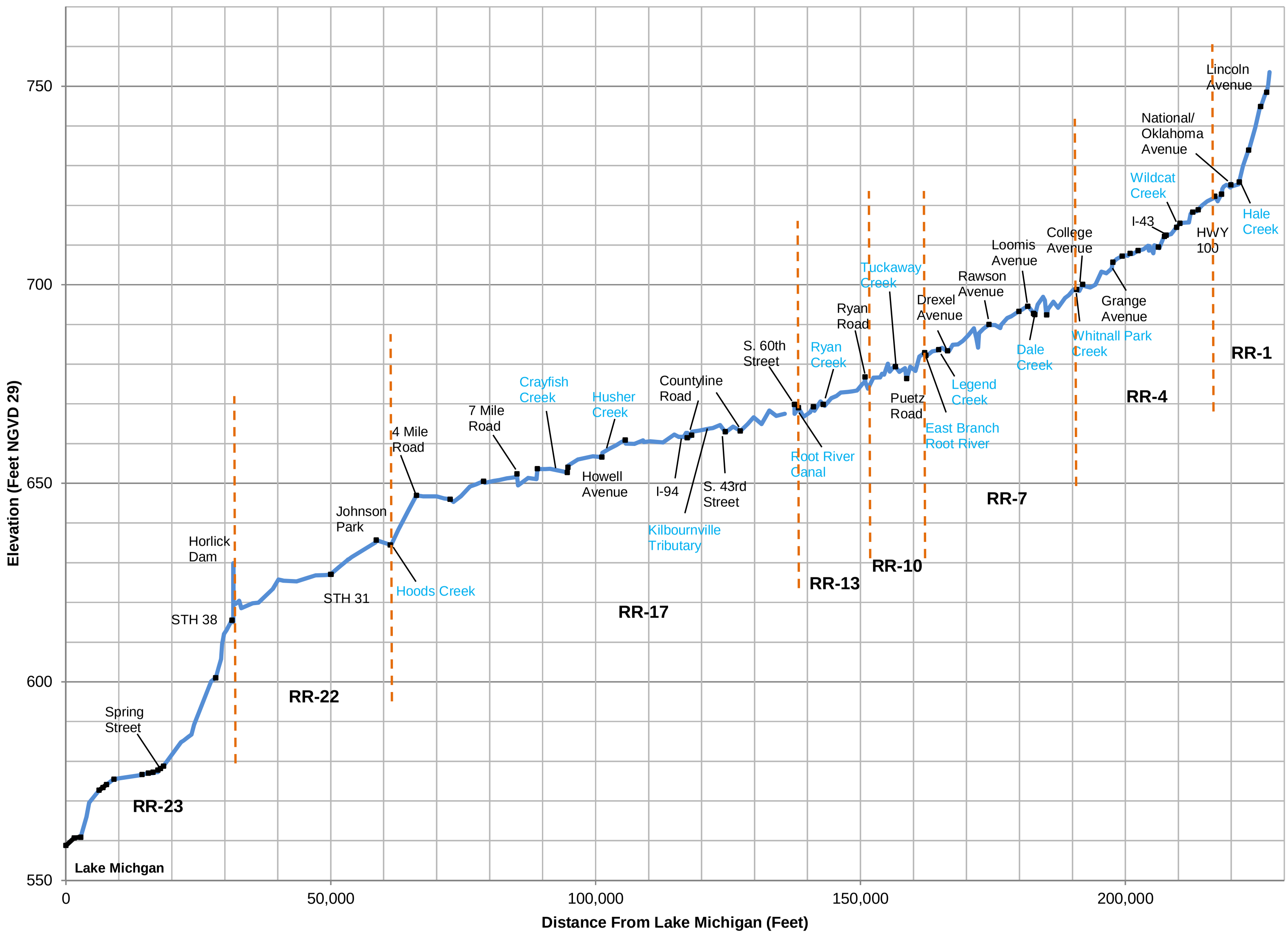
[180]*WDNR, Guidelines for Evaluating Habitat of Wadable Streams, Bureau of Fisheries Management and Habitat Protection, Monitoring and Data Assessment Section, Revised June 2000; Timothy Simonson, John Lyons, and Paul Kanehl, "Guidelines for Evaluating Fish Habitat in Wisconsin Streams,"* General Technical Report NC-164*, 1995; and Lihzu Wang, "Development and Evaluation of a Habitat Rating System for Low-Gradient Wisconsin Streams,"* North American Journal of Fisheries Management*, Volume 18, 1998.*

[181]*Edward T. Rankin, The Quality Habitat Evaluation Index [QHEI]: Rationale, Methods, and Application, State of Ohio Environmental Protection Agency, November 1989.*

Figure 88

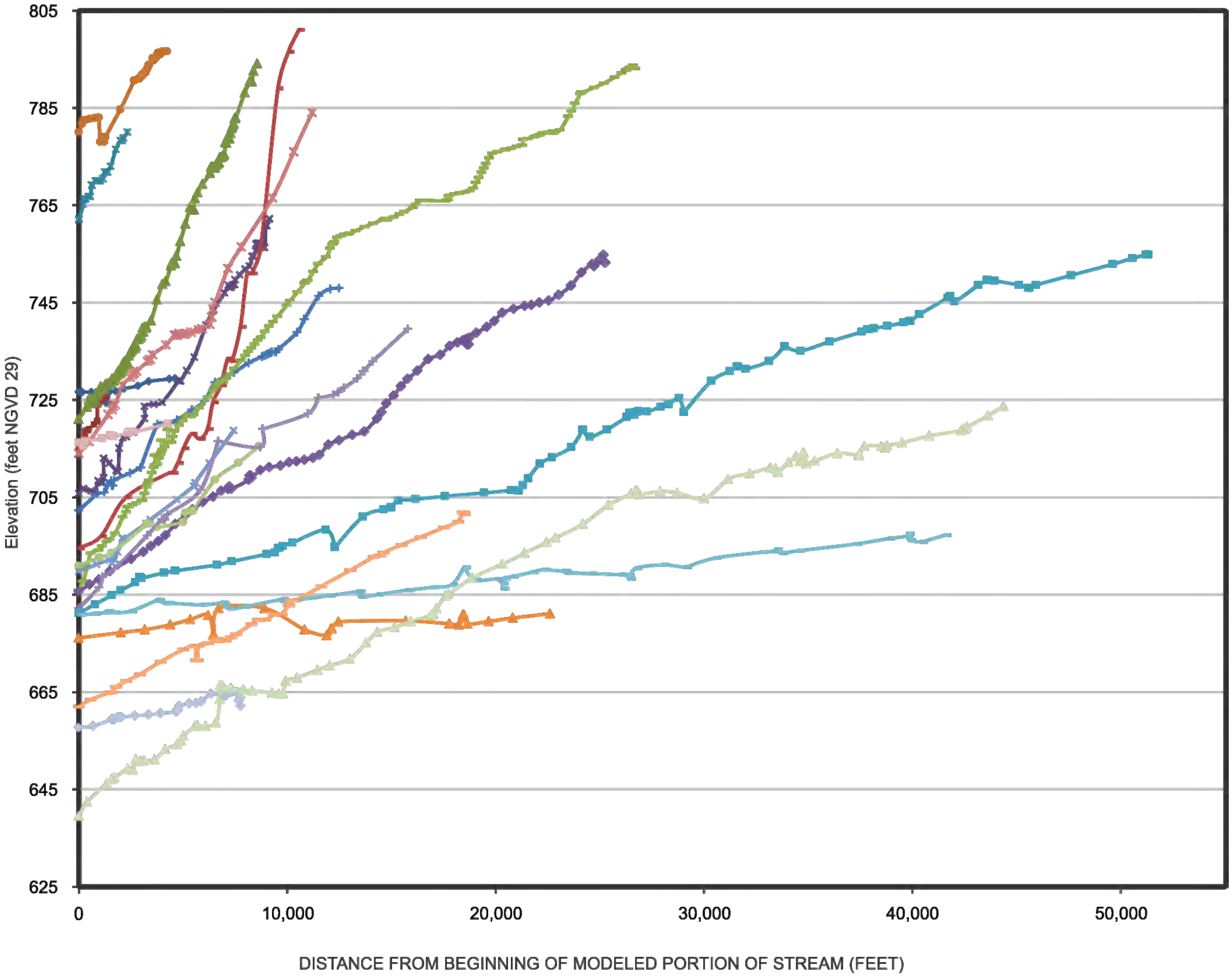
APPROXIMATE CHANNEL BOTTOM ELEVATION PROFILE OF THE MAINSTEM OF THE ROOT RIVER



Source: Graef, Anhalt, Schloemer & Associates; Mussetter Engineering; and SEWRPC.

Figure 89

APPROXIMATE CHANNEL BOTTOM ELEVATION PROFILES OF STREAMS TRIBUTARY TO THE ROOT RIVER



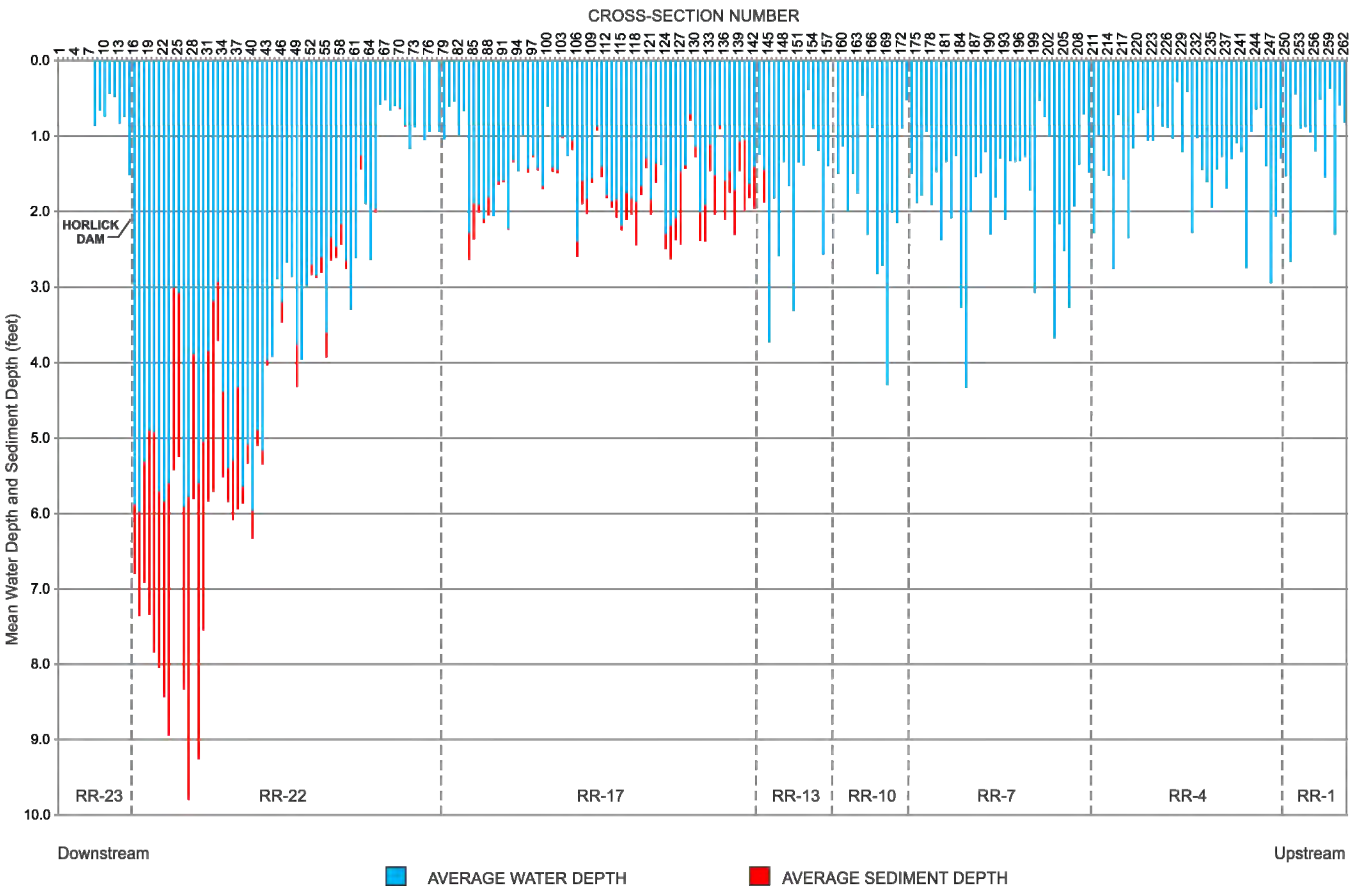
Source: Federal Emergency Management Agency, Milwaukee Metropolitan Sewerage District, and SEWRPC.

typically greater than 10 percent. However, slopes within the Root River reaches are more indicative of lowland streams found in southeastern Wisconsin and generally do not exceed 1 percent. (see Table 48 and Figures 88 and 89).

In general, tributary streams within the Root River watershed exhibit greater slopes than the mainstem of the Root River, as is typical in most watersheds. Dale Creek, Wildcat Creek, 104th Street Ditch, and the Root River headwaters within stream reach area RR-1 have the greatest slopes within the watershed and are located in some

Figure 90

MEAN WATER DEPTH AND MEAN SEDIMENT DEPTH ALONG STREAM REACHES OF THE MAINSTEM OF THE ROOT RIVER



NOTE: Sediment depths were not collected as part of the Root River Streambank Erosion and Outfall Assessment conducted by AECOM within stream reach RR-23, and the Root River Sediment-Transport Study conducted by Mussetter Engineering, Inc. within stream reaches RR-13, RR-10, RR-7, RR-4, and RR-1. Therefore, only water depths for those stream reaches are shown on this figure.

Source: ECOM; Mussetter Engineering, Inc.; and SEWRPC.

of the furthest upstream stream reaches. Mainstem stream reach RR-23, just below the Horlick dam, has the greatest slope among the Root River mainstem reaches, and is more than twice as steep as the next steepest sloped mainstem reach. These higher sloped reaches typically contain the greatest proportions of larger substrates, including sands, gravels, cobbles, and boulders compared to the other reaches which are typically dominated by sand and organic substrates such as silt. These characteristics are exhibited within Hoods Creek where reach 1 has the greatest slope and contains the greatest proportions of boulders, cobbles, and gravels and very little silt. Conversely, reach 3 of Hoods Creek has a very gentle slope, which is also associated with decreased water velocities, and as expected, the substrates within this reach are dominated by organic silt. Reach 3 of Hoods Creek also contains much higher unconsolidated sediment depths compared to the other Hoods Creek reaches (see Figures I-3 and I-4 in Appendix I). The highest unconsolidated sediment depths among mainstem Root River reaches occur within stream reach RR-22, where the backwater effect of the Horlick dam slows water velocities and allows fine sediments from upstream to settle out of the water column and accumulate (see Figure 90).

Channelization

Straightening of meandering stream channels or “channelization” was once a widely used and accepted technique in agricultural management. The U.S. Department of Agriculture National Resources Conservation Service (NRCS) (formerly Soil Conservation Service) provided cost-share funds for such activities up to the early 1970s within southeastern Wisconsin.[182] The objectives of channelization were to reduce flood elevations by conveying stormwater runoff more rapidly, to facilitate drainage of low-lying agricultural land, and to allow more efficient farming in rectangular fields. In many cases channelization was accompanied by the installation of drain tiles within the farm fields to better facilitate water movement off the field (see Maps I-11 through I-13 and Maps I-24 through I-26 in Appendix I for locations of drain tile outfalls observed during SEWRPC staff field inventories). Through channelization and installation of drain tiles, farmers attempted to protect their crops by lowering the groundwater table and increasing the capacity to convey water downstream. In order to facilitate drainage, many channelized reaches were often dredged much deeper and wider than the existing stream channel to increase the conveyance and storage capacity, which tends to produce areas that are characterized by slow moving, stagnant waterways. Many channelized reaches became long straight pools or areas of sediment deposition. Because the velocities within these reaches are too low to carry suspended materials, sediment particles settle out and accumulate. This is why many channelized reaches contain uniformly deep, unconsolidated, organic sediments.

Channelization can also lead to instream hydraulic changes that can decrease or interfere with the connection between the channel and overbank areas during floods. This may result in reduced filtering of nonpoint source pollutants by riparian area vegetation and soils, as well as increased erosion of the banks. Channelization can lead to increased water temperature, due to the loss of riparian vegetation, and it can alter instream sedimentation rates and paths of sediment erosion, transport, and deposition. For example, the most heavily channelized sections of streams assessed by SEWRPC staff for this plan contained some of the greatest amounts of unconsolidated sediment deposition, particularly in reach 3 of Hoods Creek. The same conditions would be expected within the channelized reaches of the East and West Branch Root River Canals, as well as some of their tributary streams within the agricultural stream reaches RR-14 and RR-15. In addition to the loss of stream length, channel straightening causes a major decrease in the number of pool and riffle structures within the stream system. Pool-riffle sequences are often found in meandering streams, where pools occur at meander bends and riffles at crossover stretches.[183] Therefore, channelization activities, as traditionally accomplished without mitigating features, generally lead to a diminished suitability of instream and riparian buffer habitat for fish and wildlife.

Examination of the earliest available 1906 and 1907 U.S. Geological Survey (USGS) quadrangle maps of Milwaukee County and the extreme northern portion of Racine County indicate that the headwaters and mainstem of the Root River, as well as Wildcat Creek, Whitnall Park Creek, Dale Creek, Tess Corners Creek, East Branch Root River, Ryan Creek, and Crayfish Creek were all relatively low sinuosity streams. These maps provide no indication that channelization of these streams within Milwaukee County had occurred by the time the maps were created. Aerial photography from 1950 and 1956, along with the 1958 USGS quadrangle map of the Milwaukee County portion of the Root River watershed, indicate that by that time the headwaters of the Root River in stream reach area RR-4 from W. Oklahoma Avenue to just downstream of W. Layton Avenue had been channelized. Channelization most likely occurred in this area in the early 1900s (after 1907) during the conversion of the existing hardwood forests to farmland. Spoils from the dredging were deposited as berms on both sides of the channel and are still present on these channelized reaches. Aerial photography also indicates that a meandering, highly sinuous channel segment of the mainstem Root River between S. 76th Street and W. Loomis Road was straightened sometime before 1995. Tributary streams including the lower reaches of Hale Creek, Wildcat Creek, 104th Street Ditch, Ryan Creek, and the upper portions of the East Branch Root River, were also channelized by 1958. The remainder of the Root River mainstem and its tributaries within Milwaukee County do not appear to have been channelized and remain similar today to mapped conditions in 1958.[184]

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[182]*Personal Communication, Gene Nimmer, NRCS engineer.*

[183]*N.D. Gordon, et al.,* Stream Hydrology*, John Wiley and Sons, April 1993, page 318.*

[184]*Mussetter Engineering, Inc.,* op .cit.

Examination of the earliest available map of Racine County, produced by the State Highway Commission of Wisconsin in 1937, indicates that the majority of the mainstem of the Root River within Racine County has shown little change over time. This map also clearly shows that the highly channelized East and West Branch Root River Canals, along with their tributaries (stream reach areas RR-14 and RR-15), were already straightened by this time, as most of that portion of the County had been cleared to facilitate the intense agricultural use of the land that still exists today. It is likely that these streams were channelized in the early 1900s.

Stream Width and Water Depths

There is a general increase in mean stream width and water depth in reaches of the Root River from upstream to downstream, with the exception of stream reach RR-23, where maximum depths decrease in the surveyed cross-sections just downstream of the Horlick dam, where there are bedrock outcrops (see Figure 91).[185] It should be noted that data is only available to about a half mile downstream of Horlick dam within stream reach RR-23. Maximum water depths downstream of that location increase significantly as the Lake Michigan backwater begins to take effect. Figure 90 shows a general increase in average water depths from upstream to downstream, with depths ranging from less than one foot in the Root River headwaters at the Waukesha-Milwaukee County line near cross-section No. 262, to almost six feet within the impoundment above the Horlick dam in Racine County. There are some significant fluctuations in water depth between cross-sections throughout stream reaches RR-7, RR-10, and RR-13, as seen in Figure 90. Figure 91 shows an increase in average stream width from about 13 feet in the Root River headwaters within reach RR-1 to about 22 feet in reach RR-4 and then a further increase to around 37 feet wide in reaches RR-7 and RR-10 before decreasing in width through stream reach RR-13 to an average of about 27 feet. The River almost doubles in width in reach RR-17 to an average of 55 feet and then reaches its widest in reach RR-22, with an average width of just over 100 feet. The abrupt increase in width starting at reach RR-17 is caused by the inflow from the Root River Canal, which enters at the upstream end of this reach. Reach RR-22 is by far the widest reach of the Root River, mostly due to the backwater created by the Horlick dam. Below the dam in reach RR-23, while less wide than the impoundment-influenced RR-22, the River is still wider than the rest of the Root River that was measured, with an average width of almost 75 feet.

Streambed Materials

As part of the analysis for the 2007 Root River Sediment-Transport Planning Study, Mussetter Engineering, Inc. collected 16 samples of bed materials. These samples were taken to a laboratory, where grain size distribution analyses were conducted. In addition, where the bed materials were courser, four pebble counts were conducted to determine surface gradations. Unlike most alluvial streams where there is a trend for bed materials to become finer the further downstream they occur, the bed material sizes within the Root River showed no such trend. Based on the samples collected, it was clear that the median sizes of bed material are dependent on local sources of sediment from both channel erosion and the tributaries that flow into the Root River. Within the headwaters of the Root River in stream reach RR-1, the bed materials were likely derived from erosion of the coarser-grained bank materials and ranged from coarse sands to cobbles (median size of 1.8 mm), with slightly coarser sediments introduced from Hale Creek in the downstream portions of RR-1 (median size of 2.2 mm). The bed materials in the upstream portions of RR-4 were similar to those of RR-1, but considerably coarser bed materials were present immediately downstream of 104th Street Ditch and Wildcat Creek (19 mm), indicating that these tributaries are most likely introducing these very coarse- to medium-sized gravels. Stream reach RR-7 had bed materials that ranged from very coarse gravels immediately downstream of Whitnall Park Creek (65.6 mm) to finer materials made up of medium to course sands (0.7 mm) that are typically located just upstream of large woody debris jams within this reach. Reach RR-10 had bed materials ranging from medium- to fine-sized gravels (7 to 10 mm). In general, stream reach RR-13 had some of the finer bed materials sampled under the Mussetter study, ranging from fine to coarse sand (1.3-6.7 mm).

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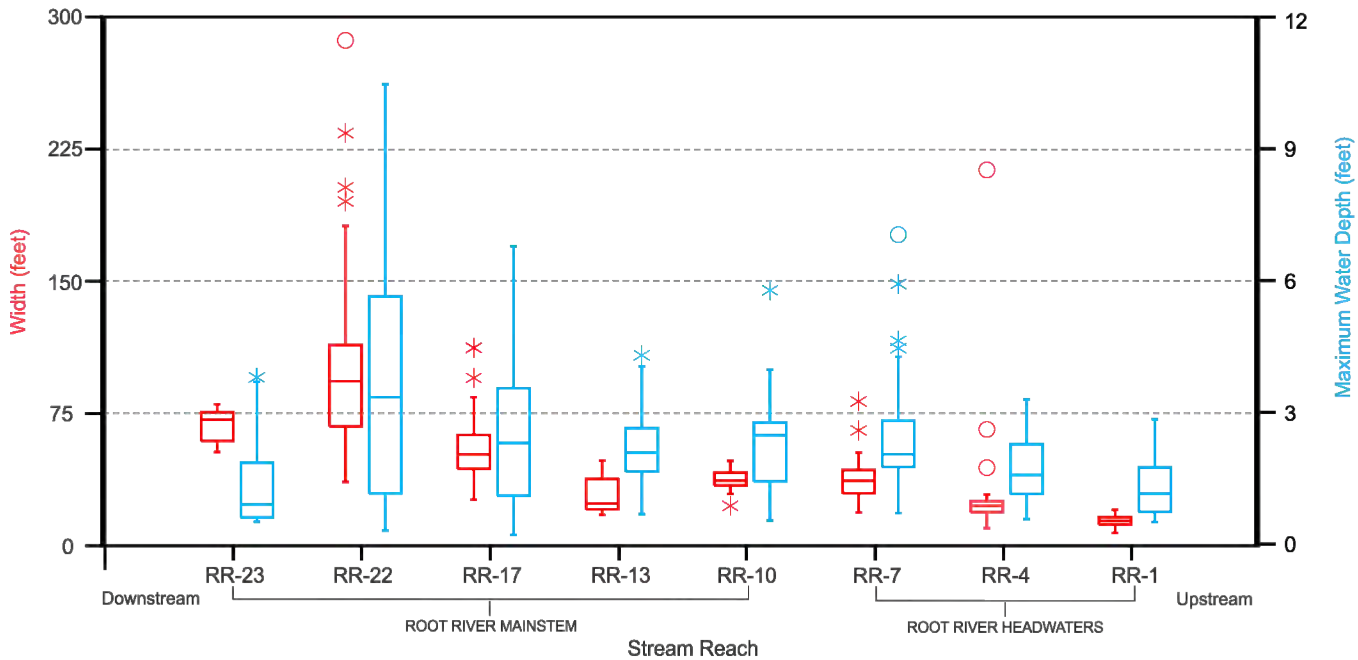
[185]*Stream width and depth data are available for the Root River mainstem from the Waukesha-Milwaukee County line to about one-half mile downstream Horlick dam in Racine County.*

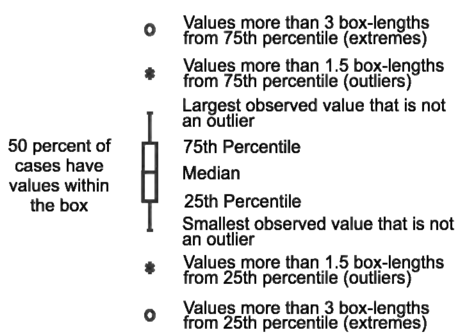
Figure 91

STREAM WIDTH AND MAXIMUM DEPTH AMONG REACHES IN THE ROOT RIVER: 2007-2013



NOTES: Six stream width values that exceeded 300 feet in width within stream reach RR-22 were excluded from this figure.

Maximum water depth and stream widths within stream reach RR-23 represent the first half mile of the Root River downstream of the Horlick dam.



Source: SEWRPC.

Substrates were characterized on a per cross-section basis by SEWRPC staff along Root River mainstem stream reaches RR-17 and RR-22 and along Hoods Creek in stream reach RR-21. Figure I-1 in Appendix I shows the relationship between water depth, sediment depth, and dominant substrates in relation to all cross-sections surveyed among stream reaches RR-17 and RR-22. In general, gravel was the most abundant substrate throughout reach RR-17 and surveyed portions of RR-22. Silt and sands were observed at most cross-sections of reach RR-17 from the most upstream cross-section until just downstream of Four Mile Road, where silt was no longer observed until the Horlick dam impoundment. The Horlick dam impoundment contained the largest sediment depths, with depths exceeding four feet at some cross-sections. Coarser substrates such as cobbles and boulders were scattered among cross-sections throughout much of both RR-17 and RR-22, and were common in the downstream reaches of RR-17 and upstream cross-sections surveyed in RR-22. Two cross-sections in the downstream part of RR-17 also had exposed bedrock on the streambed.

Silt, sand, and gravel were the most common substrates within the upstream sections of Hoods Creek within reach area RR-21 (see Figure I- 4 in Appendix I). Sediment depths in this stretch of Hoods Creek reached a maximum of almost two feet and averaged about 0.5 feet. Silt was common among cross-sections in the middle reach of Hoods Creek as well; however, sediment depths were not nearly as large as in the upstream reach. Coarser substrates such as gravel, cobble, and boulders were more common in the middle reach. The most downstream reach of Hoods Creek, especially downstream of a private dam located near Hoods Creek Road, was dominated by large boulders, cobble, gravel, and sand.

Streambank Stability and Erosion

The energy of flowing water in a stream is dissipated along the stream length by turbulence, streambank and bed erosion, and sediment resuspension. In general, increased urbanization may be expected to result in increased stream flow rates and volumes, with potential increases in streambank erosion and bottom scour. Streambank erosion may destroy aquatic habitat, spawning, and feeding areas; contribute to downstream water quality degradation by releasing sediments to the water; and provide material for subsequent sedimentation downstream, which then covers valuable benthic habitats, impedes navigation, and fills wetlands. Research has indicated that highest-quality streams have less than 20 percent of their total streambank lengths severely eroded. Streams with less than 20 percent severe streambank erosion have been found to maintain high-quality fisheries.[186] These effects may potentially be mitigated by utilization of proper stormwater management and streambank bio-engineering practices.

Between July 2005 and August 2006, Mussetter Engineering, Inc. conducted a streambank assessment of the mainstem of the Root River and its primary tributaries within Milwaukee County. Locations of streambank erosion sites that were observed during this field reconnaissance are shown on Map 52 and summarized in Table 48. A total of 300 streambank erosion sites were observed during this field reconnaissance, totaling 4.8 miles of streambank erosion. The longest bank erosion site observed was more than 500 feet in length; the average length of erosion was about 85 feet. The majority of the lateral streambank erosion, as well as vertical bed erosion, was observed in the headwaters of the Root River within reach RR-1, where the relative magnitude of the in-bank flows are the highest and the channel was modified either directly by channelization or by bed lowering.[187] Within stream reaches RR-1 and RR-4, 22.5 percent and 18.5 percent of the banks were eroding, respectively. Very little bank erosion was observed on the headwaters of the Root River in reach RR-7, where only 3.4 percent of the total bank length was eroding. This is probably due to the combined effects of highly erosion-resistant bed and bank materials (mainly consolidated and clay-rich ground moraines), wide floodplains, and generally low stream energy. More moderate erosion was observed in the more sinuous reaches of the mainstem of the Root River, reaches RR-10 and RR-13, where 7.0 percent and 8.7 percent of the respective banks were experiencing erosion. Among the tributary streams that were surveyed for this study, the East Branch Root River (RR-9) exhibited the highest percentage of erosion with 10.0 percent of its banks eroding, while the surveyed portions of Hale Creek, Whitnall Park Creek, and 104th Street Ditch all had less than 2.0 percent of their respective banks eroding (see Table 48).

In the summer of 2013, SEWRPC staff conducted a survey of streambank erosion along the mainstem of the Root River within stream reach areas RR-17 and the portions of RR-22 upstream of STH 31, as well as Hoods Creek from the confluence with the Root River upstream to STH 20 within stream reach RR-21. Erosion sites observed by SEWRPC staff during this survey are mapped on Maps I-11 through I-13 and on Maps I-24 through I-26 in Appendix I. While there were several severe erosion sites within the mainstem reaches surveyed within RR-17 and RR-22, with a maximum erosion length of almost 900 feet, as a whole, these reaches retained relatively stable

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[186]*T.D. Simonson and others,* Guidelines for Evaluating Fish Habitat in Wisconsin Streams, *U.S. Department of Agriculture," General Technical Report NC-164, 1994.*

[187]*Mussetter Engineering, Inc.,* op. cit.

Map 52

STREAMBANK EROSION SITES INVENTORIED WITHIN THE ROOT RIVER WATERSHED: 2007-2013

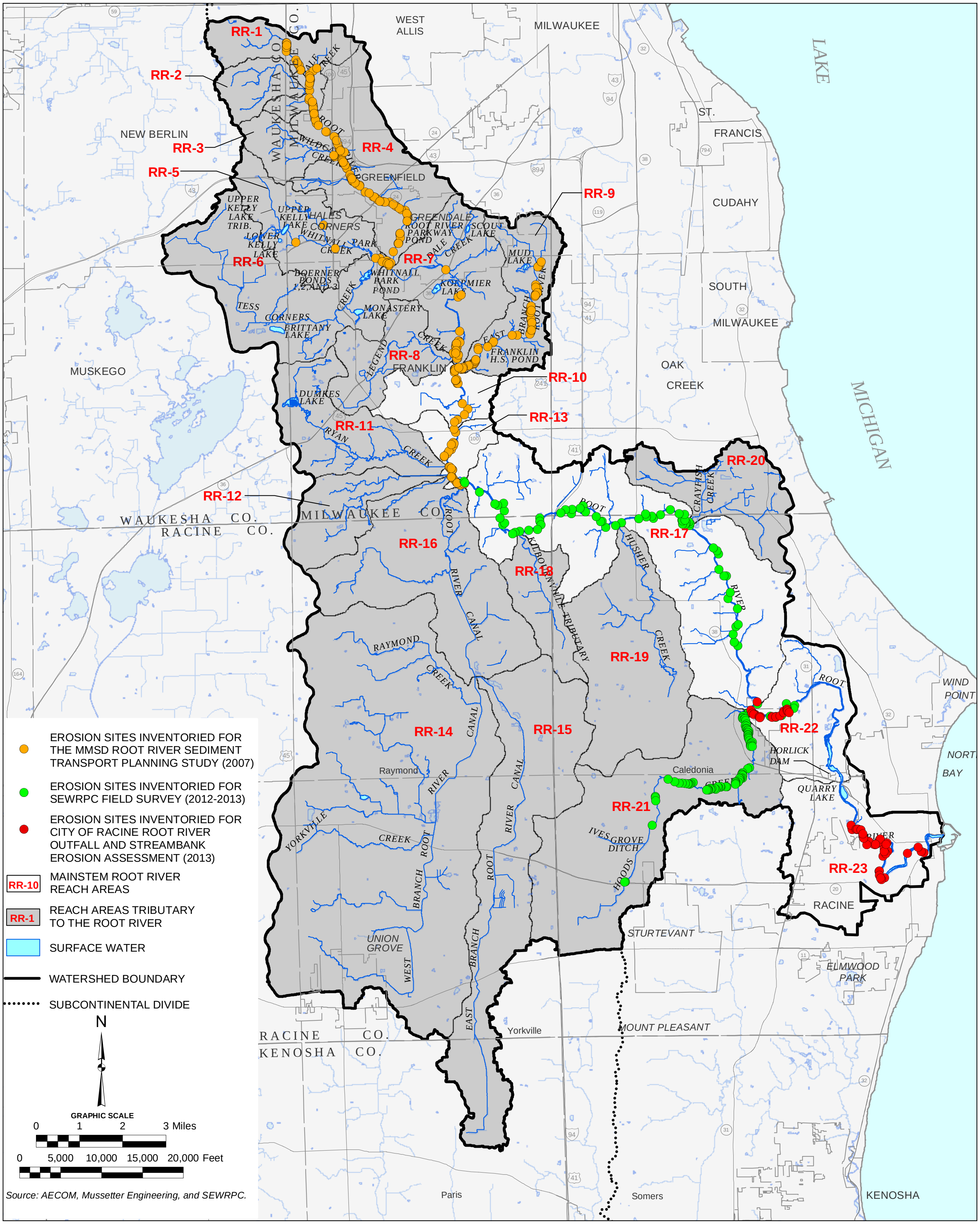

Figure 92

EXAMPLES OF EROSION SITES ALONG THE MAINSTEM OF THE ROOT RIVER WITHIN REACH AREA RR-17

Source: SEWRPC.

banks. The Root River mainstem within stream reach area RR-17 contained 63 bank erosion sites, totaling 2.4 miles, or nearly 9 percent of the streambanks. The average length of bank erosion observed within the reach was 191 feet and the average bank erosion height was 5.3 feet. Examples of some typical observed erosion sites within stream reach RR-17 are shown in Figure 92. Only nine erosion sites were observed on the surveyed portions of the Root River within stream reach area RR-22, totaling 3.2 percent of the banks surveyed. The longest site measured 180 feet, with the average length being about 80 feet and the average height being 4.8 feet.

Within the surveyed reaches of Hoods Creek in stream reach area RR-21, 88 erosion sites were recorded, ranging from minor cutting to massive bank failure (see Figure 93). Almost 1.5 miles of streambank was eroding within the reaches surveyed, or just over 9 percent of the total banks. The longest eroded bank was measured at over 300 feet and, on average, erosion sites were about 92 feet long and about five feet high. Several severe erosion sites along Hoods Creek were almost 20 feet high.

Figure 93

EXAMPLES OF EROSION SITES ALONG HOODS CREEK WITHIN REACH AREA RR-21

Source: SEWRPC.

In the summer of 2013, AECOM conducted a study to evaluate the conditions of streambanks and storm sewer outfalls along the Root River within the limits of the City of Racine. This study was slightly different from the surveys described above in that both active erosion and erosion potential were assessed. The goal of the report was to develop an update to the prior assessment conducted by AECOM in 2004, which identified, characterized, and mapped current erosion problems associated with stormwater outfalls and hydromodifications such as riprap, concrete, and retaining walls, along with erosion problems from other causes. Potential mitigation measures for critical areas as well as associated permitting requirements, estimated remediation costs, and potential grant funding sources were also included within the report. Sites were identified as having either high, moderate to high, moderate, or low erosion potential.[188] In all, 62 individual sites (some individual sites were grouped into single erosion areas), totaling about 1.2 miles of streambank, were identified as having either high, or moderate to high, erosion potential. Locations of these sites are shown on Map 52.

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[188]*AECOM*, op. cit.

Large Woody Debris

Branches, tree limbs, root wads, and entire trees that fall into or collect along streams are commonly referred to as large woody debris (LWD). LWD plays a vital role in the hydraulic, geomorphic, and biological function of the streams and floodplains within the Root River watershed.[189] Instream LWD is an important component of stream ecosystems that helps control the shape of the channel and provides essential food and habitat for aquatic organisms. In addition, LWD can affect channel morphology and form pools, retain organic matter, gravel, and sediment, influence invertebrate abundance, and provide cover and velocity refuge for fish.[190] The interaction between LWD, water, and sediment has a significant effect on channel form and process, increasing geomorphic complexity and the quality of aquatic habitat.[191] Contrary to popular belief, LWD can often help prevent erosion by slowing water down as well as armoring banks and preventing down cutting. In most cases, removal of LWD can be detrimental to fish and other aquatic organism habitats downstream. By removing LWD, sedimentation can occur in pools and on top of gravels that are located downstream. Gravels that are covered by sediment become unsuitable as sites for fish spawning.

In some cases, woody debris can form massive jams that span the entire width of the stream and extend completely to the bed of the channel. These debris jams can persist for decades. In these extreme instances, woody debris jams can act as fish passage barriers. Some bridges on the mainstem and roadway culverts on the tributary streams have the potential to be blocked by LWD accumulations, which act to impede flow and can also act as barriers for fish trying to pass theses bridges and culverts to get to upstream resting, feeding, and spawning areas. Culverts in particular are vulnerable to this. Additionally, these accumulations of LWD jams have the potential to promote bank erosion, bed scour, and localized roadway flooding. While most of the bridges on the mainstem of the Root River appear to be capable of passing wood transported by the River, many of the culverts on the tributary streams may be susceptible to blockage.

The occurrence of pests and diseases affecting tree populations is an emerging issue within the Southeastern Wisconsin Region. Of particular concern is the rapid emergence and spread of the emerald ash borer. The presence of emerald ash borer has been confirmed in all counties that make up the Root River watershed. Ash trees are plentiful within the riparian lands along the mainstem of Root River as well as its tributaries. As these trees continue to die, it can be expected that the amount of LWD that enters the Root River will increase. SEWRPC staff encountered many LWD jams during their survey, particularly along the stretch of the Root River in RR-17 that traverses the Milwaukee-Racine county line (see Figure 94). Several of these jams were close to eight feet in height and caused substantial backwater effect. Considerable ash tree die-off has been reported within the watershed, particularly within riparian lands along the mainstem of the Root River that are owned by Milwaukee County.[192] Considering this emerging issue, LWD jams can be expected to increase and become more troublesome in the near future.

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[189]*Mussetter Engineering, Inc.,* op. cit.

[190]*B. Mossop and M.J. Bradford,"Importance of Large Woody Debris for Juvenile Chinook Salmon Habitat in Boreal Forest Streams in the Upper Yukon River Basin, Canada,* Canadian Journal of Forestry Resources, *Vol. 35, 2004, pp. 1955-1966.*

[191]*C.J. Brummer, T.B. Abbe, J.R. Sampson, and D.R. Montgomery, "Influence of Vertical Channel Change Associated with Wood Accumulations on Delineating Channel Migration Zones," Geomorphology, Volume 80, pp. 295-309, 2006.* Cited in *Mussetter Engineering, Inc., 2007,* op. cit.

[192]*Personal communication with Brian Russart, Trails and Natural Areas Coordinator, Milwaukee County Department of Parks Recreation and Culture, December 4, 2013.*

Figure 94

EXAMPLES OF LARGE WOODY DEBRIS JAMS ALONG THE MAINSTEM OF THE ROOT RIVER WITHIN REACH AREA RR-17

Source: SEWRPC.

A total of 56 LWD jams were reported in the studies along the mainstem of the Root River and an additional 241 LWD sites were reported in the surveyed tributaries within the watershed (see Map 53). Stream reach RR-17 as well as tributaries in reach areas RR-7, RR-9, and RR-21 seem to be particularly susceptible to LWD jams, containing 34, 46, 89, and 58 LWD jams, respectively (see Table 48).

Habitat Quality

The apparent loss of many species of the fishery community within the Root River watershed, as shown in Table 40, can be attributed to habitat loss and degradation as a consequence of human activities primarily related to the historical and current agricultural and urban development that has occurred within the watershed. Agricultural and/or urban development can cause numerous changes to streams that have the potential to alter aquatic biodiversity. The following changes have been observed to varying degrees in the Root River watershed:[193]

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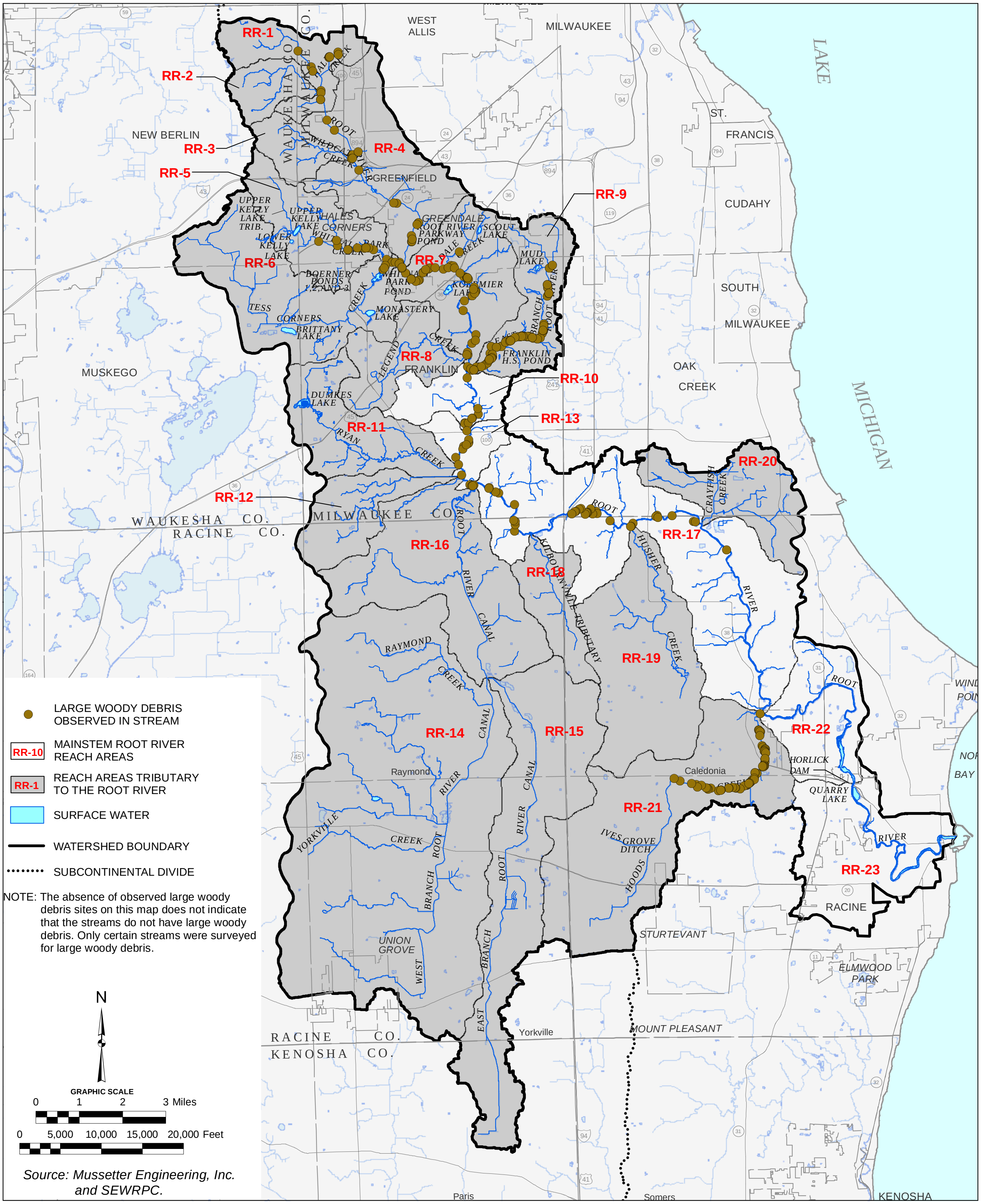
[193]*Center for Watershed Protection, "Impacts of Impervious Cover on Aquatic Systems,"* Watershed Protection Research Monograph No. 1, *March 2003.*

Map 53

LARGE WOODY DEBRIS SITES WITHIN THE ROOT RIVER WATERSHED: 2007-2013



Source: Mussetter Engineering, Inc. and SEWRPC.

- Increased flow volumes and channel-forming storms—These alter habitat complexity, change availability of food organisms related to timing of emergence and recovery after disturbance, reduce prey availability, increase scour related mortality, deplete large woody debris for cover in the channel, and accelerate streambank erosion.

- Decreased base flows—This leads to increased crowding and competition for food and space, increased vulnerability to predation, a decrease in habitat quality, and increased sediment deposition.

- Increased sediment load from cultivated agricultural lands and urban lands during and after construction of urban structures, resulting in sediment transport and deposition in streams—This leads to reduced survival of eggs, loss of habitat due to deposition, siltation of pool areas, and reduced macroinvertebrate reproduction.

- Loss of pool and riffles—This leads to a loss of deep water cover and feeding areas causing a shift in balance of species due to habitat changes.

- Changed substrate composition—This leads to reduced survival of eggs, loss of inter-gravel cover refuges for early life stages for fishes, and reduced macroinvertebrate production.

- Loss of large woody debris—This leads to loss of cover from large predators and high flows, reduced sediment and organic matter storage, reduced pool formation, and reduced organic substrate for macroinvertebrates.

- Increased temperatures due to loss of riparian buffers and from increased runoff from pavement versus natural landscapes—This leads to changes in migration patterns, increased metabolic activity, increased disease and parasite susceptibility, and increased mortality of sensitive fishes and macroinvertebrates.

- Creation of fish blockages by road crossings, culverts, drop structures, and dams—This leads to loss of spawning habitat, inability to reach feeding areas and/or overwintering sites, loss of summer rearing habitat, increased vulnerability to predation.

- Loss of vegetative rooting systems—This leads to decreased channel stability, loss of undercut banks, and reduced streambank integrity.

- Channel straightening or hardening—This leads to increased stream scour and loss of habitat quality and complexity (i.e., width, depth, velocity, and substrate diversity) through disruption of sediment transport ability.

- Reduced water quality—This leads to reduced survival of eggs, reduced plant productivity, and increased physiological stress on aquatic organisms.

- Increased algae blooms due to increased nutrient loading—Chronic algae blooms lead to increased eutrophication of standing waters and to oxygen depletion, causing fish kills. These effects can be worsened through encroachment into the riparian buffer adjacent to the waterbody and loss of riparian canopy, which increases light penetration.

As described in the previous Runoff from Urban Development and Impervious Surfaces sections, the amount of imperviousness in a watershed that is directly connected to the stormwater drainage system can be used as a surrogate for the combined impacts of urbanization in the absence of mitigation. As of 2010, the Root River watershed had about 35 percent urban land overall (approximately 9 percent directly connected imperviousness). That level of imperviousness is enough to significantly change the properties of streams, potentially resulting in increased temperature and turbidity, reduced dissolved oxygen concentration, and increased concentrations of pollutants, all of which would be expected to lead to negative biological impacts. Studies have indicated that the amount of agricultural land in a watershed can also be correlated with negative instream biological conditions, as noted in the previous Runoff from Agricultural Development section. The Root River watershed was comprised of about 62 percent agricultural land use by 1970; it currently has about 52 percent agricultural land overall. Agricultural land use dominates the lower portion of the Root River watershed (with the exception of localized urban development near the lower portion of stream reach area RR-23), whereas the upper portions of the watershed are dominated by urban development.

As shown on Map 99 in SEWRPC Technical Report 39, habitat data have been collected in the Root River watershed as part of the WDNR baseline monitoring program and by the WDNR Fish and Habitat Research Section. The baseline monitoring program data were analyzed using the Qualitative Habitat Evaluation Index (QHEI),[194] which integrates the physical parameters of the stream and adjacent riparian features to assess potential habitat quality. This index is designed to provide a measure of habitat that generally corresponds to those physical factors that affect fish communities and which are important to other aquatic life, such as macroinvertebrates. This index has been shown to correlate well with fishery IBI scores. The WDNR Research Section evaluated the quality of fish habitat at sites based upon the guidelines developed from several publications.[195] Based upon the limited data available, the results reported in SEWRPC Technical Report 39 suggest that aquatic habitat ranges from poor to very good throughout stream reaches along the headwaters and mainstem of the Root River (see Table 39). Among the evaluated tributary streams in the watershed reported in SEWRPC Technical Report 39, habitat ratings range from poor to very good. It is important to note that many of the tributary streams have been channelized within the Root River watershed. Such channelization impacts habitat quality by reducing instream and riparian vegetation cover, increasing sedimentation, decreasing diversity of flow, decreasing water depths, and decreasing substrate diversity, among others.

As part of cross-section surveys conducted in the summer of 2013 along the mainstem of the Root River in stream reaches RR-17 and RR-22 and along Hoods Creek in stream reach RR-21, SEWRPC staff collected data related to the amount, quality, and diversity of available instream fisheries habitat. Summary statistics for the physical habitat characteristics within the Root River stream reach RR-17 and RR-22 are set forth in Table I-1 in Appendix I. Summary statistics for habitat characteristics within Hoods Creek in stream reach RR-21 are set forth in Table I-2 in Appendix I. Habitat characteristics for specific locations along Hoods Creek are set forth in Tables I-4 through I-6 in Appendix I. The overall distribution of instream habitat types as characterized by pools (deep water and slower water velocities) and riffles (shallow water, large substrates, and higher water velocities), along with locations of surveyed cross-sections are shown on Maps I-5 through I-7 in Appendix I for reaches RR-22 and RR-17, and on Maps I-18 through I-20 in Appendix I for Hoods Creek within reach RR-21. QHEI ratings ranged from poor to fair among surveyed cross-sections of reach RR-22; fair to good among reach RR-17A (the downstream portion of the Root River in RR-17, see Map I-1 in Appendix I); and poor to fair among reach RR-17B (the upstream portion of the Root River in RR-17). Among Hoods Creek cross-sections surveyed, QHEI ratings ranged from fair to good within the Hoods-1 reach (the most downstream reach including its confluence with the Root River); fair to good within the middle reach (Hoods-2); and very poor to fair within surveyed cross-sections of Hoods-3, the most upstream portions of the creek.

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[194]*Edward T. Rankin, The Quality Habitat Evaluation Index [QHEI]: Rationale, Methods, and Application, State of Ohio Environmental Protection Agency, November 1989.*

[195]*Timothy Simonson, John Lyons, and Paul Kanehl, "Guidelines for Evaluating Fish Habitat in Wisconsin Streams,"* General Technical Report NC-164, *1995; and Lihzu Wang, "Development and Evaluation of a Habitat Rating System for Low-Gradient Wisconsin Streams,"* North American Journal of Fisheries Management, *Vol. 18, 1998.*

Pool, riffle, and run habitat units are the fundamental instream features upon which the QHEI is based to determine overall habitat quality within these surveyed reaches. The quality of habitat scores within the QHEI is predicated upon the presence and distribution of these discrete habitat types and their associated cover types, such as woody debris, undercut banks, boulders and other substrates, submergent and emergent macrophyte vegetation, and overhanging riparian vegetation. As shown in Tables I-1 and I-2 in Appendix I, the diversity of pool and riffle structure (i.e., number of pools compared to the number of riffles) is poor in RR-17B, where less than one riffle per mile was observed, as well as in the Hoods-3 reach of Hoods Creek. Both of these reaches were mostly comprised of run habitats. In contrast, the pool and riffle distribution is more balanced in reaches RR-22 and RR-17B and Hoods Creek reaches 1 and 2. The general lack of riffle habitats within the upper reach of Hoods Creek is due to this area being dominated by run habitats as well as higher composition of silt and sand substrates, most likely due to channelization, and the resulting incised stream, to accommodate the agricultural practices of the area. Since riffle habitats are important spawning and feeding areas for many native fish species, the numbers and distribution of riffle habitats can affect fish species distribution. Therefore, maintaining access to the existing riffle habitats throughout these reaches, as well as throughout the watershed, will be key to protecting and enhancing the native fishery. For example, although stream reach RR-17B has limited riffle habitats, it is connected to RR-17A that contains many more riffle habitats, as well as to the Hoods-1 reach which offers even more riffle habitats.

Pool habitats are the opposite of riffle habitats, but they are also important components of the fish habitat in streams, especially for larger fish, because their greater depth offers protection from predators, provides feeding areas, and provides refuge from high temperatures in the summer and cold temperatures in the winter. As shown in Figure I-2 in Appendix I, pool habitats are the deepest within both reaches of RR-17, where more than 50 percent of the pools are greater than four feet. The Horlick dam impoundment located within RR-22 is not included in the data presented in Figure I-2 in Appendix I. The impoundment can also offer some of the same attributes that pools have as described above. However, the impoundment does not offer the same refuge for fish seeking cooler temperatures in the summer, as the stagnant waters of the impoundment tend to experience thermal warming in summer months.

In addition to water width and depth, which are major determinants of pool, riffle, and run habitat quality scores as discussed above, the QHEI scores can be further enhanced by the presence of one or more of the following features: 1) fallen trees or branches (woody debris), 2) undercut banks, 3) boulders and other substrates, 4) submergent and emergent macrophyte vegetation, and 5) overhanging riparian vegetation, as shown in Figure I-8 in Appendix I. In general, the surveyed cross-sections of the Root River were comprised mostly of moderate to low abundance of cover types, while Hoods Creek-1 and -2 had a low to high abundance of cover types (see Tables I-1 and I-2 in Appendix I). While the specific locations of cross-sections surveyed along the Root River did not exhibit particularly high amounts of cover, it should be noted that many large woody debris accumulations are present and do offer good cover for fish upstream and downstream of these cross-sections, as is subsequently discussed.

Boulders are considered to be one of the highest quality substrates in terms of providing good cover for fishes. However, all substrate types and their composition are important and contribute to overall habitat quality. Tables I-1 and I-2 and Figures I-1 and I-4 in Appendix I show that there is a high diversity of substrates among the surveyed reaches of the Root River and Hoods Creek, from smaller organic silt to sand and gravel to larger cobbles and boulders. For more detail on substrate diversity refer to the Streambed Materials section above.

The type and amounts of riparian vegetation are significant drivers of the types and amounts of instream cover which include woody debris, overhanging vegetation, shading, algae, and macrophytes. Instream large and small woody debris is an important component of stream ecosystems that provides essential food and habitat for aquatic organisms. Woody debris can affect channel morphology and form pools; retain organic matter, gravel, and sediment; influence invertebrate abundance; and provide cover and velocity refuge for fish. Woody debris is moderately abundant within the surveyed reaches of the Root River, and moderately to highly abundant within the two most downstream reaches of Hoods Creek. Woody debris is of low abundance or nonexistent in heavily agricultural Hoods Creek-3 stream reach, where riparian vegetation is limited to reed canary grass.

Riparian zone and floodplain quality is another important dimension included within the QHEI scoring criteria to assess instream habitat quality. More specifically, greater extent or width of riparian (stream side) vegetation is associated with a greater quality and higher score for this feature. Riparian buffers extending greater than 50 meters (approximately 164 feet) from each streambank are necessary to obtain the highest scores for this dimension of the index. Riparian buffers are discussed more thoroughly in the previous Riparian Corridor Conditions section, but, in general, riparian buffer width and floodplain quality range from poor to excellent within the Root River watershed. The riparian buffer areas within the watershed have been significantly impacted within agricultural portions of the watershed, which is the primary reason that the cross-sections within the Hoods Creek-3 reach areas contain the lowest QHEI scores in the watershed. In contrast, areas with the most extensive and high quality floodplain within reach area RR-17 allow high discharge events to dissipate across the landscape, providing protection from flooding while at the same time reducing water velocities (which protects the streambed and streambanks from erosion).

Tires and Trash

Although the accumulation of trash and debris is not part of the QHEI scores as summarized above, these materials degrade the aesthetics of the River system and can cause physical and/or chemical (i.e., toxic) damage to aquatic and terrestrial wildlife. They also give the general public a negative impression of the stream as a resource with the potential for rehabilitation. Therefore, SEWRPC staff recorded and mapped the significant trash and debris encountered during the comprehensive survey of the Root River within stream reach areas RR-17 and RR-22, and Hoods Creek within stream reach area RR-21, as shown on Maps I-8 through I-10 and on Maps I-21 through I-23 in Appendix I (also see Table 48). A total of 62 large trash items were observed within surveyed reaches of the mainstem Root River, including 50 discarded automobile tires. Within Hood Creek, 34 large trash items were observed, including 12 automobile tires. Other large trash items observed included a water heater tank, 55 gallon metal drums, construction barrels, television parts, various discarded metal piping, plastic buckets, and a washtub, among other items.

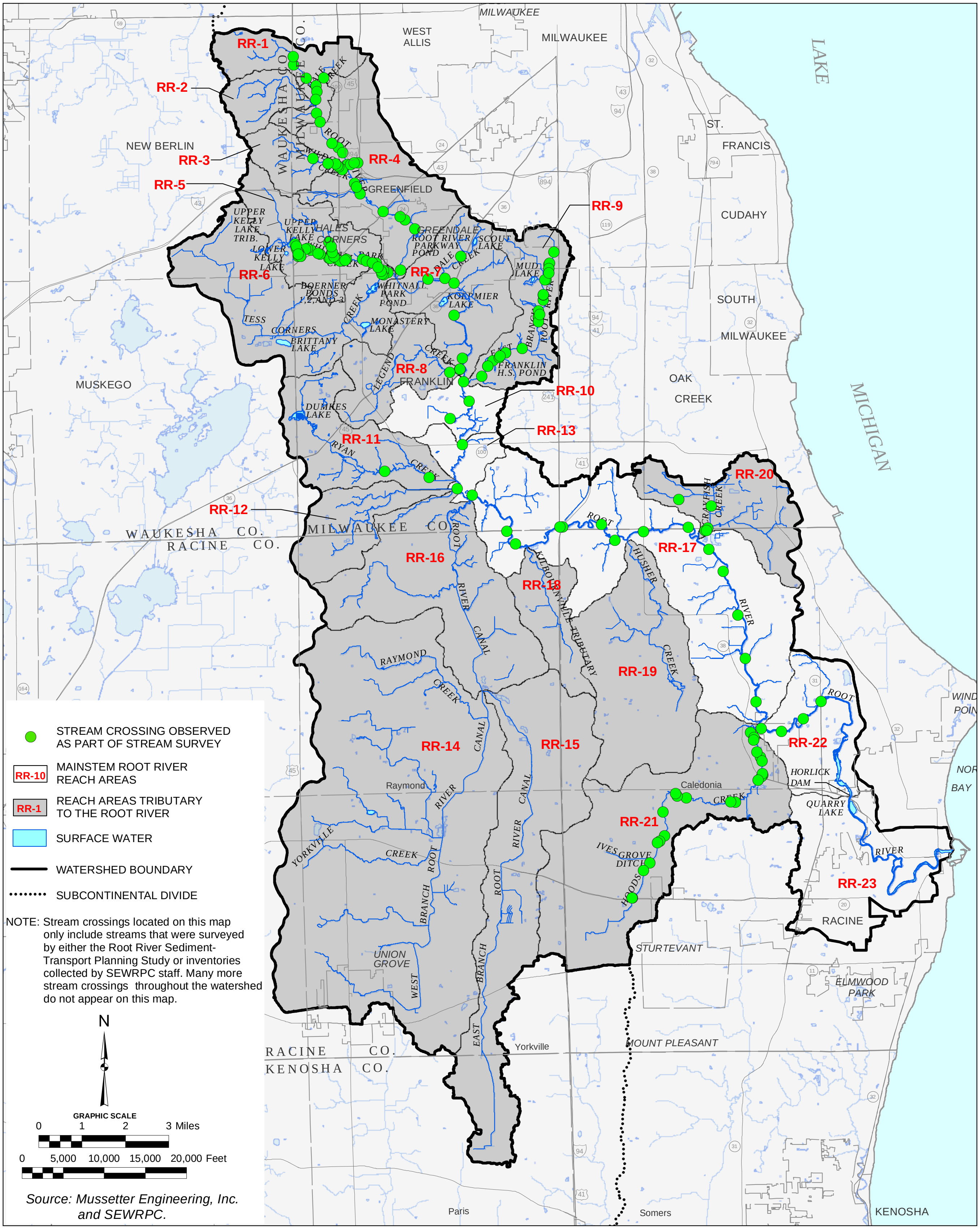
Stream Crossings and Dams

Bridges and culverts can affect stream widths, water and sediment depths, velocities, and substrates. These structures also have potential to pose physical and/or hydrologic barriers to fish and other aquatic organisms. The streams within the Root River watershed have over 500 crossings. Along surveyed reaches of streams within the Root River watershed, 163 bridges and culverts were identified (see Map 54). Little is known about whether any of these structures are potential impediments to passage of fish and aquatic organisms. In addition, eight dams or drop structures were recorded on surveyed streams.

SEWRPC staff conducted an inventory and assessment of 17 stream crossings along the Root River in stream reach areas RR-17 and RR-22 (see Map I-2 in Appendix I). All crossings observed in this inventory were bridges, and they posed no fish passage barriers. The Horlick dam is also located at the downstream limit of RR-22 and is a passage barrier for almost all species of fish likely to be found within the Root River. Along Hoods Creek, SEWRPC staff assessed 20 stream crossings and one dam. Of these crossings, eight were culverts and 12 were bridges. Appendix I includes for each structure a description and photograph (see Figure I-7 in Appendix I), location map (see Map I-15 in Appendix I), condition evaluation, and a fish passage obstruction assessment (see Table I-3 in Appendix I). Based upon this assessment, conducted in the summer of 2013, the majority of structures were identified to be passible by fish; however five of the stream crossing structures were considered to be partial barriers to fish passage. STH 38 is considered to be a fish passage obstruction due to the 217-foot length of the culvert. Culverts this long often present passage problems for some species of fish, as there are very few resting areas and water velocities tend to be increased within the structure. Four other crossings along Hoods Creek are considered to be partial fish passage obstructions during low flow (see Table I-3 in Appendix I). These structures have low limiting water depths even during base flow periods. When low flow conditions occur, water depths may not be sufficient for fish to migrate upstream or downstream. In addition, one dam with a four-foot head was observed on Hoods Creek about 1,800 feet upstream of Hoods Creek Road. This privately-owned dam is a barrier to most fish species that are present within Hoods Creek, and cuts off many potential spawning areas for fish within the mainstem of the Root River.

Map 54

STREAM CROSSINGS OBSERVED ALONG STREAMS SURVEYED WITHIN THE ROOT RIVER WATERSHED



The combined impact of culverts on fish communities in streams within the Root River watershed could potentially be significant.[196] Culverts tend to have a destabilizing influence on stream morphology that can create selective barriers to fish migration because swimming abilities vary substantially among species and size-class of fish, affecting their ability to traverse the altered hydrologic regime within the culverts.[197] Fish of all ages require freedom of movement to fulfill needs for feeding, growth, and spawning. Such needs generally cannot be found in only one particular area of a stream system. These movements may be upstream or downstream and may occur over an extended period of time, especially in regard to feeding. In addition, before winter freeze-up, fish tend to move downstream to deeper pools for overwintering. Fry and juvenile fish also require access upstream and downstream while seeking rearing habitat for feeding and protection from predators. The recognition that fish populations are often adversely affected by culverts has resulted in numerous designs and guidelines that have been developed to allow for better fish passage and to help ensure a healthy sustainable fisheries community.[198]

HORLICK DAM AND IMPOUNDMENT CHARACTERISTICS

Introduction

The Horlick dam is located on the Root River in the City of Racine at River Mile 5.3, which is just upstream of the STH 38 crossing of the River. The Root River drainage area upstream of the dam is approximately 198 square miles, encompassing portions of Waukesha, Milwaukee, Kenosha, and Racine Counties (see Map 55). The Wisconsin Department of Natural Resources (WDNR) classifies the Horlick dam as a Low Hazard Dam[199] with a hydraulic height of 12 feet. The structural height is listed as 19 feet, and the upstream impoundment surface area is approximately 60 acres.[200]

This evaluation documents the history of the dam and provides information on the current impoundment and River. Development of alternative and recommended plans to address the status of the dam and its social, physical, biological, and recreational effects on the watershed are set forth in Chapter V, “Targets and Alternatives,” and Chapter VI, “Recommended Watershed Restoration Plan,” of this report.

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[196]*Thomas M. Slawski and Timothy J. Ehlinger, “Fish Habitat Improvement in Box Culverts: Management in the Dark?”* North American Journal of Fisheries Management*, Volume 18, 1998, pages 676-685.*

[197]*Stream Enhancement Research Committee, “Stream Enhancement Guide,” Province of British of Columbia and the British Columbia Ministry of Environment, Vancouver, 1980.*

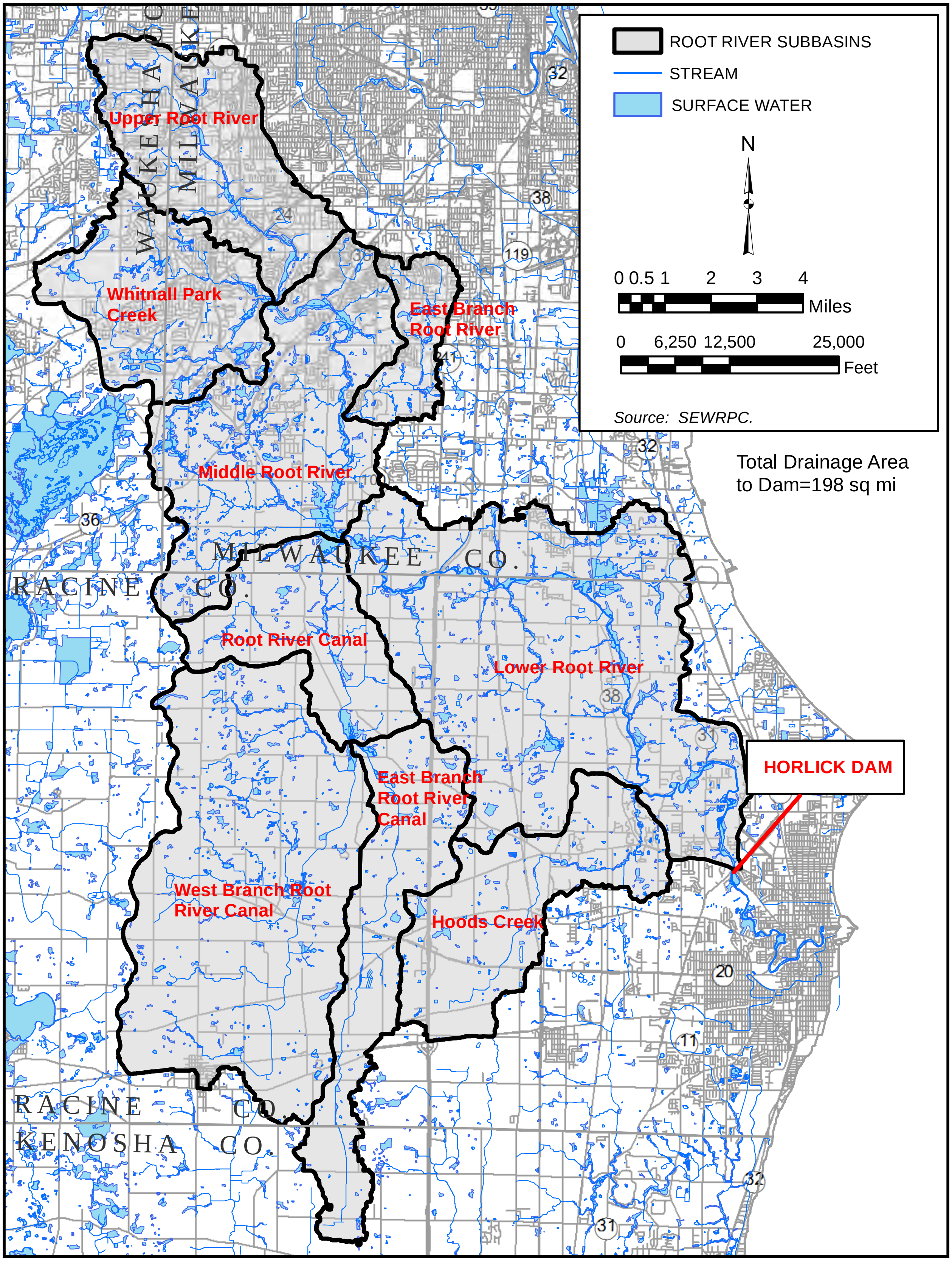
[198]*B.G. Dane,* A Review and Resolution of Fish Passage Problems at Culvert Sites in British Columbia*, Canada Fisheries and Marine Sciences Technical Report 810, 1978. Chris Katopodis, “Introduction to Fishway Design,” Freshwater Institute Central and Arctic Region Department of Fisheries and Oceans, January, 1992.*

[199]*April 22, 2014, dam failure analysis review letter from the Wisconsin Department of Natural Resources to Racine County.*

[200]*WDNR Surface Water Data Viewer – Horlick dam* (http://dnrmaps.wi.gov/imf/imf.jsp?site=SurfaceWaterViewer.floodplain).

Map 55

THE ROOT RIVER WATERSHED UPSTREAM FROM HORLICK DAM



Inventory Findings

History of the Dam

The Horlick dam was originally constructed in 1834, under the Mill Dam Act, and operated as a sawmill until 1870.[201,202] The dam was rebuilt in 1873 and again in 1885, and was operated as a grist mill until 1940.[203] After 1940, the dam was used to maintain the upstream impoundment for recreational purposes. A permit to abandon the dam was submitted by Charles and Richard Horlick on March 16, 1962. The 1962 application was denied by the Wisconsin Public Service Commission (PSC) in 1964 due to lack of proper legal notice and is included in Appendix J.[204,205] Subsequently, the Horlick dam was rebuilt in late 1975,[206] when it assumed its present configuration. Transfer of ownership of the dam from the Horlick family to Racine County was initiated in 1974 and finalized in 1977.[207]

Figures 95 through 97 present historical photographs and sketches of the dam taken during the period from 1915 to 1975. Note the deterioration of the dam structure during the period from 1950 to 1975. Figure 97 includes photographs taken during the 1975 reconstruction of the dam and provides an indication of how the new dam was placed in relation to the older, deteriorated dam. Figure 98 includes photographs of the dam taken by the SEWRPC staff during 2011.

Figures 99 through 101 were abstracted from the 1975 plan set prepared at the time of the reconstruction. These figures show plan views of the Horlick dam in 1946 and 1975. Figure 102 is a view of the dam looking upstream, and depicts the 1946 conditions and 1975 conditions prior to reconstruction. An idealized combined cross-section of the Horlick dam, based upon the 1975 plans is included in Figure 103. Based on the historic photographs and plans, it appears that the reconstructed 1975 dam was placed immediately downstream of the then-existing structure.

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[201]*WDNR Intra-Department Memorandum from Lewis A. Posekany to Elmer Herman regarding the Abandonment of Horlick's Dam, Root River, Racine County, April 15, 1962.*

[202]*Inspection Report by F. A. Potts of the Engineering Department, Railroad Commission of Wisconsin, June 11, 1915.*

[203]*Decision and Order by the Public Service Commission of Wisconsin on Petition 2-WP-500 filed by J. C. Jensen, February 17, 1948.*

[204]*Letter from William Sayles, Director of the Bureau of Water and Shoreland Management, Wisconsin Department of Natural Resources, to Mr. Gilbert Berthelsen, County Administrator, Racine County, April 15, 1970.*

[205]*Memorandum to file G-4806 by R. W. Roden regarding the Horlick Dam, Root River, Racine County, April 5, 1973.*

[206]*Findings of Fact, Permit and Order by the WDNR on Petition 3-WR-1874 filed by Charles and Richard Horlick, February 24, 1977.*

[207]Ibid.

Figure 95

HORLICK DAM, RACINE COUNTY: 1915

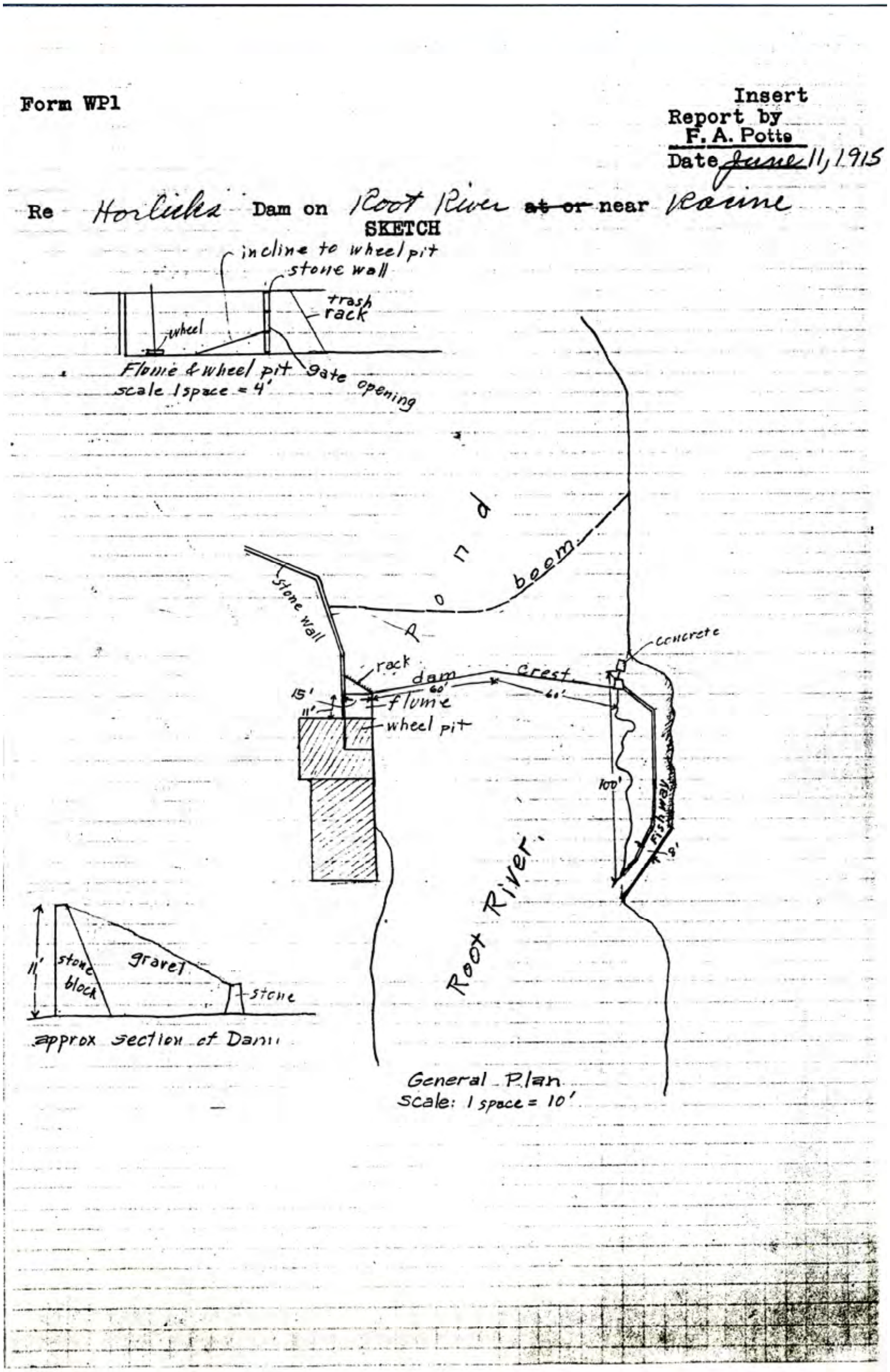
HORLICK DAM: JUNE 1915

HORLICK DAM FISHWAY: JUNE 1915

Source: Wisconsin Department of Natural Resources.

Figure 95 (continued)

HORLICK DAM FIELD NOTES: JUNE 11, 1915



Source: Wisconsin Department of Natural Resources.

Figure 96

HORLICK DAM: 1950-1975

1950

1960

Figure 96 (continued)

1975

1975

Source: Wisconsin Department of Natural Resources.

Figure 97

HORLICK DAM CONSTRUCTION: 1975

LOOKING NORTHWEST

LOOKING SOUTHWEST

Source: Wisconsin Department of Natural Resources.

Figure 98

HORLICK DAM: 2011

LOOKING WEST

LOOKING NORTHEAST TO FISHWAY

Figure 98 (continued)

LOOKING NORTHEAST

Source: SEWRPC.

Based on a 1977 SEWRPC survey of the Horlick dam, the main concrete spillway is 119.5 feet long at an elevation of 629.9 feet above National Geodetic Vertical Datum of 1929 (NGVD 29). The stop log section is 6.8 feet wide with a maximum stop log elevation of 630.8 feet above NGVD 29 at the time of the survey.[208] Aluminum, six-inch-high stop logs were installed after April 2011.[209] The stop log section is approximately 36 feet from the left end of the main spillway.[210] The main spillway has one horizontal bend, which is approximately 59 feet from the right end of the dam.

Inspections and Repairs

Numerous inspections of the Horlick dam have been completed by the Railroad Commission, the PSC, and WDNR over the years. A brief summary of the inspections and repairs required, obtained from WDNR files, is set forth in Appendix K.

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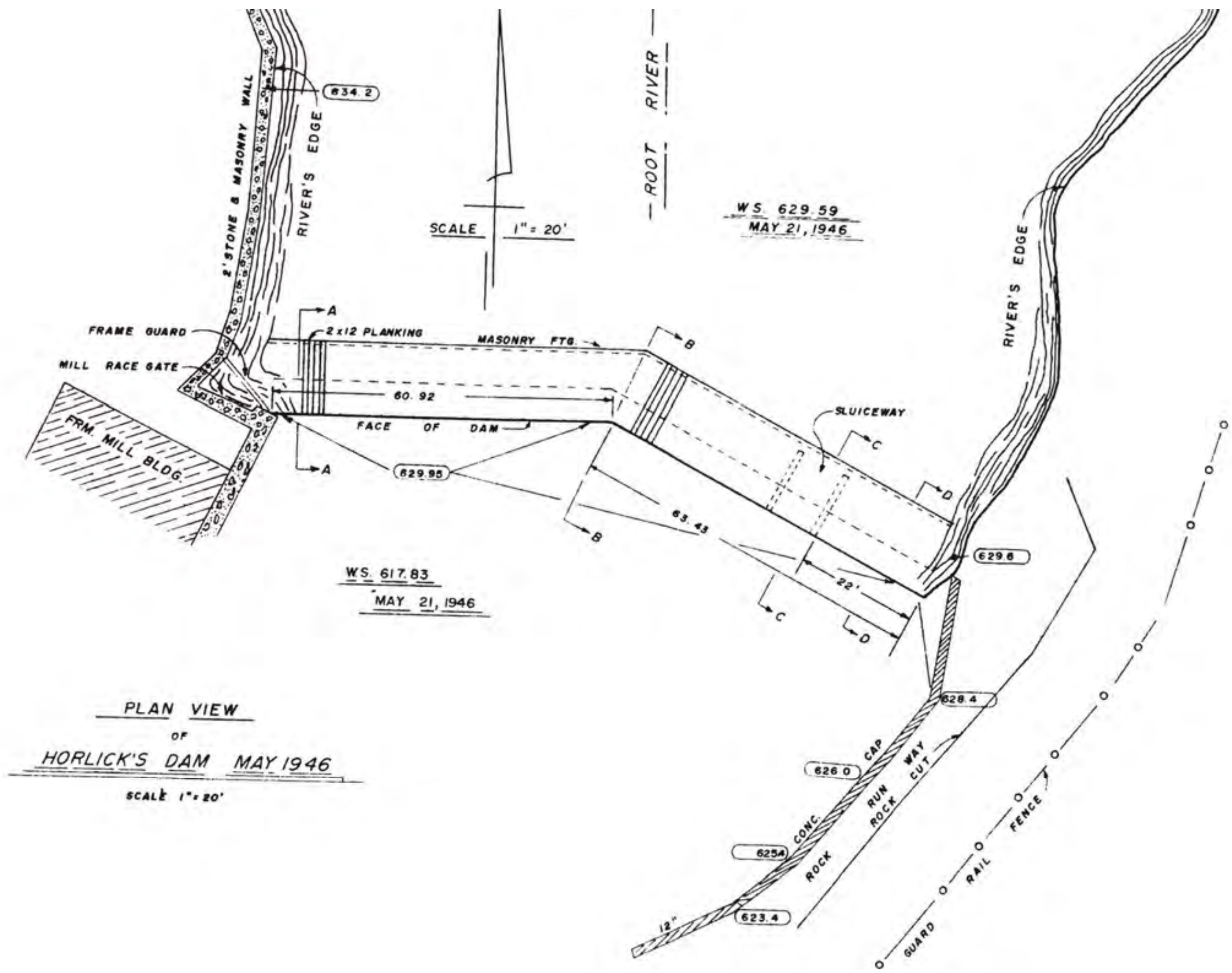
[208]*1977 SEWRPC survey of the dam for the regional water quality management plan (SEWRPC Planning Report No. 30).*

[209]*Racine County, Department of Public Works, Project Manual,* Horlicks Dam Stop Log Replacement, *September 24, 2010.*

[210]*References to right and left are based on looking downstream.*

Figure 99

PLAN VIEW OF HORLICK DAM: 1946



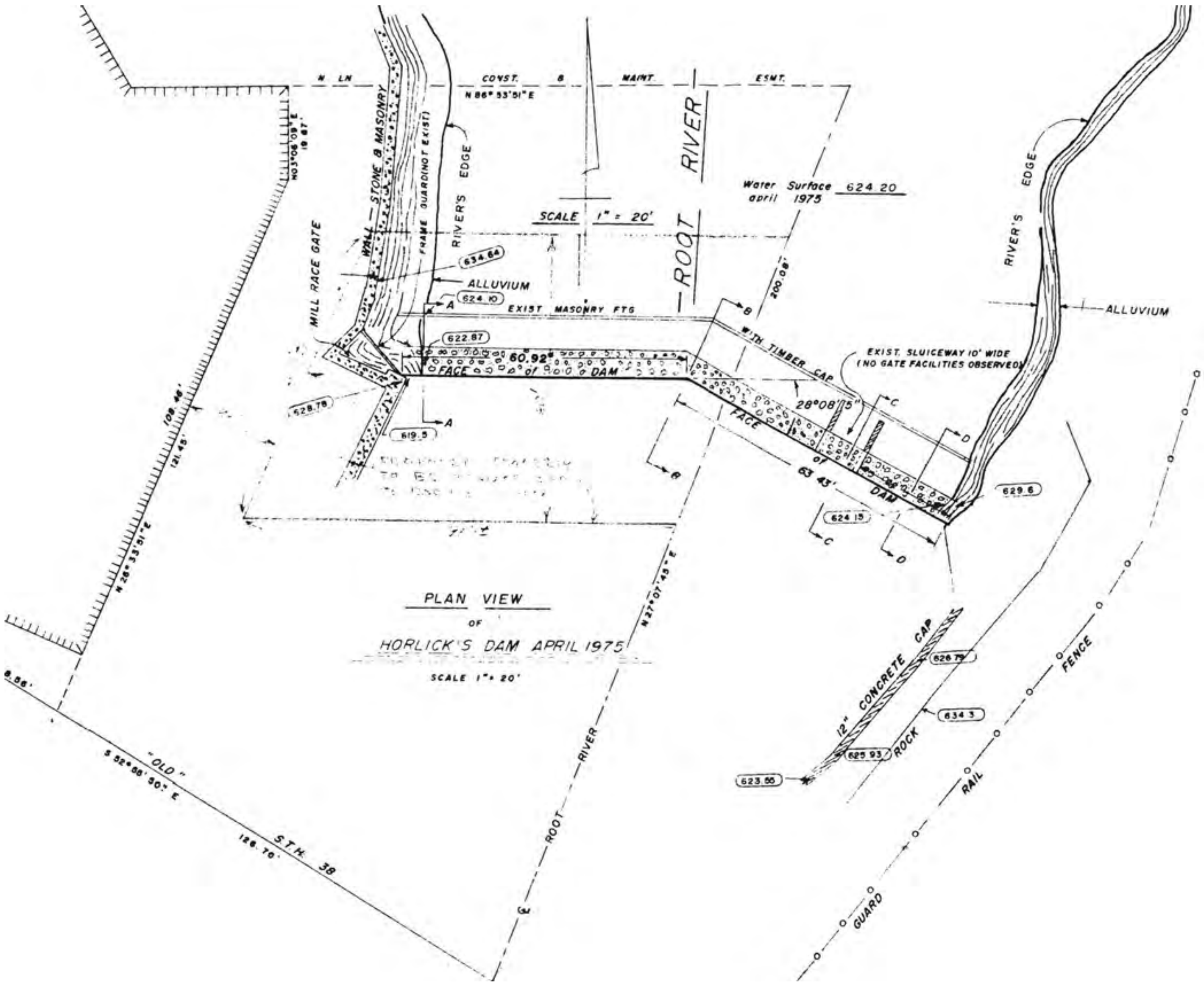
Source: Robers and Boyd, Inc., Consulting Engineers.

The first record of inspection of the Horlick dam was in 1915 and noted the dam construction as stone block masonry with a limestone block foundation in good condition. The left side rock and concrete fishway was also noted as functional in the 1915 inspection. There is a large gap in inspection reports after 1915, with the 1961 inspection report noting that the fishway was not in use. After considerable deterioration over time the dam was rebuilt in late 1975 to its present configuration. The WDNR completed an environmental assessment prior to reconstruction of the dam in 1975, and this assessment is included in Appendix L.

Since 1975 there was one minor seepage repair made to the dam and replacement of the original stop logs with aluminum ones. Inspection reports in 2008 and 2011 call for numerous efforts to be completed by Racine County for the Horlick dam to ensure its proper operation and integrity.

Figure 100

PLAN VIEW OF HORLICK DAM: APRIL 1975



Source: Robers and Boyd, Inc., Consulting Engineers.

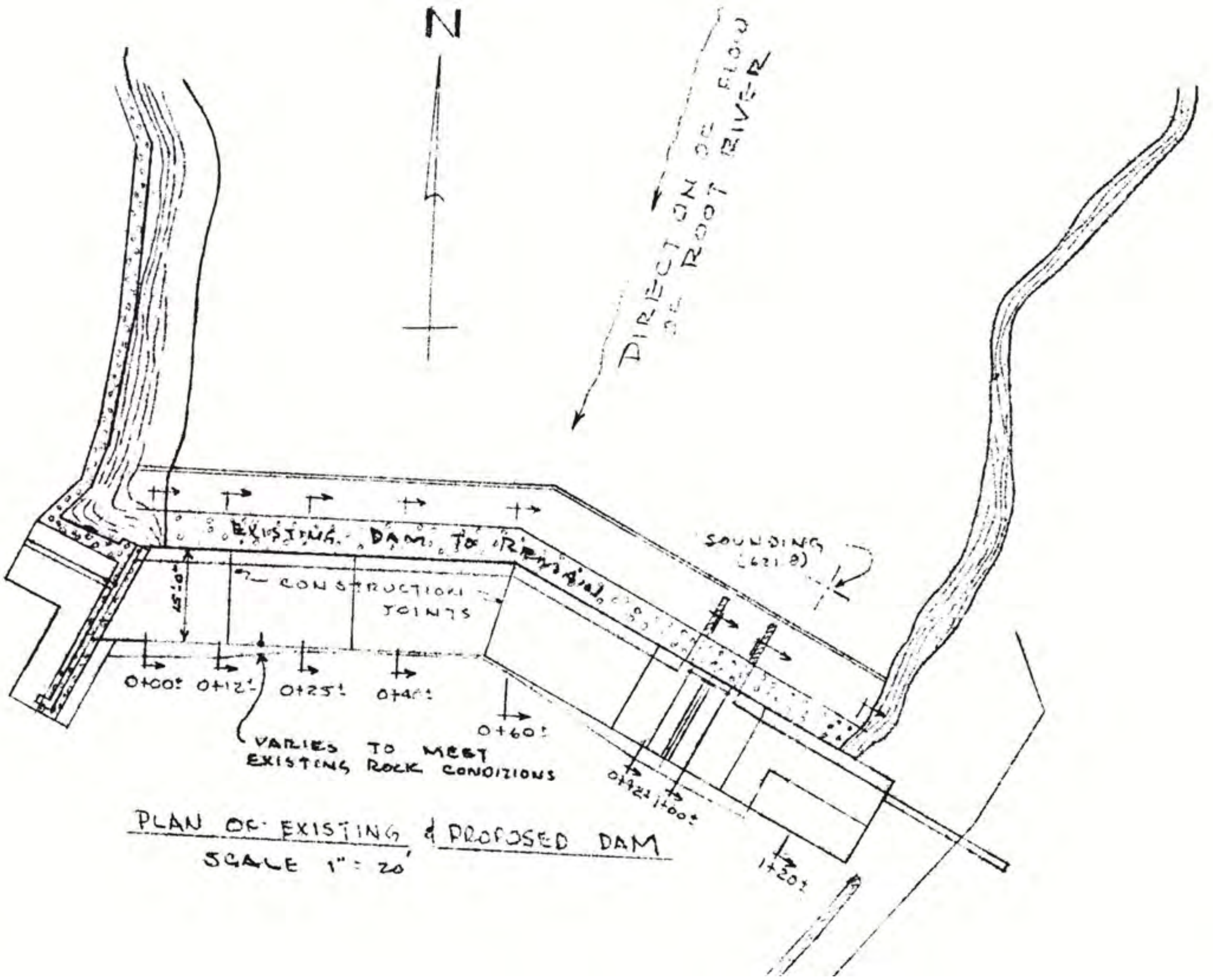
Significant Geologic Site

A survey of scientifically and historically important bedrock geological sites in southeastern Wisconsin was conducted by a team of experienced geologists, and the results are set forth in the SEWRPC regional natural areas and critical species habitat plan.[211] The final bedrock geological sites were selected based on their scientific importance, significance in industrial history, natural aesthetic quality, ecological qualities, educational value, and public access potential. The Horlickville Bluffs and Quarries were included in the survey as a geologic site of statewide or greater significance. The planning report referenced the Horlickville Bluffs and Quarries to be in

[211] *SEWRPC Planning Report No. 42*, A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997*.

Figure 101

PLAN VIEW OF HORLICK DAM: 1975 RECONSTRUCTION



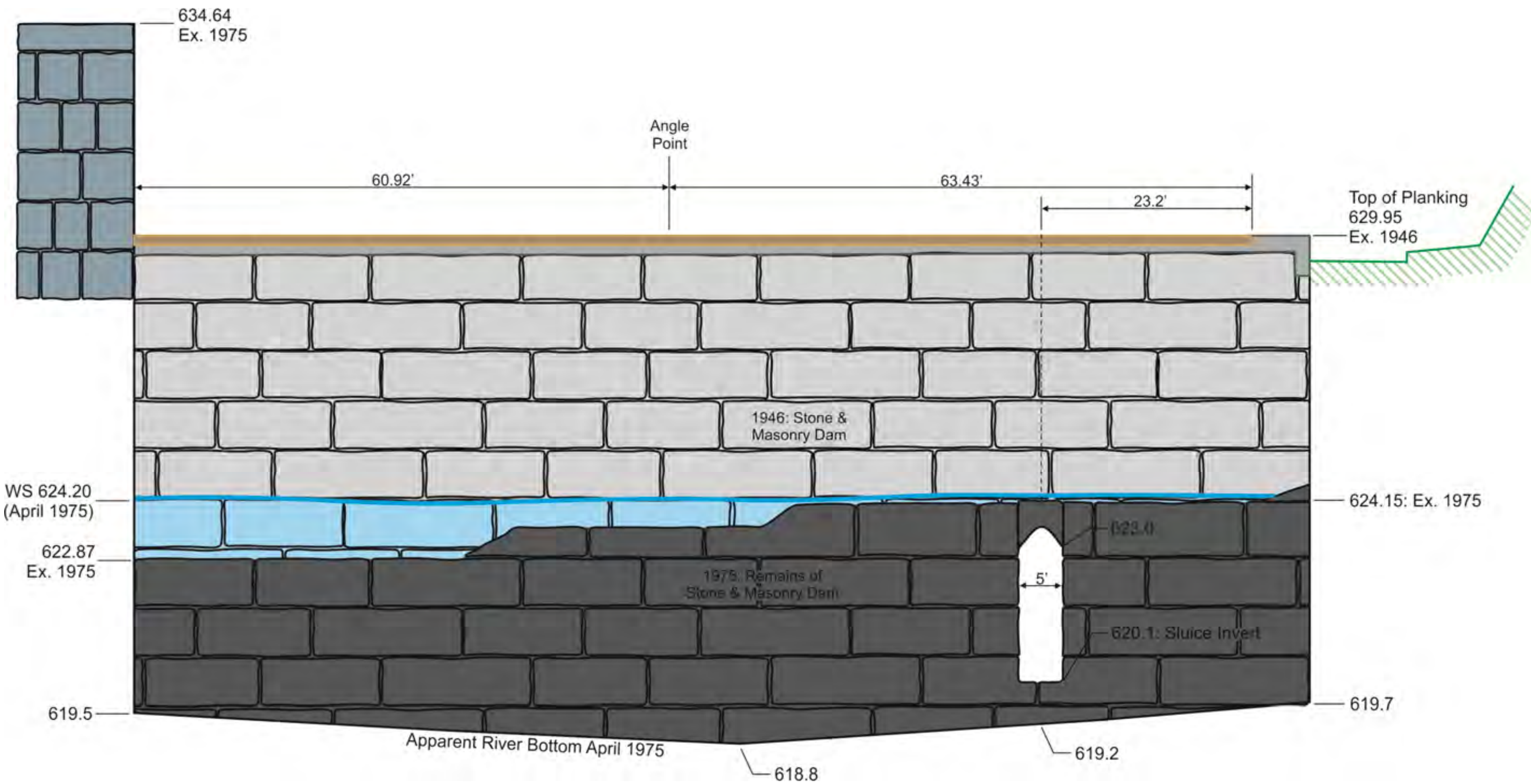
Source: Robers and Boyd, Inc., Consulting Engineers.

U.S. Public Land Survey Section 6, Township 3 North, Range 23 East, which includes the area of the Horlick dam and downstream quarry pond. The planning report describes the Horlickville Bluffs and Quarries as natural bluffs and old quarries along the Root River, with exposures of richly fossiliferous Racine Dolomite reef strata. The planning report indicates the site has produced the largest known diversity of fossil marine organisms from any Silurian reef in the world. This site has been considered for designation as a National Historic Landmark in the History of Science.

To date, the Horlickville Bluffs and Quarries have not been awarded National Historic Landmark status. The planning report designation of the Horlickville Bluffs and Quarries as a geologic site of statewide or greater significance is only advisory and does not provide any legal protections. Nevertheless, if any work is proposed that would disturb the bluff walls, the impact on the geologic resource would need to be addressed.

Figure 102

VIEW OF HORLICK DAM BASED ON 1946 AND 1975 PLANS (LOOKING UPSTREAM)

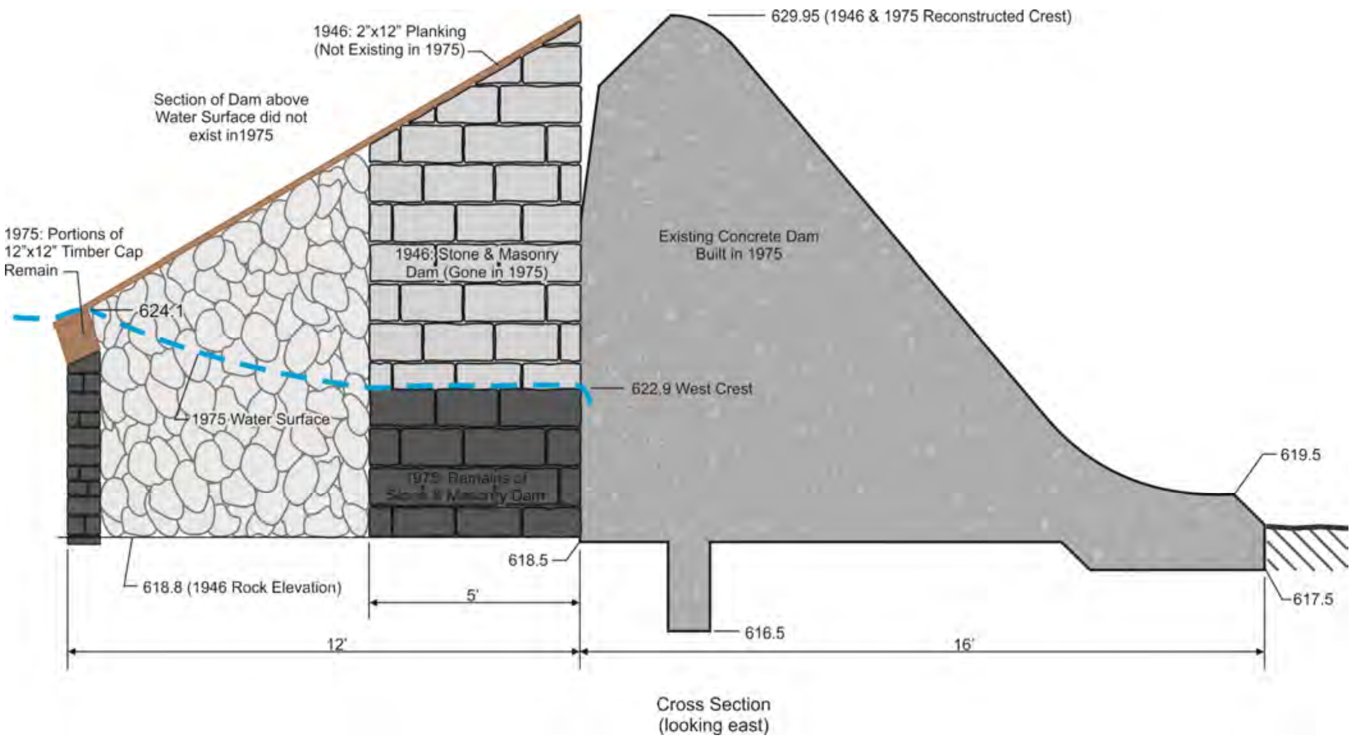


NOTE: Elevations in feet above National Geodetic Vertical Datum, 1929 adjustment (NGVD 29).

Source: Robers and Boyd, Inc., Consulting Engineers.

Figure 103

COMBINED CROSS SECTION OF HORLICK DAM BASED ON 1946 AND 1975 PLANS



NOTE: 1946 Sluiceway portion was to be removed with 1975 construction along with the 1946 timbers and debris at the upstream face of dam. Elevations in feet above NGVD 29.

Source: Robers and Boyd, Inc., Consulting Engineers.

Sediment in the Impoundment

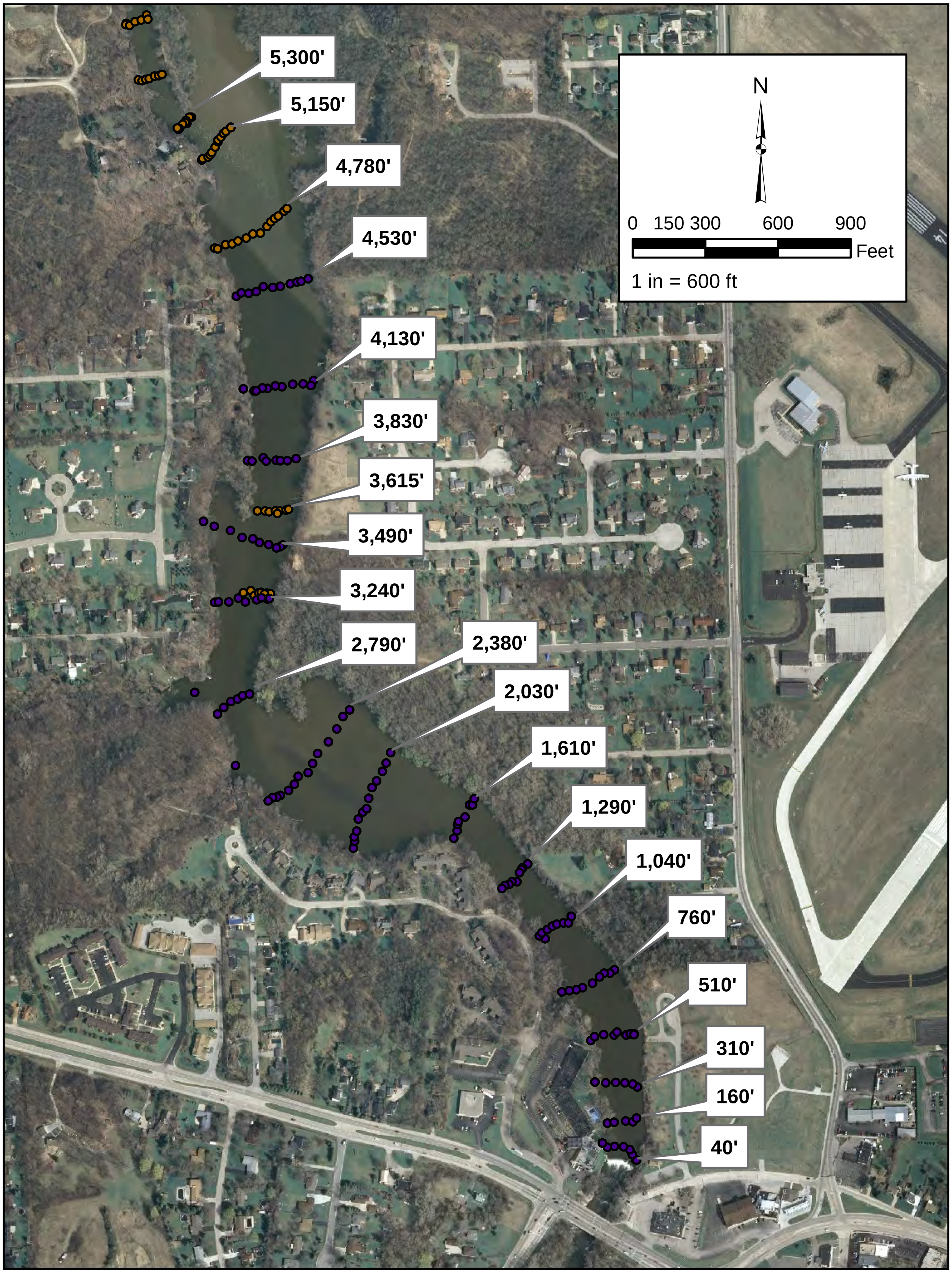
An evaluation was made of both the volume of sediment accumulated in the impoundment upstream from the dam and the presence of contaminants in that sediment. If modifications to the current Horlick dam configuration are pursued, the sediment accumulated behind the dam must be properly managed to avoid adverse consequences in, or downstream from, the impoundment. It is necessary to characterize sediment quality to evaluate possible future management options related to maintaining or removing the dam.

Sediment Quantity

Field work to identify the quantity of sediment upstream of the Horlick dam was accomplished on November 17, November 30, and December 1, 2011. A plastic polyvinyl chloride (PVC) pipe probe was used to determine sediment depths, and probe points were located using global positioning system (GPS) methods and the 2010 digital orthophotograph prepared by SEWRPC and the Racine County Land Information Office. Stream cross-section locations used in the sediment calculations are shown on Map 56. Selected cross-sections are included in Figure 104. Sediment quantity calculations were completed between the dam and a point about 5,300 feet upstream using all of the data collected from the cross-sections shown on Map 56. Figure 105 depicts the deepest probe depth for each cross-section shown on Map 56. Also included in Figure 105 are some pertinent elevations at the Horlick dam, including historic dam crests and gate inverts. As can be seen from Figure 105, the top of sediment in the Horlick dam impoundment matches reasonably well with the lowest crest of the deteriorated dam

Map 56

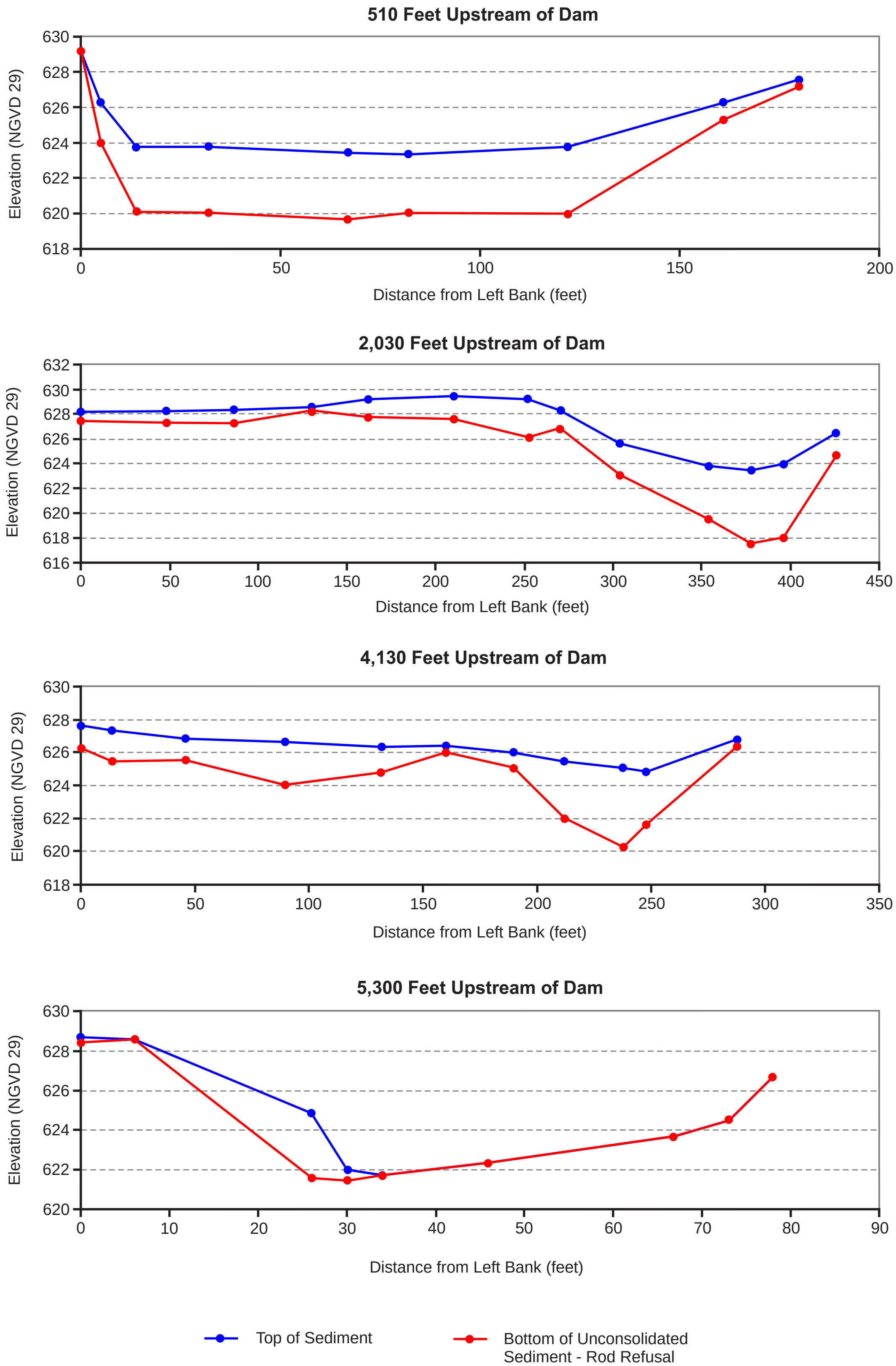
STREAM CROSS-SECTION LOCATIONS



Source: SEWRPC.

Figure 104

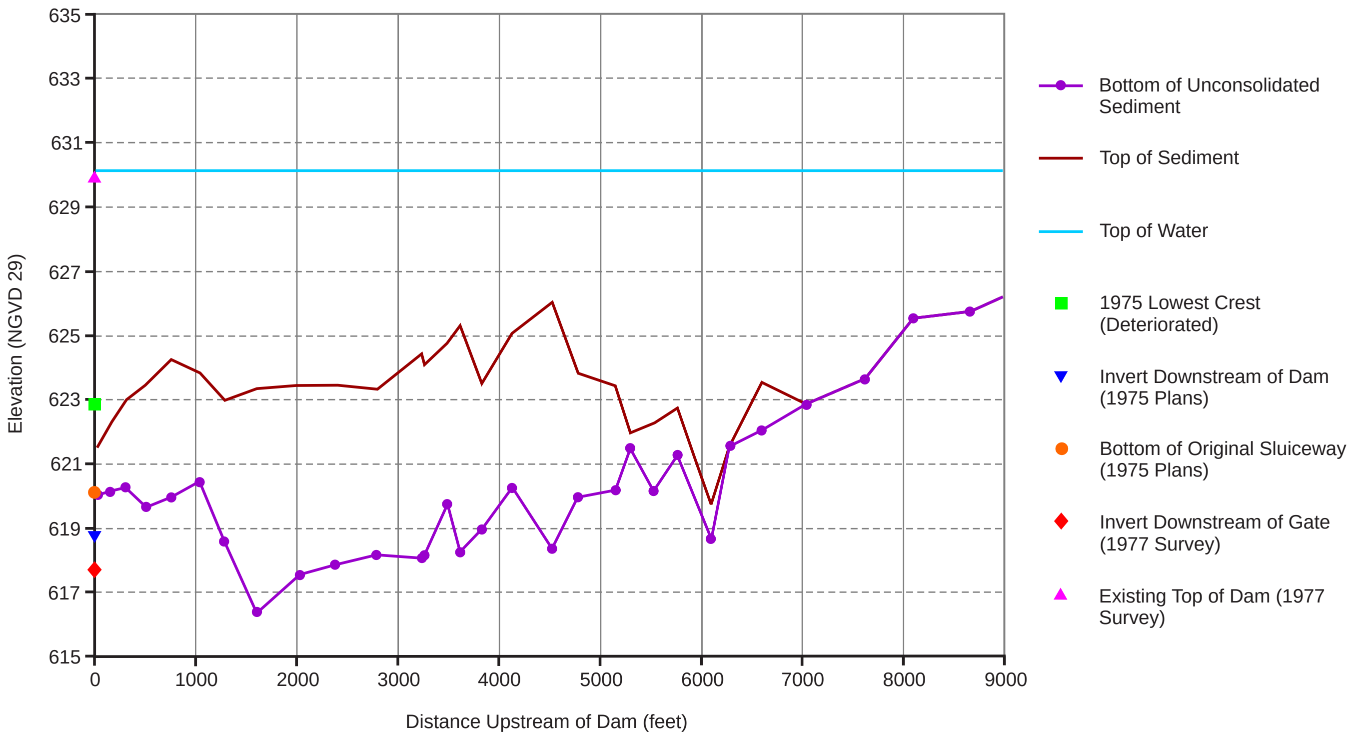
SELECTED HORLICK DAM IMPOUNDMENT CROSS-SECTIONS (looking downstream)



Source: SEWRPC.

Figure 105

HORLICK IMPOUNDMENT PROFILE ON DECEMBER 1, 2011



Source: Wisconsin Department of Natural Resources and SEWRPC.

in 1975. Also the lowest elevation of the bottom of unconsolidated sediment at the dam matches the bottom of the original sluiceway prior to the 1975 reconstruction. The total volume of sediment behind the dam based on the assumptions above was calculated to be about 109,000 cubic yards.

Sediment Quality[212]

WDNR took three sediment cores from the impoundment upstream of the Horlick dam on June 18, 2001. The first core was taken about 10 feet upstream of the face of the dam (RRS-1), the second was taken about 40 feet upstream of the dam (RRS-2), and the third was taken about 200 to 300 feet upstream of the dam (RRS-3). Each core was taken until the point of resistance was reached, which was about 1.2 feet into the sediment. Each core was well mixed and the sample was kept on ice or refrigerated until analyzed at the State Laboratory of Hygiene. Each of the three samples was analyzed for percent solids, and particle size, and concentrations of total organic carbon (TOC), ammonia-nitrogen (NH_3-N), phosphorus, metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). The sample results, set forth in Table 49, were compared to recommended values to assess the likelihood of their having a toxic effect on benthic-dwelling organisms.[213] Each test result was

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[212]*Information on the 2001 sediment sampling in this subsection was provided by Craig D. Helker, WDNR Water Management Specialist, during an October 11, 2012, conversation with SEWRPC staff.*

[213]*Wisconsin Department of Natural Resources,* Consensus-Based Sediment Quality Guidelines: Recommendations for Use & Application, Interim Guidance, *WT-732 2003, December 2003.*

Table 49

SEDIMENT QUALITY DATA FOR HORLICK DAM

Parameter	Required by NR-347?	Sample RRS-1[a]	MPEQ[b] Value	Sample RRS-2[c]	MPEQ[b] Value	Sample RRS-3[d]	MPEQ[b] Value
Percent Solids (percent)	Y	39.4	NA[e]	41.8	NA	45.8	
Particle Size							
Percent Sand	Y	2	NA	30	NA	3	- -
Percent Silt	Y	38	NA	30	NA	52	- -
Percent Clay	Y	60	NA	40	NA	45	- -
Total Organic Carbon (TOC) (µg/kg)	Y	30700	NA	29700	NA	26600	- -
Nitrogen (NH3-N) (mg/kg)	Y	0.6	NA	0.7679	NA	2.1	- -
Phosphorous (mg/kg)	Y	1000	NA	1090	NA	1110	- -
Oil and Grease	Y	Not tested	- -	Not tested	- -	Not tested	- -
Moisture Content	Y	Not tested	- -	Not tested	- -	Not tested	- -
Settleability	Y	Not tested	- -	Not tested	- -	Not tested	- -
PCBs (µg/kg)	Y	ND[g]	<TEC[h]	ND[g]	<TEC[h]	ND[g]	<TEC[h]
Pesticides (µg/kg)	Y	Not tested	- -	Not tested	- -	Not tested	- -
Metals (mg/kg)							
Arsenic	Y	10	>TEC&<MEC[f]	ND[g]	<TEC[h]	7	<TEC[h]
Barium	Y	Not tested	- -	Not tested	- -	Not tested	- -
Cadmium	Y	ND[g]	<TEC[h]	ND[g]	<TEC[h]	ND[g]	<TEC[h]
Chromium	N	38	<TEC[h]	35	<TEC[h]	31	<TEC[h]
Copper	Y	35	>TEC&<MEC[f]	33	>TEC&<MEC[f]	30	<TEC[h]
Lead	Y	38	>TEC&<MEC[f]	36	<TEC[h]	33	<TEC[h]
Mercury	Y	0.71	<TEC[h]	0.066	<TEC[h]	0.075	<TEC[h]
Nickel	Y	37	>MEC&<PEC[i]	33	>TEC&<MEC[f]	31	>TEC&<MEC[f]
Selenium	Y	ND[g]	<TEC[h]	ND[g]	<TEC[h]	ND[g]	<TEC[h]
Zinc	Y	140	>TEC&<MEC[f]	130	>TEC&<MEC[f]	120	<TEC[h]
PAHs (µg/kg) (normalized to 1 percent TOC)							
Acenaphthylene	N	16.3	>TEC&<MEC[f]	16.8	>TEC&<MEC[f]	18.8	>TEC&<MEC[f]
Acenaphthene	N	16.3	>TEC&<MEC[f]	16.8	>TEC&<MEC[f]	18.8	>TEC&<MEC[f]
Anthracene	N	16.3	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Fluorene	N	16.3	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Phenanthrene	N	16.3	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Benzo(a)anthracene	N	16.3	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Benzo(a)pyrene	N	16.3	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Benzo(e)pyrene	N	16.3	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Benzo(b)fluoranthene	N	39.1	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Benzo(k)fluoranthene	N	35.8	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Benzo(g,h,i)perylene	N	16.3	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Chrysene	N	35.8	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Dibenz(a,h)anthracene	N	16.3	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Fluoranthene	N	78.2	<TEC[h]	47.1	<TEC[h]	63.9	<TEC[h]
Indeno(1,2,3-c,d)pyrene	N	16.3	<TEC[h]	16.8	<TEC[h]	18.8	<TEC[h]
Pyrene	N	68.4	<TEC[h]	43.8	<TEC[h]	56.4	<TEC[h]

Footnotes to Table 49

[a]RRS-1 sample location was approximately 10 feet upstream of the Horlick dam.

[b]MPEQ stands for "Mean Probable Effects Quotient."

[c]RRS-2 sample location was approximately 40 feet upstream of the Horlick dam.

[d]RRS-3 sample location was approximately 200 to 300 feet upstream of the Horlick dam.

[e]NA stands for "Not Applicable," meaning that there is no MPEQ defined for this parameter.

[f]>TEC&<MEC means that the data falls between the Threshold Effect Concentration and the Midpoint Effect Concentration.

[g]ND stands for "No Detect" which indicates a sample that was tested for but had results below the Limit of Detection.

[h]<TEC means that the data falls below the Threshold Effect Concentration.

[i]>MEC&<PEC means that the data falls between the Midpoint Effect Concentration and the Probable Effect Concentration.

Source: Wisconsin Department of Natural Resources.

assigned to a category within the Mean Probable Effects Quotient (MPEQ), which indicated its toxicity level. The MPEQ consists of a lower limit of effect, called the Threshold Effect Concentration (TEC), and an upper limit of effect, called the Probable Effect Concentration (PEC). The midpoint of the TEC and the PEC is designated the Midpoint Effect Concentration (MEC). Values below the TEC are considered to be safe for benthic organisms, and values above the PEC are likely to have a toxic effect. Values that fall between the TEC and the PEC are considered to be borderline. The MPEQ values are reported relative to these three benchmarks. The data in Table 49 indicates that none of the measured contaminants concentrations exceeded the PEC.

With regard to composition, the sediment samples were reported to consist primarily of silt, sand, and clay, with clay making up an average of 48 percent of the samples, silt making up 40 percent of the samples, and sand making up 12 percent of the samples. Sample RRS-2 had the highest amount of sand, at 30 percent, while Samples RRS-1 and RRS-3 consisted of only 2 percent and 3 percent sand, respectively. Silt and clay particles are more effective than sand at binding metals and other contaminants, therefore making contaminants less available in the environment.

Most of the metals were below the MEC, except for nickel, which slightly exceeded the MEC in RRS-1. The concentration for nickel in RRS-1 was 37 mg/kg, which is between the MEC value of 36 mg/kg and the PEC value of 49 mg/kg. The values for arsenic and chromium, which are considered to be of most concern to the environment, were all below the TEC, except for RRS-1 where the value of 10 mg/kg for arsenic was slightly above the TEC of 9.8 mg/kg.

The raw data for the Polycyclic Aromatic Hydrocarbons (PAHs) were normalized using the Total Organic Carbon (TOC) values for each sample. This was done because samples with a higher TOC concentration have more binding sites for PAHs, which make the PAHs less available in the environment. The sample values were normalized to a concentration equivalent to 1 percent TOC to account for this variability. Some of the raw sample results for the PAHs were below the detection limit of 100 µg/kg (dry weight). For purposes of calculation, these results were assumed to be 100 µg/kg. For these samples, it is likely that the ambient concentrations of PAHs were actually less than 100 µg/kg, so the calculated values can be considered to be the upper limit. The normalized concentrations for most of the PAHs tested were below the TEC values. However, the normalized concentrations for Acenapthene and Acenaphthylene were the only exceptions. The average values for the three sampling locations for both Acenapthene and Acenapthylene were 17.3 µg/kg. For Acenapthene, this fell between the TEC of 6.7 µg/kg and the MEC of 48 µg/kg, and, for Acenapthylene, this fell between the TEC of 5.9 µg/kg and the MEC of 67 µg/kg. However, since the values for these two PAHs were calculated based on an assumed concentration of 100 µg/kg, equivalent to the limit of analytical detection, it is possible that the real values actually do fall below the TEC.

The sample values for PCBs were all below the limit of detection of the laboratory and the sediment samples were not tested for pesticides. Because of the largely agricultural setting of the Root River system upstream of the Horlick dam, pesticide contamination of the sediments may be of concern, and on-site treatment of any dredge spoil may have to be implemented.[214] At a minimum, the Horlick impoundment sediment should be tested for the pesticides Chlordane, Dieldrin, and DDT.

The samples also were compared by the SEWRPC staff to the recommended sampling parameters set forth in Chapter NR 347, "Sediment Sampling and Analysis, Monitoring Protocol and Disposal Criteria for Dredging Projects," of the *Wisconsin Administrative Code*. Chapter NR 347 requires that sediment samples be taken with a core sampler to a depth equal to the proposed dredging depth plus two feet, or to the point of resistance. Because the sediment depth just upstream of the Horlick dam where the WDNR took their samples met resistance at about 1.2 feet, the samples should meet this requirement. Most of the analyses required by Chapter NR 347 were performed, with the exception of the pesticide analyses, as already noted. Table 49 lists the analytes that may be required by the WDNR pursuant to Chapter NR 347 together with the results of the 2001 analyses. As indicated in Chapter NR 347, analysis for any specific chemical may be waived if previous sampling data demonstrate that the possibility of contamination could be considered to be negligible, as well as additional analyses for specific chemicals that may be required if deemed appropriate by the WDNR.

River Flow Conditions

A U.S. Geological Survey (USGS) water stage recording Station No. 04087240 is located on the left bank of the Root River approximately 30 feet downstream of the STH 38 bridge and 350 feet downstream of the Horlick dam. The gage has been in operation since 1962.

Mean daily peak flow data for Station No. 04087240 are summarized in Figure 106. This exhibit summarizes the monthly average, mean daily flows for the period of record. Also included in Figure 106 are the monthly average maximum mean daily flows for the period of record. From Figure 106 it can be concluded that, for water years 1963 through 2011, the mean daily flow of the Root River did not exceed 360 cfs, while the maximum mean daily flow did not exceed 1,150 cfs. It can also be noted that the highest mean daily flow months for the Root River at the Horlick dam occurred from the months of March through June.

Additional data for Station No. 04087240 include flow exceedance statistics compiled by the USGS for the entire period of record from water years 1963 to 2012. The gage is a continuous water stage recorder, taking a reading every 15 minutes. Based on the entire period of record, the Root River flow just downstream from the Horlick dam is less than 56 cfs 50 percent of the time, less than 409 cfs 90 percent of the time, and less than 10 cfs 10 percent of the time.

Annual instantaneous peak flows for USGS Gage Station No. 04087240 are summarized in Figures 107 and 108. These are the annual instantaneous maximum flows recorded at the gage during the period of record from water year 1964 through 2011.[215] Annual peak flows in the Root River at the Horlick dam were below 4,500 cfs with one exception, that being the June 2008 flood, which had a maximum peak of 8,050 cfs. Figure 108 shows the 48 annual peak flows for the period of record at the gage by the month in which they occurred. February through April accounted for 29 of the annual peaks observed, while May through July included 15 of the 48 annual peaks.

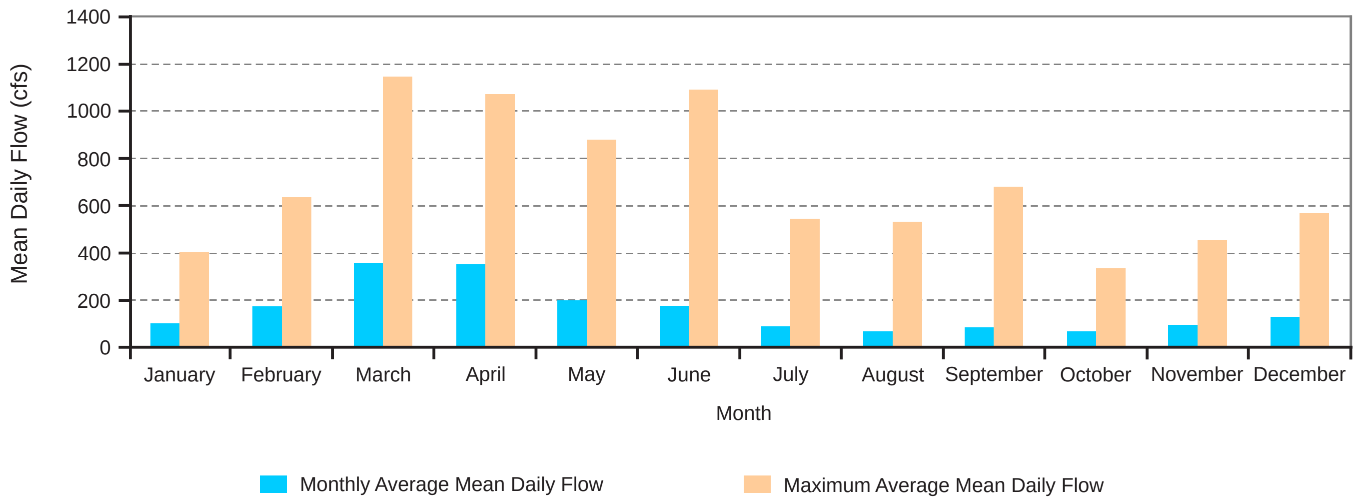
The Racine County Flood Insurance Study (FIS), effective May 2, 2012, includes flood frequency information for the Root River at the STH 38 bridge, just downstream of the Horlick dam. These discharges were determined using output from the Hydrologic Simulation Program and weather data from 1940 through 1979. The FIS discharges estimated for the Root River at the Horlick dam are set forth in Table 50.

[214]*Such treatment could consist of providing soil cover and a vegetative cover crop.*

[215]*The water year runs from October 1 of the preceding year through September 30 of the designated water year.*

Figure 106

**MONTHLY AVERAGE AND MAXIMUM MEAN DAILY FLOW
ROOT RIVER AT HORLICK DAM: WATER YEAR 1963 THROUGH 2011**



Source: U.S. Geological Survey.

Threatened and Endangered Species

Known endangered, threatened, and special concern species were investigated within a defined area both upstream and downstream of the Horlick dam (see Table 51). The upstream reach was investigated to 4 Mile Road in the Village of Caledonia, and the downstream reach was investigated to the WDNR weir facility, which is located just northwest of the intersection of CTH C and Chicago Street in the City of Racine. The data were collected from the National Heritage Inventory (NHI) database maintained by the WDNR on September 13, 2012. A line that traced the Root River from where it crosses 4 Mile Road down to the WDNR weir facility was drawn through the NHI map, and any occurrences of endangered, threatened, or special concern species that crossed that line were recorded. Additional data within the defined area was also collected from additional sources to supplement the NIH database.[216] Inclusion of an endangered, threatened, or special concern species in Table 51 is not a guarantee that the species will currently be found in the project area, but only indicates its potential for occurrence there.

Upstream of the dam, there were three potential occurrences of endangered species, six occurrences of threatened species, and four occurrences of special concern species (see Table 51). Of these species, those likely to occur within the stream channel itself include two threatened species of fish—longear sunfish (*Lepomis megalotis*) and redfin shiner (*Lythrurus umbratillis*)—two herptiles, and one species of plant. The Queensnake (*Regina septemvittata*) is endangered, and Blanding's turtle (*Emydoidea blandingii*) is threatened, but is in the process of being delisted by the WDNR. The seaside crowfoot (*Ranunculus cymbalaria*) is a threatened plant species that typically occurs in saline ditches, but is an obligate wetland species.

Downstream of the dam, there were three potential occurrences of endangered species, seven occurrences of threatened species, and nine occurrences of special concern species (see Table 51). The same species as those listed upstream of the dam that occur within the downstream portion of the channel include the longear sunfish, redfin shiner, Queensnake, Blanding's turtle, seaside crowfoot.

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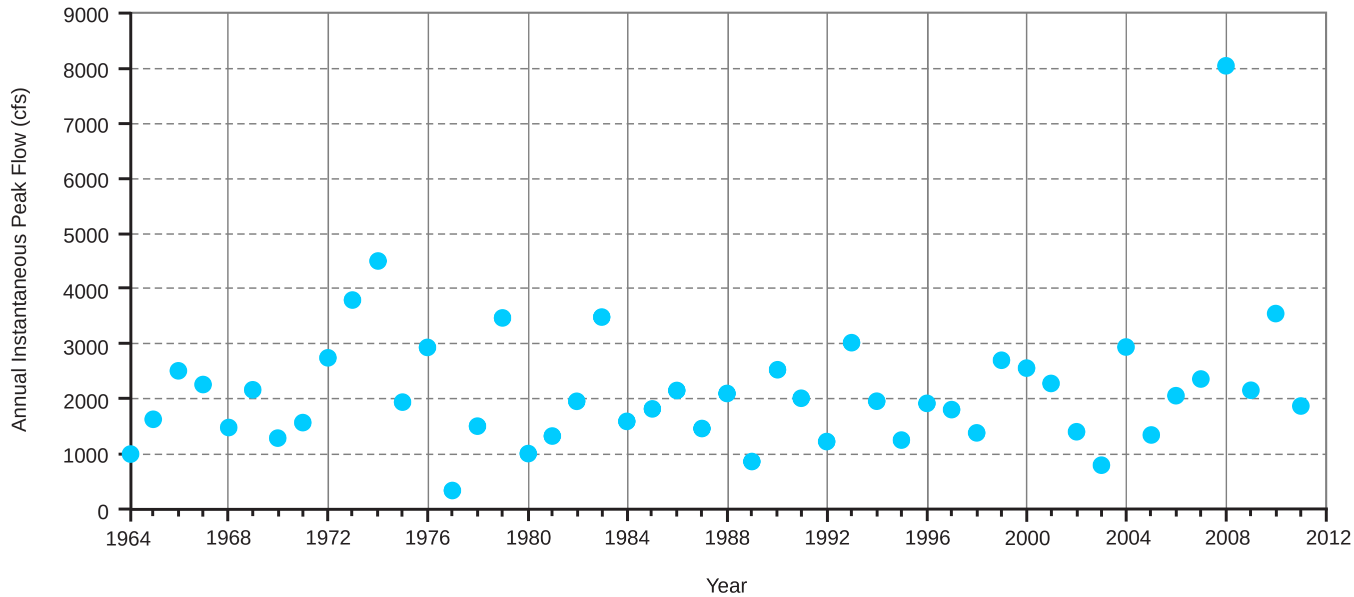
[216]*SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *1997, amended 1998 and 2010.*

Figure 107

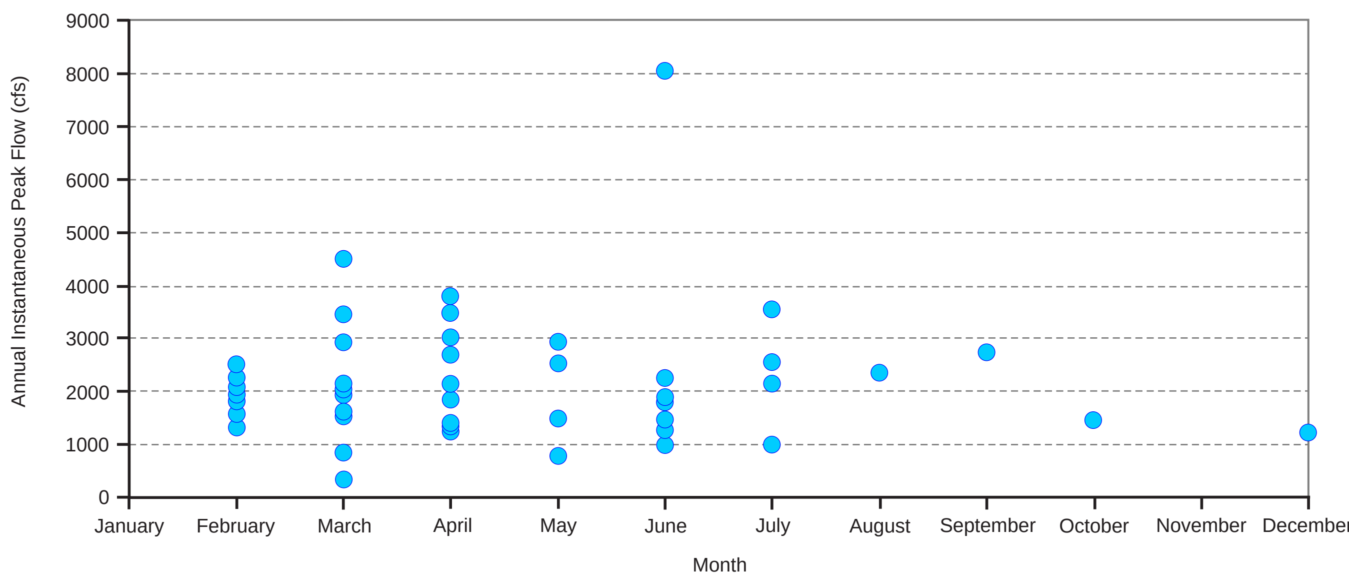
ANNUAL INSTANTANEOUS PEAK FLOWS ROOT RIVER AT HORLICK DAM: WATER YEARS 1964 THROUGH 2011



Source: U.S. Geological Survey.

Figure 108

ANNUAL PEAK FLOWS BY MONTH ROOT RIVER AT HORLICK DAM: WATER YEARS 1964 THROUGH 2011



Source: U.S. Geological Survey.

Table 50

2012 RACINE COUNTY FIS SUMMARY OF DISCHARGES

Annual Probability of Occurrence (percent)	Flow Root River at STH 38 (cfs)
10.0	3,130
2.0	5,200
1.0	6,380
0.2	10,200

Source: SEWRPC.

Upstream and downstream of the dam three mussel species have been observed.[217] The mussel species observed include the giant floater (*Pyganodon grandis*), Lilliput (*Toxolasma parvus*), and White heelsplitter (*Lasmigona complanata*).

FLOODING (RACINE COUNTY)

Early in the process of developing this watershed restoration plan, input from Racine County officials identified flooding as an important issue of concern in the Root River watershed, especially in portions of Racine County.[218] This section provides inventory information on flooding in the portion of the Root River watershed that is located in Racine County.

On August 5, 2011, Commission staff sent a memorandum to Racine County and to those municipalities in Racine County that are wholly or partially located within the Root River watershed. The memorandum requested stormwater and flooding information for areas within the watershed. A copy of the memorandum is included in Appendix M of this report.

A follow-up inquiry to this request was sent by electronic mail on September 16, 2011.

The following municipalities sent information in response to the memorandum:

- Racine County provided maps indicating general areas of flooding along the mainstem of the Root River in the Village of Caledonia and the Town of Raymond; a tabulation of flood damages in the City of Racine, the Villages of Caledonia, Mt. Pleasant, and Union Grove, and the Town of Raymond from the spring 2008 floods; maps of floodprone areas in the City of Racine; an inventory of principal structures in the 1-percent-annual-probability floodplain; and July 2008 and July 2010 flood inspections from the Village of Caledonia and the Town of Raymond.

- The City of Racine provided addresses of properties in the special flood hazard area.

- The Village of Caledonia provided maps from its master drainage plan, preliminary flood insurance rate map panels, and its stormwater management plan.

- The Village of Mt. Pleasant provided copies of several ordinances related to floodplains, stormwater management, and erosion control; a copy of its municipal separate storm sewer system discharge permit; and data related to a hydraulic analysis of Hoods Creek.

- The Village of Union Grove provided a copy of its stormwater management plan.

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[217]*Mussel Monitoring Program of Wisconsin,* http://wiatri.net/inventory/mussels/.

[218]*MMSD has jurisdiction for flood mitigation activities in the Milwaukee County portion of the Root River watershed. Flooding problems in that portion of the watershed are being addressed through the MMSD watercourse planning program and the ongoing floodplain mapping that SEWRPC is conducting for the Milwaukee County Automated Mapping and Land Information System Steering Committee and MMSD.*

Table 51

ENDANGERED, THREATENED, AND SPECIES OF SPECIAL CONCERN LIST FOR HORLICK DAM: 1861-2012

Group	Scientific Name	Common Name	State Designation	Date Observed
Upstream of Horlick Dam, to 4 Mile Road				
Bird	*Buteo lineatus*	Red-shouldered hawk	THR	1982
Plant	*Asclepias purpurascens*	Purple milkweed	END	1879
	Asclepias sullivantii	Prairie milkweed	THR	1880
	Deschampsia cespitosa	Tufted hairgrass	SC	1900
	Polystichum acrostichoides	Christmas fern	SC	1861
	Ptelea trifoliata	Wafer-ash	SC	1993
	Ranunculus cymbalaria	Seaside crowfoot	THR	1878
	Scutellaria ovata	Heart-leaved skullcap	SC	2005
	Solidago caesia	Bluestem goldenrod	END	1997
Fish	*Lepomis megalotis*	Longear sunfish	THR	1900
	Lythrurus umbratillis	Redfin shiner	THR	1924
Herptile	*Emydoidea blandingii*	Blanding's turtle	THR	ND
	Regina septemvittata	Queensnake	END	ND
Downstream of Horlick Dam, to Weir Facility				
Bird	*Nycticorax nycticorax*	Black-crowned night-heron	SC/M	1950s
Plant	*Adlumia fungosa*	Climbing fumatory	SC	1861
	Asclepias purpurascens	Purple milkweed	END	1879
	Asclepias sullivantii	Prairie milkweed	THR	1880
	Aster furcatus	Forked aster	THR	2004
	Calamintha arkansana	Low calamint	SC	1891
	Cirsium hillii	Hill's thistle	THR	1897
	Deschampsia cespitosa	Tufted hairgrass	SC	1900
	Festuca paradoxa	Cluster fescue	SC	1930s
	Polystichum acrostichoides	Christmas fern	SC	1861
	Ptelea trifoliata	Wafer-ash	SC	1966
	Ranunculus cymbalaria	Seaside crowfoot	THR	1898
	Scutellaria ovata	Heart-leaved skullcap	SC	2006
	Solidago caesia	Bluestem goldenrod	END	2006
	Thalictrum revolutum	Waxleaf meadowrue	SC	1906
	Viburnum prunifolium	Smooth black-haw	SC	ND
Fish	*Lepomis megalotis*	Longear sunfish	THR	1900
	Lythrurus umbratillis	Redfin shiner	THR	1924
Herptile	*Emydoidea blandingii*	Blanding's turtle	THR	ND
	Regina septemvittata	Queensnake	END	1971

NOTE: THR means threatened, END means endangered, SC means species of special concern, SC/M means species of special concern/migrant, ND means no date provided.

Source: National Heritage Inventory, Wisconsin Department of Natural Resources, and SEWRPC as of September 13, 2012.

- The Town of Raymond and Raymond Stormwater Utility District provided project maps for stream clearing projects in the Root River and the East and West Branches of the Root River Canal and a copy of the Town's stormwater fee ordinance.

- The Town of Yorkville and Yorkville Stormwater Utility District provided a map showing locations of road flooding and closures and a description of design and bidding for a box culvert to replace the failing culvert at the Braun Road crossing of the East Branch of the Root River Canal.

The Village of Sturtevant responded that it had no pertinent information to provide. No information was provided by the Towns of Dover and Norway, which only have small areas within the watershed.

Existing Floodland Management Plan for the Root River Watershed

In 1966, SEWRPC adopted a comprehensive plan for the Root River watershed.[219] In preparing that plan, a concerted effort was made to offer for public evaluation a full range of physically feasible alternative plan elements that might satisfy one or more agreed-upon watershed development objectives. Each alternative plan element was evaluated insofar as possible in terms of technical, economic, and legal feasibility, and public acceptability, as well as with respect to satisfaction of the watershed development objectives. The alternative plan elements can best be conceptualized in terms of various combinations of land use patterns and water control facilities. A number of alternatives incorporating both structural and nonstructural measures were explored in the preparation of the plan. The flood control alternatives considered include: 1) channel modification; 2) channel clearing and maintenance; 3) construction of peak flow diversion channels to Lake Michigan; 4) construction of a multi-purpose reservoir; 4) preservation of existing floodplain areas in essentially natural open uses; 5) structure floodproofing; and 6) structure removal.

In addition to the Racine County portion of the Root River watershed, alternative floodland management measures have also been evaluated that address upstream flooding problems in Milwaukee County. As part of the evaluation of those alternatives, including their potential impact on flooding in Racine County, updated flood discharges and stages were developed for the Root River mainstem through Racine County.[220] That evaluation was designed to ensure that measures implemented in Milwaukee County do not compound problems in Racine County.

Recent Local Actions

The City of Racine completed a Flood Response Plan in 2003.[221] The plan identifies proactive remediation measures and provides guidance on coordination of City departments and resources. In 2009 the City of Racine hired a consultant to perform a Root River Flood Stage Relationship Study.[222] The purpose of the study was to develop a relationship between stages at the Root River USGS gage located just downstream of the Horlick dam and flood elevations in the City. The study compared stages at the gage to river stage data collected by the City at a site about 500 feet upstream from the Spring Street Bridge and to results from a hydraulic model of this portion of the Root River.[223] Using model results, the study correlated stage information with flood elevations at four locations along the Root River in the City. These locations included Domanik Drive, the Lincoln Park Bike Bridge, Parkview Drive, and the intersection of McKinley Avenue and Cedar Bend Avenue. The study presented estimates of water surface elevations for a series of gage stages ranging from seven feet to 14 feet, presented

[219]*SEWRPC Planning Report No. 9,* op. cit.

[220]*SEWRPC Community Assistance Planning Report No. 152,* A Stormwater Drainage and Flood Control System Plan for the Milwaukee Metropolitan Sewerage District, *December 1990.*

[221]*Earth Tech, Inc.,* Flood Response Plan Spring Flood Control, *August 2003.*

[222]*Jaren Hiller, AECOM, "Root River Flood Stage Relationship Study," Memorandum to the City of Racine, July 20, 2009.*

[223]*The model was constructed using the U.S. Army Corps of Engineers HEC-RAS river analysis system model. This model was developed in 2002 by AECOM (formerly Earth Tech) for the Root River bike path project and was based upon a HEC-2 model developed by SEWRPC.*

estimated flood limits associated with these stages for lands adjacent to these four locations, described the flood conditions associated with each of these stages, and described actions that can be taken in response to those flood conditions.[224]

Since 2004, the Village of Sturtevant has completed four regional stormwater detention facilities that reduce flood flows to the local stormwater management system in Hoods Creek in the Root River watershed and Chicory Creek, Waxdale Creek, and the Pike River in adjacent watersheds.

One home in the Village of Caledonia was substantially damaged as a result of the June 2008 flooding event. The homeowner used FEMA National Flood Insurance Program funds to demolish the damaged house and build a new house on the same parcel outside of the Root River floodplain.

Prior to 2009, the Village of Union Grove cleared, expanded, and riprapped the West Branch of the Root River Canal along Maurice Drive to more readily convey flood flows. In addition, in 2008 the Wisconsin Department of Transportation made storm sewer improvements along Main Street from STH 11 past 7th Avenue in order to reduce street flooding. The June 2009 flood event caused significant flooding in the Village of Union Grove as outlined below. The West Branch of the Root River Canal is constricted by a railroad bridge crossing just east of 67th Drive. The Village indicated that as of 2009, the Canadian Pacific Railway did not have any plans to modify the bridge crossing.

In 2009, the Town of Raymond conducted an evaluation of the 3 Mile Road crossing over the East Branch Root River Canal. The evaluation indicated that the crossing is impassable anytime two or more inches of rain falls and this was identified as the highest priority flooding problem to be addressed by the Town. The evaluation included a floodplain impact study of raising the road and providing additional high-water culverts. This study concluded that these actions would have no impact on the floodplain. Between 2009 and 2011, the Raymond Stormwater Utility District conducted three projects along the mainstem of the Root River, the Root River Canal, and the East and West Branches of the Canal. In each of these projects, woody and nonwoody debris were removed from streams and dead, dying, and leaning trees that were located within 30 feet of the ordinary high water mark of the streams were removed. Projects were conducted along the Root River Canal between 5 Mile Road and 8 Mile Road in 2009, the East Branch Root River Canal and the Root River Canal between 3 Mile Road and 5 Mile Road in 2010, and the mainstem of the Root River from 43rd Street to the north town line in 2011.

Historical Flooding Problems

The Root River watershed's area includes 124 square miles that lie in Racine County. A comprehensive watershed plan was prepared for the Root River watershed in 1966 under the direction of the SEWRPC Root River Watershed Committee.[225] That plan and subsequent analyses indicated that, up to and including 1974, major floods had occurred within the watershed in August 1940, March 1960, July 1964, September 1972, and April 1973. As of 1974, the March 1960 flood caused by a combination of rainfall and snowmelt, was the most damaging in the watershed within living memory and historical records. This flood was determined to have approximately a 1-percent-annual-probability and caused damages totaling about $370,000 expressed in 1966 dollars.[226] Reaches of particularly heavy damage within Racine County included portions of the City of Racine,

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[224]*It should be noted that the HEC-RAS model developed in the AECOM study has not been approved by the WDNR or the Federal Emergency Management Agency and should not be used for any regulatory purposes, such as floodland zoning or official floodland mapping.*

[225]*SEWRPC Planning Report No. 9,* op. cit.

[226]*This dollar value is equivalent to about $2,870,000 in 2012 dollars, as adjusted to year 2012 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

where about 62 residences were estimated to have been directly flooded, and about 260 residences were affected by basement flooding due to seepage and sewer backup. In addition, flood damages to crops and farming operations occurred in the Towns of Caledonia, Mt. Pleasant, Raymond, and Yorkville, and included reaches in the City of Racine.[227] Average annual flood damages were estimated at $24,000 per year, also expressed in 1966 dollars.[228] The monetary damages reflected the existing land use and channel conditions within the watershed.

Description of Recent Flood Events

Since 1990, there have been 41 flood events affecting Racine County reported by the National Climatic Data Center (NCDC). Those flood events were reported to have caused property damages totaling, in 2012 dollars, about $44.5 million, of which $36.8 million was related to crop damages. In the following descriptions, all flood damages have been converted to 2012 dollars using the consumer price index from the U.S. Bureau of Labor Statistics.

The most severe recent events occurred in June-July 1993, June 1996, August 1998, June 1999, July 2, 2000, May-June 2004, August 19-22, 2007, June 7-9, 2008, June 19, 2009, July 14-22, 2010, and September 26, 2011. These flood events, which are significant with regard to the current planning effort for the Racine County portions of the Root River watershed, are described below. Detailed information for impacts on a watershed or local community scale was not available in the NCDC database for all events.

- The June-July 1993 flood and severe winds, known as the Great Midwest Flood, affected Racine County as well as most of the State of Wisconsin. In Racine County aggregate rainfall during June and July 1993 was about 10 inches, considerably less than was experienced in other parts of the State. The event resulted in a Presidential disaster declaration. Racine County was among the 47 counties in Wisconsin declared eligible for Federal disaster assistance and was included as one of 40 counties eligible for both public and individual assistance. Damages reported in Racine County were due primarily to severe wind conditions and were estimated to be in excess of $6.4 million. Nine states, including Wisconsin, were declared a national disaster area. Statewide damages were estimated at $1.27 billion in crop damages and $1.19 billion in other property damages. Assistance received in Racine County through the FEMA and State Hazard Mitigation Program and public assistance programs administered by the Wisconsin Division of Emergency Management associated with this 1993 event totaled about $344,000. Racine County communities in the Root River watershed receiving the assistance related to the 1993 flooding event included, in addition to Racine County itself, the City of Racine; the Village of Sturtevant; and the Towns of Caledonia, Dover, Mt. Pleasant, Norway, and Yorkville.[229]

- Widespread rains averaging one to two inches fell on April 26 and 27, 1995, over southeastern Wisconsin resulting in minor flooding on the Root River Canal in Raymond. The canal exceeded flood stage of eight feet with a crest of 9.40 feet early in the morning on April 28. No damages were reported.

- A rapid warm-up along with light to moderate rain on January 18 and 19, 1996, brought some rapid rises and minor low-land flooding to southeast Wisconsin. Temperatures in the 50s melted almost all of the existing snow cover. The Root River Canal at Raymond crested at 8.42 feet, 0.42 feet above flood stage, at 6:05 p.m. on January 18.

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[227]*Since these events, the Towns of Caledonia and Mt. Pleasant have incorporated as villages.*

[228]*This dollar value is equivalent to about $170,070 in 2012 dollars, as adjusted to year 2012 by using the average annual CPI values from the U.S. Department of Labor, Bureau of Labor Statistics.*

[229]*Since this event, the Towns of Caledonia and Mt. Pleasant have incorporated as villages.*

- An all-day rain on May 19, 1996, peaked with a late afternoon two-inch downpour in less than two hours. This resulted in widespread flooding across Racine County. Total rainfall for the day was around three inches. Many County roads were flooded to a depth of one to two feet, and a couple feet of water accumulated in numerous basements. From time to time, scattered stretches of County roads were closed.

- The June 17, 1996, flood event, which, at that time, was characterized as the worst agricultural flooding event seen by many farmers in Racine County, resulted in $24.9 million in crop damage and $585,000 in other property damage in Racine County. The event was the result of two rounds of heavy rains on top of saturated ground and resulted in scattered flooding across Racine County. In the City of Racine, 1.97 inches fell overnight from June 16 to 17. Following this, 1.5 inches fell between 7:30 p.m. and 8:00 p.m. on June 17. Many storm sewers became clogged with debris, causing many roads to flood. Flooding of residential basements and businesses was noted. Rural farm land sustained soil erosion and damage to crops.

- Scattered severe thunderstorms deposited very heavy rains of one to two inches in the pre-dawn hours of April 3, 1999. These rains resulted in small stream and urban flooding in south central and southeastern Wisconsin. In Racine County, there were scattered reports of water over the roads in both urban and rural areas.

- On April 23 and 24, 1999, long duration showers and thunderstorms deposited two to three inches of rain on top of saturated ground in parts of south central and southeastern Wisconsin. Flooding was reported in the City of Racine. Water depths reached one to two feet on low spots in roads and there were some basement flooding reports.

- The June 13, 1999, flood event, which caused widespread flood damages in a multi-county area, resulted in $207,000 in Racine County property damages. After experiencing several rounds of moderate to heavy rains during the week of June 6 to12, parts of south central and southeastern Wisconsin suffered yet another round of heavy rains on June 13. The result was widespread flooding of rivers, streams, creeks, and urban areas. Many roads were closed, and there were several cases of soil erosion, road shoulder washouts. Many basements sustained damage to personal property. From 3.1 to 4.1 inches of rain fell over the eastern parts of Waukesha and Walworth Counties, southern Milwaukee County, and Kenosha and Racine Counties in an 18-hour period from midnight to 6:00 p.m. Most of the rain fell within a few hours of 11:00 a.m.

- Severe weather struck south central and southeastern Wisconsin over night from May 11, 2000, into May 12. Some of the thunderstorms developed supercell characteristics, resulting in large damaging hail, downburst straight-line winds, and torrential rainfall. Rain coming down at the rate of one to two inches per hour in the more intense storms resulted in urban flooding. A peak rainfall of 3.6 inches in one hour was reported near the City of Racine. Many reports indicated that water was briefly six inches to two feet deep on some low-lying roads or under-passes.

- On June 12, 2000, several rounds of thunderstorms moved west to east across Kenosha and Racine Counties deposited enough rain to cause flash flooding in several locations. Urban and small stream flooding occurred in and near the Village of Sturtevant, where water was reported to be six inches deep on the roads and roadside ditches were reported to be full. About $6,700 in property damage was reported in and around the Village.

- The July 2, 2000, event in southeastern Wisconsin was a combination of tornadoes, straight-line winds, hail, and flash flooding. The most significant cluster of thunderstorms developed over southern Columbia County and proceeded to move east/southeast through Dodge, Jefferson, Waukesha, Milwaukee, and Racine Counties. A supercell on the west end of this cluster produced some damaging straight-line winds and large hail up to 2.25 inches in diameter in Jefferson County. This supercell spawned a tornado at 5:30 p.m. about three-fourths of a mile northwest of the intersection of S. 27th Street and Ryan Road. This tornado moved east/southeast through Oak Creek, and then exited Milwaukee County at 7:06 p.m., where STH 32 goes south into Racine County about seven miles south/southeast of General Mitchell International Airport. The tornado continued for about 0.2 mile into Racine County, just east of STH 32, before dissipating about 2.9 miles northeast of the settlement of Husher at the intersection of 6 Mile Road and STH 38. No one was injured or killed by the tornado that traveled through Franklin and Oak Creek into Racine County. However, significant damage did occur. In Racine County, the tornado uprooted trees as it weakened. At least 50 homes and three farm buildings in eastern Racine County were damaged by the powerful winds, or by felled trees. Minor urban/small stream flooding affected parts of Racine County. Flash flooding occurred later in the evening on July 2, as additional rounds of storms, some severe, moved across the area. Torrential downpours, sometimes reaching an inch or more within 15 minutes, produced flash flooding in and near the City of Racine. Most small streams and creeks in eastern Racine County quickly exceeded flood stage by one to two feet due to the intense rainfall. In Racine County, 429 residential buildings were damaged by flash floodwaters, and about 2,800 acres of farm land had crop damage or soil erosion. The flood resulted in an estimated $1.7 million in property damage and $1.0 million in crop damage. Twenty-four hour rainfall amounts ending at 6:00 a.m. on July 3 were 5.76 inches at Raymond and 3.99 inches in the City of Racine.

- On September 11, 2000, three rounds of severe thunderstorms affected south central and southeastern Wisconsin. The second round of storms produced torrential downpours. In Racine County, these rains were so heavy that visibility on IH 94 was reduced to less than 50 yards, forcing motor vehicles to pull off to the side of the road. Flooding was reported in the City of Racine and the Village of Union Grove.

- On September 22 and 23, 2000, intense rainfalls of 1.0 to 2.5 inches resulted in urban and small stream flooding over parts of southeastern Wisconsin. Water levels on some low-lying roads reached six to 12 inches and water levels in several small streams briefly exceeded bankfull by a foot or less.

- On February 9, 2001, a strong low-pressure system that originated in the southern Rocky Mountains moved through the southern plains and Minnesota. Ahead of this low, southerly winds pulled warm, moist air into southern Wisconsin, with temperatures reaching the 35 to 48 degree range. The heavy rains that this system produced resulted in most rivers in south central and southeastern Wisconsin reaching or exceeding flood stage. The two-day total rainfall for February 8 and 9 came to 2.33 inches in Milwaukee and 2.48 inches in Waterford. The heavy rains and partial melt of a seven to 12 inch snow pack led to widespread flooding of farm fields, roadside ditches, and other low spots. In addition, water covered or flowed across many roads. Flooding occurred along the Root River Canal near Raymond. The stream stage at the USGS gage at 6 Mile Road went above its nine-foot flood stage at 6:00 a.m. on February 9 and remained above flood stage until 3:00 a.m. on February 12. The stream crested at 11.11 feet at 10:15 a.m. on February 10. Property damages of $97,200 were reported in Racine County as a result of this incident.

- On September 18 and 19, 2001, several rounds of moderate to heavy rains moved across south central and southeastern Wisconsin. The area around the City of Racine received 2.16 to 2.22 inches of rain, which resulted in minor flooding.

- Rare, out-of-season severe thunderstorms, with up to golf ball- to baseball-size hail, pelted parts of southern Wisconsin during the overnight hours of October 23, 2001. The storms cut a swath from southern Green County to the Janesville/Beloit area in Rock County, to the area east of Elkhorn in Walworth County, to the southern part of the City of Racine. The largest hailstones, and the greatest amount of damage, occurred in the southern part of the City of Racine. In Racine, many vehicles were dented, several skylight windows were smashed, the roofs of several homes were damaged, and one sunroom was demolished by the large hailstones. Eyewitness reports indicated that the hailstorm duration was about 15 to 20 minutes as a series of thunderstorm cells trained west to east across the same part of the city. Based upon Doppler radar estimates, rainfalls of about 1.50 inches occurred, creating three- to four-foot-deep flooding on Kearney Avenue in the City of Racine, where storm sewer inlets were clogged with leaves. A two-apartment building in the City of Racine was severely damaged when its basement wall collapsed due to flooding triggered by the heavy rains and leaf-clogged storm sewers. According to newspaper accounts, this storm caused about $64,800 in property damage.

- On May 9, 2004, heavy rains of two inches in one to two hours in the Caledonia area resulted in urban-type flooding. Water depths on some roads briefly reached six to eight inches.

- The May to June 2004, flood event was the result of an extended period of light to moderate rain during early and mid-May followed by more severe rain in late May and early June. Moderate flooding within Racine County was experienced on May 20 and 21, with a number of roads being flooded along with gravel washouts. Damage to lowland crops and home basements was noted along the Root River Canal. Scattered to widespread heavy rains across south central and southeastern Wisconsin during the period of June 9 through16 kept rivers and streams at or above flood stage for much of the month. In general, the June flooding was the worst since 1993 on a widespread basis. Federal Disaster Declaration 1526 covered all 20 counties in south central and southeastern Wisconsin, including Racine County, for storms, tornadoes, and flooding for the period May 19 through July 3, 2004. Within Racine County, property and crop damages for the May and June flooding were estimated at $1,356,000 and $5,705,000, respectively. Total May rainfall across Racine County averaged 12.97 inches, or about four times normal precipitation for the month, while total June rainfall averaged 5.90 inches, or about 50 percent greater than normal.

- Scattered flash flood events occurred on September 12, 2006, over southern Wisconsin as a result of a series of slow-moving thunderstorm clusters or short lines of thunderstorms that moved into the northeast. Each round of these storms deposited heavy rain on soils that were nearly saturated before the rain began. Based on National Weather Service spotter reports, rainfall rates reached 3.0 to 5.5 inches per hour in some of the most intense storms. The Kansasville, Raymond, Sturtevant, and Racine areas of Racine County were among the areas in which the worst flooding problems occurred. In these areas, basements were flooded, some gravel road shoulders were washed out, and roads were flooded to depths of one to five feet. The floods caused an estimated $114,000 in property damages.

- The August 19 through 22, 2007, flood event was the result of a stalled surface frontal boundary that stretched from northern Iowa through northern Illinois. Warm, moist air flowing north up and over the boundary resulted in thunderstorm generation across southern Wisconsin. Significant flash flooding occurred during the overnight hours of August 18 to 19, with two-day rainfall totals of about six inches being reported across Racine County. Water depths on some roads reached three to four feet and significant soil erosion was reported. The heavy rainfall resulted in the Root River Canal at Raymond reaching then-record flood status. At this gage site, the river rose to the nine-foot flood stage at 3:52 a.m. on August 19, crested at 11.66 feet at 2:15 a.m. on August 21, and fell below flood stage at 6:22 am on August 26. Countywide at least 40 homes sustained minor flood damages to basement contents, while at least 10 homes sustained more significant damage. Ten sod farms reported minor to major damage due to flood waters and erosion. A second round of storms on August 22 produced more heavy rain which fell on saturated soils. Water reached depths of up to two feet on roadways, forcing the temporary closure of some intersections. At least two dozen homes experienced basement flooding, some due to sewer backups, while additional soil erosion and crop damages were also reported. Property and crop damages within Racine County from these floods were estimated at $631,000 and $2,325,000, respectively.

- The June 7 through 9, 2008, flood event was the result of a slow moving surface boundary nearly parallel to the mid-level flow that affected southern Wisconsin. A strengthening low-level jet stream and strong moisture advection supported training of flood-producing thunderstorms. The heavy rain axis for this event ran from Sauk County southeast to Milwaukee County, just north of Racine County. Rainfall totals within southern Milwaukee County were generally in the seven- to eight-inch range, with a report of up to 11.35 inches in the City of Oak Creek. Rainfall within Racine County was lower, with reported totals falling in the 3.5- to 4.0-inch range. However, because the headwaters of the Root River watershed are located in southern Milwaukee County, flooding of the Root River through Racine County was very much affected by the heavy rains that occurred there. The U.S. Geological Survey (USGS) Root River streamflow gage located at STH 38 near Racine recorded a peak flow rate of 8,050 cubic feet per second, which is the highest recorded since that gage went into service in 1963. Based on comparison to the USGS Root River gage in the City of Franklin in Milwaukee County, this event appears to have been similar in magnitude to the March 1960 event, which was the flood of record in the watershed, and may have even exceeded that event. Significant structural flooding occurred, particularly along the Root River in the City of Racine. Water depths on road surfaces reached three feet or more and there were gravel washouts. Several roads and bridges sustained damage. The USGS Root River streamflow gage located at 6 Mile Road recorded a peak flow rate of 1,560 cfs, which is the highest recorded since that gage went into service in 1963. Countywide, about 16,000 acres of cropland was flooded, although due to the timing of the flood, most of this land was able to be replanted. Crop losses were estimated at about $1,599,600 while property damage and public sector costs were estimated at $2,158,394. A total of nearly $4.0 million in State and Federal assistance was approved for individuals, businesses, and local governments in Racine County as a result of this event.

- The June 19, 2009, flood event was the result of a series of thunderstorms that moved across southern Wisconsin during the overnight hours of June 18 and 19 and lasted through the evening of the 19th. These storms produced very heavy rain over a relatively short period of time with each round. The heaviest rainfall occurred along a line through central Waukesha and Milwaukee Counties, mainly with the first round of storms in the early hours of June 19. A second round of storms occurring in the late afternoon and evening of June 19 brought heavy rains to Kenosha and southern Racine Counties. Rainfall across Racine County ranged from 1.5 inches at the Burlington airport to 4.2 inches at the Union Grove wastewater treatment plant. Approximately 50 homes in the Village of Sturtevant and another 100 homes in the Village of Union Grove were reported to have had basement flooding during this event. A retention basin in the Village of Union Grove was damaged. Total property damage in Racine County was estimated at $347,000.

- Parts of south central and southeastern Wisconsin experienced several rounds of record-setting torrential heavy rains during the afternoon and evening hours of July 22, 2010, that led to flash flooding and damage. During the afternoon, a persistent band of strong to severe thunderstorms developed and moved very slowly over south central and southeastern Wisconsin through the evening hours. The individual storms moved quite quickly, about 40 to 50 mph, but the slow southward movement of the boundary these storms were developing along resulted in storms repeatedly training, or moving, over the same area. Widespread three- to four- inch rainfalls were reported along and either side of the IH 94 corridor, with locally higher rainfalls of five to eight inches. The greatest rain amounts fell in Milwaukee County. Mitchell Field recorded 5.61 inches for the day, breaking a record for the date. The southern edge of a line of training thunderstorms pushed across northern portions of Racine County, producing between three and four inches of rain in two hours or less. Many area roads were covered with water which made them impassable. This happened along Racine CTH G at IH 94 where the flood waters washed out the gravel shoulders. Basements flooded, causing damage to contents, including the basement of a home on Spring Street on the northwest side of the City of Racine, flooded with water from the swollen Root River. Property damages resulting from this flood were estimated to be $21,000. Crop damages were estimated to be $1,050.

- On September 25 and 26, 2011, showers and thunderstorms associated with a cut-off upper low that stalled over northern Illinois and southern Wisconsin produced up to three inches of rain across parts of southern Wisconsin over a 48-hour period ending the morning of September 26. Between 1.5 and two inches of rain fell during the last 24 hours of that two-day period. The heavy rains flooded low-lying areas and ditches across the Region, with standing water three to four feet deep in some locations. Heavy rains resulted in flash flooding of a construction zone on the west frontage road of IH 94 between STH 20 and CTH C. A 76-year-old man died when his car stalled in the flood waters after driving into a flooded ditch in the construction zone. The preliminary cause of death was from a heart attack and hypothermia, suffered when the victim apparently tried to leave the marooned car and walk for help. This flood caused an estimated $6,398 of property damage and $1,066 in crop damage.

Floodplain Areas and Flood Hazards

This section assesses the vulnerability of the portion of the Root River watershed located in Racine County to flooding hazards and related stormwater drainage problems. For this purpose, consideration was specifically given to potential structures, including critical facilities flooding, property values, and cropland flood damages.

The floodplain areas, as well as surface waters and wetlands, within the Racine County portion of the Root River watershed are shown on Map 57. These areas are generally located along the major stream system. Floodplains have been delineated for nearly all of the major streams and selected smaller intermittent streams. The source of the hydrologic and hydraulic data for each stream reach is shown on Map 58. All of the floodplain areas for which detailed studies are available have been mapped on large-scale topographic mapping prepared at a scale of one inch equals 200 feet with a contour interval of two feet. Flood flows and stages are currently readily available for about 64.6 miles of the total stream reaches involved, while the floodplain for about 14.4 miles of stream is delineated by approximate methods under the May 2012 Federal Flood Insurance Study for the County.[230]

The 2010 update of the Racine County hazard mitigation plan defined a set of community assets that are subject to damage from natural hazards.[231] These were reviewed to indicate the potential for flooding impacts to: 1) a variety of floodprone residential, commercial, and other developed land uses; 2) agricultural lands; 3) roadway transportation facilities; 4) critical community facilities; and 5) historic sites. No significant impacts are expected to other infrastructure or utility systems, solid waste disposal sites, or hazardous material storage sites.

There are currently 205 structures estimated to be located within the 1-percent-annual probability (100-year recurrence interval) flood hazard areas in the portions of the Root River watershed that are located in Racine County. The general locations of these structures are shown on Maps 59 and 60. These include 173 residential structures, one commercial structure, 15 agricultural buildings, three government buildings, one school, one adult day care center, one group home, and nine other buildings (recreational facilities and churches). The specific location of each structure and its relationship to the floodplain is shown on the 2012 FEMA digital flood insurance rate maps for Racine County.

It is important to note that, based upon the inventory set forth in the Racine County hazard mitigation plan,[232] the three government buildings located within the 1-percent-annual-probability flood hazard area are not critical community facilities. They are associated with recreational park-related uses.

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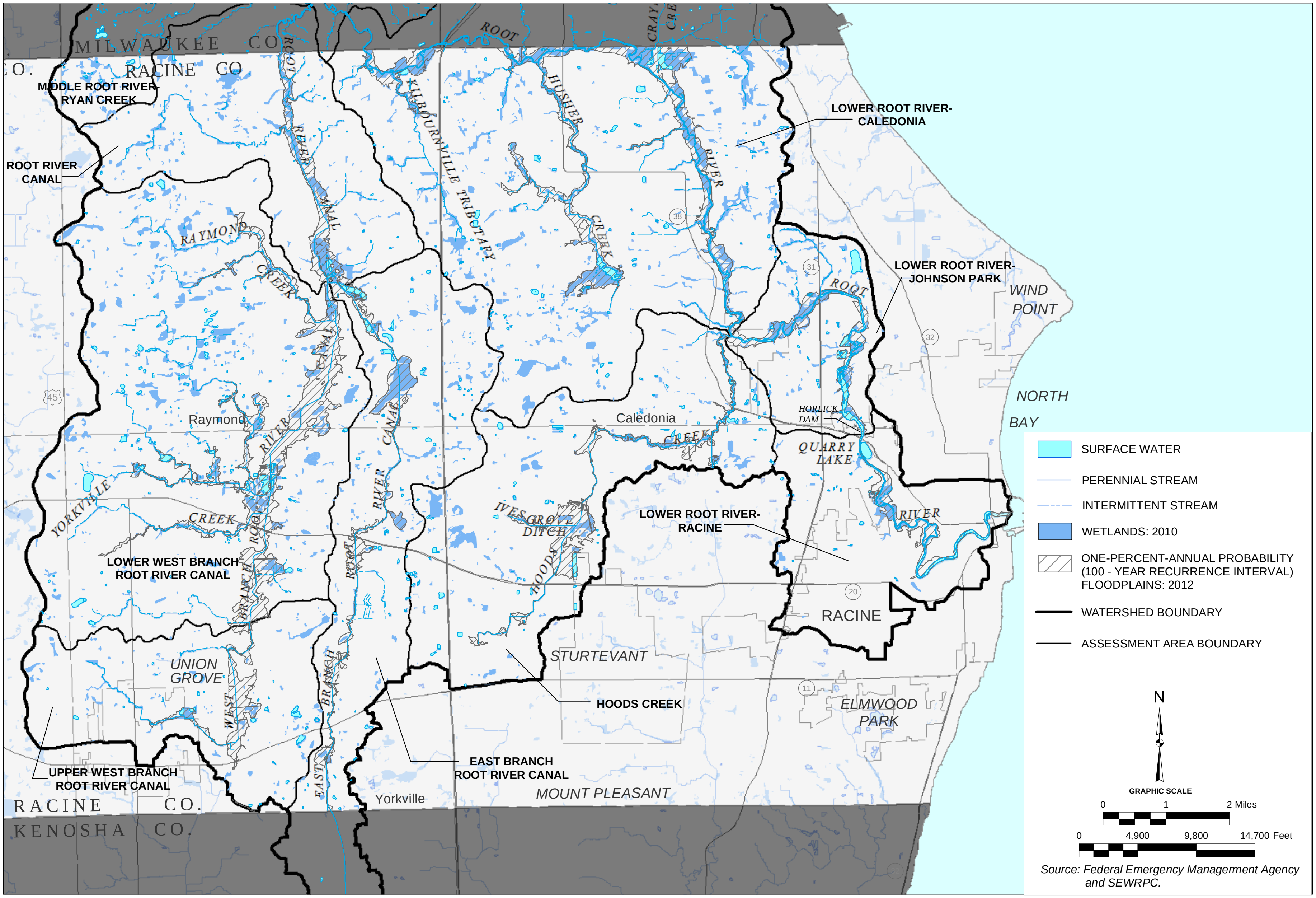
[230]*Federal Emergency Management Agency, "Flood Insurance Study-Racine County, Wisconsin and Incorporated Areas," May 2, 2012.*

[231]*SEWRPC Community Assistance Planning Report No. 266, 2nd Edition,* Racine County Hazard Mitigation Plan: 2010-2015, *July 2010.*

[232]Ibid.

Map 57

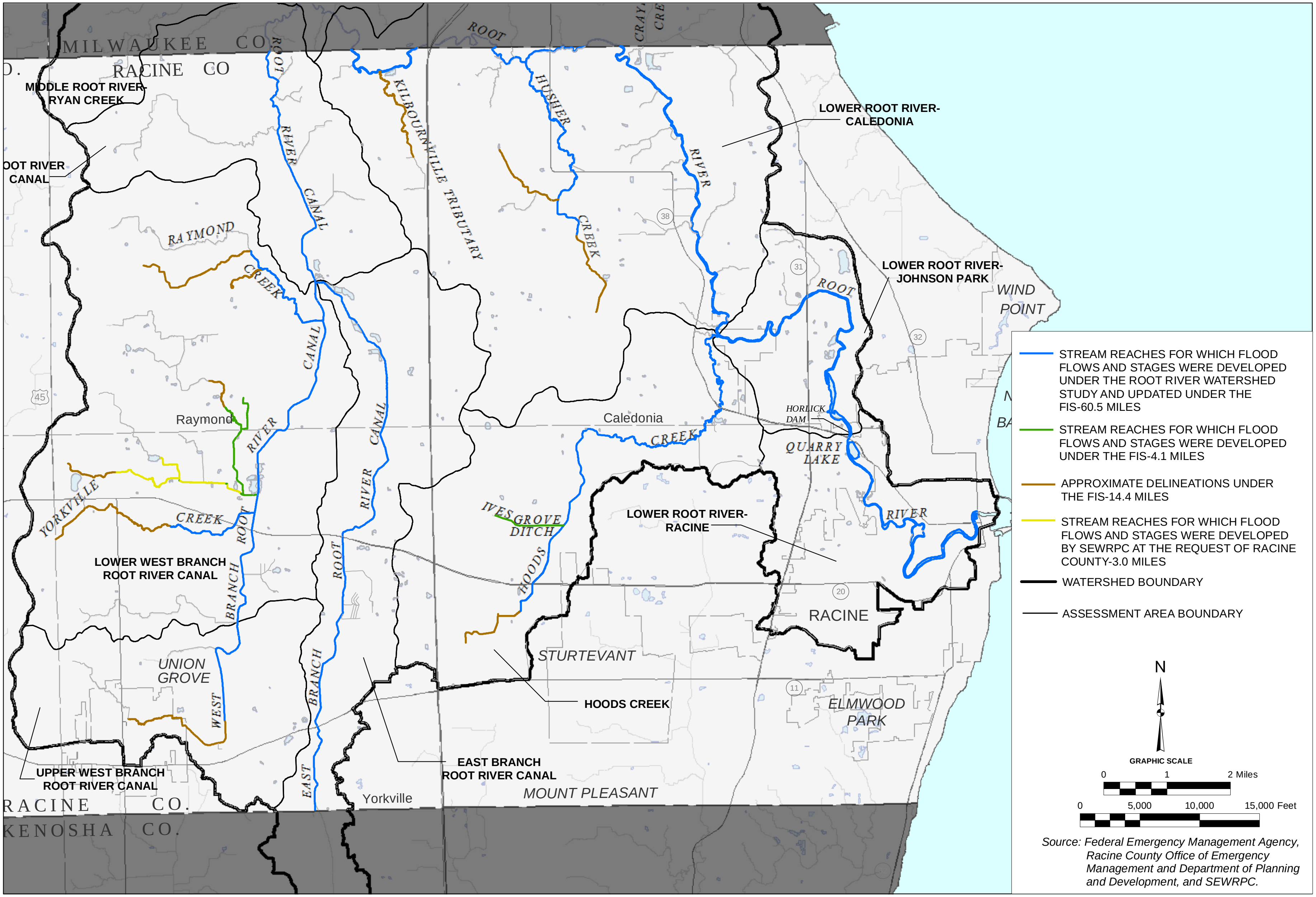
SURFACE WATERS, WETLANDS, AND FLOODPLAINS WITHIN THE RACINE COUNTY PORTION OF THE ROOT RIVER WATERSHED: 2012



Source: Federal Emergency Management Agency and SEWRPC.

Map 58

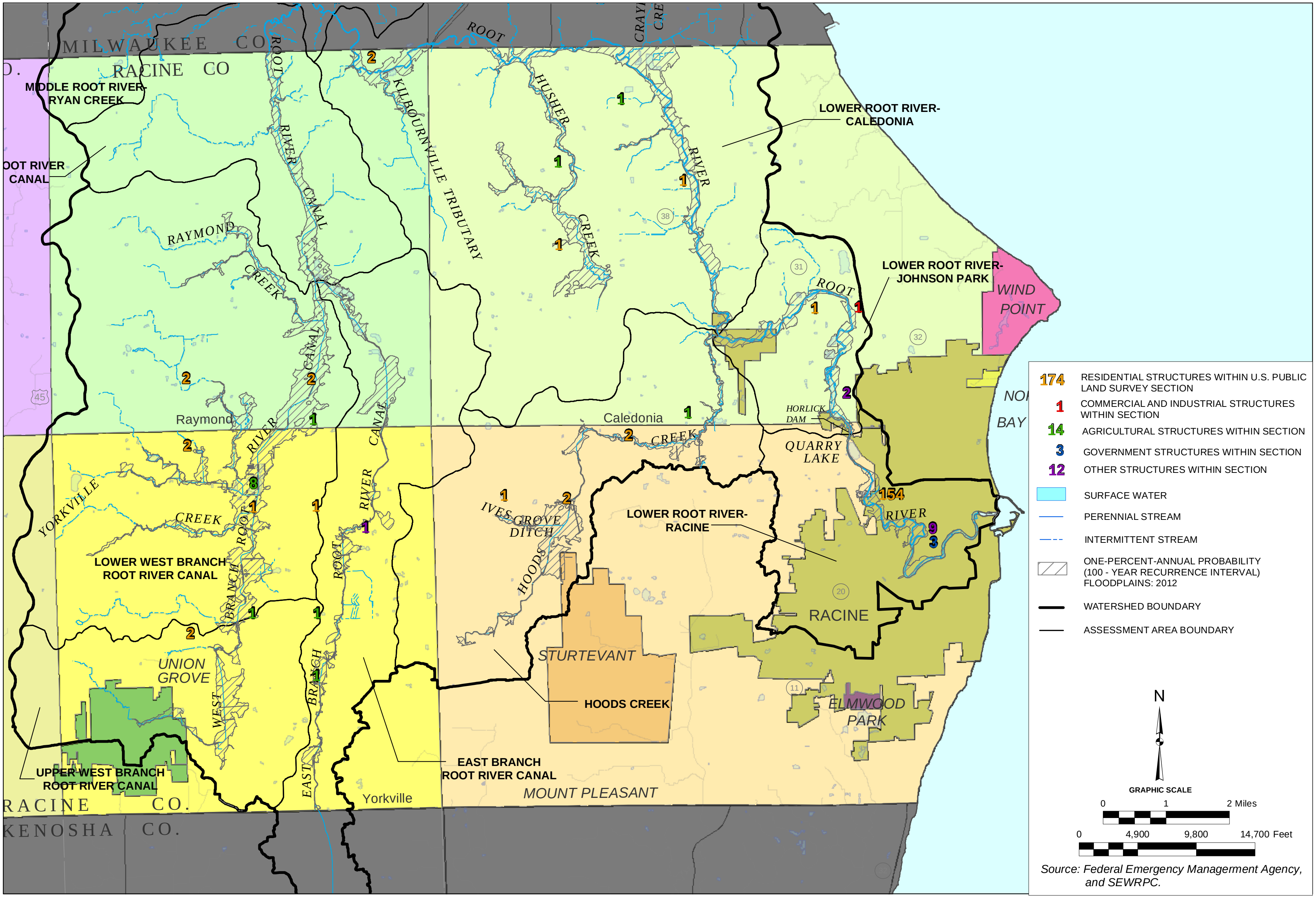
SOURCES OF FLOOD HAZARD DATA FOR STREAM REACHES IN THE RACINE COUNTY PORTION OF THE ROOT RIVER WATERSHED: 2012



Source: Federal Emergency Management Agency, Racine County Office of Emergency Management and Department of Planning and Development, and SEWRPC.

Map 59

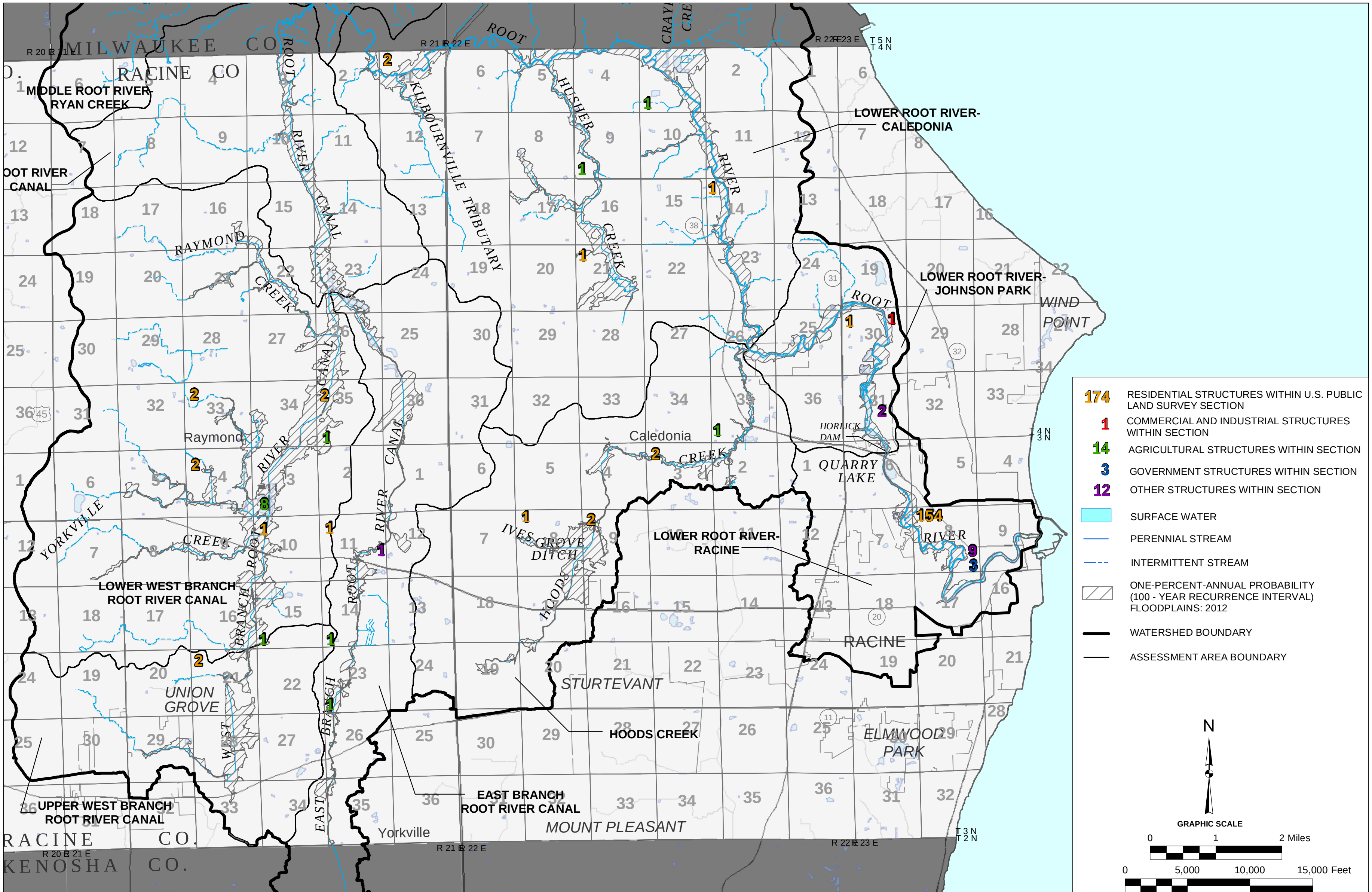
NUMBER OF STRUCTURES WITHIN FLOOD HAZARD AREAS BY CIVIL DIVISION
IN THE RACINE COUNTY PORTION OF THE ROOT RIVER WATERSHED: 2012



Source: Federal Emergency Management Agency, and SEWRPC.

Map 60

NUMBER OF STRUCTURES WITHIN FLOOD HAZARD AREAS BY U.S. PUBLIC SURVEY SECTION IN THE RACINE COUNTY PORTION OF THE ROOT RIVER WATERSHED: 2012



Source: Federal Emergency Management Agency and SEWRPC.

Two structures which are considered by FEMA to be repetitive- or substantial-loss properties in the Racine County portion of the Root River watershed. Both of these structures are in the City of Racine. Repetitive-loss structures are those which have two or more flood insurance claims of at least $1,000 each. Each of these structures sustained damages during the June 7 through 9, 2008, flood event.

Estimated damages are included in Table 52 for the 10-, 2-, and 1-percent-annual-probability (10-, 50-, and 100-year recurrence intervals, respectively) flood events and are also summarized on an average annual basis. The total value of the 205 structures which are identified as being subject to flooding or stormwater drainage problems is about $22 million. Damages expected during a 1-percent-annual-probability flood event are estimated to be $5.2 million, and annual average damages are estimated to be about $396,000.

Table 52 also presents these detailed flood hazard data by civil division. Estimated damages are included for the 10-, 2-, and 1-percent-annual probability flood events and are summarized on an annual basis. The total value of the 166 structures in the portion of the City of Racine in the Root River watershed that are identified as being subject to flooding problems is about $17 million. Damages expected during a 1-percent-annual-probability flood event are estimated to be $4.1 million; annual average damages are estimated to be $235,000. The total value of the nine structures in the watershed portion of the Village of Caledonia that are identified as being subject to flooding or stormwater drainage problems is about $541,000. Damages expected during a 1-percent-annual-probability flood event are estimated to be $217,000; annual average damages are estimated to be $61,360. The total value of the five structures in the watershed portion of the Village of Mt. Pleasant that are identified as being subject to flooding problems is about $394,000. Damages expected during a 1-percent-annual-probability flood event are estimated to be $66,800; annual average damages are estimated to be $2,640. The total value of the seven structures in the watershed portion of the Town of Raymond that are identified as being subject to flooding problems is about $1.4 million. Damages expected during a 1-percent-annual-probability flood event are estimated to be $269,000; annual average damages are estimated to be $10,200. The total value of the 18 structures in the watershed portion of the Town of Yorkville that are identified as being subject to flooding problems is about $2.2 million. Damages expected during a 1-percent-annual-probability flood event are estimated to be $563,000; annual average damages are estimated to be $86,800. No structures were identified as being located in the flood hazard area in the portions of the Root River watershed that are located in the Village of Union Grove and the Towns of Dover and Norway.

It should be noted that, with a few exceptions, all of these structures were identified as being in the floodplain based upon large-scale topographic mapping. Field surveys would be required to determine the precise relationship to the floodplain. Some structures may be found to be outside the flood hazard areas and additional structures may be found to be within those areas, based upon detailed field survey data.

The Racine County hazard mitigation plan examined the locations of selected types of critical community facilities in Racine County, including hospitals, nursing homes, clinics, schools, and community administration facilities, and fire and police stations relative to the 1-percent-annual-probability floodplain.[233] As previously indicated, two of these facilities—a group home and an adult daycare center—are located within the flood hazard area.

It should be noted that Racine County has identified 43 buildings within the County as mass care facility sites (shelters). A listing of those facilities is available at the County Office of Emergency Management. These buildings are geographically distributed throughout the County and consist mostly of churches and schools. None of these designated sites are located within the identified flood hazard area.

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[233]Ibid.

Table 52

STRUCTURE FLOOD DAMAGE SUMMARY BY CIVIL DIVISION: THE PORTIONS OF THE ROOT RIVER WATERSHED LOCATED IN RACINE COUNTY, WISCONSIN

Annual Flood Probability (percent)[a]	Number of Structures in Floodplain	Flood Damages[a]			Expected Annual Average Flood Damage[b]
		Direct	Indirect	Total	
City of Racine					
1	166	$3,420,990	$652,970	$4,073,960	$ 81,480
2	65	1,048,420	220,030	1,268,450	50,740
10	8	162,030	47,300	209,330	102,570
Total	- -	- -	- -	- -	$234,790
Village of Caledonia					
1	9	$ 166,520	$ 50,760	$ 217,280	$ 3,890
2	8	145,200	44,940	190,140	6,810
10	4	82,790	28,940	111,730	50,660
Total	- -	- -	- -	- -	$61,360
Village of Mt. Pleasant					
1	5	$ 58,120	$ 8,710	$ 66,830	$ 1,340
2	2	28,250	4,240	32,940	1,300
10	0	0	0	0	0
Total	- -	- -	- -	- -	$ 2,640
Town of Raymond					
1	7	$ 233,650	$ 35,820	$ 269,470	$ 5,390
2	3	105,430	15,820	121,250	4,850
10	0	0	0	0	0
Total	- -	- -	- -	- -	$ 10,240
Town of Yorkville					
1	18	$ 471,680	$111,760	$ 563,440	$ 11,670
2	13	338,890	70,120	409,010	16,360
10	7	102,670	17,260	119,930	58,760
Total	- -	- -	- -	- -	$ 86,790
Total for the Racine County Portion of the Watershed					
1	205	$4,331,220	$857,060	$5,188,280	$103,770
2	91	1,648,920	352,560	2,001,480	80,050
10	19	340,230	92,410	432,640	211,990
Total	- -	- -	- -	- -	$395,820

[a]*The 1-percent-annual-probability flood has a 1 percent chance of occurring in any given year. That flood is also sometimes referred to as the 100-year recurrence interval flood. The two-percent-annual-probability flood has a 2 percent chance of occurring in any given year (50-year recurrence interval flood). The 10-percent-annual-probability flood has a 10 percent chance of occurring in any given year (10-year recurrence interval flood). The flood probability in percent is equal to 100 divided by the recurrence interval in years. As an example, the annual probability of the 50-year flood is 100/50 = 2 percent.*

[b]*Flood damages have been adjusted to 2012 dollars using the U.S. Bureau of Labor Statistics Consumer Price Index.*

Source: Racine County Department of Planning and Development and SEWRPC.

As can be seen by review of Map 57, the 1-percent-probability flood overtops a number of arterial and collector streets in the portions of the Root River watershed that are located in Racine County. East to west travel in the County could potentially be restricted during flood events due to overtopping of a number of arterial streets and highways crossing the Root River and Root River Canal. Several roads in the Town of Yorkville routinely flood during the spring and have to be closed to traffic. These include:

- 2 Mile Road at the intersection with Colony Avenue, at a low point in the road about 0.4 mile east of 65th Drive, and at a low point in the road about 0.2 mile west of Forest Hill Circle;
- 50th Road at the crossing of the East Branch Root River Canal;
- 55th Avenue at a low point in the road about 0.3 mile north of Spring Street;
- Church Road at a low point in the road about 0.2 mile east of S. Raynor Avenue;
- 58th Road at the intersection with 59th Drive and at a low point about 0.5 mile east of 55th Drive; and
- 67th Drive at the Union Grove wastewater treatment plant.

Similarly, several roads in the Town of Raymond routinely flood during heavy rainfalls and have to be closed to traffic. These include:

- 3 Mile Road at the Crossing of the East Branch Root River Canal and between the East Branch of the Root River Canal and the West Frontage Road;
- 5 Mile Road between 96th Street and 100th Street;
- 43rd Street between 7 Mile Road and 8 Mile Road; and
- The intersection of 8 Mile Road and S. 27th Street.

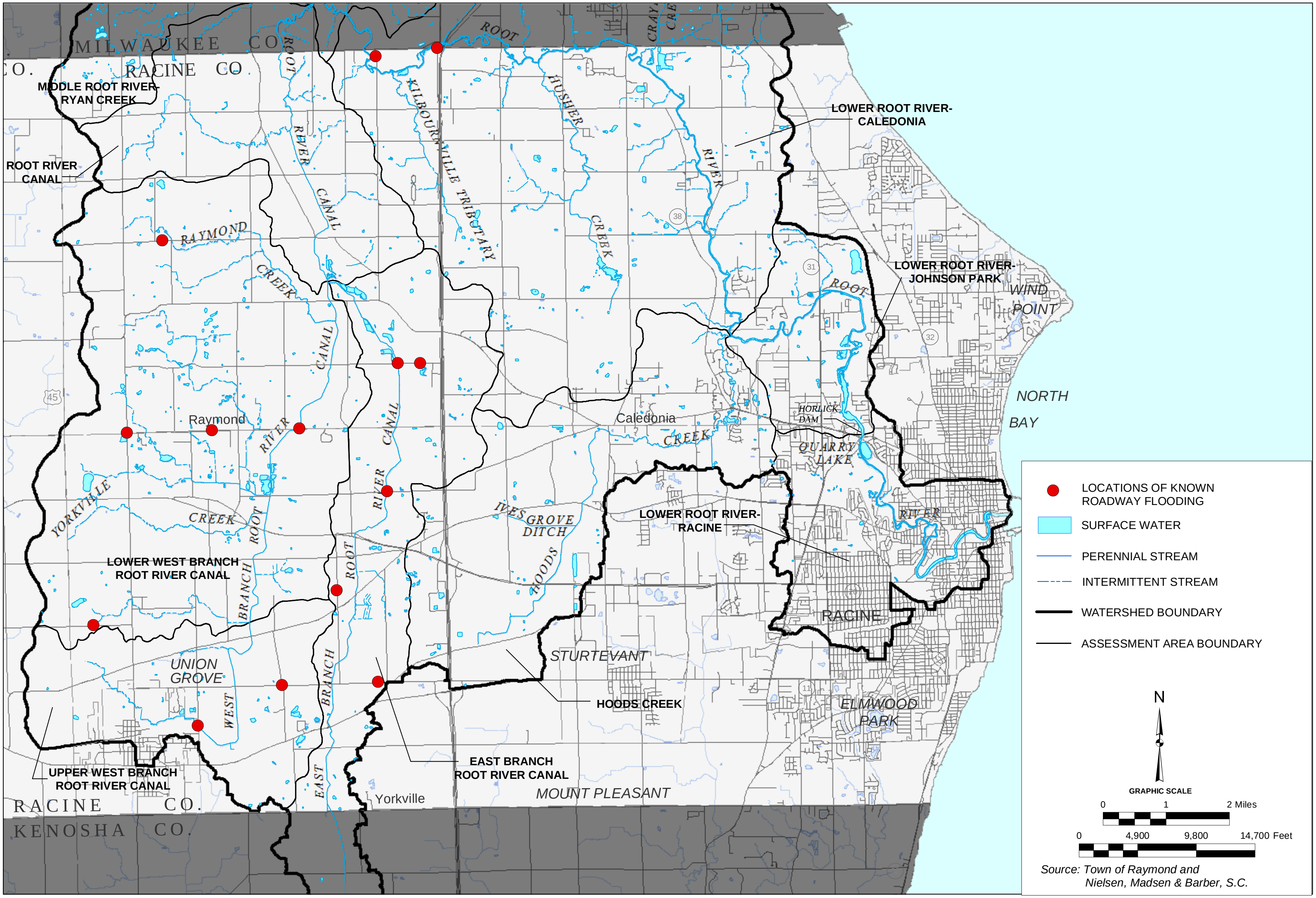
Roads known to routinely flood are shown on Map 61.

A review of the extent and severity of flooding conditions within the Racine County portion of the Root River watershed indicates that there is a significant community impact, in part, as a result of the damages caused by flooding of buildings, primarily basements, and due to disruption of the transportation system during extreme flooding events.

The flooding impacts on the community infrastructure and the need to prepare for major evacuations and other emergency actions are not a significant concern given the nature of the overland flooding problems. However, the ongoing coordinated Racine County and local emergency operations planning programs do have provisions for carrying out such actions if necessary. Significant flood-related impacts on the community economy and businesses are of an infrequent and short-term nature. The only impacts on County and local government operations which are relatively frequent involve posting and closure of roadways at locations where floodwaters frequently overtop structures and cause short-term roadway flooding. As noted earlier, east-west travel in the northeastern portion of the County is restricted due to roadway flooding under severe flood events. Another potential impact is the need for emergency and police vehicles to consider utilizing alternative transportation routes when providing needed services during periods of flooding.

Map 61

ROADWAYS WITH KNOWN FLOODING WITHIN THE RACINE COUNTY PORTION OF THE ROOT RIVER WATERSHED: 2013



Source: Town of Raymond and Nielsen, Madsen & Barber, S.C.

Agricultural Flood Damages

As previously discussed, the Root River watershed contains considerable lands that are in agricultural land uses. Most of the agricultural lands in the watershed are located in Racine County (see Map 9). Within the Racine County portion of the Root River watershed, 2,904 acres of agricultural land are within the 1-percent-annual probability flood hazard area.

Historically significant flood damages have occurred on agricultural land in Racine County. Over the period 1950 to 2008, the County experienced crop damages from flooding totaling about $36.8 million in 2012 dollars. Thus, the average annual damages in the County can be approximated at $624,000 per year. Given that in 2008 there were about 12,000 acres of agricultural land located within the identified flood hazard area in the County, the average annual flood damage is about $52 per acre.

The Racine County hazard mitigation plan considered two particularly floodprone agricultural areas of the County on a more site-specific basis. The results of these analyses can be used to refine estimates of flood damages in agricultural lands within the identified flood hazard area in the Root River watershed.

The first area is the agricultural lands lying adjacent to the Fox River in the Town of Waterford upstream of the Village of Waterford. Specific data on flood damages was developed for these lands under a 1995 water level control plan developed for the area.[234] In that planning program, 370 acres of land in the Town of Waterford were identified as being frequently flooded. Based upon estimates of the frequency of agricultural damages in a typical year, the total annual agricultural flood damages were estimated at $44,000 in 1995 dollars, or about $66,000 in 2012 dollars, and about $179 per acre per year, for the floodprone lands located in the Town of Waterford.

The second area of particular concern is lands in the Town of Norway drained by the Wind Lake Canal. These lands total about 4,000 acres, of which about 2,000 acres actually sustain damage during flood events. The frequency and severity of flooding in this area was analyzed in a 1975 drainage and water level control plan.[235] That study estimated the average annual damages on those lands at $186,000, or about $92 per acre per year. Given the estimating technique, including crop values used in 1975, the current flood damage estimates are expected to be similar. Thus in 2012 dollars, the average annual flood damage for this area was estimated at $96 per acre, or $192,000 in total, assuming 2,000 acres are impacted.

Given the foregoing, the two agricultural areas specifically considered account for about 41 percent of the agricultural damages countywide. The damages to the other approximately 9,630 acres in the floodplain area in the County would be expected to have average annual losses of about $38 per acre, or about $366,000 in total. Given that the portion of the Root River watershed that is located in Racine County includes 2,904 acres of agricultural land that is located in the flood hazard area, average annual crop losses due to flooding are estimated at $110,352 in the watershed.

Stormwater Drainage Problems

Because of the interrelationship between stormwater management and floodland management, stormwater management actions are an important consideration of the flood vulnerability assessment. Small area stormwater drainage problems are known to exist throughout the urbanized portions of the County. Most of the communities have undertaken stormwater management planning programs or initial stormwater management system

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[234] *SEWRPC Memorandum Report No. 102,* Water Level Control Plan for the Waterford-Vernon Area of the Middle Fox River Watershed, Racine and Waukesha Counties, *March 1995.*

[235] *SEWRPC Community Assistance Planning Report No. 5,* Drainage and Water Level Control Plan for the Waterford-Rochester-Wind Lake Area of the Lower Fox River Watershed, *May 1975.*

inventories as the initial step in developing comprehensive stormwater management plans. Stormwater management planning as described further in Chapter III and that planning serves as the basis of the assessment of stormwater drainage problem vulnerability.

RECREATIONAL FACILITIES AND ACCESS

The state of recreational use of and access to surface waters and riparian areas is one of the focus areas of this watershed restoration plan. While the Root River watershed is located in the most heavily urbanized portion of the State, it contains many high-quality natural resource amenities, including several small lakes and ponds, rivers and streams, attractive woodlands and wetlands, good wildlife habitat, and scenic landscapes. These resource amenities provide outdoor recreation opportunities for residents of the Southeastern Wisconsin Region. Preserving and protecting these resource amenities and finding ways to accommodate outdoor recreational activities that depend upon the natural resource base are important public policy objectives.

This section reviews the state of recreational facilities and access within the Root River watershed. It presents inventories related to four recreational features: parks and parkways, trails, access to surface waters, and nature centers.

Parks and Parkways

Park and Open Space Sites Owned or Managed by the State of Wisconsin

As indicated in Table 53 and shown on Map 62, in 2010 there were eight State-owned or managed park and open space sites in the Root River watershed, encompassing about 220 acres. Of these sites, five sites encompassing about 101 acres were either owned or managed under a conservation easement by the WDNR. One site encompassing about 108 acres was owned by the University of Wisconsin. Two sites encompassing about 12 acres were owned by the Wisconsin Department of Transportation.

The WDNR has acquired areas of park and open space land in the Root River watershed for a variety of resource protection and recreational purposes. A portion of the Big Muskego Lake Wildlife Area is located in the watershed, adjacent to Dumkes Lake. In addition, the Department has secured conservation easements on four wetland mitigation sites in the watershed.

The University of Wisconsin owns one open space site in the Root River watershed—the Renak-Polak Maple-Beech Woods, a natural area of statewide significance. This site is located in the Village of Caledonia.

The Wisconsin Department of Transportation owns two open space sites in the Root River watershed. One site was acquired as a wetland mitigation site for open space protection. This site is located in the Town of Yorkville. The other site is a wayside and memorial marker located in the Village of Caledonia.

Park and Open Space Sites Owned by the Counties

In 2010 there were 28 County-owned park and open space sites in the Root River watershed encompassing about 6,826 acres. These are shown on Map 62 and listed in Table 54. Milwaukee County owned 18 of these sites, encompassing 5,582 acres, and Racine County owned 10 of these sites, encompassing 1,244 acres. There were no County-owned park and open space sites in the portions of the watershed located in Kenosha and Waukesha Counties. There were 10 existing major county parks of 100 acres or more in size located wholly or partially within the watershed, encompassing a total of 7,595 acres. The portions of these parks located within the watershed encompass 6,308 acres. These major parks include Franklin Park, Greenfield Park, Grobschmidt Park, the Milwaukee County Sports Complex, the Oak Creek Parkway, Oakwood Park, the Root River Parkway, and Whitnall Park in Milwaukee County and Ives Grove Golf Links and the Root River Parkway in Racine County.[236]

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[236]*Portions of Greenfield Park, the Oak Creek Parkway, and Oakwood Park are located outside of the Root River watershed.*

Table 53

STATE OF WISCONSIN RECREATION AND OPEN SPACE LANDS IN THE ROOT RIVER WATERSHED: 2013

Number on Map 62	Site Name	County	Area in Watershed (acres)	Total Area (acres)
	Department of Natural Resources Sites			
M17	Statewide Wetland Mitigation Program[a]	Milwaukee	22.4	22.4
M96	Big Muskego Lake Wildlife Area	Milwaukee	63.7	525.0
R49	Statewide Wetland Mitigation Program[a]	Racine	9.5	9.5
R105	Statewide Wetland Mitigation Program[a]	Racine	0.6	0.6
R141	Statewide Wetland Mitigation Program[a]	Racine	4.7	4.7
	University of Wisconsin Sites			
R22	Renak-Polak Maple Beech Woods	Racine	107.5	107.5
	Department of Transportation Sites			
R133	32nd Division Memorial Marker and Wayside	Racine	3.6	3.6
R146	Wisconsin DOT Mitigation Site	Racine	8.0	8.0
		Total	220.0	681.3

[a]*Land under a conservation easement.*

Source: SEWRPC.

Park and Open Space Sites Owned by Local Governments and the Milwaukee Metropolitan Sewerage District

In addition to the State- and County-owned park and open space sites in the Root River watershed, in 2010 there were 132 sites owned by local units of government or the MMSD and located wholly or partially within the watershed. These sites are listed in Table 55. These sites encompass about 2,317 acres; however, portions of some sites extend outside of the watershed boundaries. The portions of these parks located within the Root River watershed encompass about 2,258 acres.

It should be noted that many of these parks are quite small, with 56 having areas of less than five acres. The locally owned park and open space sites in the Root River watershed are shown on Map 63.

Trails

Bicycle and Pedestrian

The regional park and open space plan, adopted in 1977, recommended the development of an approximately 440-mile network of hiking and bicycling trails in southeastern Wisconsin.[237] Most of the trails recommended in the regional plan were proposed to be located in areas having natural resource values of regional significance, such as the Lake Michigan shoreline, the Kettle Moraine, and the riverine areas of the Fox, Milwaukee, and Root Rivers. The regional park and open space plan, including the recreational trail component, was subsequently refined through the preparation and adoption of park and open space plans by each of the counties of the Region.[238]

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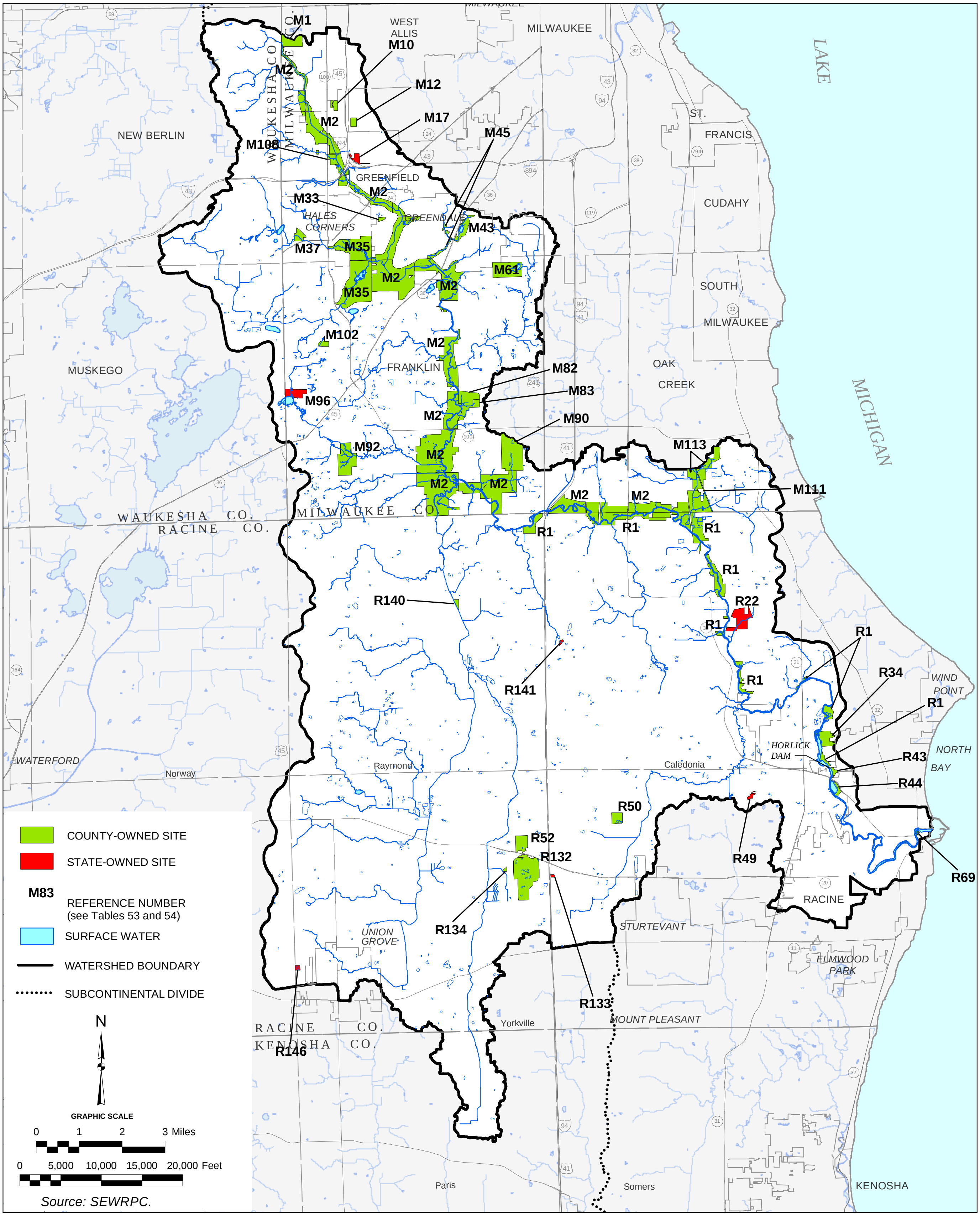
[237]*SEWRPC Planning Report No. 27,* A Regional Park and Open Space Plan for Southeastern Wisconsin: 2000, *November 1977.*

[238]*For the Root River watershed, see: SEWRPC Community Assistance Planning Report No. 131, 2nd Edition,* A Park and Open Space Plan for Kenosha County, *April 2012; SEWRPC Community Assistance Planning Report No. 132,* A Park and Open Space Plan for Milwaukee County, *November 1991; SEWRPC Community Assistance Planning Report No. 134, 3rd Edition,* A Park and Open Space Plan for Racine County, *February 2013; and SEWRPC Community Assistance Planning Report No. 137, 2nd Edition,* A Park and Open Space Plan for Waukesha County, *December 1989.*

Map 62

STATE AND COUNTY PARK AND OPEN SPACE SITES WITHIN THE ROOT RIVER WATERSHED: 2013



Source: SEWRPC.

Table 54

COUNTY RECREATION AND OPEN SPACE LANDS IN THE ROOT RIVER WATERSHED: 2013

Number on Map 62	Site Name	County	Area in Watershed (acres)	Total Area (acres)
M1	Greenfield Park	Milwaukee	63.3	282.0
M2	Root River Parkway	Milwaukee	3,817.0	3,817.0
M10	Holt Park	Milwaukee	20.6	20.6
M12	Alcott Park	Milwaukee	16.8	16.8
M33	Trimborn Park	Milwaukee	8.2	8.2
M35	Whitnall Park	Milwaukee	625.4	625.4
M37	Hales Corners Park	Milwaukee	33.1	33.1
M43	Scout Lake Park	Milwaukee	64.3	64.3
M45	Dale Creek Parkway	Milwaukee	44.7	44.7
M61	Grobschmidt Park	Milwaukee	152.0	152.0
M82	Milwaukee County Sports Complex	Milwaukee	113.6	113.6
M83	Froemming Park	Milwaukee	18.6	18.6
M90	Oakwood Park	Milwaukee	230.4	277.0
M92	Franklin Park	Milwaukee	164.5	164.5
M102	St. Martin's Park	Milwaukee	19.2	19.2
M108	Kulwicki Park	Milwaukee	27.8	27.8
M111	Former North Shore Right of Way	Milwaukee	13.1	71.0
M113	Oak Creek Parkway	Milwaukee	149.0	1,171.0
R1	Root River Parkway	Racine	703.8	703.8
R34	River Bend Nature Center	Racine	74.7	74.7
R43	Horlick Park	Racine	14.9	14.9
R44	Quarry Lake Park	Racine	39.1	39.1
R50	Haban Park	Racine	40.8	40.8
R52	Evans Park	Racine	63.4	63.4
R69	Belle Harbor Marina	Racine	4.2	4.2
R132	Ives Grove Golf Links	Racine	288.7	288.7
R134	Skewes Memorial Park	Racine	4.0	4.0
R140	Koerber Property	Racine	10.5	10.5
		Total	6,825.7	8,170.9

Source: SEWRPC.

Map 64 shows all existing bikeways and trails in the watershed as of 2010.[239] The two types of bikeways/trails shown on Map 64 accommodate a variety of users: on-street bikeways are generally used for bicycle travel only; off-street trails can be used for bicycle and pedestrian travel (which includes hiking, snowshoeing, and cross-country skiing). The trails present in the Root River watershed include the Root River Pathway and portions of the Lake Michigan Pathway, the North Shore Trail, the Oak Leaf Trail, the Racine-Sturtevant Bicycle Trail and the We Energies Trail. In addition, portions of trail systems established and maintained by the Cities of Franklin, Muskego, New Berlin, and Racine are located in the watershed. Finally, some County and local parks and nature centers also contain smaller trails, usually serving pedestrian traffic.

[239]*For purposes of this report the term "trails" refers to off-street paths and separate bicycle paths within highway right-of-way, and the term "bicycle way" refers to facilities for bicycle travel on streets, including bicycle routes and striped and signed bicycle lanes. Trails generally accommodate both foot and bicycle travel, while on-street bicycle routes and lanes generally accommodate bicycle travel only.*

Table 55

CITY, VILLAGE, TOWN, AND MMSD RECREATION AND OPEN SPACE LANDS IN THE ROOT RIVER WATERSHED: 2013

Number on Map 63	Site Name	Ownership	Area in Watershed (acres)	Total Area (acres)
Sites of Five or More Acres				
M15	Wildcat Creek Nature Corridor	City of Greenfield	7.3	7.3
M26	Shoetz Park	Village of Hales Corners	20.7	20.7
M32	84th and Grange Athletic Fields	Village of Greendale	10.6	10.6
M34	Potter's Forest	Village of Hales Corners	51.2	51.2
M38	Cobb Park	Village of Hales Corners	6.5	6.5
M41	Village Green	Village of Greendale	25.4	27.0
M48	Sherwood Heights Park	Village of Greendale	10.2	10.2
M49	Canterbury Woodlands	Village of Greendale	7.3	7.3
M53	College Park	Village of Greendale	44.6	44.6
M54	Village Green Park	Village of Greendale	7.0	7.0
M66	MMSD Conservation Plan Parcel	MMSD	9.1	9.1
M67	MMSD Conservation Plan Parcel	MMSD	9.6	9.6
M68	MMSD Conservation Plan Parcel	MMSD	71.6	71.6
M70	Pleasant View Park	City of Franklin	23.9	23.9
M74	Jack E. Workman Park	City of Franklin	12.0	12.0
M76	Cascade Creek Park	City of Franklin	8.8	8.8
M80	Lion's Legend Park	City of Franklin	40.7	40.7
M85	Meadowlands Park	City of Franklin	13.8	13.8
M87	MMSD Conservation Plan Parcel	MMSD	15.6	15.6
M89	Ollie Pederson Field	City of Franklin	20.2	20.2
M93	MMSD Conservation Plan Parcel	MMSD	49.9	49.9
M94	MMSD Conservation Plan Parcel	MMSD	33.4	33.4
M95	MMSD Conservation Plan Parcel	MMSD	11.4	11.4
M104	Ernie Lake Park	City of Franklin	13.5	13.5
M105	Mission Hills Neighborhood Wetlands	City of Franklin	13.7	13.7
M115	Haas Park	City of Oak Creek	7.0	7.0
M118	Mardeand Park	City of Oak Creek	7.8	7.8
M121	Brookside Meadow Drive Park Site	City of Greenfield	14.8	14.8
R5	Village-owned Land	Village of Caledonia	7.2	7.2
R6	Gorney Park	Village of Caledonia	40.1	40.1
R9	County Line Park	Village of Caledonia	17.4	17.4
R23	Linwood Park	Village of Caledonia	17.5	17.5
R30	Johnson Park	City of Racine	334.5	334.5
R32	Johnson Park Dog Run	City of Racine	27.4	27.4
R33	Nicholson Wildlife Refuge	Village of Caledonia	126.4	126.4
R38	Village-owned Land	Village of Caledonia	21.2	21.2
R40	Caledonia/Mt. Pleasant Memorial Park	Village of Caledonia	52.5	52.5
R47	Colonial Park	City of Racine	74.1	74.1
R48	Drozd Park	Village of Mt. Pleasant	6.1	6.1
R54	Wustum Museum	City of Racine	9.9	9.9
R57	Horlick Athletic Field	City of Racine	6.0	9.0
R75	North Beach	City of Racine	16.8	49.0
R91	Clayton Park	City of Racine	6.0	6.0
R97	Island Park	City of Racine	22.0	22.0
R102	Brose Park	City of Racine	4.9	4.9
R103	Lincoln Park	City of Racine	24.4	24.4
R109	Maple Grove Park	City of Racine	5.0	5.0

Table 55 (continued)

Number on Map 63	Site Name	Ownership	Area in Watershed (acres)	Total Area (acres)
Sites of Five or More Acres (continued)				
R113	N. Owen Davies Park	City of Racine	5.5	5.5
R117	Washington Park Golf Course	City of Racine	92.2	92.2
R120	Erskine Park	City of Racine	8.0	8.0
R124	Humble Park	City of Racine	14.4	17.0
R125	Hantschel Park	City of Racine	7.6	7.6
R130	Lockwood Park	City of Racine	38.0	38.0
R131	Village-owned Land	Village of Mt. Pleasant	74.6	74.6
R138	Lauer Wildlife Preserve	Village of Union Grove	13.9	13.9
R142	School Yard Park	Village of Union Grove	6.0	6.0
R144	Joseph Leider Memorial Park	Village of Union Grove	9.7	9.7
R145	Lincoln's Woods Park	Town of Yorkville	18.3	18.3
R161	American Legion Memorial Park	Village of Union Grove	10.6	10.6
R163	Raymond Town Park	Town of Raymond	9.5	9.5
W1	Gatewood Park	City of New Berlin	9.2	9.2
W3	New Berlin Hills Golf Course	City of New Berlin	188.5	188.5
W4	Lions Park	City of New Berlin	26.1	40.0
W5	Hickory Grove Senior Center	City of New Berlin	7.7	7.7
W6	Pro Health Care Park	City of New Berlin	23.8	28.0
W8	Fountain Square Conservancy Area	City of New Berlin	11.5	11.5
W11	Biwer Park	City of New Berlin	8.8	8.8
W13	Weathersone Park	City of New Berlin	8.4	8.4
W14	Maple Ridge Park	City of New Berlin	8.0	8.0
W16	Valley View Park	City of New Berlin	73.8	73.8
W17	High Grove Park	City of New Berlin	14.9	14.9
W18	Open Space Site	City of New Berlin	17.3	17.3
W22	Open Space Site	City of Muskego	8.6	8.6
W23	Schmidt Park	City of Muskego	6.6	6.6
W25	Kurth Park	City of Muskego	17.9	17.9
W26	Bluhm Farm Park	City of Muskego	50.0	50.0
Sites of Less than Five Acres (not labeled)				
- -	Dr. Lynette Fox Memorial Park	City of Franklin	0.4	0.4
- -	Friendship Park	City of Franklin	1.6	1.6
- -	Glenn Meadows Park	City of Franklin	1.3	1.3
- -	Ken Windl Park	City of Franklin	3.7	3.7
- -	Market Square	City of Franklin	0.5	0.5
- -	Dan Jansen Park	City of Greenfield	3.1	3.1
- -	Falcon View Park	City of Greenfield	1.6	1.6
- -	Jim Smrz Park	City of Greenfield	0.7	0.7
- -	Lavies Park	City of Greenfield	0.6	0.6
- -	Gra-Ram Playfield	City of Milwaukee	4.6	4.6
- -	Kelly Lake Park	City of New Berlin	0.9	0.9
- -	Lagoon Parkway	City of New Berlin	1.3	1.3
- -	Open Space Site	City of New Berlin	3.1	3.1
- -	Open Space Site	City of New Berlin	0.3	0.3
- -	Barbee Park	City of Racine	1.1	1.1
- -	Bicentenial Gardens	City of Racine	0.2	0.2
- -	Builders Park	City of Racine	0.2	0.2
- -	Case Corporation Easement	City of Racine[a]	3.2	3.2
- -	Cedar Bend Park	City of Racine	3.0	3.0

Table 55 (continued)

Number on Map 63	Site Name	Ownership	Area in Watershed (acres)	Total Area (acres)
Sites of Less than Five Acres (not labeled) (continued)				
- -	City Hall	City of Racine	0.6	0.6
- -	City-owned Lane	City of Racine	0.6	0.6
- -	City-owned Site	City of Racine	0.4	0.4
- -	Colbert Park	City of Racine	0.8	0.8
- -	Dr. Martin Luther King, Jr. Park	City of Racine	2.3	2.3
- -	Dr. Martin Luther King, Jr. Plaza	City of Racine	0.3	0.3
- -	Dr. Pierce Park	City of Racine	0.1	0.1
- -	Franklin Park	City of Racine	3.8	3.8
- -	Gaslight Pointe	City of Racine	0.5	0.5
- -	Harris Plaza	City of Racine	0.1	0.1
- -	Harvey Park	City of Racine	2.2	2.2
- -	John Thompson Park	City of Racine	0.6	0.6
- -	Jones Park	City of Racine	0.6	0.5
- -	Lee Park	City of Racine	2.6	2.6
- -	Marino Park	City of Racine	2.6	2.6
- -	Marquette Park	City of Racine	0.8	0.8
- -	Mary Ellen Helgren Johnson Preserve	City of Racine	3.7	3.7
- -	Memorial Drive West	City of Racine	0.6	0.6
- -	Parker Park	City of Racine	0.9	0.9
- -	Randolph Park	City of Racine	0.2	0.2
- -	Riverside Park	City of Racine	1.3	1.3
- -	Rooney Recreation Areal	City of Racine	0.3	0.3
- -	Sam Azarian Outlook	City of Racine	0.7	0.7
- -	6th Street Park North	City of Racine	1.6	1.6
- -	6th Street Park South	City of Racine	2.1	2.1
- -	Solbraa Park	City of Racine	2.6	2.6
- -	Springvale East Park	City of Racine	0.4	0.4
- -	Springvale West Park	City of Racine	3.3	3.3
- -	State Hamilton Park	City of Racine	<0.1	<0.1
- -	Tyler-Domer Community Center	City of Racine	3.2	3.2
- -	Ambruster Fields Open Space	Village of Greendale	1.8	1.8
- -	Brentwood Hill Park	Village of Greendale	0.9	0.9
- -	Lions Park	Village of Greendale	2.7	2.7
- -	Bufton Park	Village of Union Grove	0.6	0.6
- -	Ryan Moc/Michael Young Memorial Park	Village of Union Grove	3.5	3.5
- -	Village Square	Village of Union Grove	0.2	0.2
- -	MMSD Greenseams Parcel	MMSD	0.9	0.9
		Total	2,258.2	2,316.7

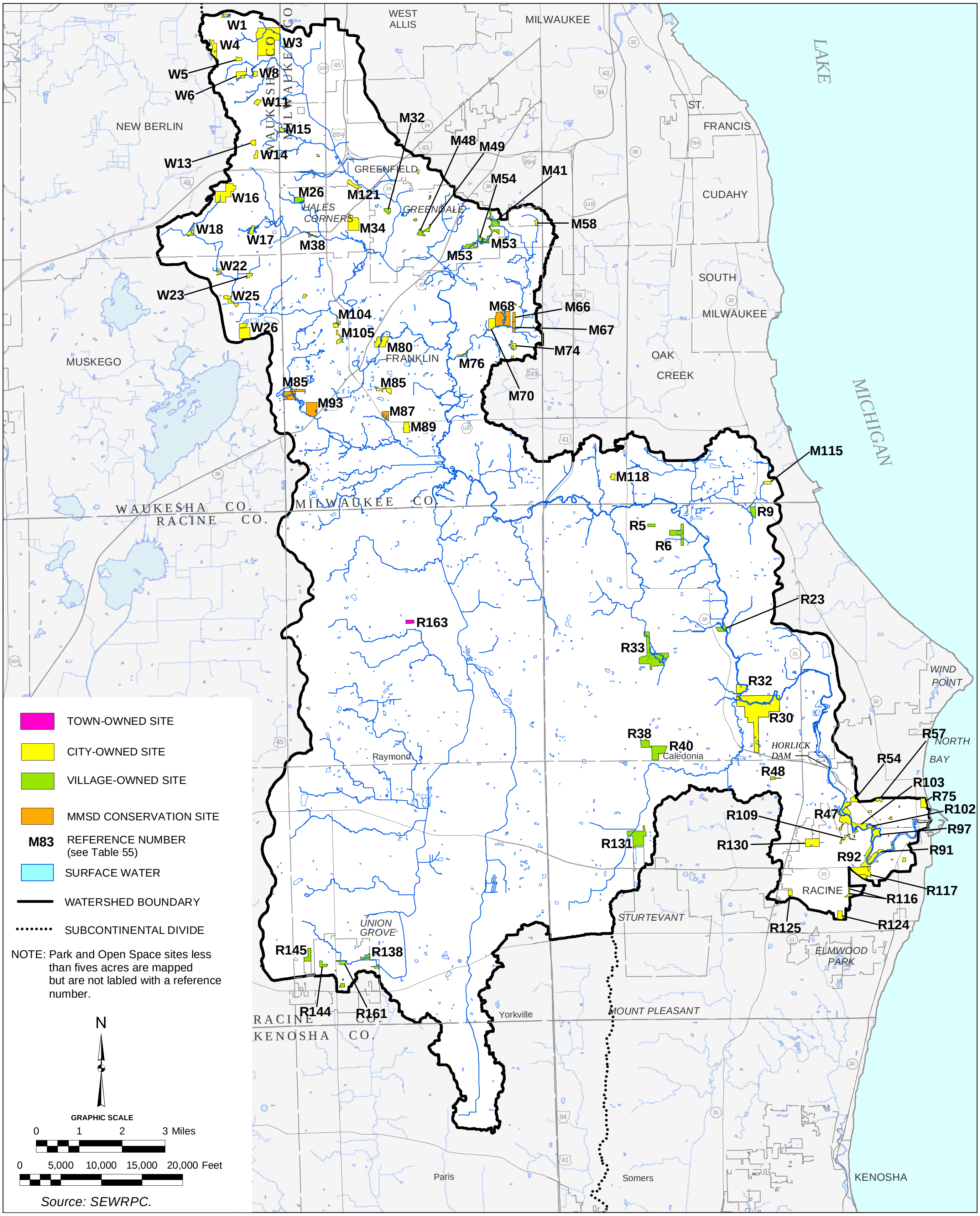
[a]*Land under a conservation easement.*

Source: SEWRPC.

In Milwaukee County, existing trails include about 23 miles of the Oak Leaf Trail and about four miles of the City of Franklin's trails. In addition, there are trails in several Milwaukee County Parks, including Greenfield Park, Grobschmidt Park, the Root River Parkway, Scout Lake Park, and Whitnall Park. These parks contain about 13 miles of trails. The portion of the watershed in Racine County currently contains about 37 miles of trails, including 11 miles of off-street trails and 26 miles of on-street trails. In Waukesha County, the Cities of Muskego and New Berlin have about 1.8 miles and 3.8 miles, respectively, of off-street trails located in the watershed.

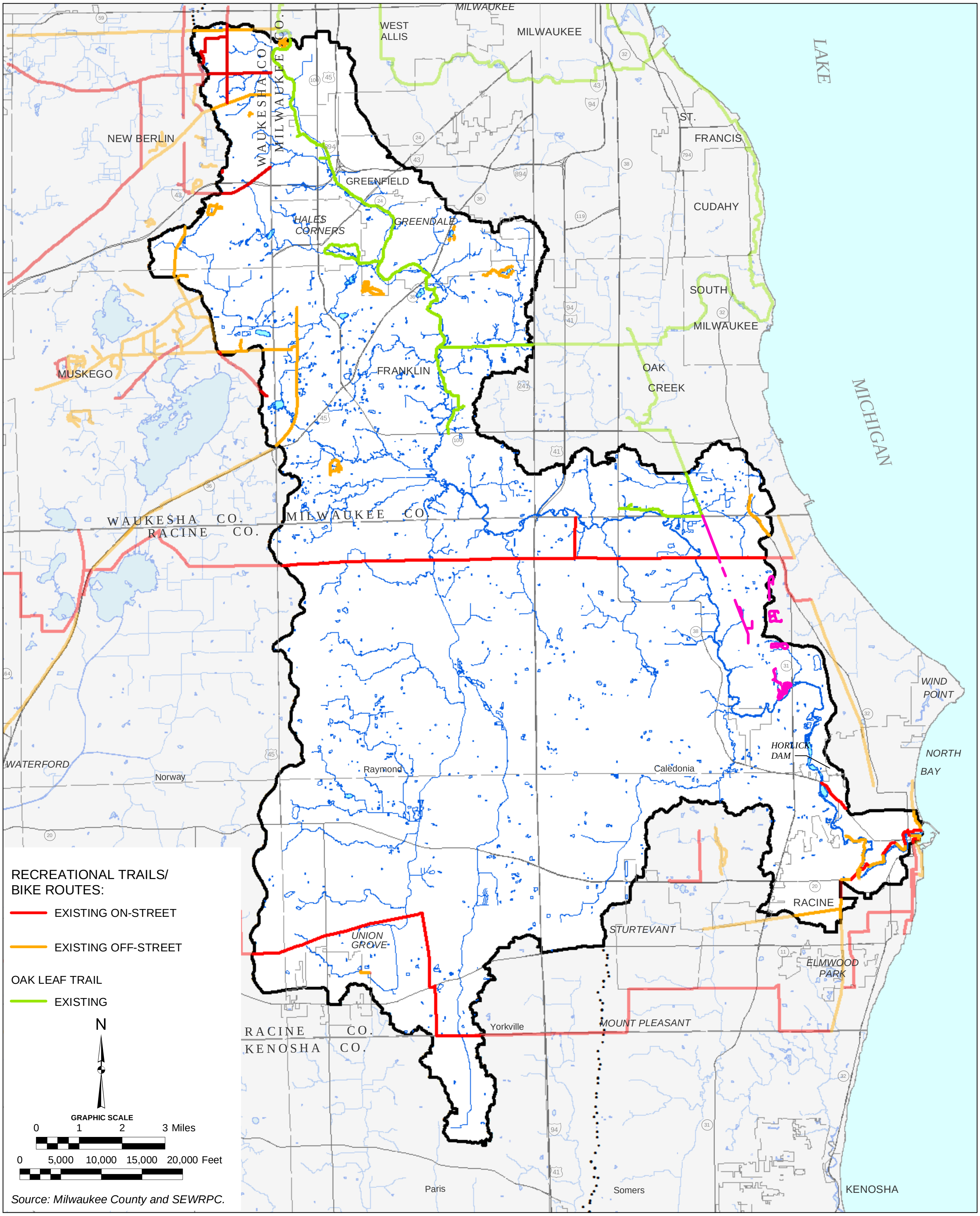
Map 63

CITY-, VILLAGE-, TOWN-, AND MMSD-OWNED PARK AND OPEN SPACE SITES WITHIN THE ROOT RIVER WATERSHED: 2013



Map 64

EXISTING RECREATIONAL TRAILS AND BIKE ROUTES WITHIN THE ROOT RIVER WATERSHED: 2013



Source: Milwaukee County and SEWRPC.

There are about six miles of on-street bicycle trails in the portion of the watershed in the City of New Berlin. Finally, a 1.2-mile-portion of the We Energies trail straddles the Milwaukee-Racine County line in the eastern portion of the watershed.

Bicycle use can and does legally occur on many public roadways in the Root River watershed that are not specifically designated for such use. State law permits bicycle use on all public roadways, except expressways and freeways, and on those roadways where the local government concerned has acted to prohibit bicycle use by ordinance.

Equestrian Trails

The Caledonia Conservancy manages about 36 miles of equestrian trails in and adjacent to the Root River watershed. These trails are located on Conservancy property and private land. They are generally located in the Village of Caledonia north of 5 Mile Road and west of STH 31 to the Root River.

Access to Surface Waters

Boat Access

Canoes and Kayaks

The Root River provides a diverse set of paddling conditions for canoeing and kayaking. At lower water levels, the River provides quiet paddling. At higher water levels, the River provides some fast rapids. Under favorable conditions, most of the River below the downstream crossing of the Milwaukee-Racine County Line is suitable for quiet-water paddling.[240] It should be noted that during periods of high water, flows in the section of the River immediately below Horlick dam may be too fast for quiet-water boats. According to local canoeists, the four-mile section of the River above Horlick dam and the mile of River immediately above the confluence with Lake Michigan are generally deep enough to support canoeing and kayaking at most times. The suitability of other sections of the River in Racine County for canoeing and kayaking depend upon water levels.[241]

The River contains several potential hazards to canoeists and kayakers. Two sections of the River contain series of rapids or riffles. One of these sections begins upstream of the 6 Mile Road crossing and ends upstream of the 5 Mile Road crossing. The other section is within Johnson Park. The rapids or riffles in these sections of the River tend to be short and easy for paddlers to navigate.[242] When higher water levels are present, more substantial rapids occur in the section of River immediately below Horlick dam. This constitutes the only section of whitewater on the River. Two dams along the River, Horlick dam and the weir at the Root River Steelhead Facility, constitute hazards to paddlers. No portage is available around Horlick dam. Other hazards that may be present include low bridges—especially in parks, low hanging branches, and log jams.

Sites providing access to the Root River by canoes and kayaks are shown on Map 65. Below Horlick dam several access points are available within the City of Racine, including canoe launches at Clayton Park, Island Park, Lincoln Park, and 6th Street Park South. In addition, a boat launch is available at Colbert Park. Above Horlick dam, a boat launch is available at Horlick Park. While there are no developed launch areas upstream from this landing, paddlers launch and take out canoes and kayaks at a number of parks and road crossings along the River, including River Bend Nature Center, Linwood Park, 4 Mile Road, 6 Mile Road, 7 Mile Road, and E. County Line Road.

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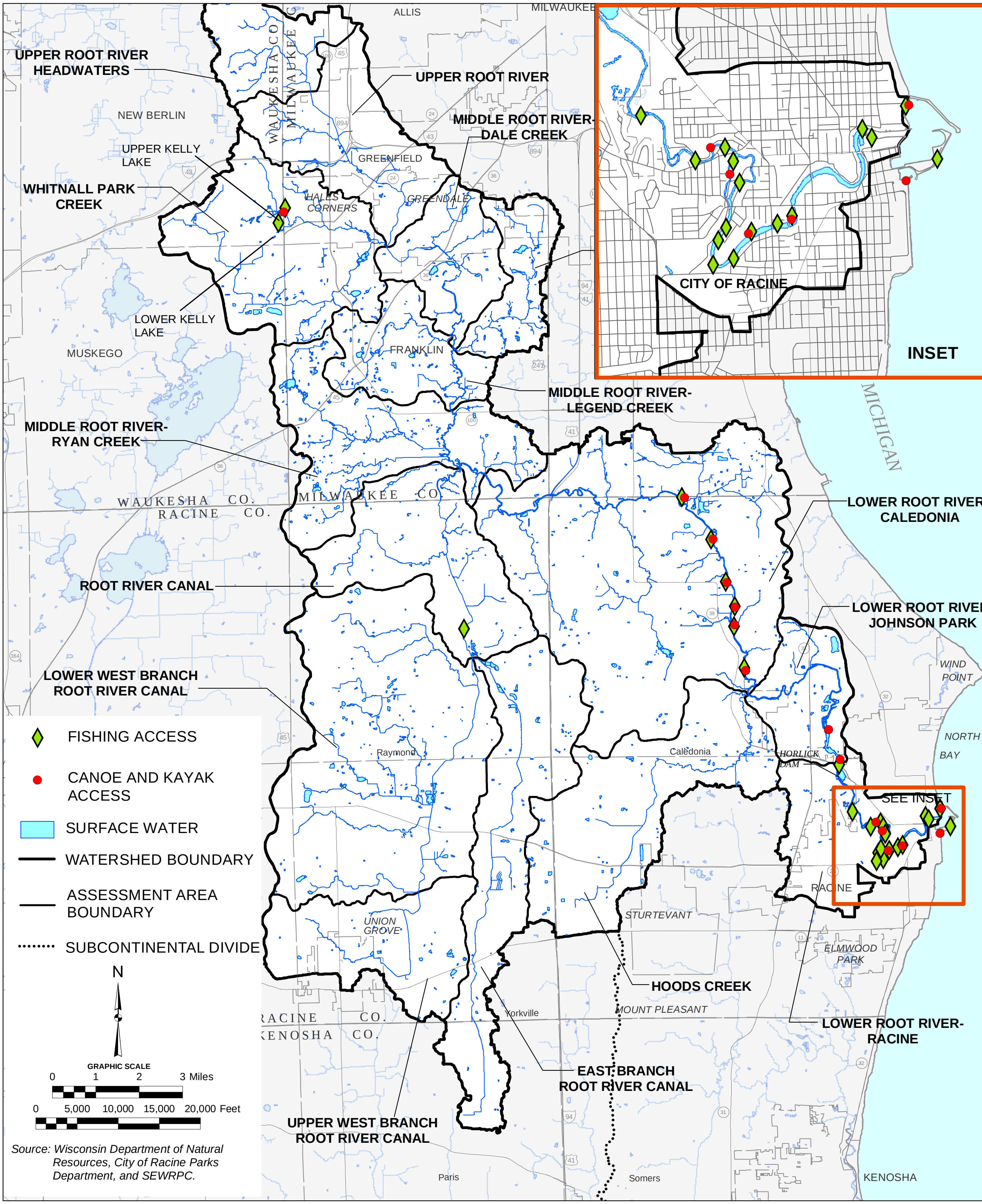
[240]*This crossing is east of the intersection of S. Nicholson Road and E. County Line Road.*

[241]*D. Piasecki, "Root River (Racine County) Canoe Routes,"* http://www.trailville/wiki/WI_Racine_Root_River, *accessed April 2, 2013.*

[242]Ibid.

Map 65

FISHING, CANOE, AND KAYAK ACCESS WITHIN THE ROOT RIVER WATERSHED: 2013



Access points are also available for boats, canoes, and kayaks on Upper Kelly Lake and Lower Kelly Lake (see Map 65). Two sites are available on Upper Kelly Lake: a public boating access on the northeastern shore and a City of New Berlin park on the southern shore. The latter site has roadside parking space for about five motor vehicles. The eastern shore of Lower Kelly Lake has one carry-in access site.

Motorized Boats
Because of low water levels, most of the Root River and its tributaries are not suitable for motorized boats. Boat launches are available at Colbert and Horlick Parks. In addition, some of the marinas and yacht clubs on the River have drive-in boat launches available (see below). As previously noted, public boating access in available on the northeastern shore of Upper Kelly Lake.

Marinas
Eleven marinas and yacht clubs are located on the Root River in the City of Racine or in the Racine harbor. Their locations are shown on Map 66. All are located downstream of the Marquette Street bridge. They primarily provide slips, storage, and facilities serving recreational boating on Lake Michigan. As shown in Table 56, four of these facilities have drive-in boat launches available. All of the facilities located in the Racine harbor are currently certified through the Wisconsin Clean Marina Program. In addition, as of December 2010 Racine Riverside Marina had committed to pursue certification.

Fishing Access
The surface waters of the Root River watershed may be accessed for fishing through a number of means. As previously noted, there are public boat launches on the mainstem of the Root River at Colbert and Horlick Parks and on Upper Kelly Lake. Carry-in access for canoes is also available at several locations. Finally, three marinas and yacht clubs in the City of Racine have drive-in boat launches available.

Access from Banks
Fishing access to the surface waters of the Root River watershed is also available from shorelines within public lands adjacent to the River and its tributary streams. For the most part, the River and its tributaries can be accessed from any adjacent public lands that the angler can legally access and where local ordinances do not prohibit fishing. Access points in parks and parkways along the Root River are shown on Map 65. Bank fishing is available at many of the parks along the Root River. In addition, seven small lakes and ponds in the watershed are managed as urban fishing waters. These are described in the next section.

Urban Fishing Waters Program
Under the State's urban fishing water program, seven small lakes and ponds of less than 25 acres are managed to provide fishing opportunities in urban areas of the watershed. These lakes and ponds are managed cooperatively by the WDNR and participating municipalities. These urban fishing waters are posted with signs, have special regulations, and have shorelines that are accessible to the public.

Special regulations on designated urban waters in southeastern Wisconsin include:

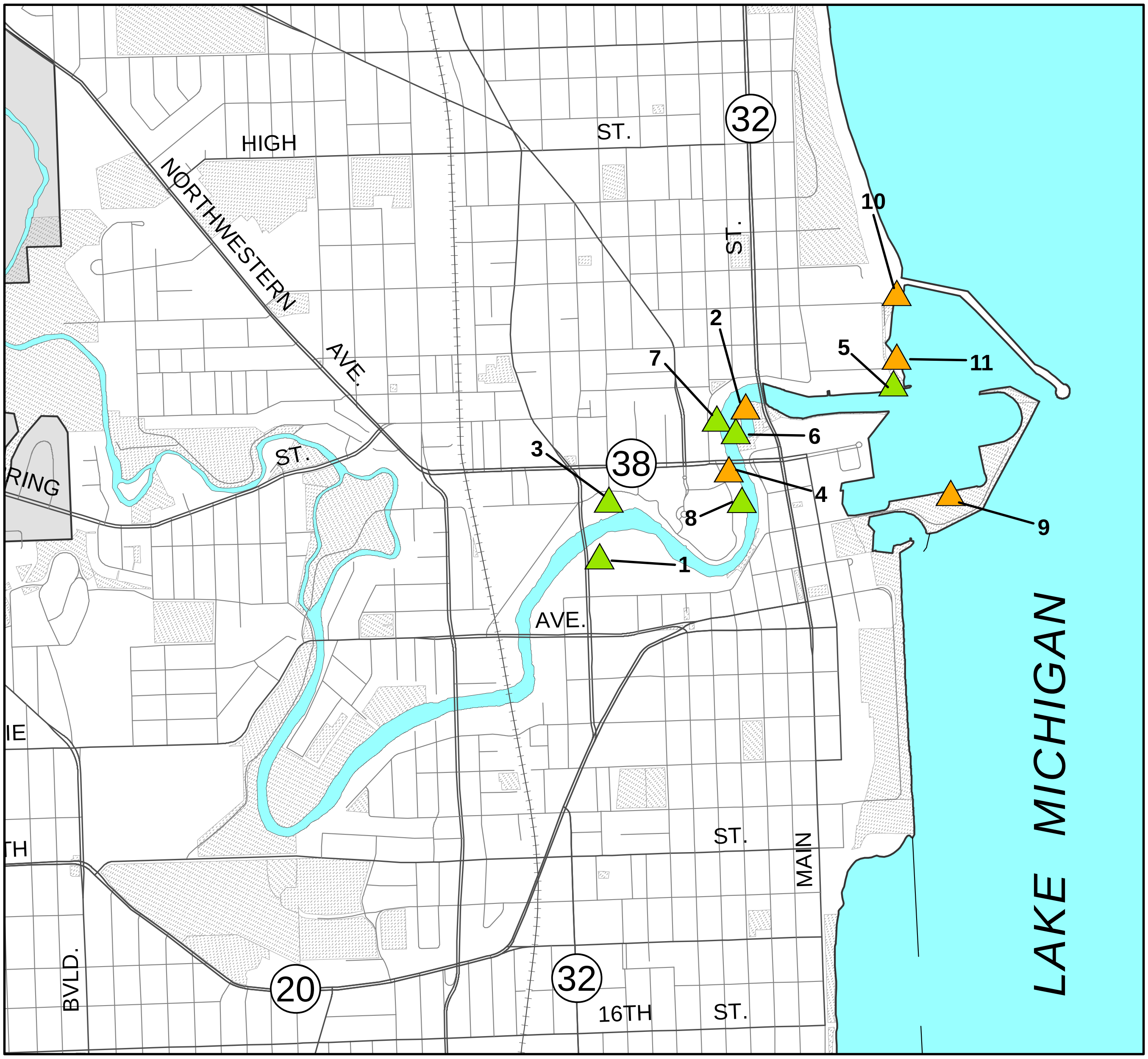
- A year-round fishing season;
- No length limits on the fish caught; and
- A special season for children 15 years of age and younger and for certain disabled anglers.

These waters also have a daily bag limit of:

- Three trout;
- One gamefish (largemouth and smallmouth bass, walleye, sauger, and northern pike); and
- Ten panfish (bluegill, crappie, pumpkinseed, yellow perch, and bullhead).

Map 66

MARINAS AND YACHT CLUBS ON THE ROOT RIVER: 2013



LEGEND

PUBLICLY-OWNED SITE

PRIVATELY-OWNED SITE

8 REFERENCE NUMBER (see Table 56)

SURFACE WATER

N

GRAPHIC SCALE

0 0.25 0.5 Miles

0 1,250 2,500 Feet

Source: City of Racine and SEWRPC.

Table 56

MARINAS AND YACHT CLUBS LOCATED ALONG THE ROOT RIVER: 2013

Number on Map 66	Name	Address	Slips	Drive-In Boat Launch	Certified Clean Marina[a]
1	Azarian and Sons Marina	726 Water Street, Racine	166	N	N
2	Belle Harbor Marina	298 1st Street, Racine	N/A	N	N
3	Fifth Street Yacht Club	761 Marquette Street, Racine	N/A	Y	N
4	Harbor Lite Yacht Club	559 State Street, Racine	N/A	Y	N
5	Pugh Marina	1001 Michigan Boulevard, Racine	128	N	N
6	Pugh Marina on the Lake Up River	Sam's River Road, Racine	22	N	N
7	Racine Riverside Marina	950 Erie Street, Racine	N/A	Y	N[b]
8	West Shore Marine	811 Ontario Street, Racine	30	N	N
9	Reef Point Marina	2 Christopher Columbus Causeway, Racine	921	N	Y
10	Racine Yacht Club	1 Barker Street, Racine	N/A	N	Y
11	Rooney Park	5 Hubbard Street, Racine	N/A	Y	Y

NOTE: N/A indicates that the information was not available.

[a]*Marinas can be certified as clean marinas through the Wisconsin Clean Marina Program if they have voluntarily adopted sufficient best management practices and met the standard for certification. Certification is reviewed every three years.*

[b]*As of December 2, 2010, Racine Riverside Marina had committed to actively pursuing designation as a Wisconsin Clean Marina.*

Source: SEWRPC.

The urban fishing waters located in the watershed are shown on Map 67 and listed in Table 57. All are accessible to the public from the shoreline. In addition, Quarry Lake and Scout Lake have piers that are handicap-accessible. Management of these ponds includes fish stocking. In 2012, the WDNR stocked about 9,200 catchable-size rainbow trout into these waters.

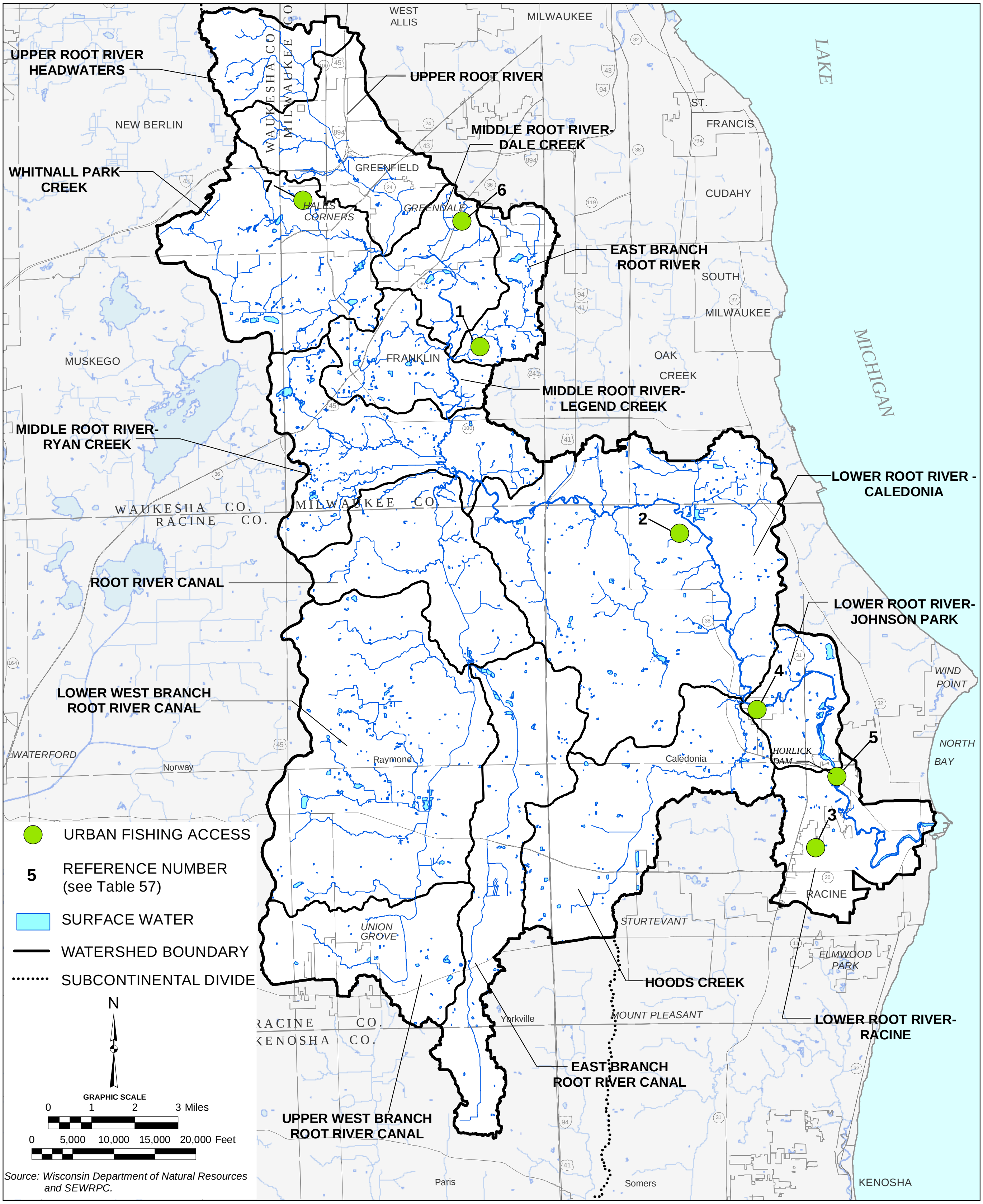
Nature Centers and Other Facilities

As described in Chapter III of this report, three nature centers are located within the Root River watershed: River Bend Nature Center, the Root River Environmental Education Community Center, and Wehr Nature Center. Each of these centers offers a unique set of programming with common offerings including field trip opportunities for school groups, nature and environmental education programs for visitors, natural history and environmental education programs for adults and families, summer day camps for school-aged children, training and educational resources for educators, and materials for self-guided activities, such as nature study.

These centers also conduct or support outdoor recreation programs. Two of the centers in the Root River watershed, River Bend Nature Center and Wehr Nature Center, have trail systems for hiking and nature study. The Root River Environmental Education Community Center is connected to urban bicycle trails. Two of these facilities provide accesses to waterbodies for fishing, canoeing, and kayaking. Two of these centers rent or loan outdoor recreation equipment. A summary of the outdoor recreation programs and facilities of the nature centers that are located within the Root River watershed is given in Table 6 in Chapter III of this report.

Map 67

URBAN FISHING SITES WITHIN THE ROOT RIVER WATERSHED: 2013



Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 57

URBAN FISHING WATERS IN THE ROOT RIVER WATERSHED: 2012

Number on Map 67	Lake or Pond	Municipality	Shoreline Accessible to Public	Fishing Pier	Catchable-Size Rainbow Trout Stocked in 2012
1	Franklin High School Pond.......	City of Franklin	Y	N	500
2	Gorney Park	Village of Caledonia	Y	N	2,000
3	Lockwood Park........................	City of Racine	Y	N	300
4	Johnson Park	City of Racine	Y	M	400
5	Quarry Park	Racine County	Y	Y	3,000
6	Scout Park...............................	Village of Greendale	Y	Y	2,250
7	Shoetz Park.............................	Village of Hales Corners	Y	N	750

Source: Wisconsin Department of Natural Resources and SEWRPC.

Root River Recreational Use Surveys

In order to assess the amount of recreation use of the mainstem of the Root River, the Commission staff conducted a series of recreational use surveys. Two types of surveys were conducted:

- Counts of watercraft on the River and
- Counts of the numbers of persons participating in a variety of outdoor recreational activities on the River and in the adjacent riparian corridor.

These surveys were conducted at 18 sites along the mainstem of the Root River during May and June, 2013. These sites are shown on Map 68. These sites were all located within the lower 19 miles of the River, where the water depth allows use by canoes and kayaks. The sites include parks, nature centers, and boat landings. Surveys were also conducted at several road crossings that staff had reasons to believe were being used for access to the River for recreational purposes. Surveys were conducted at each site on three to five occasions. During each visit, activity in the River and the adjacent corridor was observed for 20 minutes. At each site, surveys were conducted both on weekdays and weekends and during the morning and afternoon. Most sites were surveyed both in early May and in late June.

Table 58 shows direct counts of watercraft observed on the mainstem of the Root River. Several things are revealed in these data. On most occasions at most sites, no watercraft were observed on the River. In fact, no watercraft were observed on the River at any time at any site during the surveys conducted in early May. The most commonly observed class of watercraft consisted of canoes and kayaks. Dinghy-type boats were also observed.

Table 59 shows counts of persons participating in outdoor recreation activities on the mainstem of the Root River and in the adjacent riparian corridor. Of over 557 persons observed, the majority were participating in land-based activities in the riparian corridor. The most commonly observed water-based activity consisted of people fishing from the riverbank. Sixty-two persons were observed fishing from the bank. This is about three times the number of persons observed participating in activities involving boats and other watercraft. More recreational activity was observed during weekend visits to sites than during weekday visits. The total number of persons observed participating in recreational activities at the 18 sites during 39 weekend visits was about 415, while the total number observed during 36 weekday visits was 142. To adjust for the differences between the numbers of visits on weekends and weekdays, these totals were normalized by dividing them through by the number of visits. The average number of persons observed at these sites on weekends was 10.6 persons per site per visit. The average number observed on weekdays was 3.9 persons per site per visit. The results were similar when the numbers of

Map 68

RECREATIONAL USE SURVEY SITES WITHIN THE ROOT RIVER WATERSHED: 2013

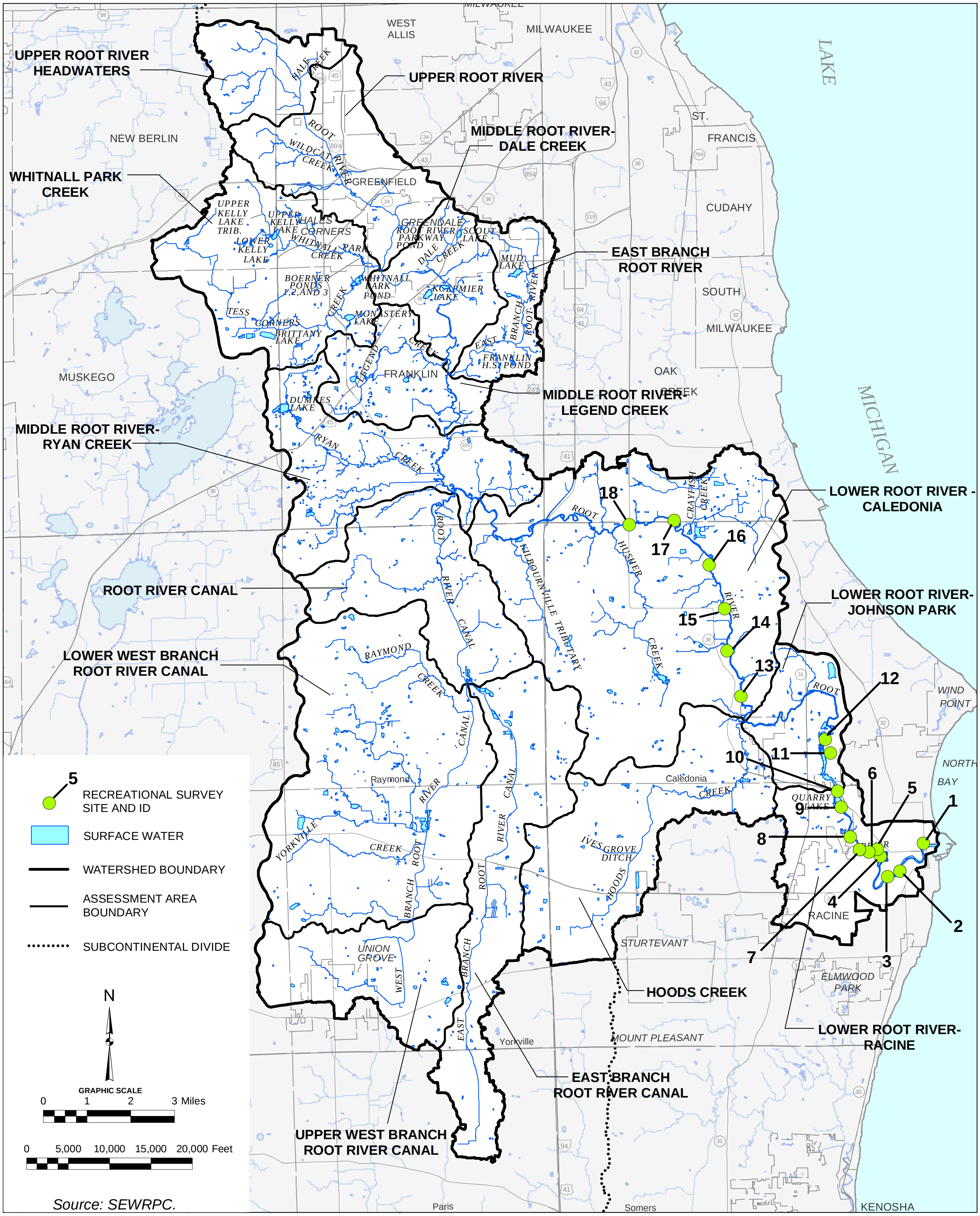


Table 58

WATERCRAFT OBSERVED ON THE MAINSTEM OF THE ROOT RIVER: MAY-JULY 2013

Site Number on Map 68	Site	Canoes and Kayaks	Fishing Boats	Dinghies	Total
1	Colbert Park				
	Weekdays				
	May 7, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	June 27, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0
	Weekends				
	May 4, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	June 30, 2013, 12:00 noon to 2:00 p.m.	0	0	3	3
2	REC Center				
	Weekdays				
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 27, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0
	Weekends				
	May 4, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	June 30, 2013, 12:00 noon to 2:00 p.m.	2	0	0	2
	June 30, 2013, 2:00 p.m. to 4:00 p.m.	2	0	0	2
3	Clayton Park				
	Weekdays				
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 27, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0
	Weekends				
	May 4, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	June 30, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
4	Island Park				
	Weekdays				
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 27, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0
	Weekends				
	May 4, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	June 30, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	June 30, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
5	Brose Park				
	Weekdays				
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 27, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	Weekends				
	May 4, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
6	Lincoln Park				
	Weekdays				
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 27, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	Weekends				
	May 4, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
7	Root River Steelhead Facility				
	Weekdays				
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 27, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	Weekends				
	May 4, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0

Table 58 (continued)

Site Number on Map 68	Site	Canoes and Kayaks	Fishing Boats	Dinghies	Total
8	Colonial Park				
	Weekdays				
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 27, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	Weekends				
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
9	Quarry Lake Park				
	Weekdays				
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 27, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	Weekends				
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
10	Horlick Park				
	Weekdays				
	June 27, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	Weekends				
	June 30, 2013, 10:00 a.m. to 12:00 noon	3	0	0	3
	June 30, 2013, 2:00 p.m. to 4:00 p.m.	1	0	0	1
11	River Bend Nature Center				
	Weekdays				
	May 7, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	Weekends				
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
12	Armstrong Park[a]				
	Weekdays				
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	Weekends				
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
13	Four Mile Road				
	Weekdays				
	May 7, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	Weekends				
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
14	Linwood Park				
	Weekdays				
	May 7, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	June 27, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	Weekends				
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 30, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0
	June 30, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
15	Six Mile Road				
	Weekdays				
	May 7, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	Weekends				
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0

Table 58 (continued)

Site Number on Map 68	Site	Canoes and Kayaks	Fishing Boats	Dinghies	Total
16	Seven Mile Road				
	Weekdays				
	May 7, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	Weekends				
	June 30, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0
17	E. County Line Road at Nicholson Road				
	Weekdays				
	May 7, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	Weekends				
	May 4, 2013, 4:00 p.m. to 6:00 p.m.	0	0	0	0
	June 30, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0
18	STH 38 near Milwaukee-Racine County Line				
	Weekdays				
	May 7, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0
	Weekends				
	May 4, 2013, 4:00 p.m. to 6:00 p.m.	0	0	0	0
	June 30, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0

Source: SEWRPC.

parked cars at sites during weekend visit were compared to the numbers at sites during weekday visits. The average number of parked cars observed at these sites on weekends was 6.2 cars per site per visit. The average number observed on weekdays was 2.2 cars per site per visit. Both the counts of persons and the counts of parked cars suggest that the number of people using these sites on weekends is about 2.7 times the number using them on weekdays.

Recreational use of the Root River can also be assessed through examining data on the rental of canoes and kayaks in the watershed. Canoe and kayak rentals are available at two nature centers in the watershed, the Root River Environmental Education Community Center (REC Center) and River Bend Nature Center. Recent data are available from both of these nature centers. The REC Center was open for eight days in June 2013. They reported having 49 canoe and kayak rentals during that month, giving an average of about six rentals per day.[243] For the 24-week period beginning in mid-May 2013 and ending at end of October 2013, River Bend Nature Center reported 966 hours of canoe and kayak rentals to 1,256 individuals. The average daily rentals over this period were about 5.8 hours per day to 7.5 individuals. River Bend Nature Center also reported about 480 hours of fishing by 320 children attending summer camps at the Center during 2013.

[243]*The REC Center also reported that an additional 54 persons rented canoes and kayaks at a community outreach event; however, they did not record how many boats were rented at this event.*

Table 59

RECREATIONAL USE ON AND ADJACENT TO THE MAINSTEM OF THE ROOT RIVER: 2013

Site Number on Map 68	Site	Activities Observed											Parked Cars
		Park Goers	Canoeing/ Kayaking	Pleasure Boating	Operating Personal Watercraft	Fishing from Shore	Fishing from Boat	Hiking/ Walking/ Running	Biking	Swimming	Bird Watching	Total	
1	Colbert Park												
	Weekdays												
	May 7, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	June 27, 2013, 8:00 a.m. to 10:00 a.m.	1	0	0	0	2	0	0	0	0	0	3	2
	Weekends												
	May 4, 2013, 10:00 a.m. to 12:00 noon	1	0	0	0	0	0	0	0	0	0	1	0
	June 30, 2013, 12:00 noon to 2:00 p.m.	0	0	6	2	0	0	0	0	0	0	8	0
2	REC Center												
	Weekdays												
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	June 27, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0	2	0	0	1	0	0	3	2
	Weekends												
	May 4, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	3	0	0	3	0
	June 30, 2013, 12:00 noon to 2:00 p.m.	0	2	0	0	5	0	0	0	0	0	7	4
	June 30, 2013, 2:00 p.m. to 4:00 p.m.	1	4	0	0	3	0	0	2	0	0	10	0
3	Clayton Park												
	Weekdays												
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	June 27, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0	0	0	0	0	0	0	0	0
	Weekends												
	May 4, 2013, 12:00 noon to 2:00 p.m.	1	0	0	0	0	0	0	0	0	0	1	0
	June 30, 2013, 2:00 p.m. to 4:00 p.m.	>50	0	0	0	0	0	0	0	0	0	>50	>25
4	Island Park												
	Weekdays												
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	21	0	0	0	2	0	1	0	0	0	24	5
	June 27, 2013, 8:00 a.m. to 10:00 a.m.	12	0	0	0	0	0	0	0	0	0	12	4
	Weekends												
	May 4, 2013, 10:00 a.m. to 12:00 noon	110	0	0	0	2	0	0	0	0	0	112	84
	June 30, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	June 30, 2013, 2:00 p.m. to 4:00 p.m.	18	0	0	0	0	0	0	3	0	0	21	8
5	Brose Park												
	Weekdays												
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	2	0	0	0	0	0	0	0	0	0	2	0
	June 27, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0	0	0	0	1	0	0	1	0
	Weekends												
	May 4, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	1	0	0	0	0	0	0	0	0	0	1	0

Table 59 (continued)

Site Number on Map 68	Site	Activities Observed											Parked Cars
		Park Goers	Canoeing/ Kayaking	Pleasure Boating	Operating Personal Watercraft	Fishing from Shore	Fishing from Boat	Hiking/ Walking/ Running	Biking	Swimming	Bird Watching	Total	
6	Lincoln Park												
	Weekdays												
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	3	0	0	0	0	0	0	0	0	0	3	0
	June 27, 2013, 10:00 a.m. to 12:00 noon	18	0	0	0	0	0	0	0	0	0	18	12
	Weekends												
	May 4, 2013, 12:00 noon to 2:00 p.m.	80	0	0	0	0	0	0	0	0	0	80	40
	June 30, 2013, 10:00 a.m. to 12:00 noon	8	0	0	0	0	0	0	0	0	0	8	1
7	Root River Steelhead Facility												
	Weekdays												
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	3	0	0	0	0	0	0	0	0	0	3	0
	June 27, 2013, 10:00 a.m. to 12:00 noon	1	0	0	0	0	0	0	1	0	0	2	1
	Weekends												
	May 4, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	7	0	0	0	0	0	0	0	0	0	7	10
8	Colonial Park												
	Weekdays												
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	2	0	0	0	0	0	0	0	0	0	2	2
	June 27, 2013, 10:00 a.m. to 12:00 noon	2	0	0	0	0	0	0	0	0	2	4	1
	Weekends												
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0	0	0	5	0	0	1	6	2
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0	0	0	0	0	0	0	0	1
9	Quarry Lake Park												
	Weekdays												
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	4	0	0	0	2	0	2	0	0	0	8	9
	June 27, 2013, 10:00 a.m. to 12:00 noon	2	0	0	0	11	0	0	0	12	0	25	8
	Weekends												
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	8	0	0	0	10	0	0	0	0	0	18	13
	June 30, 2013, 10:00 a.m. to 12:00 noon	6	0	0	0	1	0	0	0	6	0	13	10
10	Horlick Park												
	Weekdays												
	June 27, 2013, 10:00 a.m. to 12:00 noon	1	0	0	0	4	0	0	0	0	0	5	3
	Weekends												
	June 30, 2013, 10:00 a.m. to 12:00 noon	1	4	0	0	0	0	0	2	0	0	7	4
	June 30, 2013, 2:00 p.m. to 4:00 p.m.	10	1	0	0	5	2	0	0	0	0	18	7
11	River Bend Nature Center												
	Weekdays												
	May 7, 2013, 10:00 a.m. to 12:00 noon	16	0	0	0	0	0	0	0	0	0	16	7
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	20
	Weekends												
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0	0	0	2	0	0	0	2	2

Table 59 (continued)

Site Number on Map 68	Site	Activities Observed											Parked Cars
		Park Goers	Canoeing/ Kayaking	Pleasure Boating	Operating Personal Watercraft	Fishing from Shore	Fishing from Boat	Hiking/ Walking/ Running	Biking	Swimming	Bird Watching	Total	
12	Armstrong Park[a]												
	Weekdays												
	May 7, 2013, 2:00 p.m. to 4:00 p.m.	5	0	0	0	0	0	0	0	0	0	5	2
	Weekends												
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	4	0	0	0	4	0	0	0	0	0	8	5
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0	0	0	0	0	0	0	0	4
13	Four Mile Road												
	Weekdays												
	May 7, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	Weekends												
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0	0	0	0	0	0	0	0	0
14	Linwood Park												
	Weekdays												
	May 7, 2013, 12:00 noon to 2:00 p.m.	1	0	0	0	0	0	0	1	0	0	2	2
	June 27, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	Weekends												
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0	2	0	0	0	0	0	2	3
	June 30, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0	3	0	0	0	0	0	3	2
	June 30, 2013, 2:00 p.m. to 4:00 p.m.	27	0	0	0	2	0	0	0	0	0	29	17
15	Six Mile Road												
	Weekdays												
	May 7, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0	0	0	0	0	0	0	0	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	Weekends												
	May 4, 2013, 2:00 p.m. to 4:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	June 30, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0	0	0	0	0	0	0	0	0
16	Seven Mile Road												
	Weekdays												
	May 7, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0	0	0	0	0	0	0	0	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	Weekends												
	June 30, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0	0	0	0	0	0	0	0	0
17	E. County Line Road at Nicholson Road												
	Weekdays												
	May 7, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0	0	0	0	2	0	0	2	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	Weekends												
	May 4, 2013, 4:00 p.m. to 6:00 p.m.	0	0	0	0	1	0	0	0	0	0	1	1
	June 30, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0	0	0	0	0	0	0	0	0

Table 59 (continued)

Site Number on Map 68	Site	Activities Observed											Parked Cars
		Park Goers	Canoeing/ Kayaking	Pleasure Boating	Operating Personal Watercraft	Fishing from Shore	Fishing from Boat	Hiking/ Walking/ Running	Biking	Swimming	Bird Watching	Total	
18	STH 38 near Milwaukee-Racine County Line												
	Weekdays												
	May 7, 2013, 10:00 a.m. to 12:00 noon	0	0	0	0	0	0	0	0	0	0	0	0
	June 27, 2013, 12:00 noon to 2:00 p.m.	0	0	0	0	0	0	0	0	0	0	0	0
	Weekends												
	May 4, 2013, 4:00 p.m. to 6:00 p.m.	0	0	0	0	1	0	0	0	0	0	1	0
	June 30, 2013, 8:00 a.m. to 10:00 a.m.	0	0	0	0	0	0	0	0	0	0	0	0
- -	Total	>427	11	6	2	62	2	10	16	18	3	>557	>323

[a] *This is a private park owned and operated by S.C. Johnson, Inc., for its employees.*

Source: SEWRPC.

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Chapter V

DEVELOPMENT OF TARGETS AND ALTERNATIVE MEASURES

INTRODUCTION

As noted in Chapter I, the purpose of the Root River watershed restoration plan is to provide a set of specific, targeted recommendations that can be implemented over a five-year period to produce improvements relative to a set of focus issues related to conditions in the watershed. The recommendations address four focus areas: water quality, recreational access and use, habitat conditions, and flooding. The improvements that would result from implementing the recommendations represent steps toward achieving the overall goal of restoring and improving the water resources of the Root River watershed.

This watershed restoration plan represents a second-level plan for the management and restoration of water resources in the Root River watershed. It was prepared in the context of the Southeastern Wisconsin Regional Planning Commission's (SEWRPC) regional water quality management plan update for the greater Milwaukee watersheds (RWQMPU),[1] which was prepared in coordination with, and largely incorporates, the Milwaukee Metropolitan Sewerage District's (MMSD) 2020 facilities plan.[2] The recommendations of RWQMPU as they pertain to the Root River watershed and the status of their implementation are summarized in Chapter II of this report. In addition to addressing the recommendations of the RWQMPU, this watershed restoration plan also seeks to incorporate those elements of recent and ongoing watershed management programs and initiatives that are related to the plan's focus areas and are consistent with and complement the goals of the plan. These programs and initiatives are inventoried and reviewed in Chapter III of this report.

This chapter describes the development of targets to be achieved by the end of the watershed restoration plan's implementation period and alternative management measures to meet those targets. The targets developed are short-term goals or steps related to the focus issues that must be achieved to meet the long-term goals established in the RWQMPU. Establishing targets breaks the long-term goals down in to manageable pieces, helps determine the specific steps necessary to achieve a goal, and facilitates the development of measures to track progress. For each target developed, this chapter identifies specific actions, in the form of activities or projects, which define

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[1]*SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007.*

[2]*Milwaukee Metropolitan Sewerage District*, MMSD 2020 Facilities Plan, *June 2007.*

management measures to meet the target. These actions constitute a set of alternatives to be considered for inclusion in the recommended watershed restoration plan.

DEVELOPMENT OF TARGETS

For each focus area, the development of targets began with a definition of the main problems related to the focus area that the plan must address to produce improvements in conditions in the watershed. This definition is based upon the findings of the inventories presented in Chapter IV of this report. It constitutes a refinement of the focus area and points to the overall strategies to be used for setting targets and developing alternatives. The strategies are described below.

Within the context of the overall strategies expressed in the problem definition, targets were developed through reference to several sources. The recommendations and analyses presented in the RWQMPU were taken as a starting point. Attention was given to the RWQMPU recommendations that are related to each overall strategy and which have not yet been fully implemented. Other sources of targets included those State and Federal standards and goals of related efforts and plans that address the overall strategies.

Water Quality Targets

Description of Problems Related to Water Quality

The existing state of surface water quality in the Root River watershed is described in Chapter IV of this report. That description documents several water quality problems that currently exist in the watershed. These include problems related to concentrations of dissolved oxygen, nutrients, and chloride.

Problems Related to Dissolved Oxygen and Nutrients

Chapter IV documents at least two problems related to concentrations of dissolved oxygen. First, at many surface water sampling sites, concentrations of dissolved oxygen are low. In upper sections of the mainstem of the Root River dissolved oxygen concentrations are chronically low. At other locations along the mainstem of the River and in most tributaries for which data are available, dissolved oxygen concentrations are occasionally to frequently low. In addition, the few lakes and ponds for which data are available are generally eutrophic and appear to exhibit hypolimnetic anoxia during periods of thermal stratification. Second, it is likely that some locations within the stream system experience wide swings in dissolved oxygen concentration over the course of the day, with high to exceptionally high concentrations occurring during the daytime and low to exceptionally low concentrations occurring during the night. As discussed in Chapter IV, the U.S. Geological Survey has documented that these swings occur during much of the growing season at the Beloit Road sampling station along the mainstem of the Root River at river mile 39.8 upstream from the confluence with Lake Michigan (RM 39.8) and occur occasionally at the sampling stations at S. Seymour Place (RM 41.4) and Layton Avenue (RM 38.6). These sites are in the upper section of the mainstem of the Root River. The detection of concentrations indicative of supersaturation of dissolved oxygen at several other sites suggests that these sites also experience wide swings in dissolved oxygen concentration over the course of the day, at least during some portion of the year. Several “hot spots” were identified in the stream system that exemplify these two problems: the section of the mainstem of the Root River between W. Cleveland Avenue and the intersection of W. National Avenue and W. Oklahoma Avenue in the City of West Allis, the mainstem of the Root River immediately upstream from Memorial Drive in the City of Racine, the Root River Canal at 6 Mile Road in the Town of Raymond, and the West Branch of the Root River Canal at 4 Mile Road in the Town of Raymond. It is not certain whether the latter two sites represent two separate hot spots or one continuous hot spot.

The data presented in Chapter IV suggest that at least two factors are contributing to the documented problems related to concentrations of dissolved oxygen. One factor is nutrient enrichment of both the stream system and lakes and ponds. In general, both the stream system and the lakes and ponds in the watershed have high concentrations of total phosphorus. In addition, where data are available, concentrations of nitrogen compounds are high. These nutrients fuel the growth of planktonic and attached algae and attached plants in streams, lakes, and ponds. Dense growth of these organisms has two impacts on concentrations of dissolved oxygen in the water. First, through the processes of photosynthesis and cellular respiration, they can cause wide swings in dissolved oxygen. When these organisms are exposed to light, they photosynthesize, releasing oxygen, a byproduct of the photosynthetic reactions, to the water. When light is not available, these organisms meet their energy demands through cellular respiration. This process requires oxygen and results in the removal of oxygen from the water. Second, when these organisms die off during cold weather, much of the organic material that makes up these organisms ends up in sediment in the streambed or lakebed, either at the site where the organisms were growing or at some downstream location. Decomposition of this organic material by bacteria in the sediment removes dissolved oxygen from the water column, reducing the concentration of dissolved oxygen in the water. The data presented in Chapter IV indicate that nutrient enrichment is a problem in many of the surface waters of the watershed.

The second factor contributing to problems related to concentrations of dissolved oxygen results from inputs of organic material to the River. Decomposition of such organic material by bacteria in the water and the sediment removes dissolved oxygen from the water column. Because the mechanism through which inputs of organic material affect dissolved oxygen concentrations is not dependent upon the presence of photosynthetic organisms, the large swings in dissolved oxygen concentrations that can accompany nutrient enrichment are not typically seen when this factor is responsible for low dissolved oxygen concentrations. There is at least one location in the watershed at which the data presented in Chapter IV indicate that inputs of organic material in the form of sanitary wastewater may be occurring—the hot spot located between W. Cleveland Avenue and the intersection of W. National Avenue and W. Oklahoma Avenue in the City of West Allis. The data suggest that these inputs are occurring in such amounts and/or at such frequency as to be a major factor in the dynamics of dissolved oxygen concentrations at this site. Possible sources of this wastewater include cross connections between the sanitary and stormwater sewer systems, leaking sanitary sewer lines or laterals, or illicit discharges into the storm sewer system. While it is possible that at other locations in the watershed such wastewater sources are present, the data presented in Chapter IV show no evidence that they have as great an impact on dissolved oxygen concentrations at other locations as they have at this site.

Two overall strategies are suggested by this definition of the water quality problems related to dissolved oxygen and nutrients. First, targets should focus on reducing contributions of nutrients to the surface waters of the watershed. Because the availability of phosphorus acts to limit productivity in freshwater systems, the major emphasis should be on reducing phosphorus contributions. In addition, because much of the phosphorus that enters surface waters is incorporated into particles or adsorbed to particles, it would be helpful that these targets also address total suspended solids (TSS). The common use of TSS as a surrogate for other pollutants, including nutrients, in urban stormwater-related regulations also makes it desirable that targets address TSS. Second, targets should focus on locating sources that contribute sanitary wastewater to surface waters of the Root River watershed and ending these contributions. Within the next five years, particular emphasis should be given to areas tributary to the dissolved oxygen hot spot located between W. Cleveland Avenue and the intersection of W. National Avenue and W. Oklahoma Avenue in the City of West Allis. Because the inventories presented in Chapter IV indicate that problems related to nutrient enrichment are widespread within the watershed, the strategy of reducing nutrient contributions to surface waters should be given a heavy emphasis.

Problems Related to Chlorides

Chapter IV documents at least three problems related to concentrations of chlorides in surface waters of the Root River watershed. First, at those sampling stations for which long-term data are available, chloride concentrations increased from 1964 through 1997, but have possibly leveled off since then. The long-term increase is consistent with a trend in surface water chloride concentrations that has been observed in many waterbodies in southeastern Wisconsin. At sampling stations along the mainstem of the Root River, no increase in the mean was observed between the periods 1998-2004 and 2004-2012; however, it is uncertain whether this lack of an increase is due to a slowing or stopping of the long-term trend or to the combination of relatively small samples sizes and high variability in chloride concentrations masking an increase.[3] Second, concentrations of chloride detected at

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[3]*It should be noted that tributary streams in the Root River watershed have not been sampled for chloride concentrations.*

Table 60

AVERAGE AND MAXIMUM CHLORIDE CONCENTRATIONS IN THE ROOT RIVER AT SAMPLE SITES WITH AT LEAST FOUR SAMPLES COLLECTED DURING THE WINTER: 1998-2012

River Mile	Mean Chloride Concentration (mg/l)		Median Chloride Concentration (mg/l)		Maximum Chloride Concentration (mg/l)		Samples	
	Winter	Nonwinter	Winter	Nonwinter	Winter	Nonwinter	Winter	Nonwinter
36.7	587	255	266	260	1,610[a]	590[b]	6	136
28.0	277	156	155	150	670[b]	410[b]	4	130
11.5	193	123	196	123	402[b]	227	17	31

[a]*This maximum concentration exceeds both the acute toxicity criteria of 757 mg/l and the chronic toxicity criteria of 395 mg/l.*

[b]*These maximum concentrations exceed the chronic toxicity criteria of 395 mg/l.*

Source: SEWRPC.

sampling stations occasionally exceed the State's chronic toxicity criterion for fish and aquatic life, and in some instances, the State's acute toxicity for fish and aquatic life. This is especially the case in upper sections of the mainstem of the Root River. Third, it appears that a reservoir of chloride may be accumulating in groundwater, at least in some locations in the watershed. This reservoir appears to be capable of affecting instream chloride concentrations, especially during low flow periods when discharge from groundwater constitutes a substantial fraction of the flow in the stream system.

The nature, extent, and severity of these problems are poorly understood because few data are available regarding instream chloride concentrations during the winter deicing season. Water quality sampling for chloride has rarely been conducted during the winter in the Root River watershed. There is little basis for estimating winter concentrations of chloride in streams of the watershed because of a paucity of winter data regarding specific conductance, a water quality constituent which can be used as a surrogate for chloride. The few winter samples of chloride and specific conductance that are available for streams of the watershed were largely collected during very early and very late portions of the winter season and may not be representative of instream concentrations during the middle of the winter. It is likely that they may underestimate instream concentrations during the middle of the season.

Because large amounts of chloride salts are used on streets, highways, and parking lots during the winter for snow and ice control, it is likely that instream concentrations of chloride are higher during the winter than they are during other months of the year. The results of a comparison of the few chloride data available from winter months to data from the rest of the year are consistent with this idea. Table 60 shows comparisons of mean, median, and maximum concentrations of chlorides from winter months to those from nonwinter months at all sampling stations along the mainstem of the Root River that had at least four samples collected during the winter. At all three sampling stations, the mean, median, and maximum concentrations detected during the winter were higher than those detected during the rest of the year. It should be noted that this comparison relies upon a small number of samples collected during the winter.

The results of a comparison of the specific conductance data available from winter months to data from the rest of the year suggest a more complicated situation. Table 61 shows that the mean and median values of specific conductance detected at sampling stations along the mainstem of the Root River during the winter were higher than those detected at the same stations during the rest of the year. This is also consistent with the expectation that instream concentrations of chloride during the winter should be higher due to application of chloride salts for snow and ice control. Along some tributary streams, however, mean and median values of specific conductance

Table 61

AVERAGE SPECIFIC CONDUCTANCE IN STREAMS OF THE ROOT RIVER WATERSHED AT SAMPLE SITES WITH AT LEAST FOUR SAMPLES COLLECTED DURING THE WINTER: 1998-2012

Stream	River Mile	Mean Specific Conductance (μS/cm)		Median Specific Conductance (μS/cm)		Samples	
		Winter	Nonwinter	Winter	Nonwinter	Winter	Nonwinter
Root River	38.6	4,707	1,440	3,700	1,380	13	26
	36.7	4,293	1,438	3,655	1,510	29	165
	28.7	2,280	1,162	1,970	1,160	11	13
	28.0	2,115	1,055	2,430	1,090	9	142
	18.6	1,128	994	1,178	1,017	5	61
	13.6	1,117	962	1,153	999	5	61
	11.5	1,272	961	1,155	952	41	142
	9.4	1,103	979	1,130	998	5	61
	5.9	1,028	838	1,079	838	6	208
	3.9	1,013	945	990	863	6	60
	3.1	996	942	984	966	6	60
	1.8	1,421	895	1,642	865	4	9
	1.5	994	927	992	950	6	60
	0.0	880	666	888	654	6	181
Hoods Creek	0.5	1,066	1,137	1,080	1,135	6	68
Husher Creek	1.0	1,182	964	1,161	893	5	61
East Branch Root River Canal	8.1	899	1,084	900	1,089	5	61
	0.5	1,038	898	1,056	883	5	61
Legend Creek	0.5	1,114	1,049	1,108	1,080	5	61
Raymond Creek	0.8	932	1,087	910	928	5	61
Root River Canal	3.7	1,083	1,103	1,063	1,084	6	157
West Branch Root River Canal	9.3	1,389	1,880	1,350	2,020	5	61
	0.3	1,099	1,323	1,096	1,315	5	62

Source: SEWRPC.

detected during the winter were lower than those detected at the same stations during the rest of the year (see Table 61). This is not the case at all sampling stations along tributaries. It appears to be the case mostly in tributaries located in less urbanized areas with lower densities of roads.

High instream concentrations of chlorides pose a substantial threat of toxicity to freshwater aquatic organisms, such as those present in surface waters of the Root River watershed. Appendix N of this report reviews and discusses this toxicity. The chloride data available for the Root River watershed suggest that the current level of this threat is not high; however, these data are not sufficient to assess instream chloride concentrations during the time of the year when we would expect the highest instream concentrations of chloride, and the highest risk to aquatic organisms, to be present.

Data from other sites in the Southeastern Wisconsin Region might give some insight into the level of threat that chloride concentrations during the winter pose to aquatic organisms in some sections of the Root River watershed. Continuously collected data records for specific conductance are available for several sampling sites in the Menomonee River watershed. These records include collection of data during the winter deicing season. Using a regression model developed for Wisconsin streams,[4] values of specific conductance were used to estimate minimum, maximum, and mean daily chloride concentrations at monitoring stations in the Menomonee River watershed.[5] The estimated minimum, maximum, and mean daily chloride concentrations were then compared to a threshold chloride concentration associated with substantial levels of toxic effects to aquatic organisms. This threshold was identified through a review of the toxicological literature.[6] This literature review and the analyses are presented in Appendix N.

Several findings of the examination of winter values of specific conductance in the Menomonee River watershed may be relevant to the Root River watershed. First, concentrations of chloride during the winter in Honey and Underwood Creeks, as estimated from specific conductance, achieve levels that are well within the range of chloride concentrations known to produce substantial toxic effects in aquatic organisms. In both of these streams, concentrations during the winter deicing period appear to remain at levels that are associated with acute toxic effects for extended periods of time. Concentrations of chloride, as calculated from specific conductance, did not achieve these levels at stations along the Little Menomonee and Menomonee Rivers. The results suggest that chloride concentrations during the winter deicing season probably reach higher levels in smaller streams that are located in highly urbanized areas than they do in larger streams and in streams located in less urbanized areas.

The findings of the examination of specific conductance values in the Menomonee River watershed suggest that chloride concentrations in upper sections of the Root River watershed during the winter deicing season may achieve levels high enough to cause acute toxicity to aquatic organisms. As described in Chapter IV of this report, in 2000 urban land uses comprised over 60 percent of land uses in the Upper Root River-Headwaters, Upper Root River, Whitnall Park Creek, Middle Root River-Dale Creek, and East Branch Root River assessment areas (see Map 13 in Chapter IV of this report). The discharge in this section of the mainstem of the Root River is comparable to discharge at the sites in Honey and Underwood Creeks where winter chloride concentrations were estimated. The mean discharge over the period of record at the USGS gage at W. Grange Avenue along the Root River is 17.1 cubic feet per second (cfs). Mean discharge at the gages along Honey and Underwood Creeks are 11.1 cfs and 15.3 cfs, respectively. While average discharge at the W. Grange Avenue gage is slightly higher than that at the gages on Honey and Underwood Creeks, average discharge at the sites on these two Menomonee River tributaries are similar to levels that are present in the Root River upstream from the W. Grange Avenue. Thus it is likely that chloride concentrations present in upper sections of the Root River during the winter deicing season get high enough to cause toxic effects and stay at those levels for extended periods during the winter deicing season.

Several sources and activities contribute chloride to surface waters and groundwater in the Root River watershed. While few data are available regarding the amounts of chloride these sources and activities contribute to the environment within the watershed, some inferences can be made regarding the relative contributions of these sources and activities based on what is known about natural sources, salt usage, and activities in the watershed.

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[4]*S.R. Corsi, D.J. Graczyk, S.W. Geis, N.L. Booth, and K.D. Richards, "A Fresh Look at Road Salt: Aquatic Toxicity and Water-Quality Impacts on Local, Regional, and National Scales,"* Environmental Science & Technology*, Volume 44, 2010, pp. 7378-7382.*

[5]*SEWRPC Memorandum Report No. 204,* Development of a Framework for a Watershed-Based Municipal Stormwater Permit for the Menomonee River Watershed*, January 2013.*

[6]*It should be noted that the threshold value of 1,400 mg/l is considerably higher than the State of Wisconsin's acute and chronic toxicity criteria for fish and aquatic life. This threshold was used to determine whether substantial incidences of toxic effects are likely to be occurring at the sites examined and is not intended to represent a value that would be protective of fish and aquatic life.*

Natural sources of chlorides to water resources include atmospheric deposition, weathering of bedrock and soils, geologic deposits containing halite, and volcanic activity. The contributions of chloride from atmospheric deposition are unlikely to account for the historic increases in chloride concentrations and the occasional exceedences of water quality criteria for chloride in the Root River watershed. The mean annual estimated wet deposition of chloride on the central portion of the glacial aquifer system, which includes the Root River watershed, is about 0.25 ton per square mile.[7] The estimated concentration of chloride in runoff attributable to this deposition is 0.25 to 0.50 mg/l.[8] It would be expected that weathering of bedrock and soils would remain fairly constant over time and there are no known deposits of halite or volcanoes within or in the vicinity of the Root River watershed. Thus it is unlikely that natural sources of chloride can account for the historic increases in chloride concentrations and the occasional exceedences of water quality criteria for chloride in the Root River watershed.

Several anthropogenic uses also contribute chloride to surface water and groundwater. These uses include snow and ice control, water treatment, agricultural uses, and a variety of industrial and manufacturing uses. While few data on the amount of salt introduced by each of these uses exist for the Root River watershed, data on sales and uses of salt should give a rough estimate of what the relative contributions of chloride from these uses are likely to be. Such data are available on a national basis from mineral commodity surveys summarized by the USGS.[9] In 2012, salt for deicing consumed about 41 percent of total salt sales in the United States. Water treatment uses accounted for about 1 percent of sales and agricultural uses accounted for about 3 percent of sales. Other major uses of salt, such as chemical production, petroleum production, paper production, and textile production and dyeing, either do not occur in the Root River watershed or occur at such low levels that they probably do not represent major contributors of chloride to waters in the watershed. This suggests that snow and ice control activities constitute a major source of chloride to surface water and groundwater in the Root River watershed.

The preceding discussion suggests two overall strategies for addressing the water quality problems related to concentrations of chlorides in surface waters of the Root River watershed. First, the understanding of the extent of the problems posed by chloride concentrations in surface waters of the Root River watershed and the nature of the causes of these problems is limited by substantial gaps in the data. Targets should focus on filling these gaps. Second, targets should focus on reducing contributions of chloride into surface waters and groundwater of the watershed. Since the application of chlorides for winter snow and ice control represents a major source of chlorides to waters of the watershed, a major emphasis should be placed on reducing the amount introduced into the environment through these activities while maintaining public safety.

Water Quality Targets

Dissolved Oxygen and Nutrients

The description of water quality problems given above concluded that two overall strategies should be pursued in developing targets related to dissolved oxygen and nutrients: targets that focus on reducing contributions of nutrients to surface waters and targets related to locating and ending contributions of sanitary wastewater to surface waters. For reducing contributions of nutrients, the description concluded that the targets should address both phosphorus and TSS. Because the issue of contributions of sanitary wastewater is a critical factor relative to recreational access and use, targets related to this strategy will be presented in the section on recreational access and use targets, later in this chapter.

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[7]*John R. Mullaney, David L. Lorenz, and Alan D. Arnston,* Chloride in Groundwater and Surface Water in Areas Underlain by the Glacial Aquifer System, Northern United States, *U.S. Geological Survey Scientific Investigations Report No. 2009-5086, 2009.*

[8]Ibid.

[9]*Dennis S. Kostick, "Salt,"* U.S. Geological Survey, Mineral Commodity Summaries, *January 2013.*

The RWQMPU made recommendations whose implementation would act to reduce contributions of phosphorus and TSS. These recommendations were summarized and the status of their implementation was reviewed in Chapter II of this report. The RWQMPU also included estimates of pollutant loads to the stream system that would occur under three sets of conditions.[10] These conditions include:

- Existing condition: Representing watershed conditions as of the year 2000;

- Revised 2020 Baseline condition: The condition projected to occur in 2020 under planned 2020 land use conditions, assuming full implementation of the urban stormwater runoff performance standards set forth in Chapter NR 151, “Runoff Management,” of the *Wisconsin Administrative Code*, but without implementation of the recommendations of the RWQMPU; and

- Recommended Plan condition: The condition projected to occur under planned 2020 land use conditions, assuming full implementation of both the urban stormwater runoff performance standards set forth in NR 151 and the recommendations of the RWQMPU.[11]

These estimates were made using a calibrated water quality simulation model.[12] The estimated loads associated with each of the three conditions are given in Appendix O of this report.

It is important to note that for both total phosphorus and TSS, the portion of the pollutant loads contributed by point sources is quite low under all three conditions described above. On a whole watershed basis, point sources are estimated to have contributed less than 4 percent of the total phosphorus load and less than 0.001 percent of the TSS load under the Existing (2000) condition. Under the Recommended Plan (2020) condition, point sources are estimated to represent about 7 percent of the total phosphorus load and less than 0.001 percent of the TSS load.[13] Given that point sources are estimated to contribute these small percentages of the total phosphorus and

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[10]*SEWRPC Planning Report No. 50,* op. cit.

[11]*The RWQMPU included pollutant load estimates for two additional conditions: a Revised 2020 Baseline condition with a five-year level of protection to control against sanitary sewer overflows (five-year LOP) and an Extreme Measures condition. In the Root River watershed, the estimated pollutant loads under the Revised 2020 Baseline with a five-year LOP condition were identical to the estimated pollutant loads under the Revised 2020 Baseline condition. The Extreme Measures condition examined a level of nonpoint source controls in excess of the levels envisioned under the recommend plan and envisioned the virtual elimination of phosphorus from discharges of industrial noncontact cooling water. In the Root River watershed, at most locations the degree of compliance with applicable water quality standards under the Extreme Measures condition, as estimated by the calibrated water quality simulation model, was similar to the degree of compliance under the Recommended Plan condition, although more significant improvements in compliance were indicated for fecal coliform bacteria.*

[12]*The calibrated water quality model is described and its results and conclusions are presented and discussed in SEWRPC Planning Report No. 50,* op. cit.

[13]*The estimated increase in the fraction of the total phosphorus load that is contributed by point sources reflects two factors. First, anticipated urban development between 2000 and 2020 in the areas served by the Union Grove and Yorkville Sewer Utility District wastewater treatment plants can be expected to increase loads of total phosphorus discharged from these plants. It is possible, but not certain, that future application of the 2011 State of Wisconsin phosphorus could result in lower effluent limitations for these wastewater treatment plants. Second, the RWQMPU envisions about a 27 percent decrease in the portion of the total phosphorus load that is contributed by nonpoint sources between the Existing (2000) condition and the Recommended Plan condition. Much of the increase in the percentage of the total load contributed by point sources reflects this large decrease in nonpoint source loads.*

TSS loads, the targets for this watershed restoration plan should focus on nonpoint sources. The reductions in nonpoint source loads between the Existing (2000) condition and the Recommended Plan (2020) condition that are envisioned in the RWQMPU define targets to be met in order to improve water quality conditions in the Root River watershed.

These targets were refined in two ways. First, the load estimates from the three conditions were used to estimate how much of the pollutant load reductions envisioned in the RWQMPU would result from implementation of the NR 151 stormwater runoff performance standards and how much would result from other elements of the recommended plan. Second, the load reductions were adjusted to account for changes in the application of NR 151 that have been made since the RWQMPU was completed.

The developed urban area performance standard for municipalities set forth in NR 151.13 requires that municipalities with WPDES stormwater discharge permits reduce the amount of TSS in stormwater runoff from areas of existing development that was in place as of October 1, 2004, to the maximum extent practicable, by 20 percent by March 10, 2008 and by 40 percent by October 1, 2013. In addition, other sections of NR 151 require that all construction sites that have one acre or more of land disturbance must achieve an 80 percent reduction in the sediment load generated by the site. With certain limited exceptions, those sites required under NR 151 to have construction erosion control permits must also have post-development stormwater management practices to reduce the TSS load from the site by 80 percent for new development, 40 percent for redevelopment, and 40 percent for infill development occurring prior to October 1, 2012. After October 1, 2012, infill development will be required to achieve an 80 percent reduction. Recent action by the State Legislature has changed the application of these performance standards. As a result of 2011 Wisconsin Act 32 the WDNR is prohibited from enforcing the 40 percent reduction in TSS load from areas of existing development.

The impact of this is that the load reductions from urban nonpoint sources as represented under the RWQMPU need to be adjusted to account for the change in application of the developed urban area performance standard. This was done on a subwatershed basis using the existing 2000 land use (see Table 13 in Chapter IV of this report) and the planned 2035 land use (see Table 15 in Chapter IV of this report) to estimate the portions of urban lands within each subwatershed under the Recommended Plan (2020) condition that represent:

- Existing development that would have been subject to the 40 percent TSS reduction requirement, and

- New development that is subject to the 80 percent TSS reduction requirement, redevelopment that is subject to the 40 percent TSS reduction requirement, and infill development, which is subject to a 40 percent TSS reduction requirement prior to October 1, 2012 and an 80 percent TSS reduction requirement after October 1, 2012.

To adjust the urban nonpoint source load reductions for the changes in the application of NR 151, the portion of the NR 151-related load reductions that are attributable to existing development was estimated for each subwatershed. This portion of the pollutant load was reduced by half. In order to maintain the recommended levels of water quality improvement envisioned under the RWQMPU, the amount of this reduction was added to the “other reductions” categories for urban nonpoint sources in Tables 62 and 63.

Table 62 shows the adjusted nonpoint source load reductions for total phosphorus for the Root River watershed. On a watershed basis, this sets a target of reducing nonpoint source loads of phosphorus to the stream system by 21,820 pounds between 2000 and 2020. Of this reduction, 5,200 pounds would come from urban nonpoint sources, with 2,268 pounds of this reduction being attributable to implementation of NR 151 and 2,932 pounds of this reduction being attributable to implementation of other measures. The remaining 16,620 pounds would come from rural nonpoint sources, with 8,440 pounds of this reduction being attributable to implementation of NR 151 and 8,180 pounds of this reduction being attributable to implementation of other measures.

Table 62

ANNUAL REDUCTIONS IN NONPOINT SOURCE LOADS OF TOTAL PHOSPHORUS REQUIRED BY THE RWQMPU ADJUSTED FOR CHANGES IN NR 151

		Annual Reduction in Loads of Total Phosphorus (pounds)						
		Urban Sources			Rural			
Subwatershed	Assessment Areas	NR 151-Related	Other Reductions	Subtotal	NR 151-Related	Other Reductions	Subtotal	Total
Upper Root River	Upper Root River, Upper Root River Headwaters	820	920	1,740	50	0	50	1,790
Whitnall Park Creek	Whitnall Park Creek	430	430	860	270	50	320	1,180
Middle Root River	Middle Root River-Dale Creek, Middle Root River-Legend Creek, Middle Root River-Ryan Creek	175	285	460	610	640	1,250	1,710
East Branch Root River	East Branch Root River	125	155	280	130	0	130	410
West Branch Root River Canal	Upper West Branch Root River Canal, Lower West Branch Root River Canal	0	80	80	1,950	2,990	4,940	5,020
East Branch Root River Canal	East Branch Root River Canal	0	20	20	870	1,300	2,170	2,190
Root River Canal	Root River Canal	6	4	10	460	860	1,320	1,330
Lower Root River	Lower Root River-Caledonia, Lower Root River Johnson Park, Lower Root River-Racine	689	991	1,680	2,910	1,830	4,740	6,420
Hoods Creek	Hoods Creek	23	47	70	1,190	510	1,700	1,770
	Total	2,268	2,932	5,200	8,440	8,180	16,620	21,820

Source: SEWRPC.

Table 63

ANNUAL REDUCTIONS IN NONPOINT SOURCE LOADS OF TOTAL SUSPENDED SOLIDS REQUIRED BY THE RWQMPU ADJUSTED FOR CHANGES IN NR 151

Subwatershed	Assessment Areas	Annual Reduction in Loads of Total Suspended Solids (pounds)						
		Urban Sources			Rural			Total
		NR 151-Related	Other Reductions	Subtotal	NR 151-Related	Other Reductions	Subtotal	
Upper Root River	Upper Root River, Upper Root River Headwaters	327,575	291,275	618,850	10,910	0	10,910	629,760
Whitnall Park Creek	Whitnall Park Creek	200,063	130,537	330,600	569,940	0	569,940	900,540
Middle Root River	Middle Root River-Dale Creek, Middle Root River-Legend Creek, Middle Root River-Ryan Creek	177,182	76,388	253,570	3,218,650	437,680	3,656,330	3,909,900
East Branch Root River	East Branch Root River	77,118	45,852	122,970	225,190	0	225,190	348,160
West Branch Root River Canal	Upper West Branch Root River Canal, Lower West Branch Root River Canal	31,744	21,296	53,040	3,644,870	5,799,000	9,443,780	9,496,820
East Branch Root River Canal	East Branch Root River Canal	0	0	0	1,613,540	2,421,010	4,034,550	4,034,550
Root River Canal	Root River Canal	4,561	3,699	8,260	996,270	1,620,240	2,616,510	2,624,770
Lower Root River	Lower Root River-Caledonia, Lower Root River Johnson Park, Lower Root River-Racine	460,790	268,290	729,080	6,254,040	2,510,630	8,764,670	9,493,750
Hoods Creek	Hoods Creek	109,305	31,695	141,000	2,428,470	902,540	3,331,010	3,472,010
	Total	1,388,338	869,032	2,257,370	18,961,880	13,691,100	32,652,890	34,910,260

Source: SEWRPC.

Table 62 also shows adjusted nonpoint source load reductions for total phosphorus for individual subwatersheds. The reduction targets range from a reduction of 410 pounds in the East Branch Root River subwatershed to a reduction of 6,420 pounds in the Lower Root River subwatershed.

Table 63 shows the adjusted nonpoint source load reductions for TSS for the Root River watershed. On a watershed basis, this sets a target of reducing nonpoint source loads of TSS to the stream system by 34,910,260 pounds between 2000 and 2020. Of this reduction, 2,257,370 pounds would come from urban nonpoint sources, with 1,388,338 pounds of this reduction being attributable to implementation of NR 151 and 869,032 pounds of this reduction being attributable to implementation of other measures. The remaining 32,652,890 pounds would come from rural nonpoint sources, with 18,961,880 pounds of this reduction being attributable to implementation of NR 151 and 13,691,100 pounds of this reduction being attributable to implementation of other measures.

Table 63 also shows adjusted nonpoint source load reductions for TSS for individual subwatersheds. The reduction targets range from a reduction of 348,160 pounds in the East Branch Root River subwatershed to a reduction of 9,496,820 pounds in the West Branch Root River Canal subwatershed.

In addition to presenting estimates of pollutant loads, the RWQMPU provided estimates of water quality conditions under the Existing (2000) and Recommended Plan (2020) conditions.[14] These estimates were calculated using the calibrated water quality model. Comparison of the modeled water quality conditions under the Recommended Plan (2020) condition to those under the Existing (2000) condition provides an estimate of the degree of improvement in water quality conditions in the Root River watershed that would be achieved by meeting the load reduction targets given in Tables 62 and 63.

Table 64 shows a comparison of modeled total phosphorus summary statistics under the Existing (2000) and Recommended Plan (2020) conditions. These summary statistics are estimated for 15 assessment points located at or near the downstream ends of the 15 assessment areas. The locations of these assessment points are shown on Map 7 in Chapter IV of this report. Estimated mean concentrations of total phosphorus at these assessment points under the Existing (2000) condition ranged between 0.072 mg/l and 0.381 mg/l, with an average value of 0.133 mg/l. Under the Recommended Plan (2020) condition, estimated mean concentrations of total phosphorus ranged between 0.063 mg/l and 0.245 mg/l, with an average value of 0.117 mg/l. Estimated median concentrations of total phosphorus at these assessment points under the Existing (2000) condition ranged between 0.022 mg/l and 0.147 mg/l, with an average value of 0.069 mg/l. Under the Recommended Plan (2020) condition, estimated median concentrations of total phosphorus ranged between 0.019 mg/l and 0.147 mg/l, with an average value of 0.061 mg/l. The highest estimated mean and median concentrations under both conditions are present in the Root River Canal and its East and West Branches and Hoods Creek.

Table 64 also shows the amount of time the model estimated that total phosphorus concentrations at each assessment point would be at or below a concentration of 0.100 mg/l. This comparison was made because the RWQMPU was developed prior to the promulgation of the State of Wisconsin's water quality criteria for total phosphorus. The value of 0.100 is a planning standard that was recommended in the initial regional water quality management plan. The estimated level of compliance with this planning standard under the Existing (2000) condition ranged between 32 percent and 82 percent, with an average level of compliance of 68 percent. The estimated level of compliance with this planning standard under the Recommended Plan (2020) condition ranged between 41 percent and 84 percent, with an average level of compliance of 72 percent.

Table 65 shows a comparison of modeled TSS summary statistics under the Existing (2000) and Recommended Plan (2020) conditions at 15 assessment points throughout the watershed. Estimated mean concentrations of TSS at these assessment points under the Existing (2000) condition ranged between 6.3 mg/l and 57.2 mg/l, with an

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[14]*The RWQMPU also provided estimates of water quality conditions under the Revised 2020 Baseline, the Revised 2020 Baseline with a five-year LOP, and Extreme Measures conditions.*

Table 64

MODELED TOTAL PHOSPHORUS SUMMARY STATISTICS FROM THE RWQMPU FOR THE ROOT RIVER WATERSHED

		Mean Concentration (mg/l)		Median Concentration (mg/l)		Percent Compliance with Recommended Phosphorus Planning Standard (0.1 mg/l)		Percent Compliance with State Total Phosphorus Criterion (0.075 mg/l)[a]
Assessment Point	Assessment Area	Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)	Recommended Plan (2020)
RT-2: Root River	Upper Root River-Headwaters	0.079	0.067	0.025	0.020	82	84	81
RT-4: Root River	Upper Root River	0.080	0.068	0.022	0.019	78	80	76
RT-7: Whitnall Park Creek Down-stream of Tess Corners Creek	Whitnall Park Creek	0.078	0.066	0.023	0.020	78	80	76
RT-8: Middle Root River	Middle Root River-Dale Creek	0.092	0.080	0.061	0.056	73	76	69
RT-9: East Branch Root River	East Branch Root River	0.072	0.063	0.029	0.024	82	83	79
RT-10: Root River upstream of Ryan Creek	Middle Root River-Legend Creek	0.087	0.075	0.057	0.051	73	76	69
RT-11: West Branch Root River Canal	Upper West Branch Root River Canal	0.266	0.231	0.179	0.147	32	41	29
RT-13: West Branch Root River Canal	Lower West Branch Root River Canal	0.164	0.143	0.076	0.067	63	67	59
RT-15: East Branch Root River Canal	East Branch Root River Canal	0.143	0.131	0.065	0.063	72	73	64
RT-16: Root River Canal	Root River Canal	0.129	0.114	0.069	0.063	71	74	64
RT-17:Root River at Upstream Crossing of Milwaukee-Racine County Line	Middle Root River-Ryan Creek	0.104	0.091	0.071	0.065	71	74	65
RT-18: Root River Upstream of Hoods Creek	Lower Root River-Caledonia	0.102	0.089	0.068	0.064	73	76	67
RT-20: Hoods Creek	Hoods Creek	0.381	0.345	0.131	0.113	43	49	32
RT-21: Root River at City of Racine	Lower Root River-Johnson Park	0.109	0.094	0.075	0.070	67	71	56
RT-22: Mouth of Root River at Lake Michigan	Lower Root River-Racine	0.115	0.099	0.079	0.073	65	69	53

NOTE: Locations of assessment points are shown on Map 7 in Chapter IV of this report.

[a]*The assumptions of the model used to compute these estimates were slightly different from the assumptions of the model used in the RWQMPU. A major difference is that the meteorological records from the weather station a General Mitchell International Airport was used to develop these estimates over the entire Root River watershed. The model for the RWQMPU utilized meteorological records from four weather stations, each for a different portion of the watershed.*

Source: Tetra Tech, Inc., and SEWRPC.

Table 65

MODELED TOTAL SUSPENDED SOLIDS SUMMARY STATISTICS FROM THE RWQMPU FOR THE ROOT RIVER WATERSHED

Assessment Point	Assessment Area	Mean Concentration (mg/l)		Median Concentration (mg/l)	
		Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)
RT-2: Root River	Upper Root River-Headwaters	6.3	4.9	4.9	3.4
RT-4: Root River	Upper Root River	10.3	7.3	4.7	3.3
RT-7: Whitnall Park Creek downstream of Tess Corners Creek	Whitnall Park Creek	14.9	10.1	5.0	3.5
RT-8: Middle Root River	Middle Root River-Dale Creek	19.4	11.3	5.1	3.5
RT-9: East Branch Root River	East Branch Root River	10.8	6.6	5.0	3.3
RT-10: Root River upstream of Ryan Creek	Middle Root River-Legend Creek	12.9	8.8	4.8	3.3
RT-11: West Branch Root River Canal	Upper West Branch Root River Canal	31.2	20.6	3.6	3.4
RT-13: West Branch Root River Canal	Lower West Branch Root River Canal	28.1	19.5	4.0	3.6
RT-15: East Branch Root River Canal	East Branch Root River Canal	57.2	38.4	5.0	4.3
RT-16: Root River Canal	Root River Canal	27.4	19.3	4.5	4.1
RT-17:Root River at upstream crossing of Milwaukee-Racine County Line	Middle Root River-Ryan Creek	20.6	13.8	4.6	3.6
RT-18: Root River upstream of Hoods Creek	Lower Root River-Caledonia	31.0	20.0	5.2	4.1
RT-20: Hoods Creek	Hoods Creek	33.5	20.5	4.9	4.2
RT-21: Root River at City of Racine	Lower Root River-Johnson Park	35.9	22.8	7.0	5.2
RT-22: Mouth of Root River at Lake Michigan	Lower Root River-Racine	38.5	25.3	9.4	7.3

NOTE: Locations of assessment points are shown on Map 7 in Chapter IV of this report.

Source: Tetra Tech, Inc., and SEWRPC.

average value of 25.2 mg/l. Under the Recommended Plan (2020) condition, estimated mean concentrations of TSS ranged between 4.9 mg/l and 22.8 mg/l, with an average value of 16.6 mg/l. Estimated median concentrations of TSS at these assessment points under the Existing (2000) condition ranged between 3.6 mg/l and 9.4 mg/l, with an average value of 5.2 mg/l. Under the Recommended Plan (2020) condition, estimated median concentrations of TSS ranged between 3.3 mg/l and 7.2 mg/l, with an average value of 4.0 mg/l.

Chloride

The description of water quality problems given above concluded that two overall strategies be pursued in developing targets related to chloride: targets that focus on filling data gaps related to chlorides and targets that focus on reducing the application of chlorides in the watershed for winter snow and ice control.

The RWQMPU made recommendations whose implementation would act to reduce contributions of chlorides. These recommendations were summarized and the status of their implementation was reviewed in Chapter II of this report. The RWQMPU did not include estimates of pollutant loads of chlorides to the stream system. This was because the available water quality data and the available salt use data were inadequate for generating such loads through the calibrated water quality model. The lack of these load estimates means that in this report targets cannot be expressed quantitatively as load reductions and that the water quality conditions that would result from meeting the targets cannot be quantitatively estimated.

The following targets are established for water quality related to chloride for the Root River watershed restorations plan:

1. Fill data gaps related to chloride concentrations in surface waters or the Root River watershed. At the minimum, three areas of uncertainty need to be addressed:

    a. Sampling should be conducted during the winter in order to characterize instream chloride concentrations during this season,

    b. Sampling for chloride should be conducted at sites along tributaries and along the mainstem of the Root River in Racine County in order to characterize geographical variation in chloride concentrations in the stream system, and

    c. Samples for chloride and specific conductance should be collected simultaneously in order to refine regression models that would allow the use of specific conductance as a surrogate for chloride.

2. Continue ongoing evaluations of existing county and municipal road deicing and anti-icing programs with an emphasis on achieving additional salt reductions without compromising public safety.

3. Promote evaluations of private deicing operations on commercial, industrial, institutional, and residential properties with an emphasis on achieving voluntary salt reductions without compromising public safety.

Recreational Use and Access Targets

Description of Problems and Issues Related to Recreational Use and Access

The existing state of recreational facilities and access in the Root River watershed is described in Chapter IV of this report. That description inventories the natural resource-based recreational facilities that currently exist in the watershed. These facilities include parks and parkways, trails, and access to surface waters. An overriding consideration related to the recreational use of surface waters is whether the water is safe for human contact. Concentrations of bacteria indicative of fecal contamination, such as fecal coliform bacteria and the bacterium *Escherichia coli* (*E. coli*), are generally used to assess the suitability of waters for human contact. The description of surface water quality given in Chapter IV indicates that high concentrations of these indicator bacteria are often present in surface waters of the watershed. This indicates that these waters may not be safe for human contact because of the possible presence of waterborne disease agents. This reduces the recreational potential of the surface waters of the watershed.

Problems Related to Fecal Indicator Bacteria

Chapter IV documents at least one problem related to fecal indicator bacteria. High concentrations of bacteria indicative of fecal contamination were present in all of the streams of the watershed that were sampled for either fecal coliform bacteria or *E. coli*. At most sampling sites in the stream system, concentrations of these indicator bacteria exceeded the applicable water quality criteria a substantial portion of the time (see Table 28 in Chapter IV of this report).

As explained in Chapter IV, these bacteria are not themselves pollutants of concern. Instead, they act as surrogate measures indicating the likelihood that surface waters are contaminated with fecal wastes and may contain disease-causing agents, such as pathogenic bacteria, viruses, or protozoa. These wastes can originate from several sources, including sanitary sewage, agricultural and barnyard wastes, and wastes from domestic pets and wild animals. Fecal pollution from different sources will carry different pathogens; however, fecal pollution from sanitary sewage generally constitutes a more serious public health risk because multiple human pathogens can be present in high concentrations.

Several potential sources of bacteria may contribute to the high concentrations found in surface waters of the watershed. In urbanized areas, discharges from storm sewer outfalls may contribute bacteria to surface waters. At most locations, these discharges will contain bacteria washed off of impervious surfaces on the landscape. Sources of these bacteria include wild animals and pet waste. At some locations, these discharges may also contain bacteria originating from cross-connections between the sanitary and storm sewer systems, illicit discharges into the storm sewer system, or degrading sewer system infrastructure. Fecal material from waterfowl such as gulls and geese may also be a source of bacteria to the surface waters. Contributions from this source are likely to come from two different sets of areas: areas adjacent to waterbodies that are heavily used by these animals and impervious areas that are directly connected to surface waters through the storm sewer system. Effluent from three wastewater treatment plants that discharge treated effluent into streams of the watershed constitutes an additional source of bacteria to those streams. The limitations set in these plants' discharge permits under the Wisconsin Pollutant Discharge Elimination Program do not require disinfection of the effluent. These discharges have a strong local effect on concentrations of fecal indicator bacteria, but these effects are somewhat limited in the extent of their downstream impact. For example, the impacts from the Village of Union Grove's treatment plant are not evident beyond 1.2 miles downstream from the plant's outfall. In rural areas, malfunctioning and failing onsite sewage disposal systems may contribute fecal indicator bacteria to surface waters. Due to their age and differences in how they are regulated, onsite system developed prior to 1980 may be at particular risk for failure. Finally, animal husbandry represents a significant portion of agricultural activities in the Root River watershed. Animal wastes deposited on pastureland and cropland and in barnyards, feedlots, and manure piles can potentially contaminate water by surface runoff and infiltration into groundwater. This can pose a particular risk when animal manure is applies to the land surface during the winter, because the wastes can be subject to excessive runoff and transport, especially during the spring snowmelt period.

Two overall strategies are suggested by this definition of recreational use and access problems related to fecal indicator bacteria. First, targets should focus on locating sources that contribute sanitary wastewater to surface waters of the watershed and on ending these contributions. As previously indicated, fecal pollution originating from inputs of sanitary wastewater generally constitutes a more serious public health risk because multiple human pathogens can be present in high concentrations. Second, targets should focus on locating sources that contribute fecal pollution of nonhuman origin and on ending these contributions. These contributions also pose a public health risk to recreational users of surface waters in the watershed. It should be noted that U.S. Environmental Protection Agency staff have indicated that, based on the epidemiological studies they examined in developing the new recommended recreational use water quality criteria, they were unable determine that the risks to recreational users are lower from nonhuman sources of fecal indicator bacteria than from human sources of fecal indicator bacteria.[15]

Issues Related to Trails

Chapter IV inventories the current state of recreational trails and bicycle routes in the Root River watershed. Currently, county and municipal trail systems within the watershed include about 44 miles of off-street trails and 31 miles of on-street bicycle trails. In addition, several parks in the watershed have trails within their boundaries.

The existing network of trails within the watershed can be compared to the trail network envisioned in the county park and open space plans and by other local other local efforts. Map 69 shows existing and planned recreational trails and bicycle routes in the Root River watershed. These include recommendations from the Milwaukee County and Racine County park and open space plans.[16] The Milwaukee County park and open space plan proposes adding about 16 miles of trails to the Oak Leaf Trail. One portion of this addition would run through the corridor along the mainstem of the Root River, from the existing Oak Leaf Trail terminus near W. Ryan Road to the existing Oak Leaf Trail near STH 38. Two other proposed additions to the Oak Leaf Trail would connect existing and proposed portions of the trail to the City of Franklin's recreational trails. About 46 miles of off-street trails and about 41 miles of on-street bicycle routes are proposed to be added to the trail network within the Racine County portion of the Root River watershed (see Map 69). The Racine County park and open space plan proposes the development of a Root River Recreational Corridor along the mainstem of the Root River. This corridor would consist of approximately 15 miles of trails and connect to the Root River Corridor in Milwaukee County on the north and the proposed Lake Michigan Corridor on the south.

Recommendations for trail development within the Root River watershed are contained in the City of Racine's park and open space plan.[17] This plan recommends that the City develop an additional mile of the Root River Pathway within Johnson Park, noting that this would complete that portion of the Root River Trail that is within the City. It also notes that the City's 2035 comprehensive plan[18] recommends the development of on-street bikeways along 27 miles of streets within the City. Much of this development would be within the Root River watershed.

The City's comprehensive plan also recommends that the City of Racine and Racine County work together to develop a water trail along the Root River. A water trail is a designated trail on a lake or stream that regularly contains sufficient water level to navigate small watercraft such as a canoe or kayak with unobstructed passageways while providing safe and convenient access points, and may contain support facilities such as parking areas, restrooms, and picnic areas. Water trails would identify parts of the Root River as waterways that could accommodate low-impact, nonmotorized watercraft. Important factors for establishing water trails include safe and convenient access to a waterway with unobstructed passageways, adequate support facilities, and safe portaging areas.

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[15]*U.S. Environmental Protection Agency,* Recreational Water Quality Criteria, *November 26, 2012.*

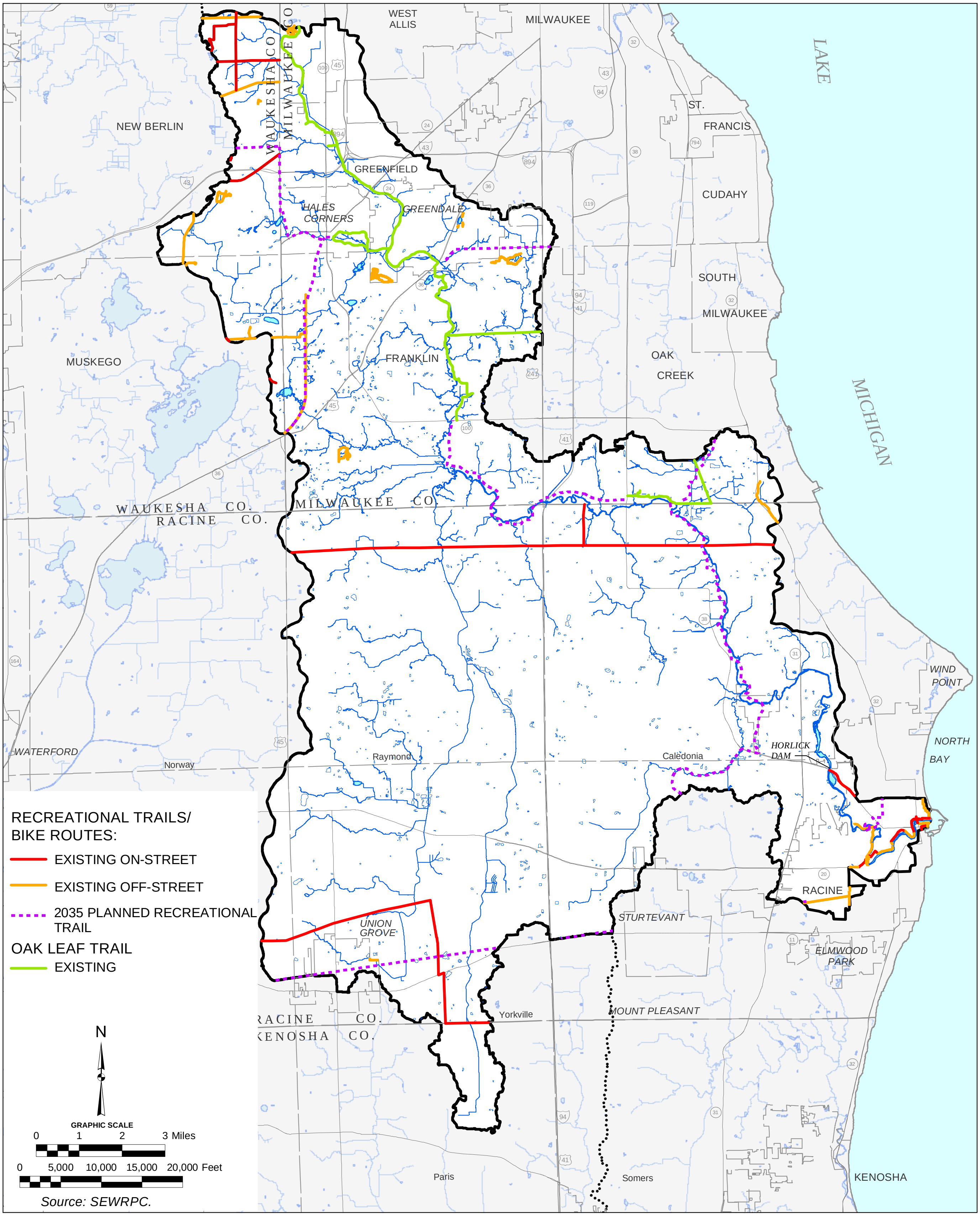
[16]*SEWRPC Community Assistance Planning Report No. 132, 2nd Edition,* A Park and Open Space Plan for Milwaukee County, *in review; SEWRPC Community Assistance Planning Report No. 134, 3rd Edition,* A Park and Open Space Plan for Racine County, *February 2013.*

[17]*SEWRPC Community Assistance Planning Report No. 270, 2nd Edition,* A Park and Open Space Plan for the City of Racine: 2035, Racine County, Wisconsin, *December 2011.*

[18]*SEWRPC Community Assistance Planning Report No. 305,* A Comprehensive Plan for the City of Racine: 2035, *November, 2009.*

Map 69

EXISTING AND PLANNED RECREATIONAL TRAILS
AND BIKE ROUTES WITHIN THE ROOT RIVER WATERSHED: 2013



Source: SEWRPC.

Additional pedestrian, bicycle, and trail recommendations proposed in City of Racine neighborhood plans and the Root River Revitalization Plan[19] include developing a riverwalk along the south side of the Root River from 6th Street to Main Street in the City of Racine, re-routing a portion of the Root River Pathway on Mound Avenue to an off-street location, installing bike paths and marked on-street bike routes, improving public access to the Root river through signs and marked walking paths, and improving pedestrian and bicycle access along 14th Street.

Issues Related to Surface Water Access

Chapter IV inventories the current state of public access to surface waters for boating in the Root River watershed. Several developed access sites to the Root River are available downstream from Horlick dam. These include a boat launch at Colbert Park and canoe launches at Clayton, Island, Lincoln, and 6th Street South Parks. Upstream from Horlick dam there is one developed access point, a boat launch at Horlick Park.[20] In addition, there is public boating access on two lakes of the watershed. Upper Kelly Lake currently has one public boating access site on its northeastern shore. The City of New Berlin maintains a park on its southern shore, with roadside parking spaces for about five motor vehicles. There is also one carry-in access site on the eastern shore of Lower Kelly Lake.

The current number and spacing of public access sites along the Root River can be compared to the State of Wisconsin's standards for public boating access development. These standards indicate that major public canoeing/kayaking access sites with parking should be provided on major streams every 10 miles.[21] Given that all current access points are within the lower six miles of the River, the Root River may fail to conform to these standards. Developing additional carry-in boating access upstream from Horlick Park would improve the recreational opportunities available to the public in the Root River watershed.

It should be noted that recent planning efforts have proposed developing additional public access for canoes and kayaks along the Root River. The Racine County park and open space plan proposed providing an additional access site for canoes and kayaks along the River.[22] The Milwaukee County park and open space plan recommended developing canoe/carry-in boat access along the Root River on existing parkway lands.[23] The Back to the Root Plan also noted that the weir at the WDNR Root River Steelhead Facility in Lincoln Park in the City of Racine creates challenges to paddlers.[24] To assist boaters in portaging around the weir, this plan recommended modifying the existing boat launch upstream from the weir and installing an additional boat launch downstream from the weir.

A similar comparison can be made of the current public boating access to lakes in the Root River watershed to State standards for public boating access development. State standards indicate that lakes with less than 50 acres area should have one carry-in access site with parking for five vehicles. Both Lower Kelly Lake and Upper Kelly

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[19]*Root River Council, City of Racine, and River Alliance of Wisconsin,* RootWorks-Revitalizing Racine's Urban River Corridor, *July 2, 2012.*

[20]*While paddlers launch and take out canoes and kayaks at a number of parks and road crossings along the River upstream for Horlick dam, these do not constitute developed landings.*

[21]*The applicable State standards are discussed in more detail in the subsection on targets related to surface water access below.*

[22]*SEWRPC Community Assistance Planning Report No. 134, 3rd Edition,* op. cit.

[23]*SEWRPC Community Assistance Planning Report No. 132, 2nd Edition,* op. cit.

[24]*Root River Council and River Alliance of Wisconsin,* Back to the Root: An Urban River Revitalization Plan, *July 2008.*

Lake meet the standards with regard to the numbers of access points; however, the Lakes have limited parking within the vicinities of the launch sites, and, hence, fail to conform to current State standards.

Recreational Use and Access Targets

Targets Related to Fecal Indicator Bacteria

The description of water quality problems given above concluded that two overall strategies should be pursued in developing targets related to bacteria indicative of fecal contamination: targets related to locating and ending contributions of sanitary wastewater to surface waters and targets related to locating sources that contribute fecal pollution of nonhuman origin and ending these contributions. Two different bacterial indicators of fecal contamination have been used and are currently in use within the Root River watershed: fecal coliform bacteria and *E. coli*. Because the State of Wisconsin's water quality criteria for fecal indicator bacteria is expressed in terms of fecal coliform bacteria and because the calibrated water quality simulation modeling conducted as part of the RWQMPU examined fecal coliform bacteria and did not examine *E. coli*, the discussion of targets related to fecal indicator bacteria will be expressed in terms of fecal coliform bacteria.[25] It should be noted that *E. coli* is a major constituent of fecal coliform bacteria.

The RWQMPU made recommendations whose implementation would act to reduce contributions of fecal indicator bacteria. These recommendations were summarized and the status of their implementation was reviewed in Chapter II of this report. The RWQMPU also included estimates of pollutant loads to the stream system that would occur under three sets of conditions.[26] These conditions include:

- Existing condition: Representing watershed conditions as of the year 2000;

- Revised 2020 Baseline condition: The condition projected to occur in 2020 under planned 2020 land use conditions, assuming full implementation of the urban stormwater runoff performance standards and a reasonable level of implementation of agricultural performance standards as set forth in Chapter NR 151, "Runoff Management," of the *Wisconsin Administrative Code*, but without implementation of the recommendations of the RWQMPU; and

- Recommended Plan condition: The condition projected to occur under planned 2020 land use conditions, assuming full implementation of the urban stormwater runoff performance standards and a reasonable level of implementation of agricultural performance standards as set forth in NR 151 along with implementation of the recommendations of the RWQMPU.[27]

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[25]*The use of fecal coliform bacteria for expressing watershed targets is not intended as a recommendation as to which of these indicators should be used in ongoing and future monitoring activities in the watershed or as a conclusion as to which of these indicators would be most appropriate for use in any future revisions of State of Wisconsin water quality criteria.*

[26]*SEWRPC Planning Report No. 50,* op. cit.

[27]*The RWQMPU included pollutant load estimates for two additional conditions: a Revised 2020 Baseline condition with a five-year level of protection to control against sanitary sewer overflows (five-year LOP) and an Extreme Measures condition. In the Root River watershed, the estimated pollutant loads under the Revised 2020 Baseline with a five-year LOP condition were identical to the estimated pollutant loads under the Revised 2020 Baseline condition. The Extreme Measures condition examined a level of nonpoint source controls in excess of the levels envisioned under the recommend plan and envisioned the virtual elimination of phosphorus from discharges of industrial noncontact cooling water. In the Root River watershed, at most locations the degree of compliance with applicable water quality standards under the Extreme Measures condition, as estimated by the calibrated water quality simulation model, was similar to the degree of compliance under the Recommended Plan condition.*

These estimates were made using a calibrated water quality simulation model.[28] The estimated loads of fecal coliform bacteria associated with each of the three conditions are given in Appendix O of this report.

It is important to note that for fecal coliform bacteria, the portion of the pollutant loads contributed by point sources is quite low under all three conditions described above. On a whole watershed basis, point sources are estimated to have contributed less than 0.2 percent of the fecal coliform bacteria load under the Existing (2000) condition. Under the Recommended Plan (2020) condition, point sources are estimated to represent about 0.6 percent of the fecal coliform bacteria load.[29] Given that point sources are estimated to contribute these small percentages of the fecal coliform bacteria loads, the targets for this watershed restoration plan should place strong emphasis on nonpoint sources. The reductions in nonpoint source loads between the Existing (2000) condition and the Recommended Plan (2020) condition that are envisioned in the RWQMPU define targets to be met in order to improve water quality conditions in the Root River watershed.

These targets were refined in two ways. First, the load estimates from the three conditions were used to estimate how much of the pollutant load reductions envisioned in the RWQMPU would result from implementation of the NR 151 stormwater runoff performance standards and how much would result from other elements of the recommended plan. Second, the load reductions were adjusted to account for changes in the application of NR 151 that have been made since the RWQMPU was completed.

The developed urban area performance standard for municipalities set forth in Section NR 151.13 requires that municipalities with WPDES stormwater discharge permits reduce the amount of TSS in stormwater runoff from areas of existing development that was in place as of October 1, 2004, to the maximum extent practicable, by 20 percent by March 10, 2008 and by 40 percent by October 1, 2013. In addition, other sections of NR 151 require that all construction sites that have one acre or more of land disturbance must achieve an 80 percent reduction in the sediment load generated by the site. With certain limited exceptions, those sites required under NR 151 to have construction erosion control permits must also have post-development stormwater management practices to reduce the TSS load from the site by 80 percent for new development, 40 percent for redevelopment, and 40 percent for infill development occurring prior to October 1, 2012. After October 1, 2012, infill development will be required to achieve an 80 percent reduction. Recent action by the State Legislature has changed the application of these performance standards. As a result of 2011 Wisconsin Act 32 the WDNR is prohibited from enforcing the 40 percent reduction in TSS load from areas of existing development.

The impact of this is that the load reductions from urban nonpoint sources as represented under the RWQMPU need to be adjusted to account for the change in application of the developed urban area performance standard. The need to adjust the load reductions applied to the load reductions for fecal coliform bacteria, as well as TSS and total phosphorus, because many of the stormwater management practices that would have been installed to achieve a 40 percent reduction in TSS loads would also act to reduce fecal coliform bacterial loads.

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[28]*The calibrated water quality model is described, and its results and conclusions are presented and discussed, in SEWRPC Planning Report No. 50,* op. cit.

[29]*The estimated increase in the fraction of the fecal coliform bacteria load that is contributed by point sources reflects two factors. First, anticipated urban development between 2000 and 2020 in the areas served by the Union Grove and Yorkville Sewer Utility District wastewater treatment plants can be expected to increase loads of fecal coliform discharged from these plants. Second, the RWQMPU envisions about a 40 percent decrease in the portion of the fecal coliform bacteria load that is contributed by nonpoint sources between the Existing (2000) condition and the Recommended Plan (2020) condition. Much of the increase in the percentage of the total load contributed by point sources reflects this large decrease in nonpoint source loads.*

The adjustment in load reductions was done on a subwatershed basis using the existing 2000 land use (see Table 13 in Chapter IV of this report) and the planned 2035 land use (see Table 15 in Chapter IV of this report) to estimate the portions of urban lands within each subwatershed under the Recommended Plan (2020) condition that represent:

- Existing development that would have been subject to the 40 percent TSS reduction requirement, and

- New development that is subject to the 80 percent TSS reduction requirement, redevelopment that is subject to the 40 percent TSS reduction requirement, and infill development, which is subject to a 40 percent TSS reduction requirement prior to October 1, 2012, and an 80 percent TSS reduction requirement after October 1, 2012.

To adjust the urban nonpoint source load reductions for the changes in the application of NR 151, the portion of the NR 151-related load reductions that are attributable to existing development was estimated for each subwatershed. This portion of the pollutant load was reduced by half.[30] In order to maintain the recommended levels of water quality improvement envisioned under the RWQMPU, the amount of this reduction was added to the "other reductions" categories for urban nonpoint sources in Table 66.

Table 66 shows the adjusted nonpoint source load reductions for fecal coliform bacteria for the Root River watershed. On a watershed basis, this sets a target of reducing nonpoint source loads of fecal coliform bacteria to the stream system by 4,725.42 trillion cells between 2000 and 2020. Of this reduction, 3,982.57 trillion cells would come from urban nonpoint sources, with 963.29 trillion cells of this reduction being attributable to implementation of NR 151 and 3,019.28 trillion cells of this reduction being attributable to implementation of other measures. The remaining 828.98 trillion cells would come from rural nonpoint sources, with 204.67 trillion cells of this reduction being attributable to implementation of NR 151 and 624.31 trillion cells of this reduction being attributable to implementation of other measures.

Table 66 also shows adjusted nonpoint source load reductions for fecal coliform bacteria for individual subwatersheds. The reduction targets range from a reduction of 54.30 trillion cells in the Root River Canal subwatershed to a reduction of 1,327.66 trillion cells in the Lower Root River subwatershed.

In addition to presenting estimates of pollutant loads, the RWQMPU provided estimates of water quality conditions under the Existing (2000) and Recommended Plan (2020) conditions.[31] These estimates were calculated using the calibrated water quality model. Comparison of the modeled water quality conditions under the Recommended Plan (2020) condition to those under the Existing (2000) condition provides an estimate of the degree of improvement in water quality conditions in the Root River watershed that would be achieved by meeting the load reduction targets given in Table 66. For fecal coliform bacteria, these estimates of water quality conditions were made over both the whole year and over the 153-day swimming season from May 1 through September 30. Because the heaviest recreational use of surface waters occurs during this period and full-body contact uses are most likely to occur during this period, it would be reasonable to conclude that if the bacteria criteria were met during the swimming season, the stream or stream reach stream in question would meet the water use objective for recreational use. Estimates of water quality conditions under Existing (2000) and Recommended Plan (2020) conditions made over the whole year and over the swimming season are given in Tables 67 and 68, respectively.

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[30]*This reflects a change from controlling 40 percent of TSS as expected under planned conditions prior to promulgation of 2011 Wisconsin Act 32, to controlling 20 percent of TSS.*

[31]*The RWQMPU also provided estimates of water quality conditions under the Revised 2020 Baseline, the Revised 2020 Baseline with a five-year LOP, and Extreme Measures conditions.*

Table 66

ANNUAL REDUCTIONS IN NONPOINT SOURCE LOADS OF FECAL COLIFORM BACTERIA REQUIRED BY THE RWQMPU ADJUSTED FOR CHANGES IN NR 151

		Annual Reduction in Loads of Fecal Coliform Bacteria (trillion cells)						
		Urban Sources			Rural			
Subwatershed	Assessment Areas	NR 151 Related	Other Reductions	Subtotal	NR 151 Related	Other Reductions	Subtotal	Total
Upper Root River	Upper Root River, Upper Root River Headwaters	288.92	881.95	1,170.87	0.47	0.00	0.47	1,171.34
Whitnall Park Creek	Whitnall Park Creek	160.70	495.76	656.46	7.36	34.28	41.64	698.10
Middle Root River	Middle Root River-Dale Creek, Middle Root River-Legend Creek, Middle Root River-Ryan Creek	69.40	404.50	473.90	0.00	60.84	60.84	534.74
East Branch Root River	East Branch Root River	47.98	211.89	259.87	2.16	0.00	2.16	262.03
West Branch Root River Canal	Upper West Branch Root River Canal, Lower West Branch Root River Canal	28.60	38.37	67.33	31.67	158.44	190.11	257.44
East Branch Root River Canal	East Branch Root River Canal	0.00	11.80	11.80	14.20	70.91	85.11	96.91
Root River Canal	Root River Canal	2.84	4.77	7.61	0.00	46.69	46.69	54.30
Lower Root River	Lower Root River-Caledonia, Lower Root River Johnson Park, Lower Root River-Racine	320.68	740.18	1,060.86	115.48	151.32	266.80	1,327.66
Hoods Creek	Hoods Creek	44.19	143.55	187.74	33.33	101.83	135.16	322.90
	Total	963.29	3,019.28	3,982.57	204.67	624.31	828.98	4,725.42

Source: SEWRPC.

Table 67

MODELED FECAL COLIFORM BACTERIA ANNUAL SUMMARY STATISTICS FROM THE RWQMPU FOR THE ROOT RIVER WATERSHED[a]

Assessment Point	Assessment Area	Mean Concentration (cells per 100 ml)		Percent Compliance with Single Sample Standard (<400 cells per 100 ml)		Geometric Mean Concentration (cells per 100 ml)		Days of Compliance with Geometric Mean Standard (<200 cells per 100 ml)[b]	
		Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)
RT-2: Root River	Upper Root River-Headwaters	7,040	3,765	66	69	630	333	27	98
RT-4: Root River	Upper Root River	7,101	3,707	56	61	865	450	19	64
RT-5: Whitnall Park Creek	Whitnall Park Creek	8,198	4,213	55	59	896	461	18	66
RT-8: Middle Root River	Middle Root River-Dale Creek	6,584	3,674	46	52	1,262	714	6	27
RT-9: East Branch Root River	East Branch Root River	6,332	3,443	65	67	594	349	35	104
RT-10: Root River Upstream of Ryan Creek	Middle Root River-Legend Creek	6,995	3,770	48	55	1,189	628	9	39
RT-11: West Branch Root River Canal	Upper West Branch Root River Canal	2,428	2,152	72	71	262	209	129	172
RT-13: West Branch Root River Canal	Lower West Branch Root River Canal	2,372	2,105	64	68	412	313	59	101
RT-15: East Branch Root River Canal	East Branch Root River Canal	3,272	2,698	71	72	288	189	121	209
RT-16: Root River Canal	Root River Canal	2,401	2,161	62	65	423	332	62	95
RT-17: Root River at Upstream Crossing of Milwaukee-Racine County Line	Middle Root River-Ryan Creek	4,656	2,909	43	51	1,123	713	7	18
RT-18: Root River Upstream of Hoods Creek	Lower Root River-Caledonia	4,253	2,801	46	51	983	629	11	37
RT-20: Hoods Creek	Hoods Creek	4,039	1,975	69	71	286	121	148	248
RT-21: Root River at City of Racine	Lower Root River-Johnson Park	4,547	2,672	48	53	853	522	17	57
RT-22: Mouth of Root River at Lake Michigan	Lower Root River-Racine	4,924	2,765	47	51	869	516	28	68

[a] *Within the water quality models for the recommended plan condition, the detection and elimination of illicit discharges to storm sewer systems and control of urban source pathogens, including those in stormwater runoff, are represented using stormwater disinfection units. Such units were initially considered as a recommended approach to treatment of runoff, but were eliminated from further consideration based on comments from the RWQMPU Technical Advisory Committee. However, the use of such units is considered to be appropriate as a surrogate representation of the varied and as yet undetermined means that would be applied to detect and eliminate illicit discharges and to control pathogens in urban stormwater runoff. Those units explicitly address the control of bacteria in stormwater runoff, and, based on the way that bacteria loads are represented in the calibrated model, they also implicitly provide some control of bacteria that may reach streams through illicit connections that contribute to baseflow.*

[b] *Out of 365 days.*

Source: Tetra Tech, Inc., and SEWRPC.

Table 68

MODELED FECAL COLIFORM BACTERIA SWIMMING SEASON SUMMARY STATISTICS FROM THE RWQMPU FOR THE ROOT RIVER WATERSHED[a,b]

Assessment Point	Assessment Area	Mean Concentration (cells per 100 ml)		Percent Compliance with Single Sample Standard (<400 cells per 100 ml)		Geometric Mean Concentration (cells per 100 ml)		Days of Compliance with Geometric Mean Standard (<200 cells per 100 ml)[c]	
		Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)
RT-2: Root River	Upper Root River-Headwaters	3,968	1,927	77	79	464	240	10	46
RT-4: Root River	Upper Root River	4,018	1,681	66	71	603	297	7	33
RT-5: Whitnall Park Creek	Whitnall Park Creek	5,142	2,141	66	70	628	301	7	34
RT-8: Middle Root River	Middle Root River-Dale Creek	3,951	1,788	58	65	770	394	3	18
RT-9: East Branch Root River	East Branch Root River	3,348	1,590	79	79	365	213	21	59
RT-10: Root River Upstream of Ryan Creek	Middle Root River-Legend Creek	3,768	1,655	59	68	717	353	4	26
RT-11: West Branch Root River Canal	Upper West Branch Root River Canal	1,995	1,579	81	80	164	137	67	85
RT-13: West Branch Root River Canal	Lower West Branch Root River Canal	2,099	1,801	74	77	256	198	41	62
RT-15: East Branch Root River Canal	East Branch Root River Canal	2,853	2,109	80	80	213	142	64	109
RT-16: Root River Canal	Root River Canal	2,066	1,772	72	75	255	202	47	66
RT-17: Root River at Upstream Crossing of Milwaukee-Racine County Line	Middle Root River-Ryan Creek	2,994	1,594	55	63	720	422	4	12
RT-18: Root River Upstream of Hoods Creek	Lower Root River-Caledonia	2,687	1,589	60	65	556	330	9	29
RT-20: Hoods Creek	Hoods Creek	3,354	1,393	81	80	158	55	84	138
RT-21: Root River at City of Racine	Lower Root River-Johnson Park	3,041	1,489	62	67	479	268	13	43
RT-22: Mouth of Root River at Lake Michigan	Lower Root River-Racine	3,327	1,508	62	67	440	240	22	54

[a] *Within the water quality models for the recommended plan condition, the detection and elimination of illicit discharges to storm sewer systems and control of urban source pathogens, including those in stormwater runoff, are represented using stormwater disinfection units. Such units were initially considered as a recommended approach to treatment of runoff, but were eliminated from further consideration based on comments from the RWQMPU Technical Advisory Committee. However, the use of such units is considered to be appropriate as a surrogate representation of the varied and as yet undetermined means that would be applied to detect and eliminate illicit discharges and to control pathogens in urban stormwater runoff. Those units explicitly address the control of bacteria in stormwater runoff, and, based on the way that bacteria loads are represented in the calibrated model, they also implicitly provide some control of bacteria that may reach streams through illicit connections that contribute to baseflow.*

[b] *The swimming season is taken as May through September.*

[c] *Out of 153 days total.*

Source: Tetra Tech, Inc. and SEWRPC.

Table 67 shows a comparison of modeled fecal coliform bacteria summary statistics under the Existing (2000) and Recommended Plan (2020) conditions calculated over the entire year. These summary statistics are estimated for 15 assessment points located at or near the downstream ends of the 15 assessment areas. The locations of these assessment points are shown on Map 7 in Chapter IV of this report. Estimated mean concentrations of fecal coliform bacteria at these assessment points under the Existing (2000) condition ranged between 2,401 cells per 100 ml and 8,198 cells per 100 ml, with an average value of 5,009 cells per 100 ml. Under the Recommended Plan (2020) condition, estimated mean concentrations of fecal coliform bacteria ranged between 2,105 cells per 100 ml and 4,213 cells per 100 ml, with an average value of 2,978 cells per 100 ml. Estimated geometric mean concentrations of fecal coliform bacteria at these assessment points under the Existing (2000) condition ranged between 262 cells per 100 ml and 1,262 cells per 100 ml. Under the Recommended Plan (2020) condition, estimated geometric mean concentrations of fecal coliform bacteria ranged between 121cells per 100 ml and 714 cells per 100 ml. The highest estimated mean concentrations under both conditions were present in upper portions of the watershed, including the Upper Root River-Headwaters, Upper Root River, Whitnall Park Creek, Middle Root River-Dale Creek, East Branch Root River, and Middle Root River-Legend Creek assessment areas. The highest estimated geometric mean concentrations under both conditions were present in central portions of the watershed, including the Middle Root River-Dale Creek, Middle Root River-Legend Creek, Middle Root River-Ryan Creek, and Lower Root River-Caledonia assessment areas.

Table 67 also shows estimates of the degree of compliance with the State's water quality criteria for fecal coliform bacteria at each assessment point under both conditions. Two estimates are given: the percent of time that concentrations of fecal coliform bacteria would be at or below the single-sample criterion of 400 cells per 100 ml and the number of days per year that the geometric mean of fecal coliform bacteria concentrations would be at or below the geometric mean criterion of 200 cells per 100 ml. The estimated level of compliance with the single-sample criterion under the Existing (2000) condition ranged between 43 percent and 72 percent, with an average level of compliance of 57 percent. The estimated level of compliance with the single-sample criterion under the Recommended Plan (2020) condition ranged between 51 percent and 72 percent, with an average level of compliance of 61 percent. The estimated level of compliance with the geometric mean criterion under the Existing (2000) condition ranged between six days per year and 148 days per year, with an average level of compliance of 46 days per year. The estimated level of compliance with the geometric mean criterion under the Recommended Plan (2020) condition ranged between 18 days per year and 248 days per year, with an average level of compliance of 94 days per year.

Table 68 shows a comparison of modeled fecal coliform bacteria summary statistics under the Existing (2000) and Recommended Plan (2020) conditions calculated over the 153-day May through September swimming season. These summary statistics are estimated for 15 assessment points located at or near the downstream ends of the 15 assessment areas. The locations of these assessment points are shown on Map 7 in Chapter IV of this report. Estimated mean concentrations of fecal coliform bacteria at these assessment points under the Existing (2000) condition ranged between 1,995 cells per 100 ml and 5,142 cells per 100 ml, with an average value of 3,241 cells per 100 ml. Under the Recommended Plan (2020) condition, estimated mean concentrations of fecal coliform bacteria ranged between 1,393 cells per 100 ml and 2,141 cells per 100 ml, with an average value of 1,708 cells per 100 ml. Estimated geometric mean concentrations of fecal coliform bacteria at these assessment points under the Existing (2000) condition ranged between 158 cells per 100 ml and 770 cells per 100 ml. Under the Recommended Plan (2020) condition, estimated geometric mean concentrations of fecal coliform bacteria ranged between 55 cells per 100 ml and 394 cells per 100 ml. The highest estimated mean concentrations under the Existing (2000) condition were present in upper portions of the watershed, including the Upper Root River-Headwaters, Upper Root River, Whitnall Park Creek, and Middle Root River-Dale Creek, assessment areas. Under the Recommended Plan (2020) condition, estimated mean concentrations in these assessment areas were similar to those in the assessment areas that make up the Root River Canal and its East and West Branches. The highest estimated geometric mean concentrations under both conditions were present in central portions of the watershed, including the Middle Root River-Dale Creek, Middle Root River-Legend Creek, and Middle Root River-Ryan Creek assessment areas.

Table 68 also shows estimates of the degree of compliance with the State's water quality criteria for fecal coliform bacteria during the swimming season at each assessment point under both conditions. Two estimates are given: the percent of time that concentrations of fecal coliform bacteria would be at or below the single-sample criterion of 400 cells per 100 ml and the number of days out of 153 that the geometric mean of fecal coliform bacteria concentrations would be at or below the geometric mean criterion of 200 cells per 100 ml. The estimated level of compliance with the single-sample criterion during the swimming season under the Existing (2000) condition ranged between 55 percent and 81 percent, with an average level of compliance of 69 percent. The estimated level of compliance with the single-sample criterion during the swimming season under the Recommended Plan (2020) condition ranged between 63 percent and 80 percent, with an average level of compliance of 72 percent. The estimated level of compliance with the geometric mean criterion during the swimming season under the Existing (2000) condition ranged between three out of 153 days and 84 out of 153 days, with an average level of compliance of 27 out of 153 days. The estimated level of compliance with the geometric mean criterion during the swimming season under the Recommended Plan (2020) condition ranged between 12 out of 153 days and 138 out of 153 days, with an average level of compliance of 54 out of 153 days.

Targets Related to Trails

Standards for the development of recreational corridors are given in the county park and open space plans for the counties in the Root River watershed.[32] These plans define a recreational corridor "as a publicly owned linear expanse of land which is generally located within scenic areas or areas of natural, cultural, or historical interest and which provides opportunities for participation in trail-oriented outdoor recreational activities especially through the provision of trails designated for such activities as biking, hiking, horseback riding, nature study, and ski-touring." The standards presented in these plans include:

1. A minimum of 0.16 mile of recreation related open space consisting of linear recreation corridors should be provided for each 1,000 persons in the County.

2. Recreation corridors should have a minimum length of 15 miles and a minimum width of 200 feet.

3. The maximum travel distance to recreation corridors should be five miles in urban areas and 10 miles in rural areas;

4. Resource-oriented recreation corridors should maximize the use of:

    a. Primary environmental corridors as locations for trail-oriented recreation activities.

    b. Outdoor recreation facilities provided at existing public park sites.

    c. Existing trail-type facilities within the County.

The most recent editions of the park and open space plans for Milwaukee and Racine Counties evaluated the existing trail systems for the achievement of these standards.[33] The evaluation for Racine County concluded that the existing trail system within the County does not meet the minimum standard of 0.16 miles of recreation corridor for each 1,000 persons in the County as applied to the County's anticipated 2035 population. In addition, the existing Root River path in the City of Racine extends 4.5 miles from the Main Street Bridge to Colonial Park, and, therefore, does not meet the 15-mile minimum length standard.

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[32]*SEWRPC Community Assistance Planning Report No. 132, 2nd Edition,* op. cit.*; SEWRPC Community Assistance Planning Report No. 134, 3nd Edition,* op. cit.

[33]Ibid.

Examination of Map 64 in Chapter IV of this report shows poor continuity of trails within the watershed. In particular, trails located in the downstream portion of the watershed in and around the City of Racine are not connected to trails in the upstream portions of the watershed. In addition, the major trails within the watershed are only partially connected to trails in adjacent watersheds and communities.

A continuous and interconnected trail system provides trail users with opportunities to hike, bike, ride horses, and ski along greater distances. It also provides a more varied landscape over which to pursue these activities. In addition, providing interconnections among trail systems may make it possible to meet the minimum length standards and the maximum travel distance standards set forth above in a more cost-effective manner.

Based upon these considerations, the target for trails and recreational corridors within the Root River watershed should be an interconnected trail system within the watershed that, to the extent practicable, provides connections to local, county, and regional trail systems within adjacent watersheds.

Targets Related to Surface Water Access

The WDNR has developed standards for public boating access to waterbodies in the State. These standards are set forth in Sections NR 1.90 through NR 1.93 of the *Wisconsin Administrative Code*. A major means of implementation of these standards is through eligibility of waterbodies for natural resource enhancement services. Natural resource enhancement services consist of funding or activities that increase the recreational or environmental values of a waterway. They include, but are not limited to, fish stocking, fish population management, habitat development, financial assistance for aquatic plant harvesting, and lake restoration grants. Under the provisions of Section NR 1.91(4)(a), the Department may only provide natural resource enhancement services for a body of water when it determines that the general public has been provided with reasonable boating access. Reasonable access is defined as the waterbodies meeting minimum public boating access development standards (see below). Section NR 1.91(4) grants the Department the discretion to continue to provide natural resource enhancement to waterbodies that do not meet the minimum public boating access development standards in cases where the Department determines that the existing access facilities are sufficient to meet existing public demand for access. In addition, Section NR 1.91(4) grants the Department the discretion to provide natural resource protection services for pollution abatement or prevention, natural resource protection, public safety, or boating access if public boating access is not available on a waterway.[34]

Table 69 summarizes the State of Wisconsin's public boating access development standards for lakes. These standards specify the launch facilities and minimum numbers of parking spaces, including automobile parking spaces and car-trailer spaces, that should be present based upon the size of the lake. Under these standards, parking is to be contiguous with the launch site unless the Department determines that resource protection, spatial restrictions, or other factors require a greater distance. One additional parking space, in addition to the minimum specified in the table, must be provided for use by disabled persons. The standards also specify a maximum number of parking spaces to be provided. This also varies according to the size of the lake, in recognition that too many boats on a lake may threaten both the safety of lake users and the environmental quality of the lake.

Table 70 summarizes the State of Wisconsin's public boating access development standards for rivers and the Great Lakes. These standards specify that launch facilities and parking along rivers be available based upon proximity to incorporated communities and distance along streams. Under these standards, parking is to be contiguous with the launch site unless the Department determines that resource protection, spatial restrictions, or other factors require a greater distance. One additional parking space, in addition to the minimum specified in the

[34]*Resource protection services include but are not limited to nonpoint pollution control grants, loans for municipal sewage treatment facilities, acquisition grants under the urban green space program, lake planning grants, lake protection grants, and funding for municipal boating safety patrols and aids to navigation.*

Table 69

STATE OF WISCONSIN PUBLIC BOATING ACCESS STANDARDS FOR INLAND LAKES

Size (acres)	Minimum Public Boating Access Development	Maximum Public Boating Access Development
<50	One carry-in access site for five vehicles	One carry-in access site for five vehicles
50-99	One or more access sites which in total provide a combination of five vehicle and car-trailer units	One or more access sites which in total provide five car-trailer units
100-499	One or more access sites which in total provide one car-trailer unit per 30 open water acres, but no less than five units for lakes of 50 to 150 open water acres	One or more access sites which in total provide one car-trailer unit per 15 open water acres
500-999	One or more access sites which in total provide one car-trailer unit per 35 open water acres, but no less than 17 units for lakes of 500 to 595 open water acres	One or more access sites which in total provide one car-trailer unit per 25 open water acres, but no less than 33 units for lakes of 500 to 825 open water acres
1,000-4,999	One or more access sites which in total provide one car-trailer unit per 50 open water acres, but no less than 29 units for lakes of 1,000 to 1,450 open water acres	One or more access sites which in total provide one car-trailer unit per 30 open water acres, but no less than 40 units for lakes of 1,000 to 1,200 open water acres
5,000 or More	One or more access sites which in total provide one car-trailer unit per 70 open water acres, but no less than 100 units for lakes of 5,000 to 7,000 open water acres	One or more access sites which in total provide one car-trailer unit per 50 open water acres, but no less than 167 units for lakes of 5,000 to 8,350 open water acres

Source: Section NR 1.91 of the Wisconsin Administrative Code*.*

Table 70

STATE OF WISCONSIN PUBLIC BOATING ACCESS STANDARDS FOR RIVERS AND THE GREAT LAKES

Class	Minimum Public Boating Access Development	Maximum Public Boating Access Development
Rivers and Lakes Michigan and Superior and Their Bays	One access site within five miles of each incorporated community bordering the shore	One access site per five miles of flowing water or where the Department determines additional facilities would exceed the resource capacity of the waterbody
Rivers and Streams Accessed Primarily by Carry-In	One access site per 10 miles of stream thread	One carry-in site per 10 miles of flowing water
Exceptions	Determined case-by-case based on a plan	Determined by a plan

Source: Section NR 1.91 of the Wisconsin Administrative Code*.*

table, must be provided for use by disabled persons. The standards also specify a maximum number of access sites to be provided. For the Root River, these standards indicate that carry-in access points with parking should be provided every 10 miles.

It should be noted that natural resource enhancement services may be provided for waters that have less public boating access than specified in the standards given in Tables 69 and 70 and that public boating access may be developed that exceeds the levels given in the standards only if local governments or the WDNR have an alternative public boating access and waterway protection plan. Plans written by local government require written approval by the WDNR prior to adoption. The factors to be considered in the development of such a plan are given in Section NR 1.91(6) of the *Wisconsin Administrative Code*.

Application of the public boating access development standards given in Tables 69 and 70 give the following targets for additional public boating access in the Root River watershed:

- There should be one carry-in access site per 10 miles of stream along the mainstem of the Root River. This indicates that one to two access sites should be created upstream from Horlick dam, and

- There should be one carry-in access site with parking for five vehicles on each of the Kelly Lakes. This indicates that additional parking may need to be developed at the existing access sites on these lakes.

Habitat Targets

Habitat is comprised of a complicated mixture of biological, physical, chemical, and hydrological variables. Biotic interactions such as predation and competition can affect species abundance and distributions within aquatic systems. These interactions take place in the context of, and are strongly influenced by, the abiotic environment. Abiotic factors such as streamflow, water depth (pools and riffles), water volume, temperature, dissolved oxygen concentrations, and substrate diversity are strong determinants of aquatic communities (fish, invertebrates, and algae). The quality of the resulting biological communities reflect the influence of abiotic factors. Therefore, biological community quality can be used as a surrogate to assess habitat quality. For example, high abundance and diversity of fishes is strongly associated with high-quality habitat.

In addition, anything that affects one or more of the abiotic factors that determine biological quality becomes an important component of habitat quality. For example, as noted previously, the alterations to the hydrology of the urbanized and agricultural areas of the Root River watershed stream system are major determinants of stream dynamics and also are a vital component of habitat for fishes and other organisms. Thus, habitat quality is intimately related to land use within this watershed, as well as to land use directly adjacent to the streambank. Consequently, watershed size and associated land use characteristics as well as riparian buffer width are critical elements in defining habitat quality. Channelization, fragmentation due to road crossings, regulation of urban and rural nonpoint source pollution, and accumulation of trash and debris are also important aspects of what constitutes "habitat" and habitat quality within the Root River watershed.

Based on these considerations, targets for habitat in the Root River watershed are expressed in terms of the biological communities that the watershed is able to support. The habitat targets of this watershed restoration plan are that the watershed will provide sufficient habitat quality and quantity capable of supporting:

- A diverse, high-quality, and sustainable aquatic community including fisheries, mussels, and insects;

- A diverse and healthy native wildlife population including, large and small mammals, amphibians, and birds; and

- Healthy, high-quality, and native wetland, marsh, prairie, grassland, and woodland flora community.

Because of the many biological, physical, chemical, and hydrological variables that determine the quality of habitat, it is recognized that achieving these targets will involve addressing many factors, including, but not limited to: protection, expansion, management, and connectivity of riparian buffers; protection of areas with high groundwater recharge potential; re-establishment of natural surface water hydrology, to the extent practicable; preservation and expansion of healthy aquatic and terrestrial wildlife populations; maintenance and improvement of aquatic organism passage; and identification and stabilization of eroding streambeds and streambanks.

Flooding Targets for Racine County

As noted in Chapter IV of this report, the consideration of flooding issues under this study is limited to Racine County because the County specifically requested that such issues be addressed. In Milwaukee County, the Milwaukee Metropolitan Sewerage District (MMSD) has jurisdiction over flood mitigation efforts on several streams and rivers and administers a watercourse system planning program which identifies flood mitigation projects that are undertaken by the District. Thus, it is not necessary to specifically address flood mitigation in Milwaukee County under this watershed restoration plan, other than to recognize the ongoing work by MMSD.

Description of Problems Related to Flooding

Flooding problems within the Racine County portion of the watershed are described in Chapter IV. There are currently 204 structures estimated to be located within the 1-percent-annual probability (100-year recurrence interval) flood hazard areas in the portions of the Root River watershed that are located in Racine County. The general locations of these structures are shown on Maps 59 and 60 in Chapter IV of this report. These include 174 residential structures, one commercial structure, 14 agricultural buildings, three government buildings, one school, one adult day care center, one group home, and nine other buildings (recreational and churches). Based upon the inventory set forth in the Racine County hazard mitigation plan,[35] the three government buildings located within the 1-percent-annual-probability flood hazard area are not critical community facilities. They are associated with recreational park-related uses.

Of the 204 structures identified in the 1-percent-probability floodplain, 166, or 81 percent, are located along the mainstem of the Root River in the City of Racine. Those include 154 residences, the three government buildings noted above, and nine miscellaneous "other" buildings. The remaining 38 residential, agricultural, commercial, industrial, and "other" structures in the floodplain are widely scattered throughout the watershed in Racine County.

Flooding Targets

To ensure that flooding problems associated with the overflow of streams and rivers and problems associated with stormwater runoff as it travels to receiving streams and rivers are resolved in a cost-effective manner, it is generally necessary to prepare system plans to address complex, larger-scale problems and more-targeted plans to address localized problems. For flooding and stormwater quantity problems, an appropriate target would be to provide flood and stormwater management systems which reduce the exposure of people to drainage-related inconvenience and to health and safety hazards and reduce the exposure of real and personal property to damage through inundation. In the cases of flooding problems, standard engineering practice calls for mitigating damages during events up to, and including the 1-percent-probability flood. For stormwater runoff problems, standard practice calls for the provision of 1) a minor stormwater management system with adequate capacity to infiltrate, store, and/or convey the runoff from a 10-percent-annual-probability (10-year recurrence interval) storm while providing acceptable levels of access to property and traffic service, 2) a major system to adequately infiltrate, store, and/or convey the runoff from the 1-percent-probability storm without causing significant property damage and safety hazards, and 3) an emergency overflow route to convey the peak rate of runoff to receiving streams during rain events with probabilities less than 1 percent.

Horlick Dam Targets

The overriding target for Horlick dam is upgrading the spillway capacity to enable the dam to safely pass the peak rate of runoff during a 1-percent-annual-probability flood, as is required by WDNR for a Low Hazard dam. The additional spillway capacity could be provided through modifications to the dam, or the dam could be removed to eliminate the potential downstream hazard. The WDNR has indicated that Racine County could have up to 10 years to increase the spillway capacity of the dam. Thus, the attainment schedule for this target does not directly

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[35]*SEWRPC Community Assistance Planning Report No. 266, 2nd Edition,* Racine County Hazard Mitigation Plan: 2010-2015, *July 2010.*

coincide with the five-year time frame established under this plan for implementing recommendations that meet the targets.

ALTERNATIVES

Alternative Measures for Recreational Use and Access

Alternative Measures to Reduce Instream Concentrations of Fecal Indicator Bacteria

This subsection describes several alternative measures for the reduction of inputs of fecal indicator bacteria—and the pathogenic organisms for which they serve as surrogates—to surface waters of the Root River watershed and evaluates these measures for incorporation into the watershed restoration plan. As noted previously, recreational use water quality standards are based upon fecal coliform bacteria concentrations. Several alternative approaches that could be taken to reduce inputs of fecal indicator bacteria to surface waters are described and placed into context. These alternatives represent a comprehensive collection of potential approaches that could be considered and evaluated for incorporation into the Root River watershed restoration plan. These alternatives are then evaluated to determine their suitability for incorporation into the plan.

It should be kept in mind that these alternatives are intended to meet the targets established for the watershed restoration plan based upon the water quality model used in the RWQMPU. As discussed earlier in this chapter, meeting these targets will result in improvements in the bacterial water quality of surface waters in the Root River watershed; however, even with full implementation, surface waters of the watershed will not achieve full compliance with the applicable water quality criteria for recreational use.

Description of Alternative Measures

COORDINATED PROGRAMS TO DETECT AND ELIMINATE ILLICIT DISCHARGES TO STORM SEWER SYSTEMS

This alternative involves a modification to the illicit discharge detection and elimination (IDDE) programs conducted by those municipalities in the watershed with municipal separate storm sewer systems (MS4) regulated under the Wisconsin Pollutant Discharge Elimination System (WPDES). Under this modification, some of the effort currently expended to detect illicit discharges would be transferred from major outfalls that show no evidence of illicit discharges to outfalls of any size that are considered likely to be conveying water contaminated with sanitary wastewater. This would facilitate finding and remediating those inputs of sanitary wastewater resulting from cross-connections between sanitary sewers and storm sewers, leaking infrastructure, and illicit connections which do not involve major storm sewer outfalls.

The WPDES stormwater discharge permits issued pursuant to Chapter NR 216, "Storm Water Discharge Permits," of the *Wisconsin Administrative Code* call for each permitted municipality to implement a program for detection and elimination of illicit discharges to its MS4. Such programs typically involve enforcement of an illicit discharge and connection ordinance prohibiting the discharge, spill, or dumping of nonstormwater substances into waters of the State or the municipal storm sewer; annual dry weather field screening at major outfalls, including field analysis of any dry weather flows from those outfalls; and immediate investigation of portions of the municipal storm sewer system that have a reasonable potential for containing illicit discharges based on field screening results or other information. NR 216.002(16) defines a "major outfall" as "a municipal separate storm sewer system outfall that meets one of the following criteria:

a. 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.

b. 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 more than 2 acres of industrial activity…"

The existing municipal stormwater discharge permits that apply to most of the permitted municipalities in the watershed include a requirement that field screening be conducted annually at all major outfalls. Recent guidance issued by the WDNR recommends a more targeted approach to illicit discharge detection and eliminations in which outfalls are prioritized based upon their potential for conveying illicit discharges rather than solely on the size of the pipe or contributing drainage area.[36] The guidance suggests several characteristics of the storm sewer system and/or contributing drainage area which should be considered in the prioritization of outfalls. These factors include:

- History of known or suspected illicit discharges reported within the last five years,
- Sections of storm sewer and/or sanitary sewer infrastructure that have exceeded or are approaching their design/useful life,
- Contributing drainage areas with 80 percent or more impervious area,
- Business or industrial parks with frequent changes in property ownership or operations,
- Schools or other institutional facilities, and
- Commercial or industrial operations that generate wastewater or wash water including food processing, metal plating or machining shops, auto and scrap recyclers, commercial car washes, and chemical manufacturers or users.

The guidance also recommended that dry-weather field screening of high-priority outfalls be conducted at least once per year and dry-weather field screening of all other major outfalls be conducted at least once during the five-year MS4 permit cycle.

Elements of this guidance have been incorporated into a watershed-based municipal stormwater discharge permit for the Menomonee River Watershed.[37] Under the conditions set forth in this permit, the permitted municipalities are required to develop an analysis procedure for identifying those outfalls that are most likely to be conveying water contaminated with sanitary wastewater. The permit requires that this analysis procedure take into account what is known about the age and condition of the sanitary and storm sewer systems, water quality within receiving waters, and other available information. The analysis procedure that was developed by the Menomonee River Permittees pursuant to this permit requirement considered several factors including the age of development, as indicated by historical urban growth; presence of outfalls that were found to be flowing in dry weather; the anticipated conditions of sanitary and storm sewers based upon the materials they were constructed from; proximity of storm sewers to sanitary sewers; and the density of residential development as measured by the number of parcels per square mile. Under the permit, those major outfalls that showed no indication of illicit discharge during the previous permit term would be required to be screened at least once during the permit term. Priority outfalls identified by the analysis procedure and outfall for which the last two samplings showed evidence of illicit discharge would be required to be screened a minimum of once per year.

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[36]*Wisconsin Department of Natural Resources, "Illicit Discharge Detection and Elimination," Program Guidance Memorandum #3800-2012-01, March 15, 2012.*

[37]*Wisconsin Department of Natural Resources,* Menomonee River Watershed-Based MS4 Permit*, November 30, 2012; see also SEWRPC Memorandum Report No. 204,* Development of a Framework for a Watershed-Based Municipal Stormwater Permit for the Menomonee River Watershed*, January 2103. It is important to note that three municipalities that are located partially in the Root River Watershed—the Cities of Greenfield, Milwaukee, and West Allis—are permitted to discharge stormwater under the Menomonee River Watershed-Based MS4 permit.*

Under this alternative, municipalities would use the existing investigation and remediation procedures specified in their WPDES stormwater discharge permits when outfalls screened under the new identification procedure show evidence of conveying illicit discharges.

Expanded Inspection and Maintenance of Private Onsite Wastewater Treatment Systems

This alternative calls for counties and municipalities to expand the requirements of their inspection and maintenance programs for private onsite wastewater treatment systems (POWTS).

As described in Chapter II, the RWQMPU recommends that mandatory county-enforced inspection and maintenance programs be implemented for all new or replacement POWTS constructed after the dates on which the counties adopted private sewage system programs and voluntary inspection programs be implemented for POWTS that were constructed prior to the dates on which the counties adopted private sewage system programs. Rules established by the Wisconsin Department of Safety and Professional Services (WDSPS) that are set forth in Section SPS 383.255 of the *Wisconsin Administrative Code* require counties with populations less than 500,000 and municipalities in counties with populations of 500,000 or more to develop and implement comprehensive maintenance programs for POWTS within their jurisdictions. These programs are to include:

- Conducting, completing, and maintaining an inventory of all POWTS located within their respective jurisdictions;
- A process that includes measures to ensure that required inspections, evaluation, maintenance, and servicing of POWTS are performed and reported;
- A process that accepts and records inspection, evaluation, maintenance, and servicing reports submitted by owners of POWTS or their agents;
- A process that notifies owners of POWTS who are delinquent in meeting reporting requirements; and
- Annual reporting to WDSPS.

Currently, the units of government are required to complete the inventory by October 1, 2017 and have the other elements of the program in place by October 1, 2019.[38]

As described in Chapter II, some of these elements are currently part of county and municipal programs; however, not all of the elements required under SPS 383.255 are currently in place. Under this alternative implementation of the requirements given in SPS 383.255 would proceed.

Strengthening and Expanding Pet Litter Management Programs

This alternative consists of strengthening and expanding existing pet litter management programs.

The transport of bacterial and other contaminants found in pet waste into surface waterbodies is accelerated in an urban environment with significant areas of impervious surface and engineered stormwater drainage systems. Management of pet wastes may reduce the amounts of these wastes that enter surface waterbodies. The regional

[38]*As of March 2012, Section SPS 383.255 required that the inventories be completed within three years of October 1, 2008 and the other elements be in place within five years of October 1, 2008; however, 2009 Wisconsin Act 392 required that these deadlines be extended to October 1, 2013, and October 1, 2015, respectively. Subsequent to March 2012, 2011 Wisconsin Act 134 required that these deadlines be extended to the dates given in the text above. Revisions to SPS 382.255 bringing the Code into conformance with 2011 Act 134 went into effect on July 1, 2013.*

water quality management plan update recommends that all municipalities have pet litter control ordinance requirements and that those requirements be enforced.

As described in Chapter III of this report, all four counties and 16 of the 19 municipalities that are wholly or partially located within the Root River watershed have enacted ordinances regarding control of pet litter. The applicability and requirements of these ordinances vary among the jurisdictions. County ordinances apply only to County parks and trails. While some municipal ordinances apply only to public property or parks and trails, others apply to any public property or private property other than that belonging to the owner, caretaker, or person in control of the animal. There are also differences among jurisdictions in which animals are regulated under the ordinances. While two counties and seven municipalities have ordinances that apply to animals, two counties and seven municipalities have ordinances that specifically apply to dogs and two municipalities have ordinances that specifically apply to dogs and cats.

Several actions could potentially be taken to strengthen and expand the pet litter management programs in the Root River watershed. These actions include:

- Enacting pet litter control ordinances in those municipalities that currently do not have them. These municipalities include the Towns of Paris, Raymond and Yorkville,

- Revising existing pet litter control ordinances to apply to any public property or private property other than that belonging to the owner, caretaker, or person in control of the animal,

- Stricter enforcement of existing ordinances,

- Installation of pet waste stations in parks and along trails that are either near waterbodies or near inputs to stormwater management systems that discharge to waterbodies,

- Locating any new dog parks away from waterbodies or inputs to stormwater management systems that discharge to waterbodies, and

- Public outreach and educational programs regarding pet waste management.

As previously indicated, three of the watershed's municipalities have not enacted ordinances regarding control of pet litter. While all three of these municipalities are predominantly rural towns, two of them—the Towns of Raymond and Yorkville—have substantial areas of urban density development (see Map 12 in Chapter IV of this report). Many of these areas of urban density development are near or adjacent to streams.

Management of Horse Manure on Trails and Roads

This alternative consists of implementing measures to manage horse manure deposited on trails and roads.

Horse manure on trails and roads can serve as a source of bacteria and nutrients to surface waterbodies. When manure is deposited on roads and trails, it can wash into streams, lakes, and ponds, either directly or through stormwater management systems. The concentration of fecal indicator bacteria in horse manure is dependent upon how long it has been in the environment and how much it has dried. A recent study found that the concentration of *E. coli* in freshly deposited manure is about 62,000 cells per gram feces.[39] Dry manure, by contrast, contains about 120,000 cells per gram feces.[40] These concentrations are deceptive because they mask the effects of mass

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[39] *R.W. Weaver, J.A. Entry, and A. Graves, "Numbers of Fecal Streptococci and* Escherichia coli *in Fresh and Dry Cattle, Horse, and Sheep Manure,"* Canadian Journal of Microbiology, *Volume 51, 2005, pp. 847-851.*

[40] Ibid.

loss related to drying on the total number of bacteria in a "pellet" of feces. When this is taken into account, the process of drying appears reduce *E. coli* numbers in horse manure by about 95 percent.[41] No data were available regarding whether *E. coli* numbers increase following rehydration of the feces.

Several approaches could be taken to manage horse manure on roads and trail. One approach might be to locate trails and riding areas away from waterbodies or inputs to stormwater management systems that discharge to waterbodies. If this could be done in such a way as to give manure deposited along trails an opportunity to fully dry, fairly large reductions in the bacterial input resulting from deposition of horse manure might be achieved. A second approach would be similar to approaches to pet waste management that require pet owners to remove litter deposited by their animals. This approach could be supported through installation of waste stations along heavily used roads and trails that are either near waterbodies or near inputs to stormwater management systems that discharge to waterbodies and educational programing.

Urban Stormwater Management

This alternative consists of implementation of best management practices to abate urban nonpoint source pollution in the watershed.

The RWQMPU recommends that urban nonpoint source pollution controls be implemented that are consistent with the nonagricultural (urban) performance standards set forth in Chapter NR 151, "Runoff Management," of the *Wisconsin Administrative Code*. By implementing controls to meet the standards of NR 151, municipalities will address:

- Control of construction site erosion;
- Control of stormwater pollution from areas of existing and planned urban development, redevelopment, and infill; and
- Infiltration of stormwater runoff from areas of new development.

Urban best management practices that would be installed under this recommendation to control nonpoint source pollution from existing or new development could include:

- Runoff infiltration/transpiration and/or pollutant filtrations devices such as grassed swales, infiltration basins, bioretention facilities, rain gardens, green roofs, and porous pavement;[42]
- Stormwater treatment facilities, such as wet detention basins, constructed wetlands, and sedimentation/floatation devices; and
- Maintenance practices such as vacuum sweeping of roads and parking lots.

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[41]*Using the data given in Weaver et al 2005, a 100-gram pellet of freshly deposited horse feces would have a moisture content of about 78 percent and would contain about 61,660,000* E. coli *cells. Full drying would reduce the moisture content of this pellet to about 14 percent and result in a dry mass of about 25.6 grams. This pellet would contain about 3,077,000* E. coli *cells.*

[42]*Installation of these green infrastructure measures would also provide control of runoff volumes which would help reduce flashiness in receiving streams. In addition, if properly designed, these measures would also serve to remove TSS and total phosphorus, which would address water quality targets of the watershed restoration plan.*

It should be noted that runoff infiltration/transpiration and/or pollution filtration devices such as grassed swales, infiltration basins, bioretention facilities, rain gardens, green roofs, and porous pavement are also recommended for installation under the MMSD green infrastructure plan.[43]

AGRICULTURAL MANURE AND BARNYARD RUNOFF MANAGEMENT

This alternative consists of a number of measures related to the management of manure and barnyard runoff.

The RWQMPU recommends that all livestock operations with 35 combined animal units or more as defined in Chapter NR 243, "Animal Feeding Operations," of the *Wisconsin Administrative Code* provide six months of manure storage, enabling manure to be spread on fields twice annually during periods when the ground would not be frozen prior to spring planting and after summer and fall harvest.[44] Based upon a review of the technical literature, it was found that storing the manure for that period of time could reduce concentrations of fecal coliform bacteria and *E. coli* by about 90 percent.[45] The RWQMPU also recommended that manure and any supplemental nutrients be applied to crop land in accordance with a nutrient management plan consistent with the requirements of Sections ATCP 50.04, 50.48, and 50.05 and Section NR 151.07 of the *Wisconsin Administrative Code*. The RWQMPU also noted that many livestock operations are not compelled to comply with provisions of ATCP 50 and NR 151 related to the control of barnyard runoff because of the limited amount of cost-share funding that is available. To address this, the RWQMPU recommended that consideration be given to increasing levels of cost-share funding to enable a higher level of implementation of the best management practices needed to meet the NR 151 performance standards and suggested a mechanism of maximizing cost-share funding through pooling funds from Federal, State, and local sources.

Under this alternative, the following sorts of actions would be pursued:

- Preparation of nutrient management plans for those agricultural operations that do not currently have them;

- Application of manure and other nutrients to fields only in accordance with nutrient management plans;

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[43]*Milwaukee Metropolitan Sewerage District,* Regional Green Infrastructure Plan, *June 2013.*

[44]*Section NR 243.05 sets forth two methods for calculating animal units: one method based on "combined animal units" and one based on "individual animal units." In determining the number of animals for which the manure storage recommendation of RWQMPU applies, the RWQMPU recommends that the method be applied that yields the lowest number of animals for a given category. For example, based on that approach, 35 animal units are equivalent to 25 milking cows, 35 steers, 87 55-pound pigs, and 1,050 to 4,375 chickens, depending on the type and whether the manure is liquid or nonliquid.*

[45]*S.R. Crane and J.A. Moore, "Modeling Enteric Bacterial Die-off: A Review,"* Water, Air, & Soil Pollution, *Volume 27, 1986, pp. 411-439; Virginia Polytechnic Institute and State University Department of Biological Systems Engineering,* Fecal Coliform TMDL for Naked Creek in Augusta and Rockingham Counties, Virginia, *prepared for the Virginia Department of Environmental Quality and Virginia Department of Conservation and Recreation, April 2002; Tetra Tech, Inc.,* Manure Management, *EPA Regional Priority AFO Science Question Synthesis Document, Workshop Review Draft, prepared for USEPA Office of Science Policy and Office of Research and Development, December 2004; D.W. Meals and D.C. Braun, "Demonstration of Methods to Reduce* E. coli *Runoff from Dairy Manure Application Sites,"* Journal of Environmental Quality, *Volume 35, 2006, pp. 1088-1100; S.V. Raava, C.Z. Sarreal, B. Duffy, and L.H. Stanker, "Survival of* Escherichia coli *O157:H7 in Wastewater from Dairy Lagoons,"* Journal of Applied Microbiology, *Volume 101, 2006, pp. 891-902.*

Table 71

PRACTICES THAT MAY BE INCLUDED AS COMPONENTS OF BARNYARD RUNOFF CONTROL SYSTEMS

Practice	Administrative Code Reference	Practice	Administrative Code Reference
Access Roads or Cattle Crossings	ATCP 50.65	Roofs	ATCP 50.84
Animal Trails and Walkways	ATCP 50.66	Roof Runoff Systems	ACTP 50.85
Critical Area Stabilization	ATCP 50.69	Sediment Basins	ATCP 50.86
Diversions	ATCP 50.70	Streambank and Shoreline Protection	ATCP 50.88
Heavy Use Area Protection	ATCP 50.74	Subsurface Drains	ATCP 50.90
Livestock Fencing	ATCP 50.75	Underground Outlets	ATCP 50.92
Livestock Watering Facilities	ATCP 50.76	Waste Transfer Systems	ATCP 50.93
Manure Storage Systems that Are Needed to Collect and Store Barnyard Runoff	ATCP 50.62	Vegetated Treatment Areas	ATCP 50.94
Nutrient Management	ATCP 50.78	Water and Sediment Control Basins	ATCP 50.95
Prescribed Grazing	ATCP 50.80	Waterway Systems	ATCP 50.96
Relocating or Abandoning Animal Feeding Operations	ATCP 50.81	Well Decommissioning	ATCP 50.97

Source: Wisconsin Department of Agriculture and Consumer Protection.

- Provision of six months manure storage for all livestock operations with 35 combined animal units or more;

- Provision of barnyard runoff control systems for livestock operations. Such systems consist of facilities or practices used to contain, divert, retard, or otherwise control the discharge of runoff from outdoor areas of concentrated livestock activity. Examples of these are given in Table 71.

PROGRAMS TO CONTROL NUISANCE ANIMALS

This alternative consists of implementing programs to control populations of nuisance animals that may be contributing fecal indicator bacteria to surface waters of the Root River watershed.

Nuisance animals, such as waterfowl, can be a significant source of fecal indicator bacteria to surface waters. Studies have found high concentrations of indicator bacteria in the feces of waterfowl. For example, estimates of the concentration of fecal coliform bacteria in the feces of ring-billed gulls range from about 58 million to 1,500 million cells per gram feces, with much of the variation occurring on a seasonal basis.[46] Concentrations of *Escherichia coli* in feces from ring-billed gulls at two Lake Michigan beaches in Chicago and Traverse City, Michigan were 14 million and 490 million cells per gram feces, respectively.[47] Concentrations of fecal coliform

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[46]*K.A. Alderisio and N. DeLuca, "Seasonal Enumeration of Fecal Coliform Bacteria from the Feces of Ring-Billed Gulls (*Larus delawarensis*) and Canada Geese (*Branta canadensis*),"* Applied and Environmental Microbiology, *Volume 65, 1999, pp.5628-5630.*

[47]*L.R. Fogarty, S.K. Haack, M.J. Wolcott, and R.L. Whitman, "Abundance and Characteristics of the Recreational Water Quality Indicator Bacteria* Escherichia coli *and Enterococci in Gull Faeces,"* Journal of Applied Microbiology, *Volume 94, 2003, pp. 865-878.*

bacteria in the feces of Canada geese were found to be about 15,000 cells per gram feces.[48] In addition to fecal indicator bacteria, feces from nuisance animals can contain pathogenic organisms. For instance, ring-billed gull feces has been found to contain species and strains of bacteria known to be pathogenic to humans, including bacteria in the genera *Aeromonas, Campylobacter, Listeria,* and *Salmonella*.

Under this alternative, programs would be implemented to discourage unacceptably high numbers of waterfowl from congregating near waterbodies. Measures that could be used in these programs include expanded use of informational signs regarding the negative aspects of feeding waterfowl, ordinances prohibiting the feeding of waterfowl, covering trash receptacles near water features, landscaping that reduces the attractiveness of areas to waterfowl use, and other innovative measures such as trained dogs. It is important to note that many of these species are legally protected, so any measures that would depredate these organisms would require a permit from the U.S. Fish and Wildlife Service.

DISINFECTION OF WASTEWATER TREATMENT PLANT EFFLUENT

This alternative consists of disinfection of the effluent discharged from the wastewater treatment plants (WWTPs) that discharge into streams of the Root River watershed. As discussed in Chapter IV of this report, three WWTPs discharge treated wastewater effluent into streams of the watershed. The effluent limitations set forth in these plants' discharge permits under the WPDES do not require disinfection of the effluent discharged. As a result, the effluent discharged from these WWTPs constitutes a source of fecal indicator bacteria to streams of the watershed. Disinfecting this effluent would reduce the amount of these bacteria discharged into these streams.

It should be noted that disinfection of wastewater effluent is required only where the WDNR has made a determination that the discharge of wastewater poses a risk to human and animal health. The requirements of the *Wisconsin Administrative Code* related to effluent limitations and disinfection requirements that are applicable to the wastewater treatment plants that discharge to streams in the Root River watershed are summarized in Appendix P.

MAINTAINING AND UPGRADING MARINA WASTE MANAGEMENT FACILITIES

This alternative consists of marinas and other recreational boating facility operators installing, maintaining, and upgrading and expanding as needed, pump-out facilities for holding tanks and marine sanitation devices on recreational boats docked or using the Root River.

To avoid the direct discharge of sewage from holding tanks to the waters of Lake Michigan, the RWQMPU recommends that boating facility operators such as the Racine Reef Point marina continue to maintain pump-out stations for the disposal of those wastes through the public sanitary sewerage system and upgrade or expand those stations as necessary. Section 30.71(3) of the *Wisconsin Statutes* requires that any marina that provides berths or moorings to five or more boats equipped with toilets and is located on any outlying water must provide pump-out stations.[49] While inland waters such as the lower reaches of the Root River are not subject to this requirement, under the Federal Clean Water Act they constitute No-Discharge Zones within which the discharge of untreated and treated sewage from all vessels is completely prohibited. In addition, the requirements for a marina to qualify for certification as a clean marina under the Wisconsin Clean Marina Program include:

- Either having a well-maintained pump-out facility appropriate for the marina or informing boaters of other pump-out locations;

- Prohibiting the discharge of sewage into the marina; and

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[48]*Alderisio and DeLuca, 1999,* op. cit.

[49]*Outlying waters are defined in Section 29.001(63) of the* Wisconsin Statutes *as Lake Superior, Lake Michigan, Green Bay, Sturgeon Bay, Sawyer's Harbor, and the Fox River from its mouth up to the dam at De Pere.*

- Encouraging compliance by including information about marine sanitation device requirements and sewage laws in contracts for slips, rentals, transient moorings, and live-aboards.

Under this alternative, existing pump-out facilities would be maintained and upgraded and expanded as necessary. Those marinas along the Root River that are not certified as clean marinas under the Wisconsin Clean Marina Program would be encouraged to seek certification.[50]

EXAMINATION OF ANY SANDY BANKS ADJACENT TO WATERBODIES TO DETERMINE WHETHER THEY ACT AS A RESERVOIR OF BACTERIA ORIGINATING IN STORMWATER THAT FLOWS OVER THEM

This alternative consists of examining sandy banks adjacent to waterbodies in order to determine whether they act as reservoirs of bacteria originating in stormwater that flows over them. Should these banks be found to be contributing bacteria to the waterbody, stormwater flows would be redirected away from the banks, possibly to best management practices such as bioswales or rain gardens. It should be emphasized that it is not known how prevalent these sorts of banks are in the Root River watershed.

Research on fecal indicator bacteria at freshwater beaches has shown that reservoirs of bacteria can accumulate in sand and sediment. Sources of these bacteria to sand and sediment include droppings from waterfowl and the discharges of stormwater that runs over the sand. Several lines of evidence indicate that sand and sediment contaminated in these manners may act as sources of bacteria to surface waters. Reported concentrations of fecal indictor bacteria in sand can be higher than concentrations in adjacent water. For example, concentrations of *E. coli* detected in foreshore sands at beaches have been reported to be 10 to 10,000 times higher than concentrations in beach waters.[51] Studies related to beach grooming have shown that the physical structure and management of sandy areas can affect the persistence of bacteria in sand and sediment, with physical structures and management techniques that allow for more rapid desiccation and greater exposure to sunlight being less favorable to bacterial persistence.[52] Bacteria have also been shown to rapidly colonize uncontaminated sand. For example, in the foreshore at one Lake Michigan beach, *E. coli* concentrations in newly placed sand increased to near ambient levels in surrounding sand within about two weeks.[53] Correlation of *E. coli* concentrations in water with several environmental variables in one beach study found that the best predictor of *E. coli* concentration in water was wave height.[54] This suggests that water running over the sand is able to draw microorganisms out of the sand and into the water. Finally, in beach environments strong positive correlations were found between concentrations of

[50]*According to the Wisconsin Clean Marina Programs website, as of November 2013 Azarian and Sons Marina, the Fifth Street Yacht Club, the Harbor Lite Yacht Club, Pugh Marina, and Pugh Marina on the Lake Up the River were not certified as Clean Marinas. The website also indicated that while Westshore Marina and Racine Riverside Marina were also not currently certified, both had committed to actively seeking certification.*

[51]*R.L. Whitman and M. B. Nevers, "Foreshore Sand as a Source of* Escherichia coli *in Nearshore Water of a Lake Michigan Beach,"* Applied and Environmental Microbiology, *Volume 69, 2003, pp. 5555-5562.*

[52]*J.L. Kinzelman, R.L. Whitman, M. Byappanalalli, E. Jackson, and R.C. Bagley, "Evaluation of Beach Grooming Techniques on* Escherichia coli *Density in Foreshore Sand at North Beach, Racine, WI,"* Lake and Reservoir Management, *Volume 19, 2003, pp. 349-354; J.L. Kinzelman, K.R. Pond, K.D. Longmaid, and R.C. Bagley, "The Effect of Two Mechanical Beach Grooming Strategies on* Escherichia coli *Density in Beach Sand in a Southwestern Lake Michigan Beach,"* Aquatic Ecosystem Health and Management, *Volume 7, 2004, pp. 425-432.*

[53]*Whitman and Nevers, 2003,* op. cit.

[54]*J.L. Kinzelman, S.L. McClellan, A.D. Daniels, S. Cashin, A. Singh, S. Gradus, and R.C. Bagley, "Non-point Source Pollution: Determination of Replication versus Persistence of* Escherichia coli *in Surface Water and Sediment with Correlation of Levels to Readily Measurable Environmental Paramenters,"* Journal of Water and Health, *Volume 2, 2004, pp. 103-114.*

E. coli in foreshore sands and adjacent waters.[55] Interestingly, correlations were found both when concentrations in water samples were compared to concentrations in sand samples collected on the same day and when concentrations in water samples were compared to concentrations in sand samples collected either the previous day or the following day. This suggests a complex relationship between bacterial levels in sand and water in which each location may, at times, serve as a source of bacteria to the other.

There is some general evidence that the pathogens that fecal indicator bacteria act as surrogates for accumulate in sands and sediment. Enteric viruses have been detected at higher concentrations in estuarine sediment than in the water column.[56] Pathogens associated with fecal contamination have been identified in beach sand and linked to bather illness.[57] Both *Campylobacter* and *Salmonella* species have been identified in beach sands, and strains known to be associated with human infections have been typed.[58]

RESTRICTING LIVESTOCK ACCESS TO STREAMS

This alternative consists of installing practices to exclude livestock from waterbodies and the adjacent riparian areas. It consists of both installing fences along narrow strips of land along the waterbodies and providing animals with alternative sources of drinking water to reduce the amount of time they spend near waterbodies and the amount of associated feces deposited in and adjacent to the waterbody.

It should be noted that the extent to which livestock have access to streams in the Root River watershed was not specifically inventoried. The 2007 National Agricultural Census showed the presence of 149 farms with 10,547 cattle and calves and 27 farms with 2,182 hogs and pigs, as well as other livestock, in Racine County, the county containing the majority of agricultural lands in the Root River watershed.[59] This would suggest that there may be locations along the watershed where livestock access to streams is contributing to water quality problems.

The installation of fencing should substantially limit livestock access to waterbodies, eliminating direct manure deposition to stream and lake beds, banks, and adjacent riparian areas as well as reducing erosion. Research indicates that restricting livestock access to waterbodies can reduce inputs of fecal indicator bacteria. For example, one study based upon land use analysis found that the direct introduction of fecal matter into streams contributed only 0.1 percent of the total annual load of *E. coli* to a watershed, with 84 percent of the total stream length fenced to exclude livestock.[60] In addition, a modeling study used to evaluate the impact of best

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[55]*Whitman and Nevers, 2003,* op. cit.

[56]*R.L. LaBelle, C.P. Gerba, S.M. Goyal, J.L. Melnick, I. Cech, and G.F. Bogdan, "Relationships Between Environmental Factors, Bacterial Indicators, and the Occurrence of Enteric Viruses in Estuarine Sediments,"* Applied and Environmental Microbiology, *Volume 39, 1980, pp. 588-596.*

[57]*K. Obrisi-Danso and K. Jones, "Intertidal Sediments as Reservoirs for Hippurate Negative Camplyobacters, Salmonellae and Fecal Indicators in Three EU Recognized Bathing Waters in Northwest England,"* Water Research, *Volume 34, 2000, pp. 519-527.*

[58]*F.J. Bolton, S.B. Surman, K. Martin, D.R.A. Wareing, and T.J. Humphrey, "Presence of* Campylobacter *and* Salmonella *in Sand from Bathing Beaches,"* Epidemiology and Infection, *Volume 122, 1999, pp. 7-13.*

[59]*U.S. Department of Agriculture National Agricultural Statistics Service,* 2007 Census of Agriculture: Wisconsin State and County Data, Volume 1: Geographic Area Series, *Part 49, February 2009.*

[60]*R.M. Monaghan, R.J. Wilcock, L.C. Smith, B. Tikkisetty, B.S. Thorrold, and D. Costall, "Linkages between land management activities and water quality in an intensively farmed catchment in southern New Zealand."* Agriculture, Ecosystems and Environment*, Volume 118, 2007, pp. 211-222.*

management practices estimated that reductions in indicator bacteria concentrations of 22 to 35 percent could be achieved with the elimination of livestock access to riparian areas.[61]

This alternative also includes the provision of alternative sources of drinking water for livestock. Under this alternative, livestock would either drink from tanks, troughs, or similar systems away from the waterbody or from narrow hardened access points along the waterbody, which allow livestock to drink but not loiter in the waterbody. Provision of a clean and convenient alternative source of water should lead cattle to reduce the time spent near the waterbody. It is important to note that to prevent these watering sites from becoming concentrated sources of nutrients and sediments that can be carried to streams during surface runoff events or contribute dissolved nutrient loadings to interflow and groundwater, these sites must be designed and maintained properly. Research indicates that providing alternative water sources can reduce the amount of time cattle spend in and around streams. One study found that installation of off-stream watering troughs decreased the average time cattle spent drinking from streams by 89 percent and the average time they spent in the stream area by 51 percent.[62]

Evaluation of Alternative Measures

The previous section described 11 alternative approaches for reducing inputs of fecal indicator bacteria to surface waters of the Root River watershed. This section presents an evaluation of those approaches in order to determine their suitability for inclusion in the recommended Root River watershed restoration plan.

Table 72 classifies the alternatives based upon whether they primarily address loadings of fecal indicator bacteria from point sources, urban nonpoint sources, or rural nonpoint sources. As shown in the table, one alternative addresses contributions from point sources, six alternatives address contributions from urban nonpoint sources, and four alternatives address contributions from rural nonpoint source sources.

EVALUATION OF MEASURES ADDRESSING POINT SOURCES

Disinfection of effluent from WWTPs addresses point sources. The evaluation of this alternative consists of three analyses:

1. Comparison of the annual loads of fecal coliform bacteria contributed by the three WWTPs that discharge into streams of the watershed to the magnitudes of the reductions in fecal coliform bacteria loads required to produce the water quality conditions envisioned in the RWQMPU,

2. Comparison of the annual loads contributed by the WWTPs to the annual loads contributed by nonpoint sources in the subwatersheds in which the WWTPs are located, and

3. Review of the data on the effects of the discharges from the WWTPs upon the receiving waterbodies.

Comparison of the annual loads of fecal coliform bacteria contributed by the three WWTPs to the reductions in fecal coliform bacteria loads required to produce the water quality conditions envisioned in the RWQMPU show that the loads contributed by the WWTPs represent a very small fraction of the annual load reduction required to produce the level of water quality envisioned in the RWQMPU. The results from the calibrated water quality model used in developing the RWQMPU indicate that an annual reduction in the load of fecal coliform bacteria contributed to streams of the watershed of 4,725.42 trillion cells would be required to produce the water quality

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[61]*R. Collins and K. Rutherford, "Modelling Bacterial Water Quality in Streams Draining Pastoral Land,"* Water Research, *Volume 38, 2004, pp. 700-713.*

[62]*R.E. Sheffield, S. Mostaghimi, D.H. Vaughn, E.R. Collins, and V.G. Allen, "Off-Stream Water Sources for Grazing Cattle as a Stream Bank Stabilization and Water Quality BMP,"* Transactions of the American Society of Agricultural Engineers, *Volume 40, 1997, pp. 595-604.*

Table 72

COMPARISON OF ALTERNATIVE MEASURES TO LOADINGS OF FECAL INDICATOR BACTERIA TO SURFACE WATERS OF THE ROOT RIVER WATERSHED

Alternative	Addresses Point Sources	Addresses Urban Nonpoint Source	Addresses Rural Nonpoint Source
Coordinated Programs to Detect and Eliminate Illicit Discharges	N	Y	N
Expanded Inspection and Maintenance of Private Onsite Systems	N	N	Y
Pet Litter Management Programs	N	Y	N
Management of Horse Manure on Trails and Roads	N	N	Y
Urban Stormwater Management	N	Y	N
Agricultural Manure and Barnyard Runoff Management	N	N	Y
Control of Nuisance Animals	N	Y	N
Disinfection of Wastewater Treatment Plant Effluent	Y	N	N
Marina Waste Management Facilities	N	Y	N
Sandy Bank Examination	N	Y	N
Restricting Livestock Access to Streams	N	N	Y

Source: SEWRPC.

conditions envisioned in the RWQMPU. This modeling also indicated that the annual load of fecal coliform bacteria contributed by the three WWTPs in 2000 was 3.29 trillion cells or about 0.07 percent of the needed reductions. Thus, on a watershed level, the reduction in fecal coliform bacteria load that would result from disinfecting effluent at the WWTPs would be very small relative to the reduction targeted by the Root River watershed restoration plan.

Similar conclusions can be drawn when the annual loads of fecal coliform bacteria contributed by each WWTP are compared to the total annual loads and to the annual load reductions for their respective subwatersheds. Table 73 shows these comparisons for each of the WWTPs in the watershed. It is important to note that the annual loads of fecal coliform bacteria contributed by two of the WWTPs, the Village of Union Grove's plant and the Yorkville Sewer Utility District's plant, are expected to increase between 2000 and 2020 due to planned urban development within their respective service areas. In 2000, the annual contributions of fecal coliform bacteria by the Fonk's Mobile Home Park WWTP represented about 0.03 percent of the total annual load of fecal coliform bacteria and about 0.14 percent of the needed annual load reductions to the East Branch Root River Canal subwatershed. The contributions from this WWTP are not anticipated to increase between 2000 and 2020. In 2000, the annual contributions of fecal coliform bacteria by the Yorkville Sewer Utility District WWTP represented about 0.04 percent of the total annual load of fecal coliform bacteria and about 0.09 percent of the needed annual load reductions to the Hood's Creek subwatershed. The discharges from this WWTP are anticipated to increase between 2000 and 2020. Thus in 2020 the annual contributions of fecal coliform bacteria by the WWTP are anticipated to represent about 0.06 percent of the total annual load of fecal coliform bacteria and about 0.13 percent of the needed annual load reductions to the Hood's Creek subwatershed. In 2000, the annual contributions of fecal coliform bacteria by the Village of Union Grove WWTP represented about 0.28 percent of the total annual load of fecal coliform bacteria and about 1.11 percent of the needed annual load reductions to the West Branch Root River Canal subwatershed. The discharges from this WWTP are anticipated to increase between 2000 and 2020. Thus in 2020 the annual contributions of fecal coliform bacteria by the WWTP are anticipated to represent about 0.37 percent of the total annual load of fecal coliform bacteria and about

Table 73

ESTIMATED ANNUAL LOADS OF FECAL COLIFORM BACTERIA CONTRIBUTED BY WASTEWATER TREATMENT PLANTS COMPARED TO TOTAL FECAL COLIFORM BACTERIA LOADS IN THE RECEIVING SUBWATERSHED AND PLANNED LOAD REDUCTIONS FROM THE REGIONAL WATER QUALITY MANAGEMENT PLAN UPDATE

Wastewater Treatment Plant (WWTP)	Subwatershed	Load from WWTP (trillion cells)		Total Load to Subwatershed (trillion cells)	Percent of Total Load Represented by WWTP Load		Planned Load Reduction (trillion cells)	Percent of Reduction Represented by WWTP Load	
		2000	2020		2000	2020		2000	2020
Fonk's Mobile Home Park	East Branch Root River Canal	0.14	0.14	466.49	0.03	0.03	96.91	0.14	0.14
Village of Union Grove	West Branch Root River Canal	2.85	3.76	1,015.59	0.28	0.37	257.44	1.11	1.46
Yorkville Sewer Utility District	Hoods Creek	0.30	0.43	695.72	0.04	0.06	322.90	0.09	0.13

Source: Tetra Tech, Inc., and SEWRPC.

1.46 percent of the needed annual load reductions to the West Branch Root River Canal subwatershed. These comparisons show that on a subwatershed level the reduction in fecal coliform bacteria load that would result from disinfecting effluent at the WWTPs would be very small relative to the reduction targeted by the Root River watershed restoration plan.

The data from longitudinal sampling of two of the streams receiving WWTP effluent suggest that the fecal indicator bacteria discharged in the effluent may have only local impact of on ambient concentrations of fecal indicator bacteria in the receiving streams. As described in Chapter IV of this report, the City of Racine Health Department collected samples of *E. coli* from longitudinal series of stations along the East and West Branches of the Root River Canal on two dates in June 2012. The results, which are presented in Figure 17 in Chapter IV, give a picture of the impacts of the WWTP discharge upon concentrations of bacteria in these two streams. While the discharges have a strong local effect on concentrations, this effect does not appear to affect concentrations too far downstream. On the West Branch of the Root River Canal, which receives wastewater discharges from the Union Grove WWTP, the length of stream over which the discharges result in elevated *E. coli* concentrations appears to be less than 1.2 miles. Given that the annual load of fecal coliform bacteria discharged by the Union Grove WWTP into the West Branch of the Root River Canal is about nine times the load discharged by the Yorkville WWTP into Hoods Creek and about 20 times the load discharged into the East Branch of the Root River Canal by the Fonk's Mobile Home Park WWTP, and that natural baseflows in those streams would be expected to be similar based on a review of approximate drainage areas, it is to reasonable estimate that for all three of these streams that instream concentrations of fecal indicator bacteria would be affected by WWTP discharges for a distance of less than 1.2 miles downstream from each point of discharge.[63]

Preliminary planning-level estimates indicate that the capital cost of adding disinfection to the treatment process at the Union Grove WWTP is likely to be about $2.4 million with annual operation and maintenance costs of $138,000.Adding disinfection at the other two plants in the watershed would be less costly, but likely still substantial.

The conclusion of this evaluation is that adding disinfection to the treatment processes at the three WWTPs that discharge to surface waters of the Root River watershed would have only a small effect on concentrations of fecal indicator bacteria in the streams receiving discharges from these plants and on downstream waters and the expense of such modifications could be considerable.

It should be noted that the RWQMPU recommends that the Yorkville WWTP be abandoned when it reaches the end of its useful life and that the sewer service area of the Yorkville Sewer Utility District No. 1 be connected to the sewerage system tributary to the City of Racine WWTP. It is anticipated that the plant will be at the end of its useful life if it is unable to meet new permit conditions relative to discharges of chloride and phosphorus. Abandoning the plant and connecting its service area to the sewerage system tributary to the Racine WWTP would end its discharges of fecal indicator bacteria to surface waters of the Root River watershed.

Evaluation of Measures Addressing Urban Nonpoint Source Pollution

Six of the previously described alternatives address urban nonpoint source pollution. These alternatives include:

- Coordinated programs to detect and eliminate illicit discharges to storm sewer systems,
- Strengthening and expanding pet litter management programs,
- Urban stormwater management programs,

[63]*It is possible that high bacteria concentrations may affect the Ives Grove Ditch which receives wastewater from the Yorkville WWTP. As noted above, Hoods Creek would not be expected to experience significant negative impacts downstream of its confluence with Ives Grove Ditch.*

- Programs to control nuisance animals,
- Maintaining and upgrading marina waste management facilities, and
- Examination of any sandy banks adjacent to waterbodies to determine whether they act as a reservoir of bacteria originating in stormwater that flows over them.

Additional information regarding approaches to reducing urban nonpoint inputs of fecal indicator bacteria to surface waters is available from the water quality modeling that was conducted during the development of the RWQMPU. As part of this modeling, additional small-scale sensitivity analyses were carried out to further test the effectiveness of certain nonpoint source control BMPs in improving instream water quality conditions. These studies were carried out to further guide the selection of practices to be included in the preliminary recommended water quality management plan developed under the RWQMPU. Analyses that focused on urban runoff control measures were carried out for the Underwood Creek subwatershed of the Menomonee River watershed. A description of this study and its conclusions was set forth in a MMSD technical memorandum.[64]

The results of the Underwood Creek study indicated that urban impervious surfaces are the predominant source of fecal coliform bacteria loads. The findings indicated that those areas would need to be targeted in order to achieve any significant reduction in overall loads. However, the findings also showed that significant reductions in such loads do not produce any meaningful reduction in the percentage of time that instream fecal coliform standards are exceeded in Underwood Creek. This is because the concentrations during wet weather events are orders of magnitude greater than allowed under the standards. Another finding of the study showed that longer term mean concentrations are dominated by subsurface sources such as illicit connections. Therefore, it would also be necessary to address these sources through a program of improved sewer system maintenance and detection and elimination of illicit connections between the sanitary and storm sewer systems. The conclusion that these findings point to is that reducing urban nonpoint source contributions of fecal indicator bacteria to surface waters of the Root River watershed will require a multifaceted approach that incorporates several of the previously described alternatives.

Additional factors enter into the evaluation of these alternatives. As described in Chapter IV, there are major differences among assessment areas of the Root River watershed in the proportion of the assessment area that is devoted to urban development (see Table 14 and Maps 9 and 13 in Chapter IV of this report). Some assessment areas are highly urbanized. In 2000, three assessment areas—the Lower Root River Racine, the Upper Root River, and the Upper Root River-Headwaters assessment areas—consisted of 80 percent or more urban lands and three other assessment areas—the East Branch Root River, the Middle Root River-Dale Creek, and the Whitnall Park Creek assessment areas—consisted of between 60 percent and 80 percent urban lands. Other assessment areas are predominantly rural. In 2000, six assessment areas—the East Branch Root River Canal, the Lower Root River-Caledonia, the Lower West Branch Root River Canal, the Middle Root River-Ryan Creek, the Root River Canal, and the Upper West Branch Root River Canal assessment areas—consisted of less than 25 percent urban lands. In 2000, the remaining assessment areas—the Lower Root River-Racine and the Middle Root River-Legend Creek assessment areas—had intermediate levels of urban development consisting of between 25 percent and 60 percent urban lands. These different levels of urban development among assessment areas present different opportunities and challenges for the implementation of measures to reduce contributions of fecal indicator bacteria to surface waters. In particular, it may be difficult to find sites for installing structural urban best management practices (BMPs), especially large structural BMPs, in those assessment areas that are already highly developed.

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[64]*Milwaukee Metropolitan Sewerage District Technical Memorandum,* Sensitivity Analysis of Urban BMPs-Underwood Creek (revised), *September 28, 2006.*

Another factor that enters into the evaluation of alternative measures to address urban contributions of fecal indicator bacteria into surface waters is the fact that several assessment areas are anticipated to experience high levels of conversion of rural lands to urban lands between 2000 and 2035. This can be examined and expressed in two different ways: the amount of land that is anticipated to undergo conversion and the percentage of land that is anticipated to undergo conversion. Several assessment areas are anticipated to experience amounts conversion that encompass large aggregate areas (compare Tables 13 and 15 in Chapter IV of this report). The highest amounts of conversion are anticipated to happen in the Hoods Creek, Lower Root River-Caledonia, Middle Root River-Legend Creek, Middle Root River-Ryan Creek, and Whitnall Park Creek assessment areas. This examination does not account for the size differences among the assessment areas. Because of this, it is also useful to examine the percentage of land in each assessment area that is anticipated to be converted from rural to urban land uses between 2000 and 2035. This analysis reveals that several assessment areas are anticipated to experience amounts conversion that encompass large percentages of the land in the assessment areas (compare Tables 14 and 16 and compare Maps 13 and 14 in Chapter IV of this report). The assessment areas in which the highest percentages of lands are anticipated to be converted from rural to urban land uses include the East Branch Root River, Hoods Creek, Lower Root River-Johnson Park, Middle Root River-Legend Creek, Middle Root River-Ryan Creek assessment areas. It should be noted that three assessment areas—the Hoods Creek, Middle Root River-Legend Creek, and Middle Root River-Ryan Creek—were identified as being among those anticipated to experience the highest levels of urbanization under both examination methods. Thus, if assessment areas that are identified by either method are considered to be “highly urbanizing” over the period 2000 through 2035, the results of this analysis indicate that seven of the assessment areas can be considered as highly urbanizing.

The different levels of conversion of land from rural to urban uses among assessment areas described in the previous paragraph present different opportunities and challenges for the implementation of measures to reduce contributions of fecal indicator bacteria to surface waters. In particular, it is likely to be less expensive to install structural BMPs, especially large structural BMPs during conversion of an area from rural to urban land use than it is to install them in an existing urbanized area. Given this, it would be desirable to install structural BMPs in these seven highly urbanizing assessment areas as the lands are being developed.

As previously noted, the results of the sensitivity analysis indicated that reducing fecal indicator bacteria contributions from urban nonpoint sources will require implementation of several alternative approaches. The sensitivity analysis found that urban impervious surfaces are the predominant source of fecal coliform bacteria loads. This indicates that the urban stormwater management program alternative should be one of the alternatives included in the watershed restoration plan. The emphases of urban stormwater management programs should be tailored to the degree of urban development and the opportunities presented by conversion or rural lands to urban lands or by redevelopment of existing urban lands in each assessment area. For example, in those assessment areas that are highly developed in urban uses, such as the Lower Root River-Racine, the Upper Root River-Headwaters, and the Upper Root River assessment areas, emphasis should be given to decentralized, small scale practices such as the installation of rain gardens, green roofs, small bioswales, and small bioretention facilities. By contrast, in those assessment areas that are anticipated to be highly urbanizing between now and 2035, larger-scale BMPs, such as infiltration basins, wet detention basins, and constructed wetlands, should be installed as a part of urban development. To the extent practicable, these BMPs should be sited and sized to serve adjacent existing urban development as well as the new development.

The second finding from the sensitivity analysis was that reducing inputs of fecal indicator bacteria from subsurface sources would be necessary to reduce mean concentrations of fecal indicator bacteria in surface waters. As described above, the permits under which most of the MS4s in the watershed are permitted to discharge stormwater require that the municipalities annually screen major outfalls for illicit discharges.[65] Their permits do

[65]*The Cities of Greenfield, Milwaukee, and West Allis, which are partially located in the Root River watershed, are permitted to discharge stormwater under the Menomonee River Watershed-Based Municipal Stormwater Discharge Permit which requires development and application of an analysis procedure to identify and target for screening those outfalls of any size that are likely to be conveying water contaminated with sanitary wastes.*

not require screening of other outfalls. Implementing coordinated programs to detect and eliminate illicit discharges to storm sewer systems would redirect some of the effort going to annually screen those major outfalls in which contaminated stormwater has not been detected to outfalls that are not currently being screened. The inventories given in Chapter IV suggest that this would be a fruitful approach. As shown in Figure 45 in Chapter IV of this report, there is at least one major hot spot in the watershed which is experiencing high loadings of fecal coliform bacteria and other substances associated with sanitary sewage. Possible sources include cross connections between the sanitary and stormwater sewer systems, leaking sanitary sewer lines or laterals, or illicit discharges into the storm sewer system. Figure 46 in Chapter IV of this report illustrates what may be a more common situation in the watershed. Concentrations of fecal indicator bacteria increase in urban areas and remain high. This pattern suggests that contributions from multiple sources throughout urbanized reaches contribute bacteria to the River. Redirecting IDDE efforts to evaluate and screen additional outfalls would increase the likelihood that sources conforming to either of these patterns, large inputs for a single hotspot or smaller inputs from multiple sources, would be located and remediated. Thus the alternative of coordinated programs to detect and eliminate illicit discharges to storm sewer systems should be incorporated into the watershed restoration plan and emphasized in urban areas.

Reducing the sources of bacteria to urban impervious areas would be a desirable supplement to urban stormwater management programs. These bacteria are contributed by the many animals that live in and pass through the urban environment. Except for addressing sites at which large numbers of nuisance animals congregate, it is probably impractical to reduce contributions of bacteria by wild animals in the watershed. In any case, while pathogens from wastes deposited by wild animals and pets present risks to human health, it is likely that the pathogens contained in human wastes pose greater risks. Because of this, the watershed restoration plan should incorporate measures to control nuisance animals and pet litter management programs only in response to identified water quality problems resulting from nuisance animals or pets. These are likely to be highly localized. The plan should give greater emphasis to urban stormwater management and IDDE programs.

An additional alternative consists of maintaining and upgrading marina waste management facilities. While this alternative is suitable for incorporation into the watershed restoration plan it should be recognized that all of the marinas along the Root River are located downstream of S. Marquette Street, which is located about 1.2 miles upstream from the confluence of the Root River with Lake Michigan. As a result, application of this alternative will not have any effect on most of the surface water system in the watershed. While this alternative is suitable for incorporation, it should not receive heavy emphasis.

The final alternative consists of examining sandy banks adjacent to waterbodies in order to determine whether they act as reservoirs of bacteria originating in stormwater that flows over them and redirecting stormwater flows away from such banks into best management practices such as bioswales or rain gardens. While these types of banks were not specifically inventoried, SEWRPC staff conducting field work along Hoods Creek and the mainstem of the Root River report that they are rarely encountered. Because of this, this alternative will not be considered further in developing recommendations for the Root River watershed restoration plan.

Evaluation of Measures Addressing Rural Nonpoint Source Pollution

Four of the alternatives previously described address rural nonpoint source pollution. These alternatives include:

- Expanded inspection and maintenance programs for private onsite wastewater treatment systems,
- Programs for the management of horse manure on trails and roads,
- Agricultural manure and barnyard runoff management, and
- Restricting livestock access to streams.

As part of the water quality modeling that was conducted during the development of the RWQMPU, additional small-scale sensitivity analyses were carried out to further test the effectiveness of certain nonpoint source control

BMPs in improving instream water quality conditions. These studies were carried out to further guide the selection of practices to be included in the preliminary recommended water quality management plan developed under the RWQMPU. Analyses that focused on rural runoff control measures were carried out for the West Branch of the Root River Canal subwatershed. A description of this study and its conclusions was set forth in a MMSD technical memorandum.[66]

The results of the West Branch of the Root River Canal study showed that, for rural areas, reductions in fecal coliform bacteria loads could best be achieved through manure management. Smaller impacts on bacteria loads and concentrations were realized when addressing subsurface sources such as failing septic systems.

The results of the sensitivity analysis indicate that the agricultural manure management and barnyard runoff management alternative should be emphasized in the Root River watershed restoration plan.

It is important to note that another alternative, restricting livestock access to streams, is partially related to this. Examination of the practices that may be included as components of barnyard runoff systems under the rules set forth in ATCP 50 and listed in Table 71 shows that barnyard runoff systems may incorporate some measures that could potentially restrict livestock access to waterbodies, such as livestock fencing and livestock watering facilities. Depending upon the placement of these practices, they may serve to both control barnyard runoff and restrict exclude livestock from waterbodies. Given that data addressing the extent to which livestock access to waterbodies contributes to water quality problems in the Root River watershed are not available, it would be most appropriate to give this alternative less emphasis. This could be done by subsuming it under the agricultural manure management and barnyard runoff management alternative.

The extent to which horse manure is deposited on trails and roads in the Root River watershed is not known. The 2007 National Agricultural Census indicated that Racine County contained 181 farms with 1,382 horses and Milwaukee County contained 10 farms with 182 horses.[67] This suggests that there may be some localized issues related to horse manure. The watershed restoration plan should incorporate measures to address these issues only in response to identified water quality problems.

As noted above, sensitivity analysis indicated that addressing subsurface sources of fecal indicator bacteria, such as failing POWTS, would have a smaller impact on bacteria loads and concentrations than could be achieved by manure management. Regulations regarding POWTS set forth by the Wisconsin Department of Safety and Professional Services in SPS 383.255 mandate an expansion of county and municipal POWTS programs. Currently, units of government are required to complete inventories of POWTS in their jurisdictions by October 1, 2017, and have the other elements of the program in place by October 1, 2019—dates within the implementation period of this watershed restoration plan.[68] Given that the impact of these measures will be less than manure management measures, it would be acceptable for POWTS programming to be implemented in accordance with the deadlines given in SPS 383.255.

Approaches to Address Flooding Problems in Racine County

This report does not include development of specific alternatives that could be implemented to mitigate flooding and stormwater quantity problems. Rather, it proposes approaches that should be pursued by local units of government to address such problems.

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[66]*Milwaukee Metropolitan Sewerage District Technical Memorandum,* Sensitivity Analysis of Rural BMPs-West Branch Root River Canal (revised), *September 13, 2006.*

[67]*U.S. Department of Agriculture National Agricultural Statistics Service 2009,* op. cit.

[68]*The State Legislature has twice extended these deadlines.*

Root River Mainstem in the City of Racine

As noted previously, the greatest concentration of buildings in the 1-percent-probability floodplain is along the mainstem of the Root River in the City of Racine, where 81 percent of the buildings in the floodplains of the Root River watershed in Racine County are located. There may be multiple, viable alternative approaches to mitigating such a concentrated flood hazard. Such approaches may include structural and/or nonstructural components. An example of structural components could be to expand areas for conveyance and storage of floodwaters in the stream overbanks along with rehabilitation to improve the ecological functioning of the low-flow stream channel. Nonstructural approaches could involve elevating potentially flooded buildings, floodproofing buildings, or demolishing and removing buildings.

The Federal Emergency Management Agency (FEMA) is implementing its Risk Mapping, Assessment, and Planning (RiskMAP) program throughout the United States. In Wisconsin, WDNR is administering the program. FEMA is now emphasizing flood mitigation under RiskMAP; therefore, participating in the program may be an effective approach for the City of Racine to work with WDNR and FEMA to conduct flood mitigation planning to develop alternatives that address the concentrated flood problem along the mainstem of the Root River. The projected schedule for initiating the Risk MAP program in the Root River watershed has not yet been established; the data collection "discovery" phase may be initiated in the next year or two. If adequate funding is available this phase would be followed by collection of field survey data and modeling of the River. SEWRPC is in the process of updating floodplain delineations along the Root River mainstem and tributaries in Milwaukee County under a program funded by the Milwaukee County Automated Mapping and Land Information System Steering Committee and MMSD. As part of this study, a hydrologic model is being developed to compute flood flows throughout the watershed, including the Racine County portion. Flood flows resulting from this model could be coupled with hydraulic models developed under the RiskMAP program and applied to delineate revised flood-plain boundaries and to analyze flood mitigation alternatives.

Flooding of Roadways in the County

Either the May 2, 2012, FEMA flood insurance study for Racine County, or updated flood profile information possibly developed in the future under the RiskMAP program, would provide information that can be used for municipalities to identify roadways that could overtop during floods. Municipalities could then consider bridge or culvert modifications to provide adequate hydraulic capacity to meet road overtopping standards as part of their capital improvements programs. Updated hydraulic models that may be developed under the RiskMAP program would be useful in designing modifications or replacements for existing bridges and culverts when they are scheduled for upgrade or replacement.

Scattered Buildings in the Floodplain Throughout the Watershed in Racine County

The SEWRPC staff's extensive experience with flood mitigation planning has shown that, when the flood hazard is scattered as it is in the Root River in Racine County outside of the City of Racine, large-scale structural flood mitigation approaches are not generally practicable or cost-effective. In such cases, the most feasible approach is generally to determine the most cost-effective combination of nonstructural approaches such as elevating potentially flooded buildings, floodproofing buildings, or demolishing and removing buildings. Consideration of nonstructural alternatives could be included under future FEMA RiskMAP activities, or the County and affected municipalities could seek FEMA Hazard Mitigation Grant Program funds, or funds from other sources, to evaluate nonstructural flood mitigation alternatives.

Stormwater Runoff Problems

Review of studies conducted by Racine County municipalities in the watershed has identified stormwater quality-related analyses associated with State of Wisconsin municipal separate storm sewer system discharge permits, but little planning work directed toward addressing stormwater quantity issues. In locally identified areas that experience stormwater flooding, as distinguished from flooding due to the overflow of streams and rivers, the targets identified above could be incorporated into a stormwater management planning program designed to develop alternatives leading to a recommended plan to specifically address the problem areas.

Horlick Dam Alternatives

Introduction

An inventory of information on the Horlick dam was compiled in Chapter IV. The Horlick dam spillway does not meet WDNR requirements for a Low Hazard dam.[69] Due to the inadequate spillway capacity, structural modifications to the dam would be necessary for the dam to be maintained. Thus, a "no action" alternative is not a viable option for the Horlick dam. Therefore, in this chapter alternatives were developed to meet the regulatory requirements associated with the dam hazard rating and the effects of implementation of those alternatives on the Root River corridor in the vicinity of the dam were addressed. First, issues of concern for evaluating the current conditions and dam alternatives are summarized, next the baseline Horlick dam condition is described, and finally, three potential categories of dam alternatives are detailed.

Issues of Concern

Surface Water and Groundwater Quantity Considerations

Water quantity issues for this dam evaluation encompass floods, normal flow, and groundwater contributions. The effect of the Horlick dam and its impoundment in attenuating large flood peaks would be expected to be negligible (i.e., there would be no significant difference in peak flows between conditions with the dam in place and with the dam removed) because during floods the runoff volume from the approximately 190-square mile watershed tributary to the dam would be very large relative to the active storage volume above the normal impoundment level. Thus, within the range of dam modifications considered under the alternatives described below, including modifications to increase spillway discharge capacity and modifications to fully or partially remove the dam, no significant difference in flood peaks would be expected. During nonflood or normal flow times, it is of interest to compare how the river corridor functions for the various alternatives. And finally, the impoundment may affect the shallow groundwater table in its vicinity. The dam impoundment could either be a source to shallow groundwater or a sink for water from the shallow groundwater.[70,71]

Water Quality

The water quality issues of concern for the Horlick dam alternatives include dissolved oxygen, nutrients, temperature, sediment, and large woody debris. Dissolved oxygen is an important characteristic for fish and aquatic biota health. For most impoundments, dissolved oxygen levels decrease with thermal stratification, and then increase by aeration as water flows over the dam spillway.[72] The limiting nutrient of greatest concern for water quality is phosphorus, and for most impoundments the main phosphorus input is the suspended sediment.[73] Typically the dam impoundment raises water temperatures by slowing the water and increasing the water surface exposed to the sun.[74] Contaminated sediments are of significant concern if they exist, as any modifications to the dam may

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[69]*An April 27, 2014, letter from the WDNR to Racine County established a Low Hazard rating for the dam, based on a dam failure analysis prepared for the County by GRAEF-USA (see Appendix Q). That letter established additional requirements, including the need to bring the spillway discharge capacity into compliance with Chapter NR 333 of the* Wisconsin Administrative Code *within 10 years from the date of the letter.*

[70]*Nancy D. Gordon, Thomas A McMahon et al.,* Stream Hydrology, An Introduction for Ecologists, 2nd Edition, *John Wiley & Sons, Ltd., 2004.*

[71]*Robert G. Wetzel,* Limnology, 2nd Edition*, Sanders College Publishing, 1983.*

[72]*James H. Thrall and Rimas J. Banys,* op. cit.

[73]*Gyles Randall et al., "Phosphorus Transport and Availability in Surface Waters,"* University of Minnesota-Extension Publication WW-06796, *2002.*

[74]*James H. Thrall and Rimas J. Banys,* op. cit.

alter sediment transport characteristics. Large woody debris is often caught at the dam crest during floods, and then either removed or moved downstream during nonflood times. Large woody debris is considered vital for fish and wildlife habitat and disruption of the natural movement of the debris downstream would be considered a negative from a fishery standpoint.[75] From the view of protection of downstream infrastructure, the large woody debris capture at the dam may be considered a positive.

Natural Resources
The natural resource considerations for the Horlick dam area include the fishery, terrestrial biota, and aquatic invasive species. In almost all cases, a dam is considered a barrier to aquatic species movement. The dam often blocks not only the river but the riverine corridor, disconnecting the system at the dam location.[76] This system disconnection may also be considered positive by preventing upstream movement of aquatic invasive species, assuming that the dam provides sufficient obstruction during all flows.

Another consideration for aquatic invasive species is the ability to move upstream past the dam by another method, such as intentional or unintentional human actions or passage on another species. Unfortunately, this aided transport method is difficult to predict or control, but has been widespread in the dispersal of multiple invasive species including zebra mussel, quagga mussel, Eurasian water milfoil, and purple loosestrife, among others. This is why the WDNR has invested in programs such as Clean Boats, Clean Waters programs to promote information and education on invasive species and how to prevent their expansion into other waterbodies.

Social
Social issues related to dams include aesthetics, safety, and recreation. Aesthetics encompasses how the river corridor looks in the area of the dam, and often are of a very personal nature. Safety includes both the safety of boaters and fisherman in the river, and those onshore and downstream. With the dam in place there is the danger that the dam will fail and a large amount of water and sediment will flow downstream suddenly. Recreational considerations include boating, fishing, biking, hiking, bird watching, and many other uses that can be enjoyed along a river corridor.

Cost
Two costs will be evaluated for each Horlick dam alternative: 1) the capital costs of construction/demolition and 2) maintenance costs. Construction or demolition costs are onetime costs incurred in the dam area to either modify or remove the dam structure. Maintenance costs associated with a structure remaining at the Horlick dam location may include inspections, repairs, studies, dredging, and instream debris management.

Maintenance costs for dam removal may include habitat enhancements and impoundment area restoration. Future structural maintenance costs are somewhat difficult to accurately represent, as some work will depend on how the dam performs and the severity and frequency of future floods.

Baseline Condition
This section discusses the existing state of the Horlick dam for the issues of concern described above.

Surface Water and Groundwater Quantity Considerations
As noted previously in the "Issues of Concern" subsection, the Horlick dam and impoundment as currently configured (see Figure 109) do not significantly attenuate peak flood flows. The water surface profile during a flood drops significantly from the upstream side of the dam to the downstream side, but peak flows are not significantly reduced with the fixed dam crest and minimal storage available in the impoundment area.

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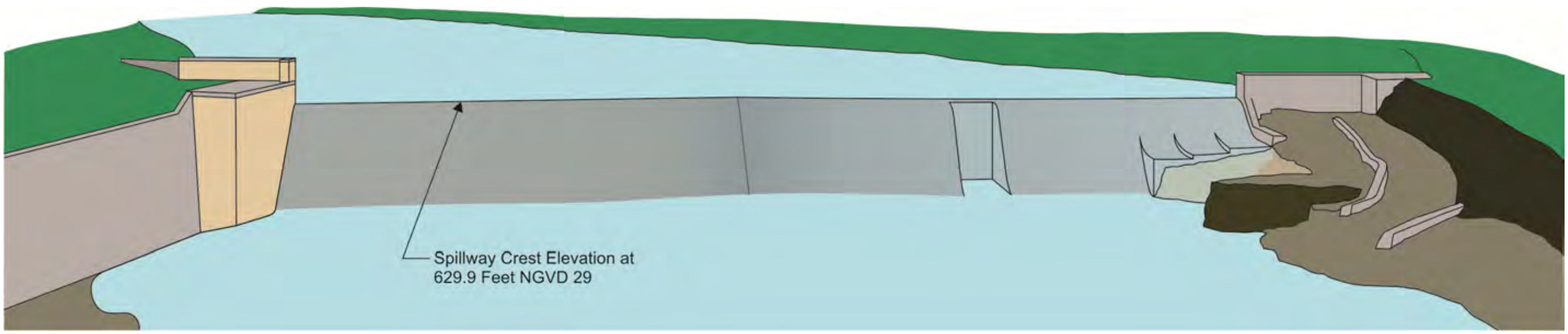
[75] *Jeff Operman et al., "Maintaining Wood in Streams: A Vital Action for Fish Conservation,"* ANR Publication 8157, *University of California, Division of Agriculture and Natural Resources, 2006.*

[76] *James H. Thrall and Rimas J. Banys*, op. cit.

Figure 109

EXISTING CONDITIONS OF HORLICK DAM – LOOKING NORTH (UPSTREAM)



Source: SEWRPC.

Table 74

MODELED FLOW RATES FOR THE ROOT RIVER AT HORLICK DAM

Annual Probability of Occurrence (recurrence interval) or Description	Flow Rate (cfs)	Source
99-Percent (1-year)	686	SEWRPC Gage Analysis 2013
50-Percent (2-year)	1,900	SEWRPC Gage Analysis 2013
10-Percent (10-year)	3,500	SEWRPC Gage Analysis 2013
2-Percent (50-year)	5,200	2012 FIS
1-Percent (100-year)	6,380	2012 FIS
0.2-Percent (500-year)	10,200	2012 FIS
90 Percent Exceeds	10	USGS Water-Data Report 2012
50 Percent Exceeds	56	USGS Water-Data Report 2012
10 Percent Exceeds	410	USGS Water-Data Report 2012
March-June Maximum Mean Daily	1,000	USGS Gage Summary Statistics 1963-2011

Source: U.S. Geological Survey gage 04087240, 2012 Racine County FIS, and SEWRPC.

To evaluate peak and base flow profiles at the Horlick dam, a U.S. Army Corps of Engineers (USCOE) Hydrologic Engineering Center (HEC-RAS) river analysis system model[77] was developed using the USCOE HEC-2 water surface profiles model developed by the SEWRPC staff under a 1990 drainage and flood control plan for the Milwaukee Metropolitan Sewerage District.[78] The hydraulic model was also modified to reflect a 1977 dam survey and WisDOT plans for STH 38 and STH 31. Model cross sections were modified in the impoundment area to match the 2012 SEWRPC channel soundings described in Chapter IV. Flows for which water surface profiles were computed are listed in Table 74. The Horlick dam HEC-RAS model results were checked for reasonableness versus the observed June 2008 and April 2013 flood elevations at STH 38, the Horlick dam, and USGS gage 04087240 just downstream of the dam.

Hydraulic model results for the existing Horlick dam indicate that the current spillway capacity is equal to the peak flow rate during the 10-percent-annual-probability (10-year recurrence interval) flood. This means that larger floods are not contained by the Horlick dam spillway, overflowing the left[79] and right abutments and walkways. Based on model results, the water surface elevation just downstream of the dam (also called the tailwater elevation) is approximately at the top of the existing spillway crest (629.9 feet above National Geodetic Vertical Datum, 1929 adjustment (NGVD 29)) for the 0.2-percent-annual-probability (500-year recurrence interval) flood. The 0.2-percent-annual-probability velocity at the dam spillway crest is approximately 11.0 feet per second (fps). The 1-percent-annual-probability (100-year recurrence interval) flood tailwater elevation is approximately three feet below the existing spillway crest, with a spillway crest velocity of approximately 9.0 fps. The two-percent-annual-probability (50-year recurrence interval) flood tailwater elevation is approximately four feet below the existing spillway crest, with a spillway crest velocity of approximately 8.0 fps.

[77] *Version 4.1.0.*

[78] *SEWRPC Community Assistance Planning Report No. 152*, A Stormwater Drainage and Flood Control System Plan for the Milwaukee Metropolitan Sewerage District, *December 1990.*

[79] *References to left and right are based on looking downstream.*

Normal or base flows on the Root River are fairly small (10 to 56 cfs) as discussed in Chapter IV. What this means for the current Horlick dam configuration is that the residence time in the impoundment is between two and eight days. It also means that the dam is minimally overtopped during normal flow times (one to three inches), making fish passage downstream over the spillway difficult. During base flow conditions, the pool created by backwater from the Horlick dam extends upstream to STH 31, a length of approximately 3.4 miles.

The Horlick dam impoundment most likely raises the shallow groundwater table in the immediate area. Thus, maintenance of the dam in place may be beneficial to shallow private wells in the vicinity of the impoundment if they are still being utilized. However, if upgrading the spillway capacity of the dam to meet State requirements necessitates lowering the permanent pond elevation, as indicated by several alternatives that are described below, the positive effect of the permanent pond on groundwater levels would be reduced somewhat. Map 70 includes all private well log data found on the Wisconsin Department of Natural Resources (WDNR) website for the three U.S. Public Land Survey sections encompassing the Horlick impoundment.[80] The numerous wells with standing water less than 25 feet below the ground surface (highlighted in yellow) are of particular concern because their water levels would be most likely to be affected by fluctuations in the impoundment level. It is unknown which wells included in Map 70 are still in use.

Water Quality

Water quality data for the Root River in the vicinity of the Horlick dam are set forth in Chapter IV. Unfortunately, the more comprehensive water quality data sets were at Johnson Park which is at approximate river mile 11.5 and at the gage just below the Horlick dam at river mile 5.9 (see Table 21 in Chapter IV of this report). Thus, there are no known water quality data explicitly representing the Horlick dam impoundment.

What can be determined from the available water quality data is that dissolved oxygen concentrations are very good just downstream of the Horlick dam (see Figure 2 and Table 28 in Chapter IV of this report). This may be due to re-aeration over the dam spillway or the fact that the flow over the dam is from the top layer of the impoundment, which has direct interaction with the air surface. Root River total phosphorus levels both five miles upstream and just downstream of the Horlick dam are above the 0.075 mg/l warmwater fish and aquatic life criterion for a significant portion of the water quality dataset (see Figure 29 and Table 28 in Chapter IV of this report). The river temperature dataset is not continuous, thus comparisons to the sublethal and acute standards for small warmwater communities is not possible (see Tables 28 and 23 in Chapter IV of this report). However, if the temperature data in Figure 15 in Chapter IV of this report is compared between the upstream and downstream gages that are closest to the Horlick dam at river miles 11.5 (Johnson Park) and 5.9 (just downstream of Horlick dam) there does appear to be a consistent upward trend in temperature between the upstream and downstream gage, which may be indicative of the rise in water temperatures that would be expected to occur because of the increased residence time and larger water surface area within the Horlick dam impoundment. The only exception to this upward temperature trend between the two gages is the period from 1987 through 1993. The temperature data included in Figure 15 in Chapter IV of this report are from grab samples, thus it is assumed the samples at the upstream and downstream gages were taken on the same day for comparison purposes.

The Horlick dam impoundment has captured significant sediment since its original construction in 1834, as evidenced by the streambed/accumulated sediment profile shown in Figure 105 in Chapter IV of this report. This sediment capture may have caused erosion downstream of the dam as the river attempted to regain sediment equilibrium.[81] But sediment capture in the Horlick impoundment may have benefitted the harbor with reduced sediment volumes at the Root River mouth. It was documented in Chapter IV that contaminated sediment in the impoundment does not appear to be a concern based on testing to date.

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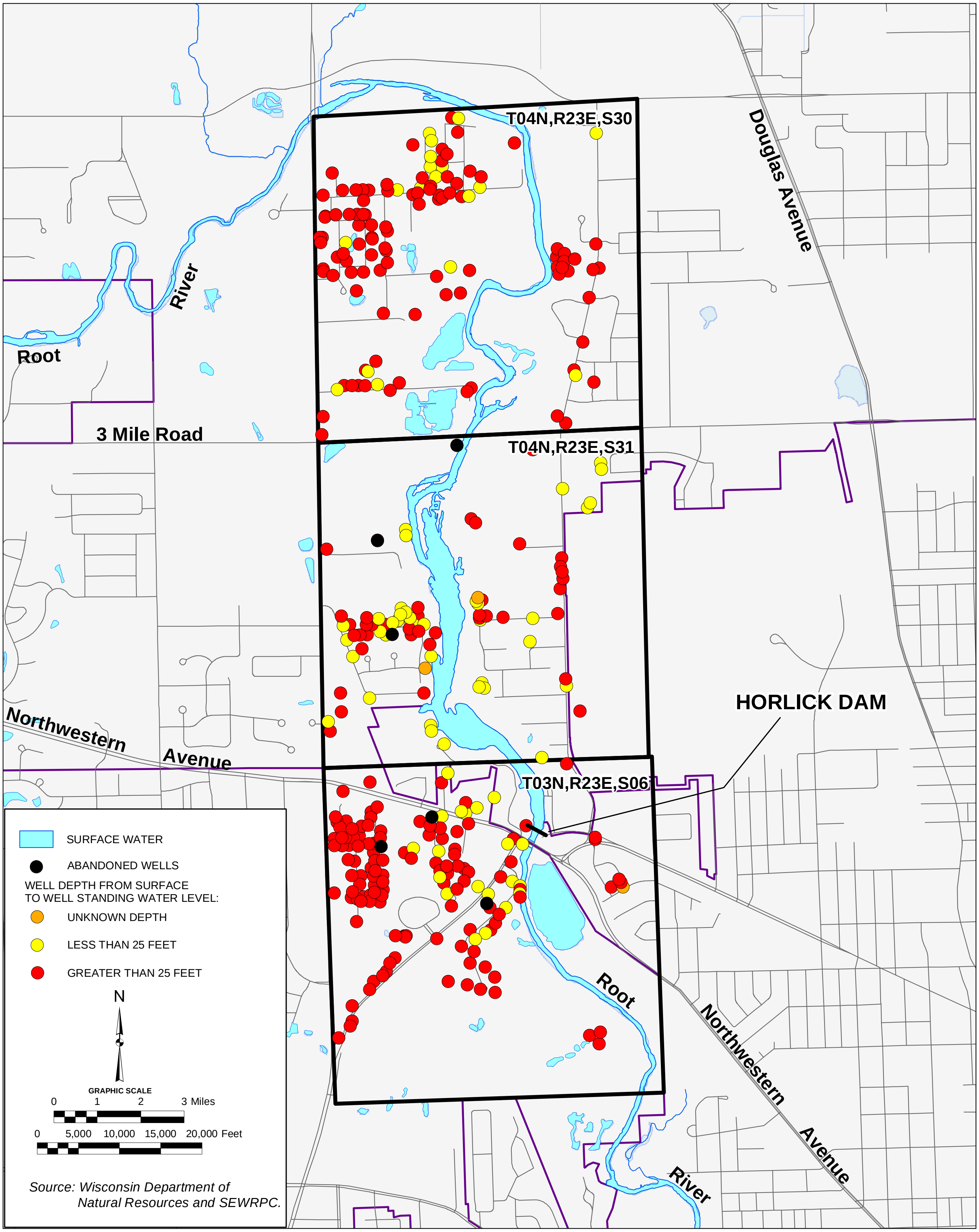
[80]http://dnr.wi.gov/topic/groundwater/data.html.

[81]*Angela T. Bednarek, "Undamming Rivers: A Review of the Ecological Impacts of Dam Removal,"* Environmental Management, *Vol. 27, No. 6, 2001.*

Map 70

PRIVATE WELLS NEAR THE HORLICK
DAM IMPOUNDMENT CONSTRUCTED 1940-2010



As evidenced by WDNR inspections, the Horlick dam does catch large woody debris at its crest, although an annual estimate of large woody debris accumulation at the Horlick dam is not available. Some large woody debris also settles in the upstream impoundment, depending on flow conditions and the size of the debris. The WDNR has recommended facilitating downstream movement of debris caught at the dam crest on an ongoing basis. Thus, the Horlick dam does essentially pass large woody debris, albeit often after the flood flows have receded when downstream sections are less able to convey it further downstream until the next major flood.

Natural Resources

A meeting was held between Commission staff and WDNR staff on June 13, 2013, to discuss the Horlick dam and the Root River. A summary of the meeting discussion can be found in Appendix R. Guidance from the WDNR related to the Horlick dam and the Root River fishery and aquatic invasive species discussed in subsequent sections is documented in those meeting notes. In addition, the January 1, 2014, "Fish Passage Guidance" document issued by WDNR was considered in evaluating considerations related to passage of fish and aquatic invasive species and the possible transmission of viral hemorrhagic septicemia (VHS) within the watershed.[82] That document was discussed during an April 24, 2014, meeting between the WDNR and SEWRPC staffs.

Lake Michigan aquatic invasive species are blocked from the upper Root River by the Horlick dam the majority of the time. The WDNR has indicated that the Root River Steelhead Facility, located downstream in Lincoln Park, is not considered a barrier as the flashboards are fully removed for most of the year. The Steelhead Facility flashboards are in place during the annual salmon spawning runs from about early September to November and then from early March to mid/late April.

The WDNR considers both VHS and the aquatic invasive species of sea lamprey and round goby to be of greatest concern for the Root River. To stop the movement of the aquatic invasive sea lamprey, the U.S. Fish and Wildlife Service (USFWS) has recommended at other dam facilities a crest to tailwater difference of at least 1.5 feet for a step ladder fishway design for the 10-percent-annual-probability (10-year recurrence interval) flood. To determine if the Horlick dam is a complete barrier to the migration of aquatic organisms, the WDNR has recommended in their fish passage guidance[83] utilizing the 1-percent-annual-probability (100-year) flood.

During the 10-percent-annual-probability flood, the hydraulic modeling results indicate that the Horlick dam tailwater elevation is approximately six feet below the spillway crest. During the 1-percent-annual-probability flood, the hydraulic modeling results indicate that the Horlick dam tailwater elevation is approximately three feet below the spillway crest. Thus, the dam appears to be a barrier to sea lamprey movement during floods up to, and including, the 10-percent-probability flood and may still be a barrier at the 1-percent-annual probability flood. It should be noted that the tailwater elevation is approximately at the top of the existing spillway crest (629.9 feet above NGVD 29) for the 0.2-percent-annual-probability (500-year) flood, meaning that the dam is no longer a barrier for invasive aquatic species for this extreme flood.

To determine if the dam is a barrier to fish passage for the 0.2- and 1-percent-annual-probability floods, a comparison of hydraulic modeling results to the swimming capacities of three fish species was completed. Smallmouth bass was selected as a smaller native sport species potentially occurring in the Root River. Based on recent dam modification analyses completed at other southeastern Wisconsin locations, northern pike was selected to represent the native fishery for the evaluation of fish passage conditions. Chinook salmon was the third species reviewed, as it is the largest WDNR stocked salmonid population in Lake Michigan. Available prolonged and burst speed data for these three fish species is included in Table 75. Based on the burst speeds listed in Table 75, both the northern pike and Chinook salmon could pass the Horlick dam spillway for the modeled

[82]*Wisconsin Department of Natural Resources, Bureaus of Fisheries Management, Water Quality, and Watershed Management, "Fish Passage Guidance," January 1, 2014.*

[83]Ibid.

Table 75

ADULT FISH SWIMMING SPEEDS AND LEAPING DATA FOR HORLICK DAM

Fish species	Prolonged Speed (fps)	Burst Speed (fps)	Maximum Leap Height/Distance (feet)
Northern Pike	- -	5.0-13.0[a]	- -
Chinook Salmon	3.4-10.8[b]	10.8-22.4[b]	7.0/5.0[b]
Smallmouth Bass	1.8-3.9[c]	3.6-7.8[c]	- -

[a]*Luther P. Aadland,* Reconnecting Rivers: Natural Channel Design in Dam Removals and Fish Passage, Minnesota Department of Natural Resources*, January 2010 and S.J. Peake,* Swimming Performance and Behaviour of Fish Species Endemic to Newfoundland and Labrador: A Literature Review*, Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2843, 2008.*

[b]*Gregory T. Ruggerone,* Evaluation of Salmon and Steelhead Migration Through the Upper Sultan River Canyon Prior to Dam Construction*, City of Everett, July 2006.*

[c]*Stephan Peake,* An Evaluation of the Use of Critical Swimming Speed for Determination of Culvert Water Velocity Criteria for Smallmouth Bass*, Transactions of the American Fisheries Society 133: 1472-1479, 2004 and Normandeau Associates, Inc.,* Claytor Hydroelectric Project Fish Entrainment and Impingement Assessment, *Appalachian Power Company, R-20979.001, January 2009.*

Source: SEWRPC.

0.2-percent-annual-probability flood, while the smallmouth bass most likely could not get past the dam spillway. Based on the leaping ability of Chinook salmon and the Horlick dam spillway configuration, Chinook should also be able to jump the dam during a two-percent-annual-probability (50-year recurrence interval) flood and any larger event. As the Chinook salmon is considered an aquatic invasive fish species, the current Horlick dam would be deemed an incomplete barrier based on the WDNR Fish Passage Guidance.[84] A summary of fish passage issues for the Baseline Condition and all alternatives is included in Table 76.

Social

The Horlick dam is not in a high profile location in the City of Racine and a bit difficult to view, with the best view being from the STH 38 bridge immediately downstream. Views of the dam and impoundment can also be enjoyed by patrons of the Riverside Inn on the right side of the dam as well. Views and access from Horlick Park on the left side of the dam are limited, with difficult foot access to the walkway over the former fishway via a narrow unmarked path along the park fence line. Access to the impoundment is good, with a boat launch and pier in Horlick Park. Immediately downstream of the dam, access is again difficult along an unmarked path at the end of Rapids Court behind the River Run Family Restaurant.

Safety issues at the current Horlick dam include periodic high flows, the possibility of dam failure, boater and fisherman safety, and access hazards by the public. During high flows, the water can approach the walkways on either end of the dam and be quite turbulent downstream of the dam. Falling or being swept into the Root River at the Horlick dam during high flows would be dangerous. Dam failure could be caused by instability during large floods, resulting in a structural failure. The possible significant downstream effects to property resulting from loss of the dam are described in Chapter IV. Boater safety is a concern near the crest of the dam, which is marked with warning signs only. Fishermen predominately fish downstream of Horlick dam during the salmon runs in spring and fall. The water is typically very shallow during the salmon runs, and most fisherman use waders and walk along the River bottom. Foot access below the dam is probably the biggest safety concern for fisherman.

[84]Ibid. *See Appendix 4 of the WDNR Fish Passage Guidance.*

Table 76

HORLICK DAM ALTERNATIVE SUMMARY—FISH PASSAGE AND INVASIVE SPECIES

Alternative	Spillway Crest Elevation (feet above NGVD 29)	Tailwater Elevation Event at Crest (recurrence interval)	Chinook Passage Event (recurrence interval)	Invasive Species Passage Event[a] (recurrence interval)	Barrier to Invasive Species [b]
Baseline Condition................................	629.9	500-year	50-year	500-year	Incomplete
Alternative 1–Lower Crest for 100-Year Capacity	626.6	Between 50 and 100-year	2-year	50-year	Incomplete
Alternative 2[c]–Alt 1 with Fishway..........	626.6	Between 50 and 100-year	2-year	50-year	Incomplete
Alternative 3–Lengthen Spillway for 100-Year Capacity	629.9	500-year	50-year	500-year	Incomplete
Alternative 4–Full Notch of Dam for 500-Year Capacity	620.0	Between 1 and 2-year[d]	50 percent exceeds	10 percent exceeds	Incomplete
Alternative 5–Dam Removal.................	620.0	Between 1 and 2-year[d]	50 percent exceeds	10 percent exceeds	No

[a]*Species other than Chinook salmon.*

[b]*The January 2014 WDNR* Fish Passage Guidance *defines an incomplete barrier as: "A man made or natural structure which allows the migration of aquatic organisms upstream during events less than the 100 year event."*

[c]*Assumes fishway closed for larger flood events.*

[d]*This condition represents the March through June maximum mean daily flow of 1,000 cfs.*

Source: SEWRPC.

As previously discussed, recreational opportunities at the Horlick dam and impoundment include small watercraft use in the impoundment, fishing, and bird watching. Although birds are attracted to the impoundment and river corridor, bird hunting is not allowed. For most individuals, the almost complete obstruction of fish movement across the dam from downstream to upstream as discussed previously would be considered a negative, but for those enjoying the salmon run, the downstream side of the Horlick dam is a popular fishing spot.

Land ownership along the Root River corridor upstream of the Horlick dam to STH 31 is indicated on Map 71. Publicly owned lands are shaded in green, and property boundaries are shown in black. Privately owned property that includes a portion of the Horlick dam impoundment is indicated with a yellow boundary. It is important to note that the majority of the Horlick dam impoundment is not in private ownership, and the majority of the private property lines end at the water's edge of the current impoundment.

Cost

The Horlick dam was reconstructed in late 1975, making the current configuration of the dam about 39 years old. Based on recent inspections by WDNR, there do not appear to be any substantial concerns with the condition of the dam. Maintenance and future study costs (in 2013 dollars) for the current Horlick dam were estimated by Racine County and SEWRPC staff as outlined below. The majority of these items were called for in the 2008 and 2011 WDNR inspection reports (Appendix K). The cost of implemented actions called for under the WDNR Horlick dam inspection totals $6,000, the ongoing yearly costs are estimated at $1,000, and efforts yet to be completed as required by WDNR total $68,000.

- Woody debris passage—ongoing cost estimated at $1,000/year
- Dam break analysis—(completed 2014) $5,000

Map 71

LAND OWNERSHIP IN THE VICINITY OF HORLICK DAM IMPOUNDMENT

Map 71 (continued)

LAND OWNERSHIP IN THE VICINITY OF HORLICK DAM IMPOUNDMENT

Source: SEWRPC.

- Take-out sign and benchmark establishment—(completed) $1,000
- Outstanding requested actions from WDNR inspections:
    - Preparation of plans and a condition report for stop logs, sill plate, and embedded slots—$5,000
    - Installation of a bridge operation deck and mechanism for stop log removal—$25,000
    - Development of an Emergency Action Plan—$5,000
    - Development of an Inspection, Operation, and Maintenance Plan—$3,000
    - Investigation of concrete condition—$10,000
    - Preparation of scour study—$10,000
    - Bank repairs—$10,000

Conceptual Alternatives

Three categories of conceptual alternatives for the Horlick dam were developed as outlined below, with the goals of enhancing spillway capacity, providing fish passage, or removing the dam. Four specific alternatives are described, and additional information needs to be addressed during preliminary engineering are identified.

As documented in Chapter IV, the analyses presented in this report are based on the fact that the dam has a Low Hazard rating. For a Low Hazard dam, Chapter NR 333, "Dam Design and Construction," of the *Wisconsin Administrative Code* requires that the spillway safely convey the 1-percent-annual-probability (100-year) flood flow. Under the current Horlick dam configuration, the 1-percent-annual-probability flow is not contained within the spillway as discussed above, overtopping the right and left observation decks at the dam and causing erosion and failure concerns at both locations.

Due to the inadequate Horlick dam spillway capacity discussed in the Baseline Condition section, structural modifications to the dam would be necessary for the dam to be maintained. Thus, a "no action" alternative is not a viable option for the Horlick dam. As noted above, the WDNR staff has stated that Racine County will have 10 years to implement modifications to the dam to meet spillway requirements. Another option available to the County would be removal of the dam.

As described in the Baseline Condition section, the Horlick dam is currently a barrier to fish passage to the upstream watershed for all but the most extreme floods. Downstream fish passage may occur over the dam crest, but during normal flow times it is difficult due to the shallow overtopping depth. As noted above, the Horlick dam is considered an incomplete barrier to aquatic invasive species.

The hydraulic effects of each of the alternatives were evaluated using the HEC-RAS model developed for the Baseline Condition. Modifications to the hydraulic model were made only at the dam location to represent each of the alternative configurations.

The provision of freeboard during the 1-percent-annual-probability spillway design flood was established based on the more restrictive of the following two criteria:[85]

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[85] *Freeboard is the difference between the water surface elevation on the upstream side of Horlick dam and the top of the dam abutments. Freeboard provides a level of safety against overtopping of the abutments, since such overtopping could potentially cause structural and safety concerns for the dam.*

- Providing one foot of freeboard to the tops of the existing, or proposed depending on the alternative, left and right concrete abutments for the maximum 1-percent-annual-probability flood elevation, or

- Containing the 0.2-percent-annual-probability flood event within the dam spillway with the upstream water surface elevation at the top of the lowest abutment.

For all the alternatives but full removal (Alternative 5) (i.e., for all alternatives under which the dam would be kept in place), the 0.2-percent-annual-probability flood freeboard criterion governs the design.

Alternatives that Modify the Dam to Enhance Spillway Capacity

ALTERNATIVE 1—LOWER CURRENT DAM SPILLWAY CREST FOR ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR) FLOOD CAPACITY SURFACE WATER AND GROUNDWATER QUANTITY CONSIDERATIONS

This alternative modifies the dam to safely pass the 1-percent-annual-probability (100-year recurrence interval) flood. Lowering the entire dam spillway by 3.3 feet to elevation 626.6 feet above NGVD 29 would enable safe conveyance of the 1-percent-annual-probability flood within the dam spillway (see Figure 110).[86] Under Alternative 1 the 0.2-percent-annual-probability flood would be just contained within the dam spillway, and there would be approximately two feet of freeboard to the top of the existing left concrete abutment for the maximum 1-percent-annual-probability flood elevation.

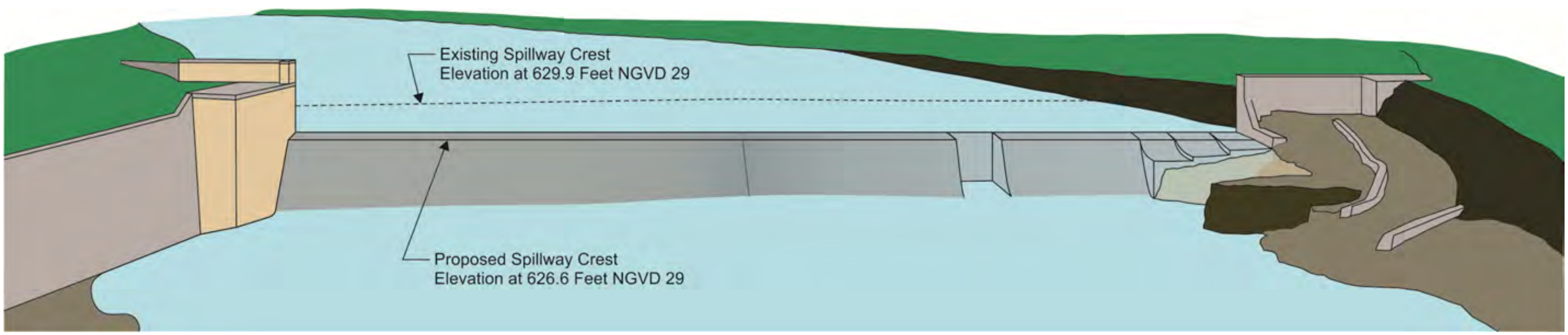
The modifications included under Alternative 1 would significantly alter both the flood and normal flow profiles upstream of the dam to STH 31. The 1-percent-annual-probability profile would be lowered approximately three feet at the dam crest from Baseline Conditions, while the 0.2-percent-annual-probability (500-year recurrence interval) flood would be lowered approximately 2.6 feet. Dam tailwater elevations associated with this alternative would remain the same as the Baseline Condition. The 1-percent-annual-probability flood effects of Alternative 1 are not as pronounced upstream at STH 31, with the water surface elevation upstream of the bridge for Alternative 1 only 0.3 foot lower than the elevations for the Baseline Condition. The 0.2-percent-annual-probability water surface elevation upstream of the STH 31 bridge for Alternative 1 would also be only 0.3-foot lower than the Baseline Condition.

Based on hydraulic model results, the tailwater elevation for Alternative 1 is approximately at the top of the lowered spillway crest (626.6 feet above NGVD 29) for a flood condition between the one- and two-percent-annual-probability (100 and 50-year recurrence interval) floods. The one- and two-percent-annual-probability velocities at the dam spillway crest are approximately 9.8 and 9.1 fps, respectively. The significance of the tailwater elevation being at or just above the Alternative 1 spillway crest is that the dam structure would essentially no longer be a barrier to fish and aquatic species passage for the flows between the one- and two-percent-annual-probability floods. The 1-percent-annual-probability flood tailwater elevation is approximately 0.4 foot above the modified spillway crest. The 0.2-percent-annual-probability (500-year) flood tailwater elevation is approximately 3.3 feet above the modified spillway crest, with a spillway crest velocity of approximately 11.5 fps. And finally, the 10-percent-annual-probability (10-year recurrence interval) flood tailwater elevation is approximately 2.5 feet below the modified spillway crest, with a crest velocity of approximately 8.0 fps.

[86]*The requirement to safely pass the 1-percent-annual-probability (100-year recurrence interval) flood could also be attained by a gate-type system modification to the Horlick dam. This would be significantly more expensive to construct and would also require active operation to safely convey flood flows. Such active operation normally is not desirable, as timing of operations can be difficult to predict. Therefore, this is not a viable option and was not considered further in this study.*

Figure 110

HORLICK DAM CONCEPTUAL ALTERNATIVE 1
LOWER CURRENT DAM SPILLWAY CREST FOR ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR) FLOOD CAPACITY – LOOKING NORTH (UPSTREAM)



Source: SEWRPC.

With the reduction in spillway elevation to 626.6 feet above NGVD 29, the extent of the impoundment area will be significantly reduced during normal, or base, flow times. It is estimated that the impoundment will extend approximately 1.5 miles upstream, or only encompass the lower half of the original impoundment area. This means that base flow residence times will be lower in the impounded area, which should improve water quality overall. And the upper reach between the alternative impounded area and STH 31 will experience flooded overbanks less frequently, which may allow surface vegetation to establish and improve terrestrial habitat in this area.

With a reduced impoundment area at a lower elevation during normal flow times, shallow groundwater levels most likely will also be lowered. This may adversely affect the still active groundwater wells developed in the shallow aquifer previously discussed and depicted in Map 70.

Water Quality

Water quality impacts associated with Alternative 1 cannot be definitively predicted, but as was discussed earlier, the size of the impoundment would be reduced with this alternative, which should reduce base flow residence times and reduce phosphorus deposition and water temperature in the impoundment area. Dissolved oxygen concentrations may not change dramatically as there would still be an opportunity for aeration over the lower dam spillway. It is very likely that the sediment which has accumulated on the bed of the impoundment over time may be partially flushed out of the downstream portion of the impoundment under this alternative with the lower spillway elevation. It is difficult to predict if this sediment flush would happen all at once or over time, but in all likelihood there would be an adverse impact to downstream reaches. It would be best to lower the dam in small increments over time in such a way as to minimize the potential for a large-scale loss of settled sediment downstream. The lower spillway crest will also more easily facilitate large woody debris passage during high flow times, which may be an adverse impact for downstream reaches as compared to the Baseline Condition.

Natural Resources

During the 10-percent-annual-probability flood, the hydraulic modeling results for Alternative 1 indicate that the Horlick dam tailwater elevation is approximately 2.5 feet below the altered spillway crest (626.6 feet above NGVD 29). During the 1-percent-annual-probability flood, the hydraulic modeling results indicate that the Horlick dam tailwater elevation is approximately 0.4 feet above the spillway crest. Thus, under this alternative the dam appears to be a barrier to sea lamprey movement during floods up to, and including, the 10-percent-probability flood, but no longer a barrier at the 1-percent-annual probability flood or larger floods.

Based on the fish burst speeds listed in Table 75, northern pike and chinook salmon could pass the modified Horlick dam spillway for the modeled one- and two-percent-annual-probability floods, while smallmouth bass most likely could not get past the dam spillway. Based on the leaping ability of Chinook salmon and the modified Horlick dam spillway configuration of Alternative 1, chinook should also be able to jump the modified dam for the 50-percent-annual-probability (2-year recurrence interval) flood and any larger event. As the chinook salmon is considered an aquatic invasive fish species, under Alternative 1, the dam would be deemed an incomplete barrier based on the WDNR Fish Passage Guidance. A summary of fish passage issues for the baseline and all alternatives is included in Table 76.

Social

Alternative 1 does leave a portion of the dam spillway in place, thus the cascading nature of the flows is maintained to a smaller degree. Therefore, the aesthetics are not changed dramatically at the dam. Upstream impoundment area changes would be expected to occur as discussed previously.

Boating and paddling safety issues are still a concern for this alternative, as a portion of the dam will remain in place and the drop between the impoundment and the downstream reach will still occur. Thus the safety concerns that were included in the Baseline Condition still exist, but perhaps to a smaller degree with 3.3 feet less of dam height. The original hydraulic height of the dam is approximately 12 feet, and Alternative 1 would have a hydraulic height of approximately nine feet, which is still significant from the perspective of safety of paddlers and fishers in the vicinity of the dam.

Implementation of Alternative 1 would alter recreational opportunities in the dam and impoundment area in numerous ways. There would be opportunities for new riparian trails and passive recreation, as the impoundment area would be reduced. Passive recreation would ultimately be dependent on ownership status for the exposed land. Small watercraft use would still be viable, but on a much smaller impoundment area. Fishing would also be somewhat altered in the smaller impoundment, and under high-flow conditions the dam may no longer be a full barrier to fish passage and fish normally stopped at the dam may now move farther upstream. This would be considered a positive from a fishery perspective, but possibly a negative for salmon fishing just downstream of the dam. Alternative 1 may affect watercraft access at River Bend Nature Center, but should not adversely affect the access at Horlick Park.

Map 72 includes a comparison of the approximate Baseline Condition for the impoundment as represented on the 2010 SEWRPC digital color orthophotograph, and the estimated extent of the River during normal flow conditions with Alternative 1 implemented. Also shown on Map 72 are several field-surveyed cross sections along the impoundment for comparison purposes between the existing impoundment and estimated normal water surface elevations under Alternative 1. The comparison indicates that the aesthetics of the former impoundment area will change under Alternative 1, with a more riverine look to the corridor between the River Bend Nature Center and STH 31.

With the lowered and reduced extent of the area impounded under Alternative 1, land ownership in this area would be affected. The nine properties highlighted in yellow on Map 71 would gain some dry land with Alternative 1, which would most likely be considered a positive effect. However, the majority of the private landowners between the dam and STH 31 would most likely would no longer have their properties abut the Root River under normal flow conditions. This effect would be most pronounced in the immediate impoundment area, and less so upstream where the River is more confined. A final determination of changes to Horlick impoundment property boundaries would require a review of the individual deed language.

Cost

A systems planning-level cost estimate for Alternative 1 was completed in 2013 dollars. Construction cost information was obtained from R.S. Means Heavy Construction Cost Data.[87] Components included in the preliminary cost estimate for Alternative 1 include concrete removal, provision of a slide gate in the existing stop log area to enable drawdown of the impoundment, seeding of the impoundment area, and final finishing to elevation 626.6 feet above NGVD 29. It was assumed that seeding would only be required in the bays of the existing impoundment as depicted in Map 73. Base costs were increased by 35 percent to account for engineering, administration, and contingencies. Based on these assumptions, the systems-level present-worth cost estimate, including capital cost and operation and maintenance, is $411,000. While a significant effort has been made under this system-plan to collect field data and to characterize the anticipated costs associated with this alternative, at the systems-planning level there are many uncertainties in estimating costs relative to alterations of existing dams. Those uncertainties are reduced and estimated costs are refined after an alternative is selected for implementation and preliminary engineering and final design are conducted; however, it should be noted that the WDNR has indicated, that even after the final design stage, the average dam reconstruction change order amount is 40 percent of the initial capital cost estimate, mainly due to unforeseen site conditions once construction begins.

Under Alternative 1 a portion of the dam structure is retained, thus ongoing maintenance costs will also be incurred for this conceptual alternative. Maintenance costs assumed include debris passage, inspection every 10 years, the development of an emergency action plan, an operation and maintenance plan, and minor bank repairs. A summary of all Alternative 1 costs are included in Table 77.

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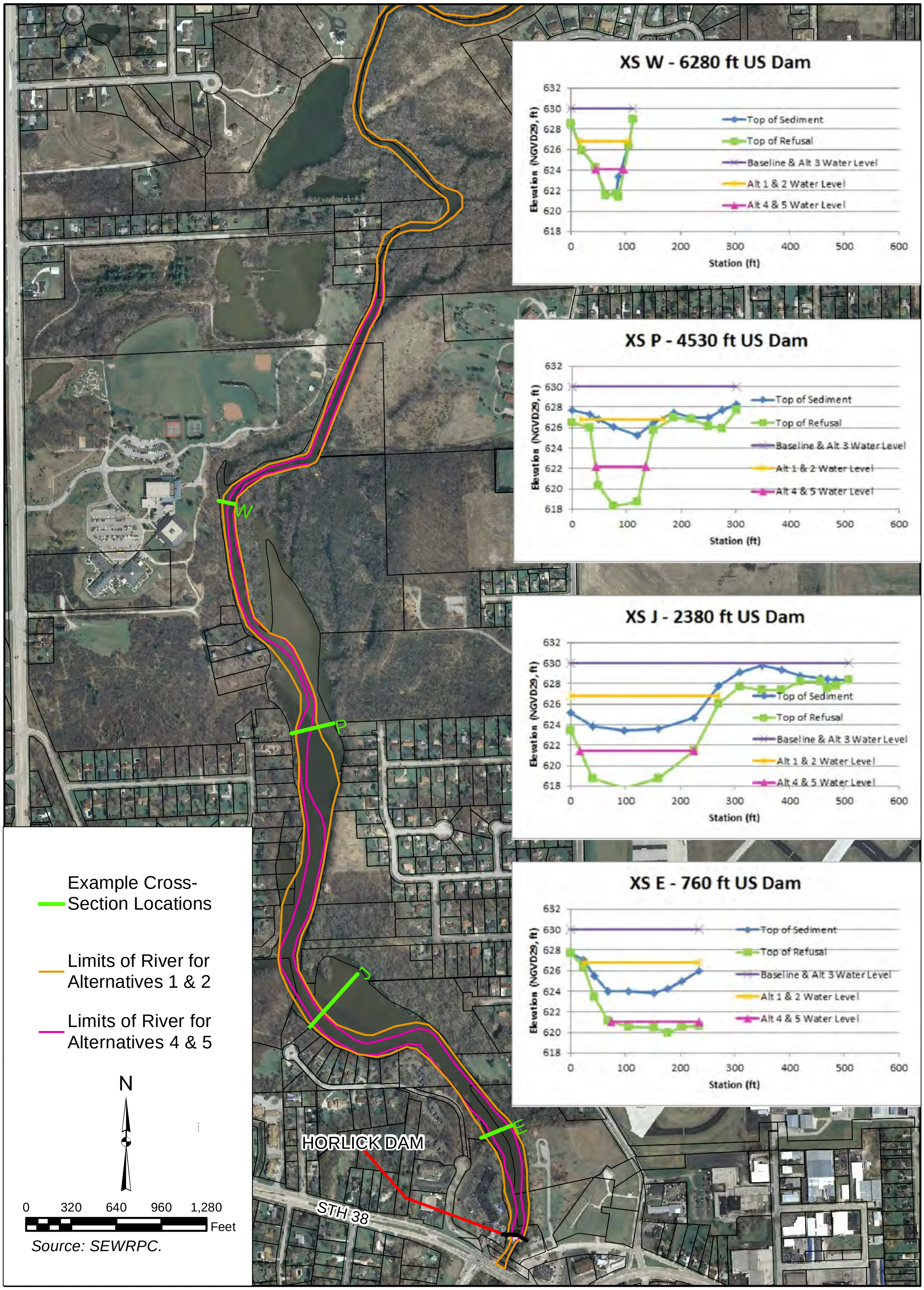
[87] *R.S. Means Company, Inc.,* RSMeans Heavy Construction Cost Data, *23rd Annual Edition, 2009.*

Map 72

CONCEPTUAL ALTERNATIVES: APPROXIMATE EXTENT OF FLOODPLAIN DURING BASEFLOW (50 percent exceedence, 56 cfs)



Source: SEWRPC.

Map 73

SEEDING AREAS FOR PRELIMINARY COST ESTIMATES

Table 77

HORLICK DAM ALTERNATIVE SUMMARY—COSTS

Alternative	Capital Cost[a,b] (dollars)	Annual Operation and Maintenance (dollars)[c]	Total Present Worth Cost (dollars)
Alternative 1–Lower Crest for 100-Year Capacity	$370,000	$2,600	$411,000
Alternative 2–Alt 1 with Fishway	$510,000	$2,900	$555,000
Alternative 3–Lengthen Spillway for 100-Year Capacity	$960,000[d]	$2,400	$998,000
Alternative 4–Full Notch of Dam for 100-Year Capacity	$450,000	$2,100	$483,000
Alternative 5–Dam Removal	$540,000	$ 700	$551,000

[a]*Capital costs based upon year 2013 conditions. Engineering News-Record Construction Cost Index: 12,208.*

[b]*These are systems-level planning costs and the WDNR has indicated that even after the final design stage, the average dam reconstruction change order amount is 40 percent of the initial capital cost estimate, mainly due to unforeseen site conditions once construction begins.*

[c]*Based on an interest rate of 6 percent and a project life of 50 years.*

[d]*Capital cost includes $240,000 for raising Old Mill Drive.*

Source: SEWRPC.

The above preliminary cost estimate does not include dredging of sediment from the Horlick impoundment. It was assumed the Alternative 1 dam lowering would be done in small increments over time or in such a way as to minimize the potential for a large-scale loss of settled sediment downstream. If dredging were required, it was calculated that approximately 72,300 cubic yards (CY) would need to be removed above elevation 620.0 feet above NGVD 29 for an Alternative 1 pilot channel. The elevation of 620.0 feet above NGVD 29 was chosen as that is the elevation of the observed natural shelf upstream of the Horlick dam. With the above assumptions, the preliminary cost estimate in 2013 dollars to dredge the upstream impoundment ranges from $1.5 to $3.6 million. The estimated cost range of sediment removal is only provided for information because different approaches to minimizing sediment release downstream of the dam site are recommended for all alternatives.

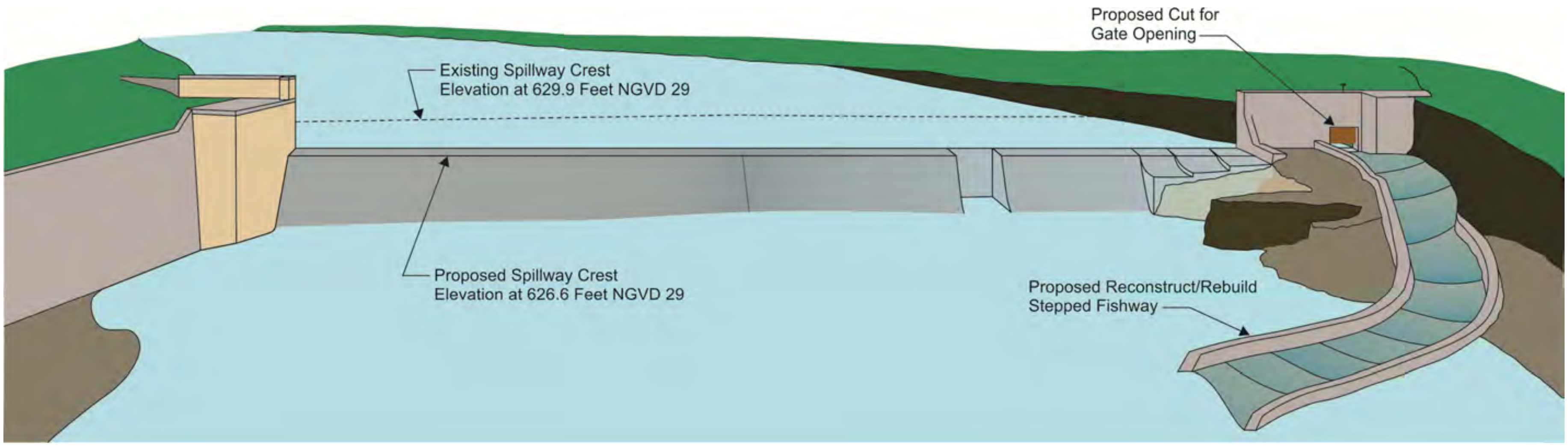
Alternative that Modifies the Dam to Enable Fish Passage under Low and High Flow Conditions

ALTERNATIVE 2—MODIFY CURRENT FISHWAY IN ADDITION TO ALTERNATIVE 1 CHANGES

To provide full fish passage at the Horlick dam, this alternative examines how the current fishway could be modified to allow fish passage during base flow conditions. By definition, the dam would be an incomplete barrier. Alternative 2 includes the modifications of Alternative 1 for providing additional spillway capacity, as it was envisioned that the modified fishway gate would be closed during flood times (see Figure 111). As was noted previously, the dam configuration under Alternative 1 does not present a barrier to aquatic invasive species passage during the 1-percent-annual-probability (100-year recurrence interval) flood, according to the criterion in the January 1, 2014, WDNR fish passage guidance. The dam configuration under Alternative 1 would be considered to present a barrier to sea lamprey passage during a 10-percent-probability flood. Because of the provision of a fishway, that might no longer be the case under Alternative 2. If this alternative were considered for implementation, the fishway design would require close coordination with regulatory agencies, which should be involved at the start of the process.

Figure 111

HORLICK DAM CONCEPTUAL ALTERNATIVE 2
MODIFY CURRENT FISHWAY IN ADDITION TO ALTERNATIVE 1 CHANGES – LOOKING NORTH (UPSTREAM)



Source: SEWRPC.

The gated fishway evaluated under this alternative would be a stair-step structure six feet wide with 10 one-foot high drops spaced approximately 16 feet apart. The overall fishway length would be approximately 160 feet. The current fishway is approximately 100 feet long, so under this alternative, the fishway would be extended and its alignment modified as indicated on Figure 111. The upstream elevation for the fishway sill at the gated structure would be 625.0 feet above NGVD 29, which would be 1.6 feet below the dam spillway crest elevation of 626.6 feet above NGVD 29. This would allow base flows to be conveyed through the fishway, bypassing the spillway. This configuration would require blasting through approximately four feet of rock along most of the existing fishway alignment, and then creating the lower 60 feet of fishway using concrete and large rocks.

Surface Water and Groundwater Quantity Considerations

The hydraulic model results for flood flows for Alternative 2 are the same as for Alternative 1, as it was assumed the fishway gate would be closed during high flow times to protect the structure. An evaluation of normal or base flow conditions was done for Alternative 2 to evaluate adequate fish passage conditions for smallmouth bass. The smaller flows in Table 74 were applied to evaluate velocities and depths over the fishway steps. For the 90-percent-exceedence flow[88] (10 cfs) the velocity over the steps is approximately 2.6 fps, with a water depth of approximately eight inches. The 90-percent-exceedence flow would not pass over the main spillway, while for all larger flows the main dam spillway is utilized along with the Alternative 2 fishway. For the 50-percent-exceedence flow (56 cfs) the velocity over the steps is approximately 4.2 fps at a depth of 1.7 feet. For the March-June maximum mean daily flow (1,000 cfs) which would be split between the spillway and the fishway, the depth over the steps is 3.3 feet with a velocity of 5.8 fps.

Water Quality

The reduction in impoundment area and upstream impact of the dam for water quality would be the same as Alternative 1 during for floods. A slight reduction in impoundment area from that estimated under Alternative 1 would be expected under baseflow conditions as the controlling elevation (the elevation of the spillway crest under Alternative 1, but the elevation of the sill at the upstream end of the fishway under this alternative) has been lowered 1.6 feet. As is the case for all of the other alternatives, under this alternative it is envisioned that the dam would be lowered in small increments over time in such a way as to minimize the potential for a large-scale loss of settled sediment downstream, thus, dredging of accumulated sediment in the impoundment is not called for. Shallow groundwater effects would also essentially be the same as Alternative 1.

Natural Resources

Based on the fish burst speeds listed in Table 75, all three fish species could pass the modified fishway for the base flow conditions of 10 to 1,000 cfs. The shallower overtopping depth for the 10 cfs event may be a concern, but the velocities are all below or within listed burst speeds.

Social

Aesthetic changes to the dam and impoundment are similar to Alternative 1, with the only exception being the fishway protruding into the Root River. Under extremely low flow conditions (10 cfs) flow may only be through the fishway, with a dry downstream face at the main dam spillway.

Safety considerations are similar to Alternative 1, with the added complication of the fishway structure. The fishway structure may be an attraction to fisherman as well as children, and may pose a slip/trip/fall hazard if walked along.

As would be the case for Alternative 1, implementation of Alternative 2 could produce opportunities for new riparian trails and passive recreation, depending on the ownership status for the exposed land along the impoundment. Recreational opportunities under Alternative 2 would be changed from those under Alternative 1

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[88]*This is the Root River flow that would occur 10 percent or less of the time (90 percent of the flows exceed this value), based on long-term streamflow gaging by the USGS.*

by the ability of fish to bypass the dam during a larger range of flow conditions. The impoundment size reduction would be very similar to Alternative 1, thus the use of small watercraft would still be viable on the smaller impoundment. Fishing would change dramatically, as fish would no longer be completely stopped at the downstream side of the dam and they could travel upstream along the mainstem and tributaries. Opening up additional habitat to the native and sport fishery would be considered positive.

Private property ownership changes would be very similar under Alternatives 1 and 2, with a slightly smaller impoundment footprint due to the lower controlling elevation at the Alternative 2 fishway.

Cost

A preliminary cost estimate for Alternative 2 was completed in 2013 dollars. Components included in the preliminary cost estimate for Alternative 2 include the features called for under Alternative 1 plus creation of the gated fishway. The base cost was increased by 35 percent to account for engineering, administration, and contingencies. Based on these assumptions, the systems-level present-worth cost estimate, including capital cost and operation and maintenance, is $555,000. While a significant effort has been made under this system-plan to collect field data and to characterize the anticipated costs associated with this alternative, at the systems-planning level there are many uncertainties in estimating costs relative to alterations of existing dams. Those uncertainties are reduced and estimated costs are refined after an alternative is selected for implementation and preliminary engineering and final design are conducted; however, it should be noted that the WDNR has indicated, that even after the final design stage, the average dam reconstruction change order amount is 40 percent of the initial capital cost estimate, mainly due to unforeseen site conditions once construction begins.

Under Alternative 2 a portion of the dam structure is retained in addition to enhancement of the fishway, thus ongoing maintenance costs will also be incurred for this conceptual alternative. Maintenance costs assumed include debris passage, inspection every 10 years, the development of an emergency action plan, an operation and maintenance plan, and minor bank repairs. A summary of all Alternative 2 costs is included in Table 77.

The above preliminary cost estimate does not include dredging of sediment from the Horlick impoundment. As noted above, different approaches to minimizing sediment release downstream of the dam site are called for under this alternative.

Alternatives that Modify the Dam to Enhance Spillway Capacity

ALTERNATIVE 3—LENGTHEN CURRENT DAM SPILLWAY AND RAISE ABUTMENTS FOR ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR) FLOOD CAPACITY

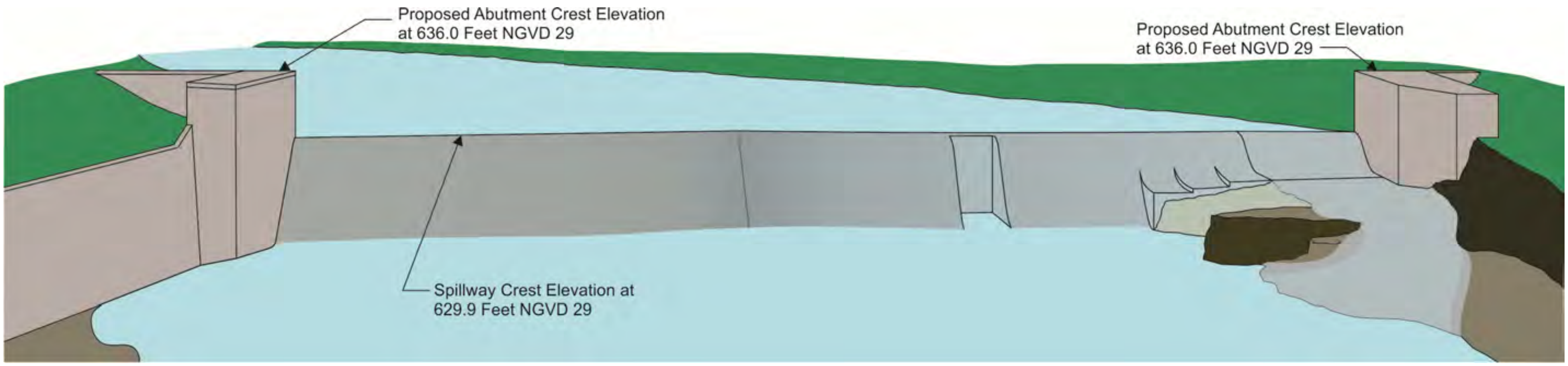
Surface Water and Groundwater Quantity Considerations

This alternative modifies the dam to safely pass the 1-percent-annual-probability (100-year recurrence interval) flood by lengthening the spillway crest and raising the top of both abutments.[89] This alternative maintains the spillway crest at elevation 629.9 feet above NGVD 29 and lengthens the crest by approximately 20 feet, utilizing the old fishway area, to a total crest length of 140 feet. Both the left and right abutments would be rebuilt to a top elevation of 636.0 feet above NGVD 29, providing approximately 1.4 feet of freeboard to the tops of the abutments based on the maximum 1-percent-annual-probability flood elevation. Also included in this alternative is raising Old Mill Drive to elevation 640.0 feet above NGVD 29, which is described later in this section. These changes would enable safe conveyance of the 0.2-percent-annual-probability flood within the dam spillway (see Figure 112).

[89]*The possibility of maintaining the Horlick dam spillway crest at its current elevation and raising the dam structures on either side of the spillway was raised during the August 28, 2013, public meeting to review alternatives relative to the dam. In a September 3, 2013, electronic mail message to the SEWRPC staff, Julie Anderson, Racine County Public Works and Development Services Director, asked on behalf of County Executive James Ladwig that such an additional alternative be considered.*

Figure 112

HORLICK DAM CONCEPTUAL ALTERNATIVE 3
LENGTHEN CURRENT DAM SPILLWAY AND RAISE ABUTMENTS FOR
ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR) FLOOD CAPACITY – LOOKING NORTH (UPSTREAM)



Source: SEWRPC.

Modifications associated with Alternative 3 would minimally alter both the flood and normal flow profiles between the dam and STH 31 in comparison to the Baseline Condition. The 0.2- and 1-percent-annual-probability (500-year and 100-year recurrence interval, respectively) flood stage elevations would be lowered approximately 0.6 foot at the dam crest relative to the corresponding flood elevations under the Baseline Condition. The one- and 0.2-percent-annual-probability flood profiles under Alternative 3 are essentially the same as under the Baseline Condition in the vicinity of STH 31. Dam tailwater elevations associated with this alternative would remain the same as under the Baseline Condition.

The hydraulic model water surface elevation just downstream of the dam is approximately at the top of the existing spillway crest (629.9 feet above NGVD 29) for the 0.2-percent-annual-probability flood. The 0.2-percent-annual-probability velocity at the dam spillway crest is approximately 12.1 feet per second (fps). The 1-percent-annual-probability flood tailwater elevation is approximately three feet below the existing spillway crest, with a spillway crest velocity of approximately 9.7 fps. The two-percent-annual-probability (50-year recurrence interval) flood tailwater elevation is approximately four feet below the existing spillway crest, with a spillway crest velocity of approximately 9.0 fps.

With the same dam crest elevation as under the Baseline Condition, conditions under Alternative 3 during normal flow periods would be almost identical to those for the Baseline. The impoundment size and width would be the same, and the minimal depth over the spillway during normal flow times would still be an impediment to downstream fish passage.

With the impoundment area maintained during normal flow times, no change from the Baseline Condition would be expected for shallow groundwater levels or for the shallow wells depicted in Map 70.

Water Quality

The modifications to the dam under Alternative 3 maintain the upstream impoundment, thus, there should be no change in water quality as compared to the Baseline Condition. It is very likely that the accumulated sediment in the impoundment area would not be flushed downstream with this alternative, and that would be considered positive. The maintenance of the spillway crest at elevation 629.9 feet above NGVD 29 would still be a barrier to large woody debris passage downstream, as it is under the Baseline Condition.

Natural Resources

During the 10-percent-annual-probability flood, the hydraulic modeling results indicate that under Alternative 3 the tailwater elevation would be approximately six feet below the spillway crest. During the 1-percent-annual-probability flood, the hydraulic modeling results indicate that the tailwater elevation would be approximately three feet below the spillway crest. Thus, under Alternative 3, the dam would appear to be a barrier to sea lamprey movement during floods up to, and including, the 10-percent-probability flood and may still be a barrier at the 1-percent-annual probability flood. It should be noted that the tailwater elevation is approximately at the top of the existing spillway crest (629.9 feet above NGVD 29) for the 0.2-percent-annual-probability (500-year) flood, meaning that the dam is no longer a barrier for invasive aquatic species for this extreme flood.

The modifications included under Alternative 3 utilize a portion of the existing fishway as part of the spillway. To provide an adequate hydraulic transition for this condition, the conceptual design and associated cost estimate assume removal of a top layer of the rock ledge at the former fishway location. At the systems planning level, this is considered to be an adequate provision for hydraulic purposes and to reduce the tailwater elevation in the vicinity of the former fishway in an effort to avoid fish passage.

Based on the fish burst speeds listed in Table 75, northern pike and chinook salmon could pass the lengthened Horlick dam spillway during the modeled 0.2-percent-annual-probability flood, while smallmouth bass most likely could not get past the dam spillway. Based on the leaping ability of chinook salmon and the lengthened Horlick dam spillway configuration under Alternative 3, chinook should also be able to jump the modified dam for the two-percent-annual-probability flood and any larger event. As the chinook salmon is considered an aquatic invasive fish species, under Alternative 3, the dam would be deemed an incomplete barrier based on the WDNR Fish Passage Guidance. A summary of fish passage issues for the baseline and all alternatives is included in Table 76.

Social

Under Alternative 3 the spillway crest would be lengthened and the crest shape would be maintained. Thus, the cascading nature of the flows is maintained as compared to the Baseline Condition, and the aesthetics are not changed appreciably at the dam. The upstream impoundment area will not change as described previously.

Boating and paddling safety issues are still a concern for this alternative as under the Baseline Condition. The original hydraulic height of the dam is maintained, so under Alternative 3 the dam would also have a hydraulic height of 12 feet, which is significant from the perspective of safety of paddlers and fishers in the vicinity of the dam.

Alternative 3 would maintain the Baseline Condition recreational opportunities at the dam and impoundment area. There would be no opportunity for new riparian trails and passive recreation, as no lowering of the impoundment would occur. Under all but the most extreme floods, fish migration upstream would continue to be stopped at the dam under the Alternative 3.

With the impoundment area maintained under Alternative 3, additional unsubmerged land would not be created, and land ownership in this area would not be an issue (see Map 71).

Cost

A systems planning-level cost estimate for Alternative 3 was completed in 2013 dollars. Construction cost information was obtained from R.S. Means Heavy Construction Cost Data.[90] Components included in the preliminary cost estimate for Alternative 3 include abutment concrete removal, concrete construction, provision of a slide gate in the existing stop log area to enable drawdown of the impoundment, and road raise and reconstruction. Base costs were increased by 35 percent to account for engineering, administration, and contingencies. Based on these assumptions, the systems-level present-worth cost estimate, including capital cost and operation and maintenance, is $998,000. While a significant effort has been made under this system plan to collect field data and to characterize the anticipated costs associated with this alternative, at the systems-planning level there are many uncertainties in estimating costs relative to alterations of existing dams. Those uncertainties are reduced and estimated costs are refined after an alternative is selected for implementation and preliminary engineering and final design are conducted; however, it should be noted that the WDNR has indicated that even after the final design stage, the average dam reconstruction change order amount is 40 percent of the initial capital cost estimate, mainly due to unforeseen site conditions once construction begins.

Under Alternative 3, the dam structure is retained, thus, ongoing maintenance costs would also be incurred for this conceptual alternative. Maintenance costs assumed include debris passage, inspection every 10 years, the development of an emergency action plan, an operation and maintenance plan, and minor corridor maintenance. A summary of all Alternative 3 costs are included in Table 77.

The only vehicular access for 15 homes and three condominium buildings located west of the impoundment is along Old Mill Drive at STH 38. Based on the current Federal Emergency Management Agency Flood Insurance Study (FIS) for Racine County, the one- and 0.2-percent-annual-probability floods would be expected to overtop Old Mill Drive under current (Baseline) conditions. It is expected that those two floods would also overtop Old Mill Road to maximum depths of 0.4 to 2.6 feet, respectively, under Alternative 3 conditions. In the other conceptual alternatives evaluated for the Horlick dam under this plan, the one- and 0.2-percent-annual-probability

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[90]*R.S. Means Company, Inc.,* RSMeans Heavy Construction Cost Data*, 23rd Annual Edition, 2009.*

flood profiles would be reduced sufficiently to avoid overtopping of Old Mill Drive. Thus, an ancillary benefit of implementing any of those alternatives would be improvement of access to the buildings along Old Mill Drive during large floods. To provide emergency service access to Old Mill Drive during large floods under either current conditions, or Alternative 3 conditions, consideration should be given to raising the grade of the Drive. The above preliminary cost estimate includes raising Old Mill Drive to 640.0 feet above NGVD 29 to eliminate roadway overtopping during the one- and 0.2-percent-annual-probability floods. The cost estimate assumes the road would require a maximum rise of four feet and the total length of road raise and new roadway pavement would be approximately 800 feet. A new longer culvert would also be required in this road section to serve a small tributary area to the immediate west of the Drive.

It should also be noted that the hotel immediately west of the dam embankment is in close proximity to the right dam abutment. If the modifications included in Alternative 3 are selected for further review, the ability to raise and modify the right abutment and not adversely affect the hotel would need to be evaluated in greater detail.

Alternatives for Partial and Full Removal of the Dam

Two dam removal options were evaluated, one that retained a portion of each end of the dam to protect the hotel and park abutments (Alternative 4),[91] and the other being full removal of the dam structure (Alternative 5). Both of these alternatives set the controlling elevation to the top of the existing channel bottom at 620.0 feet above NGVD 29.[92] No additional survey of streambed elevations was made downstream of the existing Horlick dam from what was included in the original CAPR 152 HEC-2 model. Thus the exact slope of the Root River bottom between the dam crest and the model cross section 25 feet downstream is not known and the ability of fish to swim upriver is only evaluated based on tailwater heights and crest velocities at the former dam location.

ALTERNATIVE 4—FULL NOTCH OF CURRENT DAM SPILLWAY

Alternative 4 includes a two-level notch to both contain the 1-percent-annual-probability (100-year recurrence interval) flood within the original dam spillway, and allow fish passage at the natural channel invert elevation of 620.0 feet above NGVD 29 (see Figure 113). The shape of the spillway opening is a Cipolletti notch, with the sloping portion of the notch openings designed to offset the contraction of the water around the structure. This design would include approximately 54 feet of the original spillway at elevation 629.9 feet above NGVD 29, 50 feet of crest length at elevation 621.9 feet above NGVD 29, and a six-foot opening at the Root River bottom of 620.0 feet above NGVD 29. The notch would all be to the right of the stoplog structure. The modifications included under Alternative 4 provide approximately 2.6 feet of freeboard to the tops of the existing left and right concrete abutments for the maximum 1-percent-annual-probability flood elevation. The modifications included in Alternative 4 also just contain the 0.2-percent-annual-probability flood within the dam spillway. Under this design the remaining dam structure would no longer serve as a control for base flows, and it would have a significantly reduced effect at flood flows as compared to the Baseline Condition or Alternatives 1, 2 and 3. The tailwater elevations would remain the same as under the Baseline Condition.

Surface Water and Groundwater Quantity Considerations

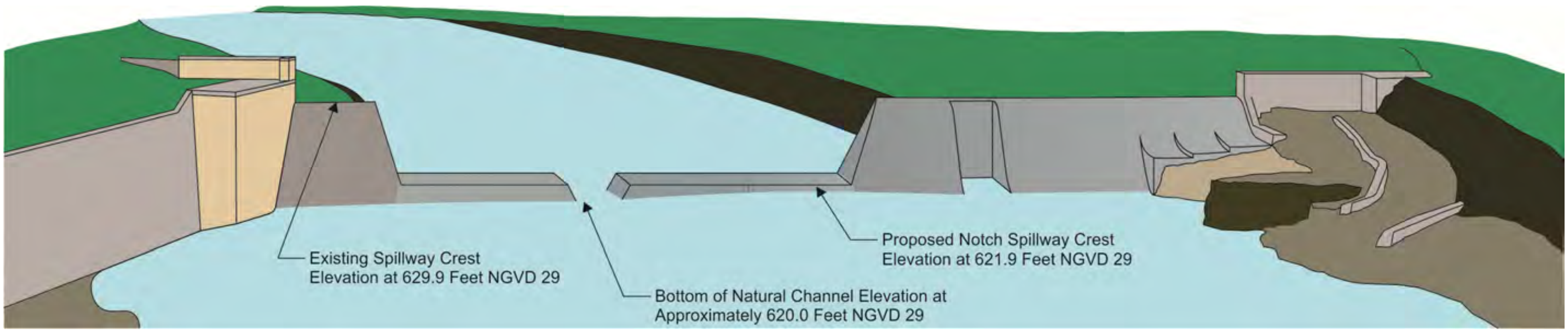
Based on hydraulic model results, the tailwater elevation for Alternative 4 is approximately at the top of the natural ledge (620.0 feet above NGVD 29) for the March-June maximum mean daily flow of 1,000 cfs. This flow is between the 99-percent-annual-probability (one-year recurrence interval) and 50-percent-annual probability (two-year recurrence interval) floods. This flow would pass over both the low notch at 620.0 and mid-level notch at 621.9 feet above NGVD 29. The mean velocity at the Alternative 4 opening for the March-June mean daily flow is approximately 5.6 fps. Only the 90 percent exceedence flow of 10 cfs is wholly contained within the

[91]*Under this alternative, the remaining structure may still be considered a dam by WDNR for regulatory purposes.*

[92]*This was determined to be the approximate top of the shelf immediately upstream of the Horlick dam, as well.*

Figure 113

HORLICK DAM CONCEPTUAL ALTERNATIVE 4
FULL NOTCH OF CURRENT DAM SPILLWAY– LOOKING NORTH (UPSTREAM)



Source: SEWRPC.

six-foot-wide low opening, with a velocity of approximately 2.6 fps. A review of tailwater elevations indicates that the 10-percent exceedence flow (410 cfs) has a tailwater elevation approximately 1.5 feet below the crest at elevation 620.0 feet above NGVD 29, which meets the USFWS criterion for inhibiting passage of sea lamprey.

Based on hydraulic model results the 1-percent-annual-probability (100-year recurrence interval) water surface elevation at the dam under Alternative 4 is approximately four feet lower than the Baseline Condition and 0.6 foot lower than under Alternative 1. The 1-percent-annual-probability flood effects of Alternative 4 are not as pronounced upstream at STH 31, with water surface elevations upstream of the bridge for Alternative 4 being only 0.3 foot lower than the Baseline Condition and essentially the same as Alternative 1.

With this partial removal of a structural barrier on the Root River, the impoundment area will essentially be eliminated under low-flow conditions. Based on hydraulic modeling results, it is concluded that the natural shelf at elevation 620.0 feet above NGVD 29 that extends upstream of the dam for approximately 1,000 feet will control hydraulic profiles for smaller flows. Along the entire corridor between the Horlick dam location and STH 31, flow would be expected to be within the banks for more floods, allowing overbank vegetation to establish and improve terrestrial habitat.

Elimination of the impoundment during normal flow times would most likely lower shallow groundwater levels in the immediate area. This may adversely affect the still active groundwater wells developed in the shallow aquifer previously discussed and depicted in Map 70.

Water Quality

With the elimination of the impoundment under Alternative 4, water quality should improve for all the constituents of concern (dissolved oxygen, phosphorus, and temperature). Normal flows will no longer be impounded and the conversion to a free-flowing river should result in better aeration of the water in the formerly impounded reach upstream from the dam site. This should help improve water quality during larger floods as well, with filtering through and deposition of sediments in overbank vegetation now a viable option to remove and store sediments and contaminants during higher overbank flows.

Under Alternative 4 the notched configuration may provide the added benefit of helping to prevent settled sediment from being transported downstream and to maintain a vegetated flood bench. Nevertheless, it is very likely that some of the settled sediment may be flushed out of the impoundment area for this alternative with the elimination of a complete barrier. It is difficult to predict if this sediment flush would happen all at once or over time, but in all likelihood in the absence of mitigation would be an adverse impact to downstream reaches. It would be best to lower the dam in small increments over time in such a way as to minimize the potential for a large-scale loss of settled sediment downstream. Thus, dredging of sediment accumulated in the impoundment is not called for under this alternative. The two-level spillway crest with a large section set at elevation 621.9 feet above NGVD 29 will also more easily facilitate large woody debris passage during high flow times, which may be an adverse impact for downstream reaches as compared to the Baseline Condition.

Natural Resources

During the 10-percent-annual-probability flood, the hydraulic modeling results for the dam under Alternative 4 indicate that the Horlick dam tailwater elevation is approximately 4.0 feet above the low sill elevation of 620.0 feet above NGVD 29. Thus, the structure configuration under Alternative 4 would not be a barrier to sea lamprey or round goby movements. As was indicated earlier, the tailwater elevation is approximately at the top of the natural shelf (620.0 feet above NGVD 29) for the March-June maximum mean daily flow of 1,000 cfs,[93] indicating that the dam would most likely no longer be a barrier for invasive aquatic species for anything larger

[93]*This flow is between the 99-percent-annual-probability (one-year recurrence interval) and 50-percent-annual probability (two-year recurrence interval) floods.*

than this flow rate. Using the USFWS preliminary 1.5 foot criterion for sea lamprey passage, under Alternative 4 the structure would no longer be a barrier to sea lamprey for any events larger than the 10-percent-exceedence flow rate of 410 cfs.

Using the fish burst speeds listed in Table 75, all three fish species could pass the modified Horlick dam spillway for the March-June maximum mean daily flow of 1,000 cfs when the tailwater elevation would be above the spillway crest. To allow sufficient depth downstream for chinook salmon to jump, it was assumed that a minimum of two feet of depth was required, which translates to the 50-percent exceedence flow rate of 56 cfs under Alternative 4. The 90 percent exceedence flow of 10 cfs is wholly contained within the six-foot-wide low opening, with a velocity of approximately 2.6 fps, which should be passable for all three fish species. Unfortunately, the streambed configuration immediately downstream of the dam is not fully known, thus depths at this low flow rate may minimize fish passage. In other words, this area downstream may be too wide under base-flow conditions to provide adequate water depths for fish passage. This area may need to be reconstructed to promote fish passage for Alternative 4. Under Alternative 4, the dam would be deemed an incomplete barrier based on the WDNR Fish Passage Guidance. A summary of fish passage issues for all alternatives is set forth in Table 76.

Social

Alternative 4 does leave a portion of the dam structure in place, thus the cascading nature of the flows is maintained for larger floods. For smaller floods, the flows will utilize the Root River channel bottom only. Thus, the aesthetics of the dam will change significantly for Alternative 4. The upstream impoundment area will also be eliminated and the corridor between the dam and STH 31 will have a more riverine look.

Safety issues are a relatively small concern for this alternative, as a portion of the dam structure will remain in place but the abrupt drop between the impoundment and the downstream reach will be eliminated. The original hydraulic height of the dam is approximately 12 feet and, under Alternative 4, there would be a naturally sloping five-foot streambed drop between the dam location and STH 38 downstream, which is a significantly reduced safety hazard compared to Alternatives No. 1, 2 and 3.

Implementation of Alternative 4 would significantly alter recreational opportunities at the dam and impoundment area. There would be opportunities for new riparian trails and passive recreation, as the impoundment has been eliminated. Passive recreation would ultimately be dependent on ownership status for the exposed land. With the elimination of the impoundment, the ability to float small watercraft would be dependent on flow conditions. Fishing would become riverine exclusive and under most flow conditions the structure configuration under Alternative 4 would no longer present a full barrier to fish passage. Fish normally stopped at the dam might now move farther upstream. Fishing would change dramatically, as fish would no longer be completely stopped at the downstream side of the dam, and they could travel upstream along the mainstem and tributaries. Opening up additional habitat to the native and sport fishery would be considered positive. This would be considered a positive from a general fishery perspective and the ecological integrity of the entire Root River system,[94] but possibly a negative for salmon fishing just downstream of the Horlick dam, where the dam would no longer serves as a barrier that concentrates the fish. Under Alternative 4 recreational boat access would also be adversely affected at River Bend Nature Center and Horlick Park, as under most flow conditions there would be no impoundment and the current launch locations would be farther from the Root River.

[94]*Victor J. Santucci, Jr. et al, "Effects of Multiple Low-Head Dams on Fish, Macroinvertebrates, Habitat, and Water Quality in the Fox River, Illinois,"* North American Journal of Fisheries Management, *Vol. 25, 2005* and *Thomas M. Slawski et al, "Effects of Tributary Spatial Position, Urbanization, and Multiple Low-Head Dams on Warmwater Fish Community Structure in a Midwestern Stream,"* North American Journal of Fisheries Management, *Vol. 28, 2008.*

With the elimination of the impoundment area, land ownership in this area would be affected. The nine properties highlighted in yellow on Map 71 would gain some dry land under Alternative 4, which would most likely be considered a positive effect. But for the majority of the private landowners between the dam and STH 31, their properties would most likely no longer be immediately adjacent to the Root River. This effect would be most pronounced in the impoundment area nearest the former dam site, and less so upstream where the Root River is narrower. A final determination of changes to Horlick impoundment property boundaries would require a review of the individual deed language.

Cost

A preliminary cost estimate for Alternative 4 was completed in 2013 dollars. Sources of cost information included RSMeans Heavy Construction Cost Data and summary dam removal costs received from WDNR. Components included in the preliminary cost estimate for Alternative 4 include concrete removal, removal of the old dam, seeding of impoundment area, and final finishing to elevation 620.0 feet above NGVD 29. It was assumed that seeding would only be required in the bays of the existing impoundment as depicted in Map 73. The base cost was increased by 35 percent to account for engineering, administration, and contingencies. Based on these assumptions, the systems-level present-worth cost estimate, including capital cost and operation and maintenance, is $483,000. While a significant effort has been made under this system-plan to collect field data and to characterize the anticipated costs associated with this alternative, at the systems-planning level there are many uncertainties in estimating costs relative to alterations of existing dams. Those uncertainties are reduced and estimated costs are refined after an alternative is selected for implementation and preliminary engineering and final design are conducted; however, it should be noted that the WDNR has indicated that even after the final design stage, the average dam reconstruction change order amount is 40 percent of the initial capital cost estimate, mainly due to unforeseen site conditions once construction begins.

Under Alternative 4, a portion of the dam structure is retained, thus ongoing maintenance costs will be incurred for this conceptual alternative. Maintenance costs assumed include debris passage, inspection every 10 years, and minor bank repairs. A summary of all Alternative 4 costs are included in Table 77.

The above preliminary cost estimate does not include dredging of sediment from the Horlick impoundment. As noted above, different approaches to minimizing sediment release downstream of the dam site are called for under this alternative.

ALTERNATIVE 5—FULL REMOVAL OF DAM

Alternative 5 calls for removal of the Horlick dam as depicted in Figure 114. The left side walkway and portion of the spillway were retained, as they are somewhat integral with the natural rock on that side of the Horlick dam. Under this alternative, the structure would be removed as a control for all flows. This means that the natural 1,000-foot shelf at elevation 620.0 feet above NGVD 29 would control the flow profiles upstream from the site of the former dam. The tailwater elevations would remain the same as the Baseline Condition.

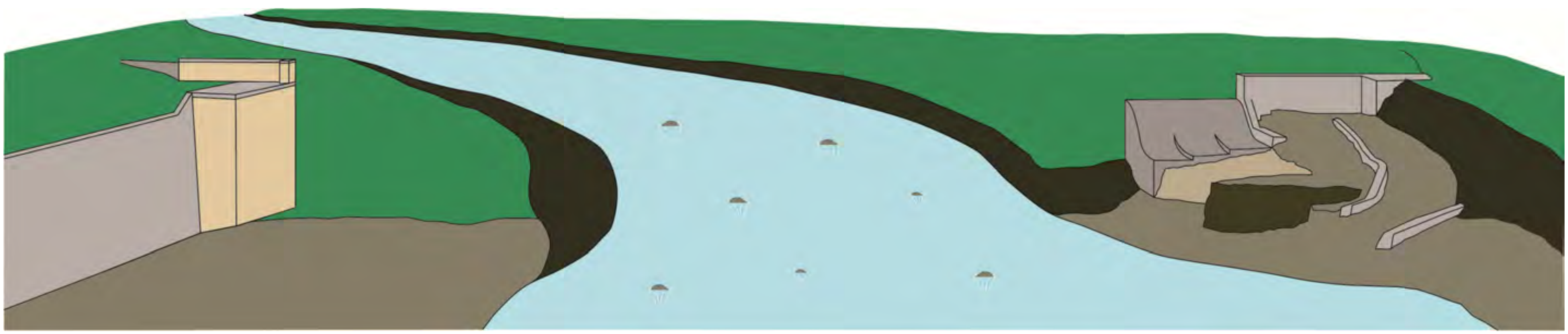
Alternative 5 provides approximately four feet of freeboard to the tops of the remaining left and right concrete abutment sections of the Horlick dam based on the maximum 0.2-percent-annual-probability flood elevation. However, while unlikely, failure of one or both abutments under the Alternative 5 configuration would not be expected to create a significant uncontrolled release of water, since there would be no impoundment of water under this condition.

Surface Water and Groundwater Quantity Considerations

Based on hydraulic model results, the tailwater elevation for Alternative 5 is approximately at the top of the natural ledge (620.0 feet above NGVD 29) for the March-June maximum mean daily flow of 1,000 cfs. This flow is between the 99-percent-annual-probability (one-year) and 50-percent-annual probability (two-year recurrence interval) floods. The mean velocity for Alternative 5 for the March-June mean daily flow is approximately 6.8 fps. The 90 percent exceedence flow (10 cfs) is very shallow across the fully exposed natural ledge, with a depth at the dam location of less than a tenth of a foot. A review of tailwater elevations indicates that the 10-percent exceedence flow (410 cfs) has a tailwater elevation approximately 1.5 feet below the natural ledge at elevation 620.0 feet above NGVD 29, which meets the USFWS criterion for inhibiting passage of sea lamprey.

Figure 114

HORLICK DAM CONCEPTUAL ALTERNATIVE 5
FULL REMOVAL OF DAM – LOOKING NORTH (UPSTREAM)



Source: SEWRPC.

Based on hydraulic model results, the 1-percent-annual-probability (100-year recurrence interval) water surface elevation at the dam for Alternative 5 is approximately eight feet lower than the Baseline Condition or four feet lower than Alternative 4. The 1-percent-annual-probability flood effects of Alternative 5 are not as pronounced upstream at STH 31, with water surface elevations upstream of the bridge for Alternative 5 only 0.3 foot lower than the Baseline Condition and essentially the same as Alternatives 1 and 4.

With the full removal of a structural barrier on the Root River, the impoundment area will be eliminated. Based on hydraulic modeling, the natural shelf at elevation 620.0 feet above NGVD 29 that extends approximately 1,000 feet upstream of the dam location would control hydraulic profiles for all flows. Along the entire corridor between the Horlick dam location and STH 31, flow will be within the banks for more floods, allowing overbank vegetation to establish and improve terrestrial habitat.

Elimination of the impoundment during normal flow times would most likely lower shallow groundwater levels in the immediate area. This may adversely affect the still active groundwater wells developed in the shallow aquifer previously discussed and depicted in Map 70.

Water Quality

With the elimination of the impoundment, water quality should improve for all the constituents of concern (dissolved oxygen, phosphorus, temperature) for Alternative 5. Normal flows will no longer be impounded and should be better aerated by movement through the corridor in a more stream-like setting. This should improve water quality for larger floods as well, with filtering through and deposition of sediments in overbank vegetation now a viable option to remove and store sediments and contaminants during higher overbank flows. It is very likely that the Baseline Condition settled sediment may be flushed out of the impoundment area for this alternative with dam removal. It is difficult to predict if this sediment flush would happen all at once or over time, but in all likelihood in the absence of mitigation would be an adverse impact to downstream reaches. It would be best to lower the dam in small increments over time in such a way as to minimize the potential for a large-scale loss of settled sediment downstream. Thus, dredging of sediment accumulated in the impoundment is not called for under this alternative. Alternative 5 will also not impede large woody debris passage, which may be an adverse impact for downstream reaches as compared to the Baseline Condition. Hence, now the Root River will function like a natural river.

Natural Resources

During the 10-percent-annual-probability flood, the hydraulic modeling results for the removal under Alternative 5 indicate that the tailwater elevation is approximately 4.0 feet above the low sill elevation of 620.0 feet above NGVD 29. Thus, the dam removed configuration under Alternative 5 would not be a barrier to sea lamprey or round goby movements. As was indicated earlier, the tailwater elevation is approximately at the top of the natural shelf (620.0 feet above NGVD 29) for the March-June maximum mean daily flow of 1,000 cfs,[95] indicating that the dam would most likely no longer be a barrier for invasive aquatic species for anything larger than this flow rate. Using the WDNR preliminary 1.5 foot criterion for sea lamprey passage, under Alternative 5 the structure would no longer be a barrier to sea lamprey for any events larger than the 10-percent-exceedence flow rate of 410 cfs.

Using the fish burst speeds listed in Table 75, all three fish species could pass the former dam site for the tail-water-submerged March-June maximum mean daily flow of 1,000 cfs. To allow sufficient depth downstream for chinook salmon to jump, it was assumed that a minimum of two feet of depth was required, which translates to the 50-percent exceedence flow rate of 56 cfs for Alternative 5. The 90 percent exceedence flow of 10 cfs has minimal depth at the controlling ledge as discussed previously, thus, the ledge may be impassible for all three fish species. A summary of fish passage issues for all alternatives is included in Table 76.

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[95]*This flow is between the 99-percent-annual-probability (one-year recurrence interval) and 50-percent-annual probability (two-year recurrence interval) floods.*

Social

Alternative 5 removes the dam structure from the river corridor, thus the cascading nature of the flows is most likely no longer possible for even larger floods. For smaller floods, the flows will utilize the Root River channel bottom only for Alternative 5. Map 72 includes a comparison of the approximate Baseline Condition for the impoundment as represented on the 2010 SEWRPC digital color orthophotograph, and the estimated extent of the River during normal flow conditions with Alternative 5 implemented. Also shown on Map 72 are several field-surveyed cross sections along the impoundment for comparison purposes between the existing impoundment and estimated normal water surface elevations under Alternative 5. The comparison indicates that the aesthetics of the former impoundment area will change significantly under Alternative 5, with a more riverine look to the corridor between the site of the former dam and STH 31.

Safety issues would be minimal for this alternative, as only the left side portion of the dam structure will remain in place. The abrupt drop between the impoundment and the downstream reach will be eliminated, improving safety at the dam. The original hydraulic height of the dam is approximately 12 feet and Alternative 5 has a naturally sloping five-foot hydraulic height between the dam location and STH 38 downstream, which would represent a significantly reduced safety hazard as well.

Implementation of Alternative 5 would significantly alter recreational opportunities at the dam and impoundment area. There would be opportunities for new riparian trails and passive recreation, as the impoundment has been eliminated. Passive recreation would ultimately be dependent on ownership status for the exposed land. With the elimination of the impoundment, the ability to float small watercraft would be dependent on flow conditions. Fishing would become riverine exclusive and under all flow conditions the minimal structure configuration under Alternative 5 would no longer present a barrier to fish passage and fish and other aquatic life normally stopped at the dam might now move farther upstream and downstream as necessary. Fishing would change dramatically as fish would no longer be completely stopped at the downstream side of the dam, and they could travel upstream along the mainstem and tributaries. Opening up additional habitat to the native and sport fishery would be considered positive. This would be considered a positive from the perspective of the general fishery and the ecological integrity of the entire Root River system, but possibly a negative for salmon fishing just downstream of the Horlick dam where the dam would no longer serve as a barrier that concentrates the fish. Under Alternative 5, recreational boat access would also be adversely affected at River Bend Nature Center and Horlick Park, as under most flow conditions there would be no impoundment and the current launch locations would be farther from the Root River.

With the elimination of the impoundment area, land ownership in this area would be affected. The nine properties highlighted in yellow on Map 71 would gain some dry land under Alternative 5, which would most likely be considered a positive effect, but the properties of the majority of the private landowners between the dam and STH 31 would most likely no longer be immediately adjacent to the Root River. This effect would be most pronounced in the impoundment area closest to the former dam site, and less so upstream where the Root River is more confined. A final determination of changes to Horlick impoundment property boundaries would require a review of the individual deed language.

Cost

A preliminary cost estimate for Alternative 5 was completed in 2013 dollars. Sources of cost information included RSMeans Heavy Construction Cost Data and summary dam removal costs received from WDNR. Components included in the preliminary cost estimate for Alternative 5 include concrete removal, removal of the old dam, and seeding of impoundment area. It was assumed that seeding would only be required in the bays of the existing impoundment as depicted in Map 73. A contingency of 35 percent was added to the base cost estimate to account for minor items, engineering, and permitting. Based on these assumptions, the systems-level present worth cost estimate, including capital cost and operation and maintenance, is $551,000. While a significant effort has been made under this system-plan to collect field data and to characterize the anticipated costs associated with this alternative, at the systems-planning level there are many uncertainties in estimating costs relative to alterations of existing dams. Those uncertainties are reduced and estimated costs are refined after an alternative is selected for implementation and preliminary engineering and final design are conducted.

Under Alternative 5 almost all of the dam structure would be removed, thus structural maintenance requirements have essentially been eliminated. It was assumed that reseeding of portions of the former impoundment area would be required after structural removal. A summary of all Alternative 5 costs is included in Table 77.

The above preliminary cost estimate does not include dredging of sediment from the Horlick impoundment. As noted above, different approaches to minimizing sediment release downstream of the dam site are called for under this alternative.

Comparison of Alternative Plans
A summary of all five conceptual alternatives for the major issues of concern is included in Table 78.

Additional Work/Information Required
The decision regarding which of the Horlick dam alternatives is to be implemented ultimately rests with Racine County as the owner of the dam. Numerous additional elements of information need to be considered during the preliminary engineering phase for whichever alternative the County chooses to pursue. The informational needs listed below are not meant to be comprehensive, but are a good starting point for future analysis:

- Determination by WDNR of aquatic invasive species of concern,[96]
- Additional sampling of impoundment sediment for potential contamination,
- Evaluation of structural integrity of right dam abutment at Riverside Inn under Alternative 5, "Full Removal of Dam,"
- Evaluation of structural issues related to lowering or notching the current Horlick dam structure,
- Investigation of the structural integrity of the rock in the fishway area,
- Determination of the prevalence of active shallow private wells in the impoundment area that would be affected by impoundment modifications,
- The exact nature of the natural 1,000-foot shelf—related to unknowns for impoundment area to predict sediment movement and riparian restoration potential, and
- Collection of additional detailed survey data in the reach between the dam and STH 38 to determine if water depths and streambed slopes will allow fish and aquatic invasive species to migrate upstream.

[96]*That determination would be made according to the criteria of the WDNR fish passage guidance.*

Table 78

HORLICK DAM ALTERNATIVE SUMMARY—MAJOR ISSUES OF CONCERN

	Environmental Considerations					Cultural Considerations						Cost
							Recreation					
Alternative	Flooding Upstream of Dam	Water Quality	Fish Passage and Overall Fish Community Improvement	Aquatic Invasive Species and VHS Upstream of Dam	Downstream Movement of Sediment in Impoundment	Safety	Paddling	New Riparian Recreational Opportunities[a]	Fishing Upstream of Dam	Recreational Salmon Fishing Immediately Downstream of Dam	Access to River by Riparian Land Owners[b]	Total Present Worth Costs (dollars)[c]
Baseline (existing) Condition[d]	0	0	0	0	0	0	0	0	0	0	0	N/A[e]
Alternative 1—Lower Crest for 100-Year Capacity	+	+	+	-	-	+	–	+	+	0	–	$411,000
Alternative 2—Alt 1 with Fishway...........	+	+	++	--	-	+	–	+	++	–	–	$555,000
Alternative 3—Lengthen Spillway for 100-Year Capacity	0	0	0	0	0	0	0	0	0	0	0	$998,000
Alternative 4—Full Notch of Dam for 100-Year Capacity..	++	++	++	---	--	++	– –	++	+++	– –	– –	$483,000
Alternative 5—Dam Removal	++	+++	+++	---	---	+++	– –	++	+++	– –	– –	$551,000
Basis for Evaluation....	Reduction/ removal of structure will lower upstream flood elevations	Reduction in impounded water should improve water quality	Elimination of structure in River or addition of fishway improves passage	Elimination of structure in River or addition of fishway increases likelihood of passage	Elimination of structure in River lowers or eliminates impoundment and exposes sediment	Reduction/ elimination of structure in River improves public safety	Loss of impoundmen t area reduces consistent paddling water levels	New options within dewatered impoundment area for trails and passive recreation	Improved fish passage will improve fishing upstream	With addition of fishway or removal of dam, fish would no longer congregate on downstream side of dam	Reduction in water level removes direct access to River	N/A

[a]The ability to realize enhanced recreational opportunities depends on ownership of lands exposed with a lower or eliminated impoundment.

[b]Based on property boundaries provided by Racine County.

[c]Based on an interest rate of 6 percent and a project life of 50 years.

[d]Alternatives are rated relative to the potential changes from the Baseline Condition which is designated neutrally as “0”. Positive (+) or negative (–) signs indicate a more positive or negative effect on the issue of concern as compared to the Baseline Condition.

[e]Not applicable.

Source: SEWRPC.

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Chapter VI

RECOMMENDED PLAN

INTRODUCTION

As noted in Chapter I, the purpose of the Root River watershed restoration plan is to provide a set of specific, targeted recommendations that can be implemented over a five-year period to produce improvements relative to a set of focus issues related to conditions in the watershed. The recommendations address four focus areas: water quality, recreational access and use, habitat conditions, and flooding. The improvements that would result from implementing the recommendations represent steps toward achieving the overall goal of restoring and improving the water resources of the Root River watershed.

This watershed restoration plan is a second-level plan for the management and restoration of water resources in the Root River watershed. It was prepared in the context of the Southeastern Wisconsin Regional Planning Commission's (SEWRPC) regional water quality management plan update for the greater Milwaukee watersheds (RWQMPU),[1] which was prepared in coordination with, and largely incorporates, the Milwaukee Metropolitan Sewerage District's (MMSD) 2020 facilities plan.[2] The recommendations of RWQMPU as they pertain to the Root River watershed and the status of their implementation are summarized in Chapter II of this report. In addition to addressing the recommendations of the RWQMPU, this watershed restoration plan also seeks to incorporate those elements of recent and ongoing watershed management programs and initiatives that are related to the restoration plan's focus areas and are consistent with and complement the goals of the RWQMPU. These programs and initiatives are inventoried and reviewed in Chapter III of this report.

This chapter presents the recommended watershed restoration plan. This plan is designed to meet the targets presented in Chapter V of this report. Those targets consist of short-term goals or steps related to the focus issues that must be achieved to meet the long-term goals established in the RWQMPU. The plan includes both general recommendations related to the management of the watershed and a list of specific projects intended to contribute to meeting the targets established in Chapter V. The general and specific types of recommendations made under this plan are described in the two subsections below.

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[1]*SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007 and* Amendment to the Regional Water Quality Management Plan for the Greater Milwaukee Watersheds, *May 2013.*

[2]*Milwaukee Metropolitan Sewerage District*, MMSD 2020 Facilities Plan, *June 2007.*

General Recommendations

Unless otherwise indicated, general recommendations are intended to be generally applicable over the entire watershed. These recommendations provide guidance for the management of water resources within the watershed with respect to a variety of general and specific factors and issues that contribute to the problems related to each of the focus areas. The problems are identified in Chapters IV and V. While general recommendations are presented for each focus area, it should be kept in mind that implementation of many of these recommendations will also have beneficial effects on other focus areas. For example, implementation of some urban stormwater management measures intended to address the water quality focus area by reducing the contributions of sediment and total phosphorus to surface waters may also act to address the recreational access and use focus area by reducing contributions of fecal indicator bacteria to surface waters.

In many instances, the general recommendations made for the Root River watershed reflect recommendations that were made under the RWQMPU. Several of the general recommendations presented in this chapter consist of refinements of RWQMPU recommendations. These refinements reflect a number of factors, including specific conditions and circumstances in the Root River watershed and additional data and knowledge that have become available since the release of the RWQMPU in 2007.

Specific Project Recommendations

This watershed restoration plan also presents recommendations for the implementation of specific projects. These projects represent specific actions that could be taken to partially implement the general recommendations given in this plan. These projects are listed and summarized in Table 79 and their locations are shown on Maps 74 through 88.

The list of specific projects recommended in Table 79 was assembled from several sources. Many were suggested by members of the public at a December 4, 2013, meeting of the Root River Restoration Planning Group that was held to solicit such suggestions. Other projects were suggested in plans or engineering surveys and reports that were developed for local units of government that are located within the watershed. Additional projects were suggested during discussions with staff from State agencies, county and municipal departments, MMSD, and interested nongovernmental organizations. Several recommended projects were suggested by the findings of a field survey of stream physical conditions and instream habitat conducted by SEWRPC staff along Hoods Creek and a portion of the mainstem of the Root River.[3]

Table 79 summarizes several aspects of each recommended project. The summarized aspects include:

- Identification of the focus area or areas that the project addresses. It should be noted that many projects address more than one focus area. For example, while projects addressing streambank erosion directly address the habitat focus area, they also address the water quality focus area because eroding streambanks act as a source of sediment and total suspended solids (TSS) to streams.

- Description of the project site. This description includes a written description of the location, the municipality or municipalities in which the project site is located, and the owner of the site. Where possible, a tax key number is included to identify the real estate parcel or parcels that encompass the project site. Project locations are also shown on Maps 74 through 88.

- A brief description of the recommended management action.

[3]*The results of this survey are presented in Chapter IV of this report.*

Table 79

SITE-SPECIFIC MANAGEMENT MEASURES FOR THE ROOT RIVER WATERSHED

		Site Information				Annual Pollutant Reductions				Costs (dollars)[b]				
ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Location	Municipality	Owner	Management Action	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Responsible Party	Capital	Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
GFD-01	Water Quality	Northeast of W. Morgan Avenue and S. 106th Street	City of Greenfield	Milwaukee County	Installation of stormwater pond with 0.5 acre permanent pool to treat runoff from a contributing area of 30 acres	8,000	15[e]	3.96[f]	City of Greenfield	$267,000	$4,950[g]	55, 64, 67	WDNR	Medium
GFD-02	Water Quality	Northwest of W. Coldspring Road and S. 104th Street along Root River	City of Greenfield	Milwaukee County	Installation of stormwater pond with 0.3 acre permanent pool to treat runoff from a contributing area of 41 acres	4,200	7[e]	5.41[f]	City of Greenfield	185,000	3,790[g]	55, 64, 67	WDNR	Medium
GFD-03	Water Quality	East of I-43/US-45 intersection near north end of W. Spring Green	City of Greenfield	Milwaukee County	Installation of stormwater pond with 0.3 acre permanent pool to treat runoff from a contributing area of 31 acres	3,800	6[e]	4.09[f]	City of Greenfield	169,000	3,790[g]	55, 64, 67	WDNR	Medium
GFD-05	Water Quality	Intersection of I-43 and US-45	City of Greenfield	State of Wisconsin	Installation of stormwater pond with 0.3 acre permanent pool to treat runoff from a contributing area of 30 acres	4,400	8[e]	1.58[f]	City of Greenfield	177,000	3,790[g]	55, 64, 67	WDNR	Medium
GFD-06	Water Quality	Northwest of W. Coldspring Road and S. 84th Street at St. John School	City of Greenfield	St. John School	Installation of stormwater pond with 0.8 acre permanent pool to treat runoff from a contributing area of 72 acres	14,000	27[e]	9.50[f]	City of Greenfield	658,000	6,600[g]	55, 64, 67	WDNR	Medium
GFD-09	Water Quality	Southwest of W. Coldspring Road and S. 92nd Street, Wisconsin Electric Power	City of Greenfield	We Energies	Installation of stormwater pond with 0.2 acre permanent pool to treat runoff from a contributing area of 25 acres	4,400	8[e]	3.30[f]	City of Greenfield	234,000	3,380[g]	55, 64, 67	WDNR	Medium
GFD-10	Water Quality	Northwest of W. Coldspring Road and S. 100th Street on drainage right-of-way	City of Greenfield	City of Greenfield	Installation of stormwater pond with 0.4 acre permanent pool to treat runoff from a contributing area of 49 acres	6,800	12[e]	6.47[f]	City of Greenfield	153,000	4,260[g]	55, 64, 67	WDNR	High
GFD-11	Water Quality	East of S. 84th Street and north of I-43	City of Greenfield	Milwaukee County	Installation of stormwater pond with 0.4 acre permanent pool to treat runoff from a contributing area of 47 acres	7,800	14[e]	6.20[f]	City of Greenfield	225,000	4,260[g]	55, 64, 67	WDNR	High
GFD-15	Water Quality	Northwest of W. Howard Avenue and S. 116th Street along Root River	City of Greenfield	City of Greenfield	Installation of stormwater pond with 0.3 acre permanent pool to treat runoff from a contributing area of 30 acres	4,200	7[e]	3.96[f]	City of Greenfield	120,000	3,790[g]	55, 64, 67	WDNR	Medium
GFD-16	Water Quality	North of W. Beloit Road along Wildcat Creek near S. 119th Street	City of Greenfield	City of Greenfield	Installation of stormwater pond with 1.0 acre permanent pool to treat runoff from a contributing area of 121 acres	16,200	31[e]	16.00[f]	City of Greenfield	358,000	7,280[g]	55, 64, 67	WDNR	High
GFD-17	Water Quality	Northeast of W. Howard Avenue and S. 116th Street along the Root River	City of Greenfield	City of Greenfield	Installation of stormwater pond with 0.2 acre permanent pool to treat runoff from a contributing area of 23 acres	3,400	6[e]	3.04[f]	City of Greenfield	129,000	3,380[g]	55, 64, 67	WDNR	Medium
GFD-19	Water Quality	East of I-894 north of W. Coldspring Road in Wisconsin Electric Power Company right-of-way	City of Greenfield	We Energies	Installation of stormwater pond with 1.9 acre permanent pool to treat runoff from a contributing area of 213 acres	37,000	73[e]	28.10[f]	City of Greenfield	1,527,000	11,760[g]	55, 64, 67	WDNR	High
LRC-03	Habitat	Nicholson Wildlife Refuge	Village of Caledonia	Village of Caledonia	Remove invasive plants species, restore site	- -	- -	- -	Village of Caledonia	- -[h]	- -[h]	1, 3, 5, 9, 16, 17, 20, 21, 39, 45, 46, 51	SEWISC, Racine Weed Out!	High
LRC-04	Water Quality	Husher Creek south of 5 Mile Road	Village of Caledonia	- -	Add water quality monitoring station	- -	- -	- -	City of Racine Health Department or WAV Program	- -[h]	- -[h]	5, 17, 20, 39, 40, 50, 51	- -	Medium
LRC-07	Habitat, Water Quality, Recreational Use and Access	Husher Creek south of 7 Mile Road	Village of Caledonia	Private landowner, Racine County WDOT	Stream rehabilitation, naturalization, or bank stabilization project to address eroding streambanks. Remeandering of channelized reaches including addition of buffer and canopy cover	- -[i]	- -[i]	- -	Private landowner, Racine County	- -[h]	- -[h]	5, 9, 15, 18, 20, 24, 39, 44, 45, 51, 64, 67	City of Racine Health Department	Low

Table 79 (continued)

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information			Management Action	Annual Pollutant Reductions			Responsible Party	Costs (dollars)[b]		Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
		Location	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)		Capital	Annual O&M			
LRC-15	Habitat	Wetland located north of STH 20 and east of I-94. Tax parcels 151-03-22-07-013-010, 151-03-22-07-018-000, 151-03-22-07-025-000	Village of Mt. Pleasant	Multiple private landowners	Connect wetland to Hoods Creek through a natural area	- -	- -	- -	Village of Mt. Pleasant	- -[h]	- -[h]	5, 9, 14, 17, 18, 20, 29, 32, 33, 37, 39, 44, 45, 46, 51, 60	WDNR	Low
LRC-16	Habitat, Recreational Use and Access	Floodplain that extends along Hoods Creek between CTH C and STH 20 and along Ives Grove Ditch west to CTH V	Village of Mt. Pleasant	Multiple private landowners	Acquire and place this floodplain in parkland/natural area	- -	- -	- -	Village of Mt. Pleasant	- -[h]	- -[h]	14, 16, 37, 51, 56, 64	WDNR	Low
LRC-23	Water Quality	Husher Creek at 5 Mile Road	Village of Caledonia	- -	Investigate to determine cause of low dissolved oxygen concentrations at this site during summer	- -	- -	- -	WDNR	- -[h]	- -[h]	20, 40, 51	City of Racine Health Department	Medium
LRC-29	Habitat, Water Quality	Root River south bank, west of Nicholson Road Bridge	City of Oak Creek	Milwaukee County	Shoreline restoration and installation of guard rail, gate, and signage to address high erosion from off-road vehicles	- -[i]	- -[i]	- -	Milwaukee County	8,000	4,800[j]	5, 20, 39, 45, 67	- -	High
LRC-30	Habitat	Tabor Woods	Village of Caledonia	Caledonia Conservancy	Removal and management of invasive plant species	- -	- -	- -	Caledonia Conservancy	3,149	- -	1, 3, 9, 17, 20, 21, 51, 68	SEWISC, Racine Weed Out!	High
LRJ-01	Recreational Use and Access	Root River at STH 31	Village of Caledonia	Racine County	Install canoe landing on west side of the road and north side of the River	- -	- -	- -	Racine County	30,600	- -[h]	14, 17, 20, 51, 59	- -	Medium
LRJ-03	Habitat, Water Quality	Johnson Park Dog Park	City of Racine	City of Racine	Address dog waste accumulation problem along access corridor from STH 38	- -	- -	Unknown	City of Racine	- -[h]	- -[h]	1, 3, 20, 55, 67	City of Racine Health Department	Medium
LRJ-06A	Recreational Use and Access	Island Park	City of Racine	City of Racine	Promote handicap accessible River and canoe access	- -	- -	- -	City of Racine	- -[h]	- -[h]	7, 14, 17, 20, 51, 59	WDNR	Medium
LRJ-06B	Recreational Use and Access	Lincoln Park	City of Racine	City of Racine	Promote handicap accessible River and canoe access	- -	- -	- -	City of Racine	- -[h]	- -[h]	7, 14, 17, 20, 51, 59	WDNR	Medium
LRJ-06C	Recreational Use and Access	Horlick Park	City of Racine	Racine County	Promote handicap accessible River and canoe access	- -	- -	- -	Racine County	- -[h]	- -[h]	14, 17, 20, 51, 59	WDNR	Medium
LRJ-07	Water Quality	Memorial Drive and Albert Street	City of Racine	EG Development s, LLC	Include installation of water quality and stormwater management facilities as an element in redevelopment of this site	- -[i]	- -[i]	- -[i]	City of Racine/ private landowners	- -[h]	- -[h]	39, 55, 64, 67	WDNR	Low
LRJ-08	Water Quality	Downtown Racine	City of Racine	Case Equipment Corporation	Include installation of water quality and stormwater management facilities as an element in redevelopment of this area	- -[i]	- -[i]	- -[i]	City of Racine/ private landowners	- -[h]	- -[h]	39, 55, 64, 67	WDNR	Low
LRJ-12	Recreational Use and Access	Green Bay Road and Kennedy Avenue	Village of Caledonia	Private landowner	Access to public land could be provided for foot and snowmobile by a mown path through an area between apartment buildings that is overrun with invasive species	- -	- -	- -	Village of Caledonia/ private landowners	- -[h]	- -[h]	51, 56, 59, 63	- -	Low
LRJ-14	Recreational Use and Access	Linwood Park	Village of Caledonia	Village of Caledonia	Install canoe landing	- -	- -	- -	Village of Caledonia	30,600	- -[h]	14, 17, 20, 51, 59	- -	Medium
LRJ-15	Recreational Use and Access	Root River at upstream crossing of 4 Mile Road at Blue River Reserves	Village of Caledonia	Blue River Preserves	Install canoe landing	- -	- -	- -	Blue River Preserves/ Kenosha-Racine Land Trust	30,600	- -[h]	14, 17, 20, 51, 59	- -	Medium
LRJ-16	Habitat	Property west of Holy Cross Cemetery and west of STH 32 at 4 1/2 Mile Road (extended)	Village of Caledonia	Barbara and Royse Myers	Currently under conservation easement, acquire for protective ownership when owner wants to sell or donate	- -	- -	- -	Kenosha-Racine Land Trust	1,340,000[k]	- -[h]	5, 19, 16, 56, 64	- -	Medium
LRJ-19	Recreational Use and Access	Downtown Racine	City of Racine	City of Racine	Expand bicycle path system in downtown along the Root River	- -	- -	- -	City of Racine	- -[h]	- -[h]	19, 51, 63, 70, 71	- -	Medium

Table 79 (continued

		Site Information				Annual Pollutant Reductions				Costs (dollars)[b]				
ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Location	Municipality	Owner	Management Action	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Responsible Party	Capital	Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
MPC-01	Habitat	Grobschmidt Park	City of Franklin	Milwaukee County	Address gullies in park by implementing diversions to redirect water flow, stabilizing the interior of gullies, and/or planting native plants to stabilize the soil	- -[i]	- -[i]	- -	Milwaukee County Parks	- -[h]	- -[h]	3, 9, 20, 39, 51, 55, 64, 67	- -	Medium
MPC-02	Habitat	Grobschmidt Park	City of Franklin	Milwaukee County	Install erosion control practices such as water bars along hiking trails	- -[i]	- -[i]	- -	Milwaukee County Parks	- -[h]	- -[h]	3, 20, 39, 51, 55, 63, 67	- -	Medium
MPC-03	Habitat	Grobschmidt Park	City of Franklin	Milwaukee County	Remove invasive plant species and replant with native species	- -	- -	- -	Milwaukee County Parks	17,874[l]	- -	3, 20, 39, 51	SEWISC	High
MPC-04	Recreational Use and Access	Grobschmidt Park	City of Franklin	Milwaukee County	Construct handicap-accessible elevated viewing platform overlooking Mud Lake	- -	- -	- -	Milwaukee County Parks	- -[h]	- -[h]	3, 14, 20, 39, 51, 59, 61	WDNR	Low
MPC-05	Recreational Use and Access	Grobschmidt Park	City of Franklin	Milwaukee County	Construct and install educational kiosk at trail head along S. 35th Street	- -	- -	- -	Milwaukee County Parks	- -[h]	- -[h]	3, 9, 20, 51	- -	Medium
MPC-06	Habitat	Franklin State Natural Area	City of Franklin	Milwaukee County	Invasive plant species removal and management on 40.1 acres of Management Unit 1 including prescribed fire on 40.1 acres, herbicide treatment on 16.0 acres, mowing on 28.6 acres, and forestry mowing on 10.5 acres	- -	- -	- -	Milwaukee County Parks	24,640[m]	- -	3, 20, 21, 45, 51	SEWISC	High
MPC-07	Habitat, Water Quality	Franklin State Natural Area	City of Franklin	Milwaukee County	Prairie and savanna restoration on agricultural land, degraded savanna, and land degraded by reed canary grass in Management Unit 1. Includes prairie planting on 28.6 acres and savanna planting on 7.8 acres. Converts 14 acres of agricultural land to riparian buffer along Ryan Creek	3,690	9	- -	Milwaukee County Parks	15,933	- -[h]	3, 9, 16, 18, 20, 45, 51, 55, 64	WDNR	High
MPC-08	Habitat	Franklin State Natural Area	City of Franklin	Milwaukee County	Invasive plant species removal and management on 11.2 acres of restored prairie in Management Unit 2. Includes prescribed fire on 11.2 acres, herbicide treatment of 3.7 acres, and mowing of 11.2 acres	- -	- -	- -	Milwaukee County Parks	5,210[m]	- -	3, 20, 21, 45, 51	SEWISC	Medium
MPC-09	Habitat	Franklin State Natural Area	City of Franklin	Milwaukee County	Continued prairie and savanna restoration on 11.2 acres of Management Unit 2 formerly used for agriculture. Includes seeding on 11.2 acres	- -	- -	- -	Milwaukee County Parks	4,760	- -[h]	3, 9, 16, 18, 20, 45, 51	WDNR	Medium
MPC-10	Recreational Use and Access	Franklin State Natural Area	City of Franklin	Milwaukee County	Construction and restoration of 866 linear feet of hiking trail in Management Unit 2	- -	- -	- -	Milwaukee County Parks	4,330	- -[h]	3, 14, 20, 51, 59, 63	- -	Medium
MPC-11	Habitat	Franklin State Natural Area	City of Franklin	Milwaukee County	Invasive plant species removal and management on 52 acres of degraded oak savanna in Management Unit 3. Includes prescribed fire, herbicide treatment, and forestry mowing on 52 acres	- -	- -	- -	Milwaukee County Parks	61,360[m]	- -	3, 20, 21, 45,51	SEWISC	High
MPC-12	Habitat, Water Quality	Franklin State Natural Area	City of Franklin	Milwaukee County	Savanna restoration on degraded oak savanna in Management Unit 3. Includes savanna seeding on 52 acres	120	2		Milwaukee County Parks	22,100	- -[h]	3, 9, 16, 18, 20, 45, 51	WDNR	High
MPC-13	Recreational Use and Access	Franklin State Natural Area	City of Franklin	Milwaukee County	Construction and restoration of 2,494 linear feet of hiking trail in Management Unit 3	- -	- -	- -	Milwaukee County Parks	12,470	- -[h]	3, 20, 21, 51, 59, 63	- -	Medium
MPC-14	Habitat	Franklin State Natural Area	City of Franklin	Milwaukee County	Invasive plant species removal and management on 19 acre agricultural field that will be converted into prairie in Management Unit 4. Includes prescribed fire and mowing on 19 acres and herbicide application on 6.3 acres	- -	- -	- -	Milwaukee County Parks	7,905[m]	- -	3, 20, 21, 45, 51	SEWISC	High

Table 79 (continued)

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information			Management Action	Annual Pollutant Reductions			Responsible Party	Costs (dollars)[b]		Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
		Location	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)		Capital	Annual O&M			
MPC-15	Habitat, Water Quality	Franklin State Natural Area	City of Franklin	Milwaukee County	Prairie restoration on 19 acre agricultural field in Management Unit 4. Includes prairie seeding on 19 acres. Converts 19 acres of agricultural land to riparian buffer along Ryan Creek	3,390	8	- -	Milwaukee County Parks	5,700	- -[h]	3, 9, 16, 18, 20, 45, 51, 55, 64	WDNR	High
MPC-16	Habitat	Franklin State Natural Area	City of Franklin	Milwaukee County	Invasive species removal and management on 18.4 acres of degraded oak savanna, reed canary grass colonies, and lowland shrubs in Management Unit 5. Includes prescribed fire and forestry mowing on 10.5 acres, and herbicide application on 18.4 acres.	- -	- -	- -	Milwaukee County Parks	7,720[m]	- -	3, 20, 21, 45, 51	SEWISC	Medium
MPC-17	Habitat	Franklin State Natural Area	City of Franklin	Milwaukee County	Savanna restoration on degraded oak savanna in Management Unit 5. Includes savanna seeding on 10.5 acres	24	<1	- -	Milwaukee County Parks	4,463	- -[h]	3, 9, 16, 18, 20, 45, 51	WDNR	High
MPC-18	Recreational Use and Access	Franklin State Natural Area	City of Franklin	Milwaukee County	Construction of 630 linear feet of hiking trail in Management Unit 5	- -	- -	- -	Milwaukee County Parks	3,150	- -[h]	3, 14, 20, 51, 59, 63	- -	Medium
MPC-19	Habitat	Franklin State Natural Area	City of Franklin	Milwaukee County	Invasive plant species removal and management on 23.4 acres of mostly agricultural field in Management Unit 6. Includes prescribed fire and mowing on 20 acres and herbicide application on 7.8 acres.	- -	- -	- -	Milwaukee County Parks	4,380[m]	- -	3, 20, 21, 45, 51	SEWISC	High
MPC-20	Habitat, Water Quality	Franklin State Natural Area	City of Franklin	Milwaukee County	Prairie restoration on agricultural field in Management Unit 6. Includes prairie seeding on 20 acres, converting agricultural land to riparian buffer along Ryan Creek	3,580	8	- -	Milwaukee County Parks	6,000	- -[h]	3, 9, 16, 18, 20, 45, 51, 55, 64	WDNR	High
MRR-04	Recreational Use and Access	Franklin Savanna State Natural Area	City of Franklin	Milwaukee County	Provide recreational access to Franklin State Natural Area through Milwaukee County-owned land to the north, west, or south	- -	- -	- -	Milwaukee County	- -[h]	- -[h]	14, 17, 20, 51, 59, 63	- -	Low
MRR-05a	Habitat, Water Quality	Milwaukee County lands along Tuckaway Creek, tax parcels 8519999001, 8519995007, 8519995004	City of Franklin	Milwaukee County	Establish riparian buffers on 33.8 acres of Milwaukee County lands that are currently leased and farmed	6,034	14	- -	Milwaukee County	25,200[n]	- -[h]	3, 8, 9, 14, 16, 17, 18, 20, 39, 44, 45, 51, 64	WDNR	Medium
MRR-05b	Habitat, Water Quality	Milwaukee County lands along Root River from north of W. Ryan Road to south of W. Oakwood Road. Tax parcels 883999002, 8989998, 932992002, 932997001, 9479998	City of Franklin	Milwaukee County	Establish riparian buffers on 117.2 acres of Milwaukee County lands that are currently leased and farmed	20,923	48	- -	Milwaukee County	87,300[n]	- -[h]	3, 8, 9, 14, 16, 17, 18, 20, 39, 44, 45, 51, 55, 64	WDNR	Medium
MRR-05c	Habitat, Water Quality	Milwaukee County lands along Ryan Creek, east of S. 76th Street between W. Ryan Road and W. Oakwood Road. Tax parcels 8979999, 9339993, 9339995	City of Franklin	Milwaukee County	Establish riparian buffers on 26.8 acres of Milwaukee County lands that are currently leased and farmed	4,695	11	- -	Milwaukee County	24,200[n]	- -[h]	3, 8, 9, 14, 16, 17, 18, 20, 39, 44, 45, 51, 55, 64	WDNR	Medium
MRR-05d	Habitat, Water Quality	Milwaukee County lands along Root River, Root River Canal, and Oakwood Tributary south of Oakwood Road, between S. 76th Street and S. 60th Street. Tax parcels 9469997, 9839996001, 9479998, 9829997	City of Franklin	Milwaukee County	Establish riparian buffers on 129.7 acres of Milwaukee County lands that are currently leased and farmed	37,025	68	- -	Milwaukee County	96,600[n]	- -[h]	3, 8, 9, 14, 16, 17, 18, 20, 39, 44, 45, 51, 55, 64	WDNR	Medium

Table 79 (continued

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information			Management Action	Annual Pollutant Reductions			Responsible Party	Costs (dollars)[b]		Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
		Location	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)		Capital	Annual O&M			
MRR-05e	Habitat, Water Quality	Milwaukee County lands along Root River, south of Oakwood Road, between S. 51st Street and S. 35th Street. Tax parcels 9809998, 8509998001	City of Franklin	Milwaukee County	Establish riparian buffers on 135.7 acres of Milwaukee County lands that are currently leased and farmed	37,022	72	- -	Milwaukee County	101,100[n]	- -[h]	3, 8, 9, 14, 16, 17, 18, 20, 39, 44, 45, 51, 55, 64	WDNR	Medium
MRR-05f	Habitat, Water Quality	Milwaukee County lands along Root River, south of Elm Road, between IH-94 and railroad. Tax parcels 9779997, 9769996, 9759998, 9759999002	City of Oak Creek	Milwaukee County	Establish riparian buffers on 49.6 acres of Milwaukee County lands that are currently leased and farmed	8,854	21	- -	Milwaukee County	37,000[n]	- -[h]	3, 8, 9, 14, 16, 17, 18, 20, 39, 44, 45, 51, 55, 64	WDNR	Medium
MRR-05g	Habitat, Water Quality	Milwaukee County lands along Root River, south of Elm Road, between S. Howell Avenue and Nicholson Road. Tax parcels 9749995001, 9739994, 9729997, 9719000002, 9719999001, 9749995001, 9739994, 9730151,	City of Oak Creek	Milwaukee County	Establish riparian buffers on 109.9 acres of Milwaukee County lands that are currently leased and farmed	19,616	47	- -	Milwaukee County	81,900[n]	- -[h]	3, 8, 9, 14, 16, 17, 18, 20, 39, 44, 45, 51, 55, 64	WDNR	Medium
MRR-05h	Habitat, Water Quality	Milwaukee County lands along Crayfish Creek, south of Elm Road, north of Oakwood Road east of Union Pacific Railway Tax parcels 9709992,9719999001, 9599997, 9209993	City of Oak Creek	Milwaukee County	Establish riparian buffers on 47.3 acres of Milwaukee County lands that are currently leased and farmed	8,426	19	- -	Milwaukee County	35,200[n]	- -[h]	3, 8, 9, 14, 16, 17, 18, 20, 39, 44, 45, 51, 55, 64	WDNR	Medium
MRR-07	Recreational Use and Access	Root River Parkway Pond east and downstream from Koepmier Lake	City of Franklin	Milwaukee County	Provide boardwalk for recreational access across lower lake at narrow point	- -	- -	- -	Milwaukee County Parks	- -[h]	- -[h]	3, 14, 17, 18, 20, 51, 59, 63	- -	Low
MRR-11	Habitat, Water Quality	Legend Creek near S. 76th Street and W. Drexel Avenue, tax parcel 7919986000	City of Franklin	Drexel 76th Street, LLC	Stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks. Could be done in conjunction with upcoming reconstruction of S. 76th Street	- -[i]	- -[i]	- -	Drexel 76th Street, LLC	- -[h]	- -[h]	9, 18, 20, 24, 39, 44, 45, 51, 64, 67	MMSD, WDOT	Low
MRR-14	Recreational Use and Access	Victory Creek Park	City of Franklin	City of Franklin	Connect the City of City of Franklin Victory Trail to Milwaukee County trails at W. Drexel Avenue and S. 35th Street through undeveloped park	- -	- -	- -	City of Franklin	- -[h]	- -[h]	19, 20, 39, 51, 63, 70, 71	- -	Low
MRR-17	Habitat, Water Quality	Dale Creek in Dale Creek Parkway	Village of Greendale	Milwaukee County	Remove failing drop structures and perform stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks	- -[i]	- -[i]	- -	Milwaukee County	- -[h]	- -[h]	9, 15, 18, 20, 26, 39, 44, 45, 51, 61, 64, 67	MMSD, WDNR	Low
MRR-22	Water Quality	Stormwater basin at S. 68th Street and W. Rawson Avenue	City of Franklin	Milwaukee County	Retrofit basin to either add mechanical treatment or convert to wet bottom pond	- -[i]	- -[i]	- -[i]	Milwaukee County	- -[h]	- -[h]	55, 64, 67	WDNR	Low
MRR-23	Habitat, Water Quality	Hidden Oaks Savanna along Root River north of W. Ryan Road and west of S. 60th Street	City of Franklin	Milwaukee County	Project to restore 15 acres of wetland, prairie, and oak savanna; remove invasive species, and reduce runoff into Root River	2,680	6	- -	Hunger Task Force and Milwaukee County Parks	70,316	- -[h]	3, 8, 9, 14, 16, 17, 18, 20, 22, 39, 44, 45, 51, 55, 64	WDNR	High
RAC-01	Water Quality	Case Equipment property near Ontario Street	City of Racine	Case Equipment Company	Installation of stormwater pond with 0.7 acre permanent pool to treat runoff from a contributing area of 44.6 acres	12,000	16	2.68[o]	City of Racine	358,000	3,400	55, 64, 67	WDNR	Medium
RAC-02	Water Quality	Colonial Park adjacent to W. High Street	City of Racine	City of Racine	Installation of stormwater pond with 0.7 acre permanent pool to treat runoff from a contributing area of 63 acres	12,200	23	3.78[o]	City of Racine	213,000	3,500	55, 64, 67	WDNR	Medium

Table 79 (continued)

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information: Location	Site Information: Municipality	Site Information: Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Responsible Party	Costs (dollars)[b]: Capital	Costs (dollars)[b]: Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
RAC-03	Water Quality	Open space between Racine County Club and Quarry Lake Park	City of Racine and Village of Caledonia		Installation of stormwater pond with 0.7 acre permanent pool to treat runoff from a contributing area of 128.8 acres	24,800	39	7.73[o]	City of Racine	240,000	3,500	55, 64, 67	WDNR	High
RAC-04	Water Quality	Graceland Cemetery at Graceland Boulevard and Osbourne Boulevard	City of Racine	City of Racine	Expansion of existing wet pond to 0.8 acre permanent pool. Would need to be supported by potential Lockwood North and Lockwood South wet ponds to get full benefit. Will treat runoff from a contributing area of 593 acres	4,200	3	35.60[o]	City of Racine	201,000	3,500	55, 64, 67	WDNR	Medium
RAC-05	Water Quality	Hantschal Park south of 16th Street and west of Perry Avenue	City of Racine	City of Racine	Installation of stormwater pond with 0.7 acre permanent pool in existing undeveloped depression to treat runoff from a contributing area of 69.6 acres	8,400	17	4.18[o]	City of Racine	105,000	3,400	55, 64, 67	WDNR	Medium
RAC-06	Water Quality	Humble Park at 21st Street and Cleveland Avenue	City of Racine	City of Racine	Installation of stormwater pond with 1.5 acre permanent pool to treat runoff from a contributing area of 142.3 acres	28,400	47	8.54[o]	City of Racine	560,000	5,700	55, 64, 67	WDNR	High
RAC-07	Water Quality	Lockwood Park West at Graceland Boulevard and Ohio Street	City of Racine	City of Racine	Conversion of existing dry detention facility to stormwater pond with permanent pool of 4.5 acres. Will treat runoff from a contributing area of 435.7 acres[p]	25,200	46	26.10[o]	City of Racine	645,000	14,700	55, 64, 67	WDNR	Medium
RAC-08	Water Quality	Lockwood Park North at Graceland Boulevard and Ohio Street	City of Racine	City of Racine	Installation of stormwater pond with 1.5 acre permanent pool to treat runoff from a contributing area of 572.8 acres[p]	11,000	13	34.40[o]	City of Racine	404,000	5,700	55, 64, 67	WDNR	Medium
RAC-09	Water Quality	Lockwood Park South at Graceland Boulevard and Ohio Street	City of Racine	City of Racine	Installation of stormwater pond with 0.4 acre permanent pool to treat runoff from a contributing area of 137.2 acres[p]	5,600	10	8.23[o]	City of Racine	230,000	5,700	55, 64, 67	WDNR	Medium
RAC-10	Water Quality	Memorial Drive brownfield at 1442 N. Memorial Drive	City of Racine	City of Racine	Installation of stormwater pond with 1.6 acre permanent pool to treat runoff from a contributing area of 97.4 acres	26,400	39	5.84[o]	City of Racine	568,000	6,200	55, 64, 67	WDNR	Medium
RAC-11	Water Quality	Michigan Boulevard brownfield at 1149 Michigan Boulevard	City of Racine	City of Racine	Installation of stormwater pond with 2.1 acre permanent pool to treat runoff from a contributing area of 159.7 acres	36,400	67	9.58[o]	City of Racine	553,000	7,500	55, 64, 67	WDNR	High
RAC-12	Water Quality	Spring Street east of Riverbrook Drive	City of Racine	City of Racine	Installation of stormwater pond with 0.9 acre permanent pool to treat runoff from a contributing area of 836.9 acres[q]	6,000	14	50.20[o]	City of Racine	202,000	3,800	55, 64, 67	WDNR	Medium
RAC-13	Water Quality	Starbuck Middle School 1516 Ohio Street	City of Racine	Racine Unified School District	Installation of stormwater pond with 2.8 acre permanent pool to treat runoff from a contributing area of 190.7 acres	30,400	49	11.40[o]	City of Racine	1,220,000	9,700	55, 64, 67	WDNR	Medium
RAC-14	Water Quality	Washington Park between 12th Street, Horlick Park Drive, and the Root River	City of Racine	City of Racine	Installation of stormwater pond with 1.5 acre permanent pool to treat runoff from a contributing area of 1,397.8 acres	31,000	56	83.90[o]	City of Racine	365,000	5,700	55, 64, 67	WDNR	High
RHD-01	Habitat, Water Quality	Legend Creek at S. 68th Street	City of Franklin	Tuckaway Country Club, private landowners	Stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks	- -[i]	- -[i]	- -	Tuckaway Country Club, private landowners	- -[h]	- -[h]	9, 20, 39, 44, 45, 51, 64, 67	- -	Low
RHD-02	Habitat, Water Quality	Legend Creek at S. 68th Street	City of Franklin	Tuckaway Country Club	Investigate golf course for grassed buffers to convert to long-rooted vegetation	- -[i]	- -[i]	- -	Tuckaway Country Club	- -[h]	- -[h]	17, 20, 39, 44, 45, 51, 55, 64	- -	Low
RHD-03	Habitat	West Branch Root River Canal at 67th Drive	Village of Union Grove, Town of Yorkville	Private landowners, Village of Union Grove	Investigate reaches upstream and downstream of this site for remeandering	- -	- -	- -	Yorkville-Raymond Drainage District	- -[h]	- -[h]	9, 15, 20, 39, 41, 44, 45, 51, 64	- -	Low

Table 79 (continued

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information			Management Action	Annual Pollutant Reductions			Responsible Party	Costs (dollars)[b]		Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
		Location	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)		Capital	Annual O&M			
RHD-06	Habitat	East Branch Root River Canal at 4 Mile Road	Town of Raymond	Private Landowners	Investigate areas to remeander within channelized canal reaches	- -	- -	- -	Yorkville-Raymond Drainage District	- -[h]	- -[h]	9, 15, 20, 39, 41, 44, 45, 51, 64	- -	Low
RHD-12	Habitat, Water Quality, Recreational Use and Access	Root River at Johnson Park	City of Racine	City of Racine	Convert grass buffer on north bank along golf course to long-rooted native vegetation to discourage geese from congregating	- -[i]	- -[i]	Unknown	City of Racine	- -[h]	- -[h]	17, 20, 39, 44, 45, 51, 55, 64	City of Racine Health Department	Low
RHD-15	Habitat, Water Quality	Root River at WDNR Steelhead Facility	City of Racine	WDNR, City of Racine	Convert grass buffer to long-rooted native vegetation	- -[i]	- -[i]	- -	WDNR, City of Racine	- -[h]	- -[h]	17, 20, 39, 44, 45, 51, 55, 64	- -	Low
RHD-16	Water Quality	West Branch Root River Canal at 4 Mile Road	Town of Raymond	Private landowners	Investigate agricultural drain tiles that may benefit from a filtration system	- -[i]	- -[i]	- -	Private landowners	- -[h]	- -[h]	8, 16, 20, 33, 39, 40, 51, 55, 64	Racine County Land Conservation Division	Low
RHD-17	Water Quality	East Branch Root River Canal at STH 11	Town of Yorkville	- -	Investigation to find and remedy source of human *Bacteroides* in water quality samples upstream from Fonk's Mobile Home Park WWTP	- -	- -	Unknown		- -[h]	- -[h]	8, 17, 20, 39, 51, 64, 67	City of Racine Health Department	Medium
RHD-18	Water Quality	Root River Canal at 6 Mile Road	Town of Raymond	Private landowners	Investigate agricultural drain tiles that may benefit from a filtration system	- -[i]	- -[i]	- -	Private landowners	- -[h]	- -[h]	8, 16, 20, 33, 39, 40, 51, 55, 64	Racine County Land Conservation Division	Low
RHD-19	Water Quality	Husher Creek at 7 Mile Road	Village of Caledonia	- -	Investigation to find and remedy source of human *Bacteroides* in water quality samples upstream from sampling station	- -	- -	Unknown		- -[h]	- -[h]	8, 17, 20, 39, 51, 64, 67	City of Racine Health Department	Medium
RHD-20	Water Quality	Husher Creek at 7 Mile Road	Village of Caledonia	Private landowners	Investigate agricultural drain tiles that may benefit from a filtration system	- -[i]	- -[i]	- -	Private landowners	- -[h]	- -[h]	8, 16, 20, 33, 39, 40, 51, 55, 64	Racine County Land Conservation Division	Low
RHD-21	Water Quality	Root River at Island Park Bridge to Liberty Street	City of Racine	City of Racine	Continue monitoring of stormwater outfall in which sanitary sewer minsconnection was found and remedied	- -	- -	- -	City of Racine	- -[h]	- -[h]	17, 20, 51, 67	City of Racine	Medium
RRC-01	Habitat, Water Quality	East Branch Root River Canal south of STH 11	Town of Yorkville	Private landowners	Stream rehabilitation, naturalization, or bank stabilization project to address steep eroding banks on East Branch Root River Canal	- -[i]	- -[i]	- -	Yorkville-Raymond Drainage District	- -[h]	- -[h]	9, 15, 18, 20, 39, 44, 45, 51, 55, 64	- -	Low
RRC-02	Habitat, Water Quality	Unnamed Tributary to East Branch Root River Canal	Town of Yorkville	Town of Yorkville	Installation of stormwater pond, wetland, and grassed waterway	- -[i]	- -[i]	- -[i]	Town of Yorkville	685,100	- -[h]	51, 55, 64	Racine County Land Conservation Division, WDNR	Medium
RRC-03	Habitat	Agricultural field east of West Branch Root River Canal and north of 2 Mile Road	Town of Raymond	Private landowner	Expand and naturalize ephemeral wetland that is within the field and connect it to the West Branch Root River Canal through buffers or grassed waterways	- -[i]	- -[i]	- -	Private landowner	- -[h]	- -[h]	5, 7, 14, 16, 17, 18, 20, 33, 37, 39, 44, 45, 46, 47, 51, 56, 64	Racine County Land Conservation Division	Low
RRC-05	Habitat, Water Quality	East Branch Root River Canal North of 4 Mile Road	Town of Raymond	Private landowner	Stream rehabilitation, naturalization, or bank stabilization project to address bare and eroding banks on East Branch Root River Canal	- -[i]	- -[i]	- -	Yorkville-Raymond Drainage District	- -[h]	- -[h]	9, 15, 20, 34, 39, 44, 45, 51, 64, 67	- -	Low

Table 79 (continued)

		Site Information				Annual Pollutant Reductions				Costs (dollars)[b]				
ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Location	Municipality	Owner	Management Action	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Responsible Party	Capital	Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
RRC-06	Habitat, Water Quality	Raymond Creek south of 4 Mile Road	Town of Raymond	Private landowner	Stream rehabilitation, naturalization, or bank stabilization project to address erosion along cliff on Raymond Creek	- -[i]	- -[i]	- -	Yorkville-Raymond Drainage District	- -[h]	- -[h]	9, 15, 20, 34, 39, 44, 45, 51, 64, 67	- -	Low
RRC-08	Water Quality	Kilbournville Tributary south of 6 1/2 Mile Road	Town of Raymond	Raymond Business Park, LLC	Install riparian connection between stormwater detention basin that is being built on east bank and the tributary	- -[i]	- -[i]	- -	Raymond Business Park, LLC	- -[h]	- -[h]	5, 14, 17, 18, 20, 39, 44, 45, 51, 60, 64, 67	Racine County Land Conservation Division	Low
RWO-01	Habitat	Colonial Park 2300 W. High Street	City of Racine	City of Racine	Continue ongoing invasive plant species removal and management activities	- -	- -	- -	Racine Weed Out!	- -[h]	- -[h]	1, 20, 21, 22, 39, 45, 51	SEWISC	High
RWO-02	Habitat	Barbee Park 215 N. Memorial Drive	City of Racine	City of Racine	Continue invasive plant species management activities	- -	- -	- -	Racine Weed Out!	- -[h]	- -[h]	1, 20, 21, 22, 39, 45, 51	SEWISC	Medium
RWO-03	Habitat	Clayton Park 1843 Clayton Avenue	City of Racine	City of Racine	Continue invasive plant species management activities	- -	- -	- -	Racine Weed Out!	- -[h]	- -[h]	1, 20, 21, 22, 39, 45, 51	SEWISC	Medium
RWO-04	Habitat	Cedar Bend Park 33 McKinley Avenue	City of Racine	City of Racine	Continue invasive plant species management activities	- -	- -	- -	Racine Weed Out!	- -[h]	- -[h]	1, 20, 21, 22, 39, 45, 51	SEWISC	Medium
RWO-05	Habitat	Island Park 1700 Liberty Street	City of Racine	City of Racine	Continue invasive plant species management activities	- -	- -	- -	Racine Weed Out!	- -[h]	- -[h]	1, 20, 21, 22, 39, 45, 51	SEWISC	Medium
RWO-06	Habitat	Lee Park 1926 Glen Street	City of Racine	City of Racine	Continue invasive plant species management activities	- -	- -	- -	Racine Weed Out!	- -[h]	- -[h]	1, 20, 21, 22, 39, 45, 51	SEWISC	Medium
RWO-07	Habitat	Riverside Park 110 Riverside Drive	City of Racine	City of Racine	Continue invasive plant species management activities	- -	- -	- -	Racine Weed Out!	- -[h]	- -[h]	1, 20, 21, 22, 39, 45, 51	SEWISC	Medium
RWO-08	Habitat	Root River Environmental Education Community Center 1301 W. 6th Street	City of Racine	City of Racine, UW-Parkside	Invasive plant species removal and management	- -	- -	- -	Racine Weed Out!	- -[h]	- -[h]	1, 20, 21, 22, 39, 45, 51	SEWISC	Medium
RWO-09	Habitat	Horlick Park	City of Racine	Racine County	Invasive plant species removal and management	- -	- -	- -	Racine Weed Out!	- -[h]	- -[h]	1, 20, 21, 22, 39, 45, 51	SEWISC	High
URR-01	Water Quality	Root River between W. Cleveland Avenue and W. National Avenue and Hale Creek	City of West Allis	- -	Illicit discharge detection and elimination effort to locate and eliminate the source of the water quality hot spot at W. National Avenue	- -	- -	Unknown	City of West Allis	- -[h]	- -[h]	17, 39, 40, 67	MMSD, WDNR	High
URR-03	Water Quality	W. Grange Avenue	Village of Greendale	Village of Greendale	Expand W. Grange Avenue bio-swale westward during reconstruction of W. Grange Avenue	- -[i]	- -[i]	- -[i]	Village of Greendale	- -[h]	- -[h]	5, 10, 11, 12, 16, 17, 39, 51	WDOT	Low
URR-05	Habitat	Root River upstream and downstream from Wildcat Creek	City of Greenfield	Milwaukee County	Streambank stabilization or rehabilitation project to address erosion and debris jams	- -[i]	- -[i]	- -	Milwaukee County	- -[h]	- -[h]	9, 20, 28, 39, 44, 67	MMSD	Low
URR-07	Water Quality	City of New Berlin Hills Golf Course	City of New Berlin	City of New Berlin	Install wet detention basins	- -[i]	- -[i]	- -[i]	City of New Berlin	- -[h]	- -[h]	51, 55, 64, 67	WDNR	Low
URR-08	Water Quality	Hale Creek between W. Lincoln Avenue and W. Cleveland Avenue	City of West Allis	City of West Allis	Install wetland treatment system in wooded riparian area east of West Allis Hale High School	- -[i]	- -[i]	- -[i]	City of West Allis	- -[h]	- -[h]	8, 16, 17, 20, 39, 44, 45, 46, 51, 64, 67	WDNR	Low

Table 79 (continued

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information: Location	Site Information: Municipality	Site Information: Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Responsible Party	Costs (dollars)[b]: Capital	Costs (dollars)[b]: Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
URR-11	Habitat	Upper reaches of Tess Corners Creek	City of Muskego, City of New Berlin	Private landowners	1. As this area develops, leave a corridor for remeandering channelized stream reaches 2. Restore/remeander channelized stream reaches	- - - -	- - - -	- - - -	Private landowners	- -[h] - -[h]	- -[h] - -[h]	5, 9, 24, 39, 44, 45, 51, 64	Waukesha County Land and Water Conservation Division	Low
URR-13	Habitat, Water Quality	Root River in parkway upstream from confluence with 104th Street Branch	City of Greenfield	Milwaukee County	Remove low-quality ash wood and restore the area as a wetland	- -	- -	- -	Milwaukee County Parks	- -[h]	- -[h]	5, 9, 16, 17, 18, 20, 39, 44, 45, 46, 51, 64	WDNR	Low
URR-14	Habitat, Water Quality	Whitnall Park	City of Franklin, Village of Greendale	Milwaukee County	Project to remove invasive species that are colonizing this site	- -	- -	- -	Milwaukee County Parks	- -[h]	- -[h]	1, 3, 20, 39, 45, 51	SEWISC	High
URR-15	Habitat	Mangan Woods	Village of Greendale	Milwaukee County	Address gully erosion	- -[i]	- -[i]	- -	Milwaukee County Parks	- -[h]	- -[h]	20, 39, 51, 55, 64, 67	- -	Medium
URR-16	Water Quality	Southridge Mall	Village of Greendale	Simon Property Group	Install stormwater detention, infiltration, or other practices as buildings are developed in mall parking lot	- -[i]	- -[i]	- -[i]	Simon Property Group	- -[h]	- -[h]	55, 64, 67	WDNR	Low
URR-17	Habitat, Water Quality	Wildcat Creek at Kulwicki Park	City of Greenfield	Milwaukee County	Streambank stabilization	- -[i]	- -[i]	- -	City of Greenfield	- -[h]	- -[h]	20, 39, 64, 67	MMSD	Medium
URR-19	Habitat, Water Quality	Whitnall Park Creek from S. 124th Street to northeast of W. Godsell Road	Village of Hales Corners	Private landowners	Stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks	- -[i]	- -[i]	- -	Village of Hales Corners	- -[h]	- -[h]	9, 15, 18, 20, 39, 44, 45, 51, 64, 67	- -	Medium
URR-20	Habitat, Water Quality	Whitnall Park Creek from Janesville Road to 300 feet upstream from the confluence with North Branch Whitnall Park Creek	Village of Hales Corners	Village of Hales Corners, private landowners	Stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks	- -[i]	- -[i]	- -	Village of Hales Corners	- -[h]	- -[h]	9, 15, 18, 20, 39, 44, 45, 51, 64, 67	- -	Medium
URR-21	Habitat, Water Quality	North Branch Whitnall Park Creek from stormwater pond south of W. Grange Avenue to confluence with Whitnall Park Creek	Village of Hales Corners	Private landowners	Stream rehabilitation, naturalization, or bank stabilization to address eroding streambanks	- -[i]	- -[i]	- -	Village of Hales Corners	- -[h]	- -[h]	9, 15, 18, 20, 39, 44, 45, 51, 64, 67	- -	Medium
LRJ-04a	Habitat, Water Quality	Mainstem Root River within Johnson Park Golf Course, south bank adjacent to golf hole #10	City of Racine	City of Racine	Bank stabilization to address bank erosion along 125 feet of Root River mainstem with an estimated average erosion height of two feet	10,000[r]	- -[s]	- -	City of Racine	38,000[t]	2,300[j]	20, 39, 51, 64, 67	- -	Low
AER-1	Habitat, Water Quality	Mainstem Root River within Johnson Park, south bank approximately 400 feet downstream of the eastern cart bridge	City of Racine	City of Racine	Bank stabilization to address bank erosion along 180 feet of Root River mainstem with an estimated average erosion height of five feet	43,200[r]	- -[s]	- -	City of Racine	377,000[t]	22,600[j]	20, 39, 64, 67	- -	Low
AER-2	Habitat, Water Quality	Mainstem Root River within Johnson Park, west bank approximately 2,500 feet downstream of the eastern cart bridge	City of Racine	City of Racine	Bank stabilization to address bank erosion along 80 feet of Root River mainstem with an estimated average erosion height of six feet	19,200[r]	- -[s]	- -	City of Racine	28,000[t]	1,700[j]	20, 39, 64, 67	- -	Medium
AER-3	Habitat, Water Quality	Mainstem Root River within Colonial Park. Four small isolated areas ranging in length from 35 to 85 feet (245 feet total), along both banks	City of Racine	City of Racine	Bank stabilization to address bank erosion along four sections of the Root River mainstem with lengths of 80, 85, 45, and 35 feet and respective estimated erosion heights of four feet, four feet, two feet, and four feet	35,600[r]	- -[s]	- -	City of Racine	67,000[t]	4,000[j]	20, 39, 64, 67	- -	Low

Table 79 (continued)

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information: Location	Site Information: Municipality	Site Information: Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Responsible Party	Costs (dollars)[b]: Capital	Costs (dollars)[b]: Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
AER-4	Habitat, Water Quality	Mainstem Root River south of Lincoln Park, immediately upstream of the WDNR Steelhead Facility on the south bank	City of Racine	City of Racine and private landowners	Bank stabilization to address bank erosion along 625 feet of Root River mainstem with estimated average erosion height of 4 feet. (Note: the City is already in process of designing improvements in this area with construction planned in 2014)	100,000[r]	- -[s]	- -	City of Racine (majority) and private landowners	175,000[t]	10,500[j]	20, 39, 64, 67	- -	Low
AER-5	Habitat, Water Quality	Mainstem Root River across from Lincoln Park and adjacent to Spring Street, a small section of failing bulkhead wall along the south bank	City of Racine	Private landowners	Rebuild 40 feet of bulkhead retaining wall	- -[i]	- -[i]	- -	Private landowners	51,000	- -[h]	20, 39, 64, 67	- -	Medium
AER-6	Habitat, Water Quality	Mainstem Root River, a 550 foot portion of the bulkhead section on the south bank at Azarian Marina	City of Racine	Azarian Marina	Rebuild 550 feet of bulkhead retaining wall	- -[i]	- -[i]	- -	Azarian Marina (could be incorporated in future river-walk improve-ments)	406,000	- -[h]	20, 39, 64, 67	- -	Medium
AER-7	Habitat, Water Quality	Mainstem Root River, a 500 foot section of the north bank on the Case Corporation property, southeast of the intersection of Liberty and Superior Streets	City of Racine	Case Corporation	Bank stabilization to address bank erosion along 500 feet of Root River mainstem with estimated average erosion height of 14 feet	280,000[r]	- -[s]	- -	Case Corporation	182,000[t]	10,900[j]	20, 39, 64, 67	- -	High
AER-8	Habitat, Water Quality, Recreational Access	Mainstem Root River, a 1,500 foot section of the northern/western bank adjacent to Mound Avenue between Marquette and 6th Streets	City of Racine	City of Racine and private landowners	Bank stabilization to address bank erosion along 1,500 feet of Root River mainstem. This area has also been identified as an area to connect/expand the City's bike/pedestrian path and add park space. (Note: the City/County are already in process of planning improvements in this area)	720,000[r]	- -[s]	- -	City of Racine and private landowners	538,000[t]	32,300[j]	20, 39, 63, 64, 67	- -	High
AER-9	Habitat, Water Quality	Mainstem Root River, 1,200 feet on both banks along a bend in the River within Washington Park, northwest of Park High School	City of Racine	City of Racine	Bank stabilization to address four sections of moderate to high bank and ravine erosion along 1,200 feet of Root River mainstem. Erosion section lengths are 150, 205, 60, and 80 feet with respective estimated average heights of six, six, 38, and 46 feet (Note: the City is already in process of designing improvements in this area with construction planned in 2014)	130,000[r]	- -[s]	- -	City of Racine	435,000[t]	26,100[j]	20, 39, 64, 67	- -	Low
AER-10	Habitat, Water Quality	Mainstem Root River, about 1,500 feet with isolated areas on both banks within Island and Lincoln Parks	City of Racine	City of Racine	Bank stabilization to address three sections of bank erosion along 1,500 feet of Root River mainstem. Erosion sections lengths are 300, 390, and 38 feet with respective estimated average heights of six feet, six feet, and six feet	174,000[r]	- -[s]	- -	City of Racine	77,000[t]	4,600[j]	20, 39, 64, 67	- -	High
AER-11	Water Quality	Outfall on eastern bank of the mainstem Root River, just upstream of the STH 38 overpass	City of Racine	Private	Pipe replacement with riprap and end section	- -[i]	- -[i]	- -	Private owner	3,500	- -[h]	55, 64, 67	- -	Medium
AER-12	Water Quality	Outfall on eastern bank of the mainstem Root River, just upstream of the STH 38 overpass (next to outfall described above)	City of Racine	City of Racine	Pipe replacement with riprap and end section	- -[i]	- -[i]	- -	City of Racine	4,500	- -[h]	55, 64, 67	- -	Medium

Table 79 (continued

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information: Location	Site Information: Municipality	Site Information: Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Responsible Party	Costs (dollars)[b]: Capital	Costs (dollars)[b]: Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
AER-13	Water Quality	Outfall on eastern bank of the mainstem Root River adjacent to Horlick Park at the end of Parkview Drive	City of Racine	City of Racine	Pipe replacement with riprap and end section	- -[i]	- -[i]	- -	City of Racine	3,000	- -[h]	55, 64, 67	- -	Medium
AER-14	Water Quality	Outfall on southern bank of bend on the mainstem Root River adjacent to Cedar Bend Park and 12th Street	City of Racine	City of Racine	Pipe replacement with riprap and end section	- -[i]	- -[i]	- -	City of Racine	20,000	- -[h]	55, 64, 67	- -	Medium
AER-15	Water Quality	Outfall on southern bank of bend on the mainstem Root River, adjacent to Cedar Bend Park and 12th Street (next to outfall described in (AER-14)	City of Racine	City of Racine	Pipe replacement with riprap and end section	- -[i]	- -[i]	- -	City of Racine	30,000	- -[h]	55, 64, 67	- -	Medium
AER-16	Water Quality	Outfall on northern bank of bend on the mainstem Root River, within Cedar Bend Park (directly across from outfalls described in AER-14 and AER-15)	City of Racine	City of Racine	Pipe replacement with riprap and end section	- -[i]	- -[i]	- -	City of Racine	3,500	- -[h]	55, 64, 67	- -	Medium
AER-17	Water Quality	Outfall on northern bank of bend on the mainstem Root River, within Lincoln Park immediately downstream of the WDNR Steelhead Facility	City of Racine	City of Racine	Pipe replacement with riprap and end section	- -[i]	- -[i]	- -	City of Racine	3,000	- -[h]	55, 64, 67	- -	Medium
MUS-E10	Habitat, Water Quality	A 20 foot section of the west bank on the mainstem Root River, adjacent to S. 124th Street and about 150 feet downstream of the Lincoln Avenue	City of West Allis	Milwaukee County	Monitor streambank erosion progression toward S. 124th Street	- -	- -	- -	Milwaukee County	6,600[u]	- -[h]	20, 25, 39, 55, 64, 67	- -	Low
MUS-E12	Habitat, Water Quality	A 60 foot section of the west bank on the mainstem Root River, adjacent to S. 124th Street and about 275 feet downstream of Lincoln Avenue	City of West Allis	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to S. 124th Street. Estimated average height of erosion area five feet	12,000[r]	- -[s]	- -	Milwaukee County	19,800[t]	1,200[j]	20, 25, 39, 64, 67	- -	Medium
MUS-E14	Habitat, Water Quality	A 125 foot section of the west bank on the mainstem Root River, adjacent to S. 124th Street and about 300 feet downstream of Lincoln Avenue	City of West Allis	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to S. 124th Street. Estimated average height of erosion area three feet	15,000[r]	- -[s]	- -	Milwaukee County	41,250[t]	2,500[j]	20, 25, 39, 64, 67	- -	Low
MUS-E16	Habitat, Water Quality	A 180 foot section of the west bank on the mainstem Root River, adjacent to S. 124th Street and about 175 feet upstream of S. Root River Parkway	City of West Allis	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to S. 124th Street. Estimated average height of erosion area two feet	14,400[r]	- -[s]	- -	Milwaukee County	59,400[t]	3,600[j]	20, 25, 39, 64, 67	- -	Low

Table 79 (continued)

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information: Location	Site Information: Municipality	Site Information: Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Responsible Party	Costs (dollars)[b]: Capital	Costs (dollars)[b]: Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
MUS-E30	Habitat, Water Quality	A 210 foot section of the west bank on the mainstem Root River, adjacent to S. Root River Parkway and about 650 feet upstream of National Avenue	City of West Allis	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to S. Root River Parkway. Estimated average height of erosion area two feet	16,800[r]	- -[s]	- -	Milwaukee County	69,300[t]	4,200[j]	20, 25, 39, 64, 67	- -	Low
MUS-E31	Habitat, Water Quality	A 285 foot section of the west bank on the mainstem Root River, adjacent to S. Root River Parkway and about 375 feet upstream of National Avenue	City of West Allis	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to S. Root River Parkway. Estimated average height of erosion area two feet	22,800[r]	- -[s]	- -	Milwaukee County	94,050[t]	5,600[j]	20, 25, 39, 64, 67	- -	Low
MUS-E33	Habitat, Water Quality	A 230 foot section of the west bank on the mainstem Root River, adjacent to S. Root River Parkway and about 150 feet upstream of National Avenue	City of West Allis	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to S. Root River Parkway. Estimated average height of erosion area three feet	27,600[r]	- -[s]	- -	Milwaukee County	75,900[t]	4,600[j]	20, 25, 39, 64, 67	- -	Low
MUS-E60	Habitat, Water Quality	A 200 foot section of the east bank on the mainstem Root River, upstream of S. 108th Street where the Oak Leaf Trail crosses the River	City of West Allis	Milwaukee County	Bank stabilization/protection to address erosion progressing toward Oak Leaf Trail bridge footings. Estimated average height of erosion area five feet	40,000[r]	- -[s]	- -	Milwaukee County	66,000[t]	4,000[j]	20, 25, 39, 64, 67	- -	Medium
MUS-E82	Habitat, Water Quality	A 100 foot section of the east bank on the mainstem Root River, adjacent to S. Root River Parkway and about 400 feet downstream of Layton Avenue	City of Greenfield	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to S. Root River Parkway. Estimated average height of erosion area three feet	12,000[r]	- -[s]	- -	Milwaukee County	33,000[t]	2,000[j]	20, 25, 39, 64, 67	- -	Low
MUS-E84	Habitat, Water Quality	A 60 foot section of the east bank on the mainstem Root River, adjacent to S. Root River Parkway and about 575 feet downstream of Layton Avenue	City of Greenfield	Milwaukee County	Monitor streambank erosion progression towards S. Root River Parkway	- -	- -	- -	Milwaukee County	19,800[u]	1,200[j]	20, 25, 39, 51, 64, 67	- -	Low
MUS-E96	Habitat, Water Quality	A 430 foot section of the south/west bank on the mainstem Root River, adjacent to S. Root River Parkway and about 1,350 feet upstream of Forest Home Avenue	City of Greenfield	Milwaukee County	Bank stabilization/protection to address erosion in S. Root River Parkway. Estimated average height of erosion area three feet	51,600[r]	- -[s]	- -	Milwaukee County	141,900[t]	8,500[j]	20, 25, 39, 64, 67	- -	Low
MUS-E106	Habitat, Water Quality	A 315 foot section of the south/west bank on the mainstem Root River, adjacent to S. Root River Parkway and about 750 feet downstream of Forest Home Avenue	Village of Greendale	Milwaukee County	Bank stabilization/protection to address erosion in S. Root River Parkway. Estimated average height of erosion area four feet	50,400[r]	- -[s]	- -	Milwaukee County	103,950[t]	6,200[j]	20, 25, 39, 64, 67	- -	Low
MUS-E107	Habitat, Water Quality	A 70 foot section of the south bank on the mainstem Root River, adjacent to N. Root River Parkway and about 1,100 feet downstream of Forest Home Avenue	Village of Greendale	Milwaukee County	Monitor streambank erosion progression towards N. Root River Parkway	- -	- -	- -	Milwaukee County	23,100[u]	- -	20, 25, 39, 51, 64, 67	- -	Low

Table 79 (continued

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information: Location	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Responsible Party	Costs (dollars)[b]: Capital	Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
MUS-E116	Habitat, Water Quality	A 200 foot section of the east bank on the mainstem Root River, adjacent to N. Root River Parkway and about 580 feet upstream of Grange Avenue	Village of Greendale	Milwaukee County	Bank stabilization/protection to address erosion in N. Root River Parkway. Estimated average height of erosion area four feet	32,000[r]	- -[s]	- -	Milwaukee County	66,000[t]	4,000[j]	20, 25, 39, 64, 67	- -	Low
MUS-E131	Habitat, Water Quality	A 20 foot section of the west bank on the mainstem Root River, about 50 feet upstream of Loomis Road	Village of Greendale	Milwaukee County	Monitor streambank erosion progression towards Loomis Road bridge	- -	- -	- -	Milwaukee County	6,600[u]	- -	20, 25, 39, 51, 64, 67	WDOT	Low
MUS-E140	Habitat, Water Quality	A 100 foot section of the east bank on the mainstem Root River, about 90 feet upstream of Drexel Avenue	City of Franklin	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to Drexel Avenue and the Drexel Avenue culverts. Estimated average height of erosion areas two feet	8,000[r]	- -[s]	- -	Milwaukee County	33,000[t]	2,000[j]	20, 25, 39, 64, 67	- -	Low
MUS-E179	Habitat, Water Quality	A 150 foot section of the west bank on the mainstem Root River, about 200 feet upstream of STH 100	City of Franklin	Milwaukee County	Bank stabilization/protection to address erosion progressing towards STH100. Estimated average erosion height three feet	18,000[r]	- -[s]	- -	Milwaukee County	49,500[t]	3,000[j]	20, 25, 39, 64, 67	WDOT	Low
MUS-E208	Habitat, Water Quality	A 120 foot section of the east bank on the mainstem Root River, about 60 feet downstream of Oakwood Road	City of Franklin	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to the Oakwood Road crossing. Estimated average height of erosion area two feet	9,600[r]	- -[s]	- -	Milwaukee County	39,600[t]	2,400[j]	20, 25, 39, 64, 67	- -	Low
MUS-E224	Habitat, Water Quality	A 100 foot section of the south bank on the mainstem Root River, about 150 feet upstream of confluence with Root River Canal	City of Franklin	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to an electrical utility tower. Estimated average height of erosion area two feet	8,000[r]	- -[s]	- -	Milwaukee County	33,000[t]	2,000[j]	20, 25, 39, 64, 67	- -	Low
MUS-E226	Habitat, Water Quality	A 140 foot section of the south/east bank on the mainstem Root River, about 300 feet downstream of 60th Street crossing	City of Franklin	Milwaukee County	Bank stabilization/protection to address erosion in close proximity to 60th Street. Estimated average height of erosion area two feet	11,200[r]	- -[s]	- -	Milwaukee County	46,200[t]	2,800[j]	20, 25, 39, 64, 67	- -	Low
MUS-E266	Habitat, Water Quality	A 40 foot section of the west bank on the East Branch Root River, about 100 feet upstream of crossing for Franklin Mobile Estates	City of Franklin	Private landowner	Bank stabilization/protection to address erosion in close proximity mobile home in Franklin Mobile Estates. Estimated average height of erosion area two feet	3,200[r]	- -[s]	- -	Private landowner/ Franklin Mobile Estates	13,200[t]	800[j]	20, 25, 39, 64, 67	- -	Low
MUS-E267	Habitat, Water Quality	A 40 foot section of the west bank on the East Branch Root River, about 40 feet downstream of crossing for Franklin Mobile Estates	City of Franklin	Franklin Mobile, LLC	Bank stabilization/protection to address erosion in close proximity mobile home in Franklin Mobile Estates. Estimated average height of erosion area two feet	3,200[r]	- -[s]	- -	Franklin Mobile Estates	13,200[t]	800[j]	20, 25, 39, 64, 67	- -	Low
MUS-E293	Habitat, Water Quality	A 80 foot section of the west bank on the East Branch Root River, about 3,200 feet downstream of Rawson Avenue crossing (address of home is 7452 S. 35th Street)	City of Franklin	Private landowner	Monitor streambank erosion progression towards residential home on S. 35th Street in Franklin	- -	- -	- -	Private landowner	26,400[u]	1,600[j]	20, 25, 39, 51, 64, 67	- -	Low

Table 79 (continued)

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information: Location	Site Information: Municipality	Site Information: Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Responsible Party	Costs (dollars)[b]: Capital	Costs (dollars)[b]: Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
MUS-E313	Habitat, Water Quality	A 60 foot section of the west bank on the East Branch Root River, about 50 feet upstream of Drexel Avenue crossing	City of Franklin	Private landowner and MMSD	Monitor streambank erosion progression towards Drexel Avenue crossing	- -	- -	- -	Private landowner/MMSD	19,800[u]	1,200[j]	20, 25, 39, 64, 67	- -	Low
MUS-O1	Habitat, Water Quality	Stormwater outfall on the east bank of the mainstem Root River about 300 feet downstream from S. Root River Parkway overpass	City of West Allis	Unknown	Remove failed section and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	64, 67	- -	Med
MUS-O2	Habitat, Water Quality	Stormwater outfall on the north/east bank of the mainstem Root River about 2,000 feet downstream from Layton Avenue overpass	City of Greenfield	Unknown	Outfall failure occurred due to erosion at site. Remove failed section and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	55, 64, 67	- -	Low
MUS-O3	Habitat, Water Quality	Stormwater outfall on the east bank of the mainstem Root River about 20 feet downstream from Grange Avenue overpass	Village of Greendale	Unknown	Remove failed sections and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	55, 64, 67	- -	Medium
MUS-O4	Habitat, Water Quality	Stormwater outfall on the east bank of the mainstem Root River about 315 feet downstream from Grange Avenue overpass	Village of Greendale	Unknown	Remove failed sections and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	55, 64, 67	- -	Medium
MUS-O5	Habitat, Water Quality	Stormwater outfall on the east bank of the mainstem Root River about 1,900 feet upstream from N. Root River Parkway overpass (adjacent to MUS-O6)	Village of Greendale	Unknown	Remove failed sections and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	55, 64, 67	- -	Low
MUS-O6	Habitat, Water Quality	Stormwater outfall on the east bank of the mainstem Root River about 1,900 feet upstream from N. Root River Parkway overpass (adjacent to MUS-O5)	Village of Greendale	Unknown	Remove failed sections and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	55, 64, 67	- -	Low
MUS-O7	Habitat, Water Quality	Stormwater outfall on the west bank of the mainstem Root River about 2,900 feet downstream from N. Root River Parkway overpass	Village of Greendale	Unknown	Remove failed sections and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	55, 64, 67	- -	Low
MUS-O8	Habitat, Water Quality	Stormwater outfall on the east bank of the mainstem Root River about 2,975 feet downstream from N. Root River Parkway overpass	Village of Greendale	Unknown	Remove failed sections and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	55, 64, 67	- -	Low
MUS-O9	Habitat, Water Quality	Stormwater outfall on the south bank of Hale Creek about 1,400 feet downstream from where Hale Creek begins	City of West Allis	Unknown	Remove failed sections and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	55, 64, 67	- -	Low

Table 79 (continued

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information: Location	Site Information: Municipality	Site Information: Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Responsible Party	Costs (dollars)[b]: Capital	Costs (dollars)[b]: Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
MUS-O10	Habitat, Water Quality	Stormwater outfall on the north bank of Whitnall Park Creek about 80 feet upstream from 92nd Street overpass	Village of Hales Corners	Unknown	Remove failed section of corrugated metal pipe and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	55, 64, 67	- -	Medium
MUS-O11	Habitat, Water Quality	Stormwater outfall on the north bank of East Branch Root River adjacent to the intersection of S. 58th Street and Cascade Drive	City of Franklin	Unknown	Remove failed section of corrugated metal pipe and install rock toe protection to prevent local scour	- -[i]	- -[i]	- -	Owner of outfall	- -[h]	- -[h]	55, 64, 67	- -	Medium
RPC-HE1, 2	Habitat, Water Quality	Two severe erosion sites on the north bank of Hoods Creek in Johnson Park Dog Park, tax parcel 276-00-00-21-258-000	City of Racine	City of Racine	Bank stabilization to address severe erosion along 65 feet and 80 feet of Hoods Creek. Erosion height is estimated at seven feet and nine feet, respectively. Place fence along embankment to reduce dog access	47,000[r]	- -[s]	- -	City of Racine	39,600[t]	2,400[j]	20, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-HE4	Habitat, Water Quality	A 120 foot section of the south bank in tax parcel 104-04-22-26-025-030 and 150 foot section of the northeast bank of Hoods Creek in tax parcel 104-4-22-26-025-024	Village of Caledonia	Hoods Creek Settlement, LLC	Bank stabilization to address bank erosion along 120 feet of Hoods Creek. Erosion height is estimated at an average of four feet	19,200[r]	- -[s]	- -	Hoods Creek Settlement, LLC	39,600[t]	2,400[j]	20, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-HE6,7,8,9	Habitat, Water Quality	Four erosion sites of varying severity on both banks of tax parcel 104-04-22-26-029-000.	Village of Caledonia	Private landowner	Bank stabilization to address bank erosion along both banks of Hoods Creek of 30 feet, 120 feet, 100 feet, and 45 feet in length, respectively. Erosion height is estimated to be three feet, four feet, 3.5 feet, and five feet, respectively	45,800[r]	- -[s]	- -	Private landowner	97,350[t]	5,800[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-HE12	Habitat, Water Quality	A 50 foot section of erosion on the west bank of Hoods Creek in tax parcel 104-04-22-26-060-000	Village of Caledonia	Private landowner	Bank stabilization to address bank erosion along about 50 feet of Hoods Creek. Removal of old bridge footings should be considered to prevent continued scour. Erosion height is estimated at an average of five feet	10,000[r]	- -[s]	- -	Private landowner	16,500[t]	1,000[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-HE14	Habitat, Water Quality	A 120 foot section of severe erosion on the west bank of Hoods Creek in tax parcel 104-04-22-26-039-010	Village of Caledonia	Private landowner	Bank stabilization to address severe bank erosion along about 120 feet of Hoods Creek. Erosion height is estimated at an average of nine feet	43,200[r]	- -[s]	- -	Private landowner	39,600[t]	2,400[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-HE22	Habitat, Water Quality	A 175 foot section of erosion on the east bank of Hoods Creek in tax parcel 104-04-22-350-540-00	Village of Caledonia	Private landowner	Bank stabilization to address bank erosion along 175 feet of Hoods Creek in close proximity to the Hoods Creek Road crossing. Erosion height is estimated at an average of three feet	21,000[r]	- -[s]	- -	Private landowner	57,750[t]	3,500[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-HE23,24	Habitat, Water Quality	Two erosion sites on the west bank of Hoods Creek in tax parcel 104-04-22-350-620-00	Village of Caledonia	Private landowner	Bank stabilization to address bank erosion along 40 feet of Hoods Creek in close proximity to the Hoods Creek Road crossing with an erosion height estimated at four feet; bank stabilization to address erosion along 80 feet of Hoods Creek, with an erosion height estimated at an average of 3.5 feet	17,600[r]	- -[s]	- -	Private landowner	39,600[t]	2,400[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-HE25	Habitat, Water Quality	A 200 foot section of erosion on the west bank of Hoods Creek in tax parcel 104-04-22-350-850-00	Village of Caledonia	Private landowner	Bank stabilization to address bank erosion along 200 feet of Hoods Creek. Erosion height is estimated at an average of 3.5 feet	28,000[r]	- -[s]	- -	Private landowner	66,000[t]	4,000[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium

Table 79 (continued)

		Site Information				Annual Pollutant Reductions				Costs (dollars)[b]				
ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Location	Municipality	Owner	Management Action	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Responsible Party	Capital	Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
RPC-HE26, 27, 28a, 29, 30	Habitat, Water Quality	Five erosion sites of varying severity on both banks of Hoods Creek of tax parcels 104-04-22-350-190-00 and 104-04-22-350-200-00 (same owner)	Village of Caledonia	Private landowner	Bank stabilization to address bank erosion along both banks of Hoods Creek of 300 feet, 250 feet, 50 feet, 40 feet, and 200 feet in length, respectively. Erosion height is estimated at an average of seven feet, four feet, six feet, six feet, and six feet, respectively. Site HE26 has a high priority due to its proximity to a private driveway crossing; site HE30 has a high priority due to its proximity to a private dam	193,600[r]	- -[s]	- -	Private landowner	277,200[t]	16,600[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	High
RPC-HE31, 32, 33	Habitat, Water Quality	Three erosion sites all on the southern bank of Hoods Creek on tax parcels 104-04-22-353-009-51	Village of Caledonia	Jamestown Limited	Bank stabilization to address bank erosion along Hoods Creek of 40 feet, 125 feet, and 60 feet in length, respectively. Erosion height is estimated at an average of six feet, 5.5 feet, and 10 feet, respectively	61,200[r]	- -[s]	- -	Jamestown Limited	74,250[t]	4,500[j]	20, 39, 64, 67	Racine County Land Conservation Division	High
RPC-HE36	Habitat, Water Quality	A 90 foot section of severe erosion on the south bank of Hoods Creek in tax parcel 104-04-22-350-360-00	Village of Caledonia	Private landowner	Bank stabilization to address bank erosion along 90 feet of Hoods Creek. Erosion height is estimated at an average of nine feet. Erosion is in close proximity to stormwater detention basin outflow channel located on Jamestown Limited property	32,400[r]	- -[s]	- -	Private landowner, Jamestown Limited	29,700[t]	1,800[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-HE39	Habitat, Water Quality	A 100 foot section of erosion on the west bank of Hoods Creek in tax parcels 104-04-22-351-700-00 and 151-03-22-020-52-000	Village of Caledonia and Village of Mt. Pleasant	Private landowner	Bank stabilization to address bank erosion along 100 feet of Hoods Creek. Erosion height is estimated at an average of six feet. Erosion is in close proximity to a residential garage	14,400[r]	- -[s]	- -	Private landowners	33,000[t]	2,000[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-HE40,41,42,43,44,46	Habitat, Water Quality	Six erosion sites of varying severity on both banks of Hoods Creek tax parcel 151-03-22-020-180-01	Village of Mt. Pleasant	Village of Mt. Pleasant	Bank stabilization to address bank erosion along both banks of Hoods Creek of 50 feet, 100 feet, 150 feet, 75 feet, 45 feet, and 100 feet in length, respectively. Erosion height is estimated at an average of 3 feet, four feet, 3.5 feet, six feet, five feet, and four feet, respectively	86,000[r]	- -[s]	- -	Village of Mt. Pleasant	171,600[t]	10,300[j]	20, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-HE52	Habitat, Water Quality	A 60 foot section of erosion on the north bank of Hoods Creek in tax parcel 151-03-22-030-030-00 and Airline Road right of way	Village of Mt. Pleasant	Private landowner and Racine County	Bank stabilization to address bank erosion along 60 feet of Hoods Creek. Erosion height is estimated at an average of 3.5 feet. Erosion is in close proximity to a stormwater outlet and Airline Road	8,400[r]	- -[s]	- -	Private landowner and Racine County	19,800[t]	1,200[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-HE54, 55, 56, 57, 58, 59, 60, 61, 62	Habitat, Water Quality	Nine erosion sites of varying severity on both banks of Hoods Creek tax parcels 151-03-22-031-001-27, 151-03-22-031-001-28, 151-03-22-030-060-02, 151-03-22-030-060-03	Village of Mt. Pleasant	Village of Mt. Pleasant	Bank stabilization to address bank erosion along both banks of Hoods Creek of 75 feet, 150 feet, 100 feet, 40 feet, 80 feet, 50 feet, 100 feet, 75 feet, and 50 feet in length, respectively. Erosion height is estimated at an average of 3.5 feet, four feet, four feet, four feet, six feet, four feet, five feet, three feet, and 3.5 feet, respectively	118,600[r]	- -[s]	- -	Village of Mt. Pleasant	237,600[t]	14,300[j]	20, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-HE63	Habitat, Water Quality	A 60 foot section of erosion on the south bank of Hoods Creek in tax parcel 151-03-22-030-050-00	Village of Mt. Pleasant	Pennsylvania Street, LLC	Bank stabilization to address bank erosion along 60 feet of Hoods Creek. Erosion height is estimated at an average of five feet	12,000[r]	- -[s]	- -	Pennsylvania Street, LLC	19,800[t]	1,200[j]	20, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-HE67, 69	Habitat, Water Quality	Two erosion sites on both banks of Hoods Creek in tax parcel 151-03-22-030-330-00	Village of Mt. Pleasant	Private landowner	Bank stabilization to address bank erosion along 250 feet, and 60 feet of Hoods Creek, respectively. Erosion height is estimated at an average of 3.5 feet, and 15 feet, respectively	71,000[r]	- -[s]	- -	Private landowner	102,300[t]	6,100[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-HE73	Habitat, Water Quality	A 60 foot section of severe erosion on the south bank of Hoods Creek in tax parcel 151-03-22-040-230-00	Village of Mt. Pleasant	Private landowner	Bank stabilization to address bank erosion along 60 feet of Hoods Creek. Erosion height is estimated at an average of 15 feet	36,000[r]	- -[s]	- -	Private landowner	19,800[t]	1,200[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium

Table 79 (continued

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information: Location	Site Information: Municipality	Site Information: Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Responsible Party	Costs (dollars)[b]: Capital	Costs (dollars)[b]: Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
RPC-HE76	Habitat, Water Quality	A 30 foot section of erosion on the north bank of Hoods Creek in tax parcel 151-03-22-040-160-10	Village of Mt. Pleasant	Private landowner	Bank stabilization to address bank erosion along 30 feet of Hoods Creek. Erosion height is estimated at an average of 12 feet	14,400[r]	- -[s]	- -	Private landowner	9,900[t]	600[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-HE77, 78, 79	Habitat, Water Quality	Three erosion sites on the west bank of Hoods Creek in tax parcel 151-03-22-040-920-01	Village of Mt. Pleasant	Private landowner (Borzynski Farms)	Bank stabilization to address erosion along 25 feet, 20 feet, and 25 feet of Hoods Creek, respectively. Erosion height is estimated at an average of six feet, eight feet, and 10 feet, respectively. Could be combined with projects aimed at remeandering channelized stream reaches, address tile drainage, and reconnecting the stream to a constructed floodplain bench in areas of severe incision in agricultural areas (see LRC-02)	22,400[r]	- -[s]	- -	Private landowner (Borzynski Farms)	23,100[t]	1,400[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-HE80	Habitat, Water Quality	A 100 foot section of erosion on the northwest bank of Hoods Creek in tax parcel 151-03-22-090-560-00 and 151-03-22-090-970-00	Village of Mt. Pleasant	Private landowner (Borzynski Farms) and Chicago, Milwaukee, St. Paul, and Pacific Railway	Bank Stabilization to address bank erosion along 100 feet of Hoods Creek. Erosion height is estimated at an average of nine feet	36,000[r]	- -[s]	- -	Private landowner (Borzynski Farms) and Chicago, Milwaukee, St. Paul, and Pacific Railway	33,000[t]	2,000[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-HE81	Habitat, Water Quality	A 75 foot section of erosion on the southeast bank of Hoods Creek in tax parcel 151-03-22-170-010-00	Village of Mt. Pleasant	Private landowner (Borzynski Farms)	Bank stabilization to address erosion along 75 feet of Hoods Creek. Erosion height is estimated at an average of 12 feet. Could be combined with projects aimed at remeandering channelized stream reaches, address tile drainage, and reconnecting the stream to a constructed floodplain bench in areas of severe incision in agricultural areas (see LRC-02)	36,000[r]	- -[s]	- -	Private landowner (Borzynski Farms)	24,750[t]	1,500[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE2	Habitat, Water Quality	A 60 foot section of erosion on the southeast bank of the mainstem of the Root River in tax parcel 104-04-22-250-950-00	Village of Caledonia	Private landowner	Bank stabilization to address bank erosion along 60 feet of the mainstem of the Root River. Erosion height is estimated at an average of six feet	14,400[r]	- -[s]	- -	Private landowner	19,800[t]	1,200[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE5	Habitat, Water Quality	A 50 foot section of erosion on the north bank of the mainstem of the Root River in tax parcel 104-04-22-250-410-00	Village of Caledonia	Private landowner	Bank stabilization to address bank erosion along 50 feet of the mainstem of the Root River. Erosion height is estimated at an average of four feet	8,000[r]	- -[s]	- -	Private landowner	16,500[t]	1,000[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-RE7, 8	Habitat, Water Quality	Two erosion sites on the south bank of the mainstem of the Root River within Johnson Park in tax parcel 276-00-00-212-580-00	City of Racine	City of Racine	Bank stabilization to address bank erosion along 180 feet and 70 feet of the mainstem of the Root River in Johnson Park. Erosion height is estimated at an average of six feet and four feet, respectively	54,400[r]	- -[s]	- -	City of Racine	82,500[t]	4,900[j]	20, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE12	Habitat, Water Quality, Recreational Use and Access	A 600 foot section of erosion on the west bank of the mainstem of the Root River in Linwood Park, tax parcel 104-04-22-140-650-00	Village of Caledonia	Village of Caledonia	Bank stabilization to address bank erosion along 600 feet of the mainstem of the Root River. Erosion height is estimated at an average of four feet. Adjust mowing protocol to leave unmowed area along streambank. Add designated fishing area	96,000[r]	- -[s]	- -	Village of Caledonia	198,000[t]	11,900[j]	20, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-RE13	Habitat, Water Quality	A 500 foot section of erosion on the west bank of the mainstem of the Root River in tax parcels 104-04-22-140-640-01 and 104-04-22-140-610-00	Village of Caledonia	Racine County and Private landowner	Bank stabilization to address bank erosion along 500 feet of the mainstem of the Root River. Erosion height is estimated at an average of six feet	120,000[r]	- -[s]	- -	Racine County and Private landowner	165,000[t]	9,900[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	High

Table 79 (continued)

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information: Location	Site Information: Municipality	Site Information: Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Responsible Party	Costs (dollars)[b]: Capital	Costs (dollars)[b]: Annual O&M	Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
RPC-RE15	Habitat, Water Quality	A 50 foot section of erosion on the east bank of the mainstem of the Root River in tax parcel 104-04-22-140-550-01	Village of Caledonia	Private landowner	Bank stabilization and extension of existing rock toe downstream to address bank erosion along 50 feet of the mainstem of the Root River. Erosion height is estimated at an average of 12 feet	24,000[r]	- -[s]	- -	Private landowner	16,500[t]	1,000[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE18	Habitat, Water Quality	A 245 foot section of erosion on the east bank of the mainstem of the Root River in tax parcel 104-04-22-110-350-00	Village of Caledonia	Racine County	Bank stabilization to address bank erosion along 245 feet of the mainstem of the Root River. Erosion height is estimated at an average of five feet	49,000[r]	- -[s]	- -	Racine County	80,850[t]	4,900[j]	20, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE20	Habitat, Water Quality	A 240 foot section of erosion on the south bank of the mainstem of the Root River in tax parcel 104-04-22-110-240-00	Village of Caledonia	Racine County	Bank stabilization to address bank erosion along 240 feet of the mainstem of the Root River. Erosion height is estimated at an average of five feet	48,000[r]	- -[s]	- -	Racine County	79,200[t]	4,800[j]	20, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE21	Habitat, Water Quality	A 150 foot section of erosion on the west bank of the mainstem of the Root River in tax parcel 104-04-22-100-220-00	Village of Caledonia	Racine County	Bank stabilization to address bank erosion along 150 feet of the mainstem of the Root River. Erosion height is estimated at an average of five feet	30,000[r]	- -[s]	- -	Racine County	49,500[t]	3,000[j]	20, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE24	Habitat, Water Quality	A 590 foot section of erosion on the west bank of the mainstem of the Root River in tax parcel 104-04-22-03-036-000	Village of Caledonia	Private landowner	Bank stabilization to address bank erosion along 590 feet of the mainstem of the Root River. Erosion height is estimated at an average of five feet	118,000[r]	- -[s]	- -	Private landowner	197,700[t]	11,900[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE34	Habitat, Water Quality	A 250 foot section of erosion on the northeast bank of the mainstem of the Root River in tax parcels 104-04-22-03-011-000, 104-04-22-03-009-001, and 971-9992-001	Village of Caledonia, City of Oak Creek	Racine County and City of Oak Creek	Bank stabilization to address bank erosion along 250 feet of the mainstem of the Root River in close proximity to County Line Road. Erosion height is estimated at an average of four feet	40,000[r]	- -[s]	- -	Racine County and City of Oak Creek	82,500[t]	4,900[j]	20, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-RE36, 37	Habitat, Water Quality	Two erosion sites on both banks of the mainstem of the Root River within tax parcels 9729997000 and 104-04-22-04-002-000	City of Oak Creek and Village of Caledonia	Milwaukee County and Caddy Vista Sanitary District	Bank stabilization to address bank erosion along 20 feet and 160 feet of the mainstem of the Root River. Erosion height is estimated at an average of eight feet and seven feet, respectively	51,200[r]	- -[s]	- -	Milwaukee County and Caddy Vista Sanitary District	59,400[t]	5,100[j]	20, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE38, 39, 40, 41, 42	Habitat, Water Quality	Five erosion sites of varying severity on both banks of the mainstem of the Root River within tax parcels 9739994000 and 104-04-22-04-012-000	City of Oak Creek and Village of Caledonia	Milwaukee County, Racine County	Bank stabilization to address bank erosion along 400 feet, 80 feet, 80 feet, 100 feet, and 120 feet of the mainstem of the Root River. Erosion height is estimated at an average of five feet, six feet, four feet, six feet, and five feet, respectively	80,000[r]	- -[s]	- -	Milwaukee County	257,400[t]	15,400[j]	20, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-RE43,44	Habitat, Water Quality	Two erosion sites on the south bank of the mainstem of the Root River in tax parcels 104-04-22-05-010-000 and 104-04-22-05-014-000	Village of Caledonia	Racine County	Bank stabilization to address bank erosion along 80 feet and 200 feet of the mainstem of the Root River. Erosion height is estimated at an average of six feet for both sites	67,200[r]	- -[s]	- -	Racine County	92,400[t]	5,500[j]	20, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE45, 46, 47, 48	Habitat, Water Quality	Four erosion sites of varying severity on both banks of the mainstem of the Root River within tax parcels 104-04-22-05-016-000 and 104-04-22-05-024-000	Village of Caledonia	Racine County	Bank stabilization to address bank erosion along 80 feet, 200 feet, 240 feet, and 160 feet of the mainstem of the Root River. Erosion height is estimated at an average of five feet, 10 feet, five feet, and five feet, respectively	176,000[r]	- -[s]	- -	Racine County	224,400[t]	13,500[j]	20, 39, 64, 67	Racine County Land Conservation Division	High

Table 79 (continued

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information			Management Action	Annual Pollutant Reductions			Responsible Party	Costs (dollars)[b]		Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
		Location	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)		Capital	Annual O&M			
RPC-RE49, 50, 51, 52, 53, 54, 55	Habitat, Water Quality	Seven erosion sites of varying severity on both banks of the mainstem of the Root River within tax parcels 97-69-996-000 and 97-79-997-000	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 80 feet, 80 feet, 520 feet, 130 feet, 300 feet, 200 feet, and 240 feet of the mainstem of the Root River. Erosion height is estimated at an average of four feet, four feet, six feet, four feet, five feet, five feet, and five feet, respectively	319,200[r]	- -[s]	- -	Milwaukee County	511,500[t]	30,700[j]	20, 39, 64, 67	- -	High
RPC-RE56	Habitat, Water Quality	A 50 foot section of erosion on the north bank of the mainstem of the Root River in tax parcel 012-04-21-01-015-000	Town of Raymond	Private landowner	Bank stabilization to address bank erosion along 50 feet of the mainstem Root River. Erosion is within one stream width of a residential structure. Erosion height is estimated at an average of four feet	8,000[r]	- -[s]	- -	Private landowner	16,500[t]	1,000[j]	20, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-RE57, 58, 59	Habitat, Water Quality	Three erosion sites of varying severity on the east/southeast banks of the mainstem of the Root River within tax parcel 012-04-21-01-001-000	Town of Raymond	Racine County	Bank stabilization to address bank erosion along 75 feet, 100 feet, and 290 feet of the mainstem of the Root River. Erosion height is estimated at an average of five feet, four feet, and four feet, respectively	77,400[r]	- -[s]	- -	Racine County	153,450[t]	9,200[j]	20, 39, 64, 67	Racine County Land Conservation Division	Low
RPC-RE60	Habitat, Water Quality	A 50 foot section of erosion on the south bank of the mainstem of the Root River in tax parcel 012-04-21-01-025-000	Town of Raymond	Private landowner	Bank stabilization to address bank erosion along 50 feet of the mainstem Root River. Erosion is located at an outlet of a pond. Erosion height is estimated at an average of five feet	10,000[r]	- -[s]	- -	Private landowner	16,500[t]	1,000[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE61,62	Habitat, Water Quality	Two erosion sites on the north bank of the mainstem of the Root River in tax parcel 012-04-21-01-020-000	Town of Raymond	Private landowner	Bank stabilization to address bank erosion along 75 feet and 130 feet of the mainstem of the Root River. Erosion height is estimated at an average of seven feet and five feet, respectively	47,000[r]	- -[s]	- -	Private landowner	67,650[t]	4,100[j]	20, 34, 39, 64, 67	Racine County Land Conservation Division	Medium
RPC-RE64,65	Habitat, Water Quality	Two erosion sites on the north bank of the mainstem of the Root River in tax parcel 012-04-21-02-0190-00	Town of Raymond	Private landowner	Bank stabilization to address bank erosion along 170 feet and 80 feet of the mainstem of the Root River. Erosion height is estimated at an average of seven feet and six feet, respectively	66,800[r]	- -[s]	- -	Private landowner	82,500[t]	4,900[j]	34, 39, 64, 67	Racine County Land Conservation Division	High
RPC-RE66, 67, 68, 71, 72, 73	Habitat, Water Quality	Six erosion sites of varying severity on both banks of the mainstem of the Root River within tax parcels 98-09-998-000, 94-89-999-001, and 94-79-998-000	City of Franklin	Milwaukee County	Bank stabilization to address bank erosion along 150 feet, 880 feet, 50 feet, 200 feet, 100 feet, and 200 feet, of the mainstem of the Root River. Erosion height is estimated at an average of 10 feet, seven feet, 10 feet, four feet, five feet, and four feet, respectively	410,400[r]	- -[s]	- -	Milwaukee County	521,400[t]	31,300[j]	20, 39, 64, 67	- -	High
RPC-RE69,70	Habitat, Water Quality	Two erosion sites on the south/west bank of the mainstem of the Root River in tax parcel 98-09-999-000	City of Franklin	Private landowner	Bank stabilization to address bank erosion along 425 feet and 300 feet of the mainstem of the Root River. Erosion height is estimated at an average of seven feet and eight feet, respectively	215,000[r]	- -[s]	- -	Private landowner	239,250[t]	14,400[j]	20, 34, 39, 64, 67	- -	High
RCL-02	Habitat, Water Quality	Farm field draining to the East Branch Root River Canal west of IH-94 and south of 2 Mile Road in tax parcel 018-03-21-01-00-4020	Town of Yorkville	Private landowner	Installation of several agricultural BMPs including: Grade stabilization structure 78 feet long; Subsurface drain 1,542 feet long; Grassed waterway, 1,354 feet long; two underground outlets, 1,165 feet and 440 feet long; three water and sediment control basins	- -[i]	- -[i]	- -	Private landowner	64,200	- -[h]	29, 33, 35, 64	Racine County Land Conservation Division	Medium
RCL-03	Habitat, Water Quality	Farm field draining to Ives Grove Ditch near intersection of CTH C and CTH V in tax parcel151-03-22-070-210-20	Village of Mt. Pleasant	Private landowner	Installation of agricultural BMPs including: Grassed waterway 392 feet long and two lined waterway outlets 20 feet and 16 feet long	- -[i]	- -[i]	- -	Private landowner	7,300	- -[h]	29, 33, 39, 64	Racine County Land Conservation Division	Medium

Table 79 (continued)

ID Number (see Maps 74 through 88)[a]	Focus Areas Addressed	Site Information			Management Action	Annual Pollutant Reductions			Responsible Party	Costs (dollars)[b]		Potential Funding Sources[c]	Potential Technical Assistance	Priority[d]
		Location	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)		Capital	Annual O&M			
RCL-04	Habitat, Water Quality	Farm fields draining to Yorkville Creek north of CTH A, west of 63rd Drive, and south of STH 20. In tax parcels 018-03-210-80-18-000 and 018-03-21-08-01-9000	Town of Yorkville	Private landowner	Installation of agricultural BMPs including: four grassed waterways 1,450, 900, 1,945, and 520 feet long; five subsurface drains 1,314, 1,340, 930, 529, and 1,844 feet long; Underground outlet 76 feet long	- -[i]	- -[i]	- -	Private landowner	24,800	- -[h]	29, 33, 39, 64	Racine County Land Conservation Division	Medium
RCL-05	Habitat, Water Quality	Farm field draining to East Branch Root River Canal northwest of intersection of IH-94 and 3 Mile Road in tax key 012-042-125-032-000	Town of Raymond	Private landowner	Installation of agricultural BMPs including: 3 grassed waterways 1,116, 347, and 480 feet long; one lined waterway outlet	- -[i]	- -[i]	- -	Private landowner	4,100	- -[h]	29, 33, 39, 64	Racine County Land Conservation Division	Medium
RCL-06	Habitat, Water Quality	Farm field draining to West Branch Root River Canal south of CTH A and west of 55th Drive in tax key 018-03-21-15-00-3000	Town of Yorkville	Private landowner	Installation of agricultural BMPs including: Grassed waterways 1,138 feet long; subsurface drain 1,138 feet long	- -[i]	- -[i]	- -	Private landowner	6,950	- -[h]	29, 33, 39, 64	Racine County Land Conservation Division	Medium
RCL-07	Habitat, Water Quality	Farm field draining to Husher Creek in tax key 104-04-22-160-23-030	Village of Caledonia	Private landowner	Installation of 650-foot long grassed waterway	- -[i]	- -[i]	- -	Private landowner	3,250	- -[h]	29, 33, 39, 64	Racine County Land Conservation Division	Medium
RCL-08	Habitat, Water Quality	Two erosion sites along West Branch of Root River Canal East of STH 45 and south of 58th Road in tax key 186-03-21-29-00-60-11	Village of Union Grove	Private landowner	Streambank protection structures to address erosion along 65-foot and 75-foot sections of West Branch Root River Canal with respective estimated average erosional heights of eight feet and four feet	32,800[r]	- -[s]	- -	Private landowner	19,470	- -[h]	33, 34, 35, 39, 64, 67	Racine County Land Conservation Division	High
RCL-09	Habitat, Water Quality	Farm field draining into Husher Creek west of S. Howell Avenue and south of 5 Mile Road in tax key 104-04-22-20-00-10-00	Village of Caledonia	Private landowner	Installation of agricultural BMPs including: Grassed waterways 1,050 feet long; subsurface drain 1,050 feet long	- -[i]	- -[i]	- -	Private landowner	11,950	- -[h]	29, 33, 39, 64	Racine County Land Conservation Division	Medium
RCL-10	Habitat, Water Quality	Farm field along East Branch Root River Canal west of IH-94 and north of 2 Mile Road in tax key 012-04-21-36-01-20-00	Town of Raymond	Private landowner	Conversion of 6.2 acres agricultural land to grass buffer to increase riparian buffer along East Branch Root River Canal	1,106	2	- -	Private landowner	1,950	- -[h]	5, 14, 16, 18, 29, 32, 33, 39, 44, 45, 51, 60, 64	Racine County Land Conservation Division	High
RCL-11	Habitat, Water Quality	Farm field along Husher Creek south of 5 Mile Road and east of S. Howell Avenue in tax keys 104-04-22-21-00-8000 and 104-04-22-21-00-7000	Village of Caledonia	Private landowner	Conversion of 0.8 acre of agricultural land to grass buffer to increase riparian buffer along Husher Creek	1,104	2	- -	Private landowner	950	- -[h]	5, 14, 16, 18, 29, 32, 33, 39, 44, 45, 51, 60, 64	Racine County Land Conservation Division	High
RCL-12	Habitat, Water Quality	Farm field along Kilbournville Tributary west of the 7 Mile Fair in tax key 01-20-42-10-10-34-000	Town of Raymond	Private landowner	Conversion of 6.4 acres of agricultural land to grass buffer to increase riparian buffer along Kilbournville Tributary	6,303	19	- -	Private landowner	1,300	- -[h]	5, 14, 16, 18, 29, 32, 33, 39, 44, 45, 51, 60, 64	Racine County Land Conservation Division	High
RPC-HD-1	Habitat, Water Quality	Dam located on Hoods Creek in tax key 104-04-22-35-02-0000	Village of Caledonia	Private landowner	Explore dam abandonment and removal options	- -	- -	- -	Private landowner	- -[h]	- -[h]	5, 7, 9, 15, 18, 26, 39, 44, 45, 54	River Alliance of Wisconsin, WDNR	Low
RPC-WW-1[v]	Water Quality	Watershedwide	MS4 municipalities in the watershed[w]	Not applicable	Review and audit of municipal codes and ordinances in the watershed to assess barriers to the implementation of green infrastructure strategies	- -	- -	- -	MS4 municipalities in the watershed[j]	75,000	- -	2, 8, 20, 39, 51, 64, 67	1,000 Friends of Wisconsin, MMSD, Milwaukee County	High

Footnotes to Table 79

[a]*Prefixes indicate the general area or source of the project:*

AER = 2013 AECOM study of erosion for City of Racine
GFD = 2008 City of Greenfield Study
LRC = Lower Root River-Caledonia and Hoods Creek Assessment Areas
LRJ = Lower Root River-Johnson Park and Lower Root River-Racine Assessment Areas
MPC = Milwaukee County Department of Parks, Recreation and Culture
MRR = Middle Root River and East Branch Root River Assessment Areas
MUS = Sediment Transport Study
RAC = City of Racine Study of TMDL options
RCL = Racine County Land Conservation Division
RHD = City of Racine Health Department
RPC = SEWRPC Field Reconnaissance
RRC = Root River Canal System Assessment Areas
RWO = Racine Weed Out!
URR = Upper Root River and Whitnall Park Creek Assessment Areas

[b]*Costs reflect 2013 conditions, based on an* Engineering News-Record *Construction Cost Index of 12,217.*

[c]*Potential funding source numbers correspond to the reference numbers given in Table 102 in Chapter VII.*

[d]*It is anticipated that most high-priority projects will be implemented over the 10-year period from 2014 through 2023, most medium-priority projects will be implemented over the period from 2024 through 2038, and most low-priority projects will be implemented after 2038. It is recognized that some priority rankings may change during refinement and preliminary engineering of projects.*

[e]*Total phosphorus reductions were calculated based upon a linear regression model developed using the TSS and total phosphorus reduction estimates given for stormwater ponds in the City of Racine given in AECOM,* Storm Water Quality Management Plan Update/TMDL Preparedness Assessment, *Final Report to the City of Racine, December 2013.*

[f]*Estimate based on modeled average annual per acre nonpoint source load for Upper Root River subwatershed of 0.22 trillion cells from SEWRPC TR No. 39 and a median value for the reduction of fecal coliform bacteria by wet ponds of 60 percent from the International Stormwater BMP Database.*

[g]*Operations and maintenance costs were estimated using the cost curve in Figure 8 of SEWRPC Technical Report No. 31,* Costs of Urban Nonpoint Source Water Pollution Control Measures, *June 1991. Costs were updated from 1989 dollars (Eng CCI = 4,734) to 2013 dollars (Eng CCI = 12,210) using the Engineering Record Construction Cost Index.*

[h]*Insufficient information was available about this project for estimating costs. Costs will need to be determined during project development.*

[i]*Insufficient information was available for estimating the pollutant load reductions that would result from this project. Reductions will need to be estimated during project development.*

[j]*Average annual operation and maintenance costs for streambank stabilization/restoration were estimated as 6 percent of capital costs. This was based upon the average relationship between estimated annual operation and maintenance costs and capital costs from three projects for which data were available: The Lyman Woods streambank stabilization project in Illinois, the Hobson Creek corridor restoration project in Illinois, and the Smoky Hill River project in Kansas. The estimate includes the cost of annual inspection and the average annual cost of repairs and other maintenance.*

[k]*Estimate based on average $5,774 per acre sale cost of agricultural land in Racine County in 2012 of $5774, as per the National Agricultural Statistics Service.*

[l]*Estimated capital cost is for projects recommended over the period from 2011 through 2020.*

[m]*Estimated capital cost is for projects recommended over the period from 2013 through 2022.*

[n]*Restoration cost estimate based on per acre costs given in Milwaukee County Parks,* Franklin Oak Savanna Ecological Restoration and Management Plan: 2013-2022. *Costs assume one herbicide treatment at $50 per acre, one prescribed fire treatment at $60 per acre, two mowings at $30 per acre per mowing, seed costs of $300 per acre, and planting costs of $125 per acre. In addition, 25 percent was added to the calculated costs to reflect the costs of addressing drain tiles (e.g., drainage water management or some other option). Because these properties are owned by Milwaukee County, no costs were included for land acquisition.*

[o]*Estimate based on modeled average annual per acre nonpoint source load for Lower Root River subwatershed of 0.10 trillion cells from SEWRPC TR No. 39 and a median value for the reduction of fecal coliform bacteria by wet ponds of 60 percent from the International Stormwater BMP Database.*

[p]*Past history of this park as a fill site indicates that the site would need to be investigated for contaminated soils.*

[q]*Floodplain impacts would need to be evaluated. The potential of a willing seller of an adjacent property may expand the area available for this project.*

[r]*Estimate assumes a soil unit weight of 80 pounds per cubic foot and a recession rate of the erosional area of 0.5 foot per year.*

[s]*Reduction of phosphorus loading was not computed, but is assumed to be proportional to reduction in TSS loading.*

[t]*Estimated capital cost assumes streambank stabilization treatments that include regrading and revegetating banks as well as rock toe stabilization. Other streambank stabilization methods may be more appropriate based on site specifics. Each site should be evaluated during the design phase to determine the most appropriate bank stabilization method.*

[u]*Estimated capital cost represents the cost of a bank stabilization project at this site. These costs assume streambank stabilization treatments that include regrading and revegetating banks as well as rock toe stabilization. Other streambank stabilization methods may be more appropriate based on site specifics. Each site should be evaluated during the design phase to determine the most appropriate bank stabilization method.*

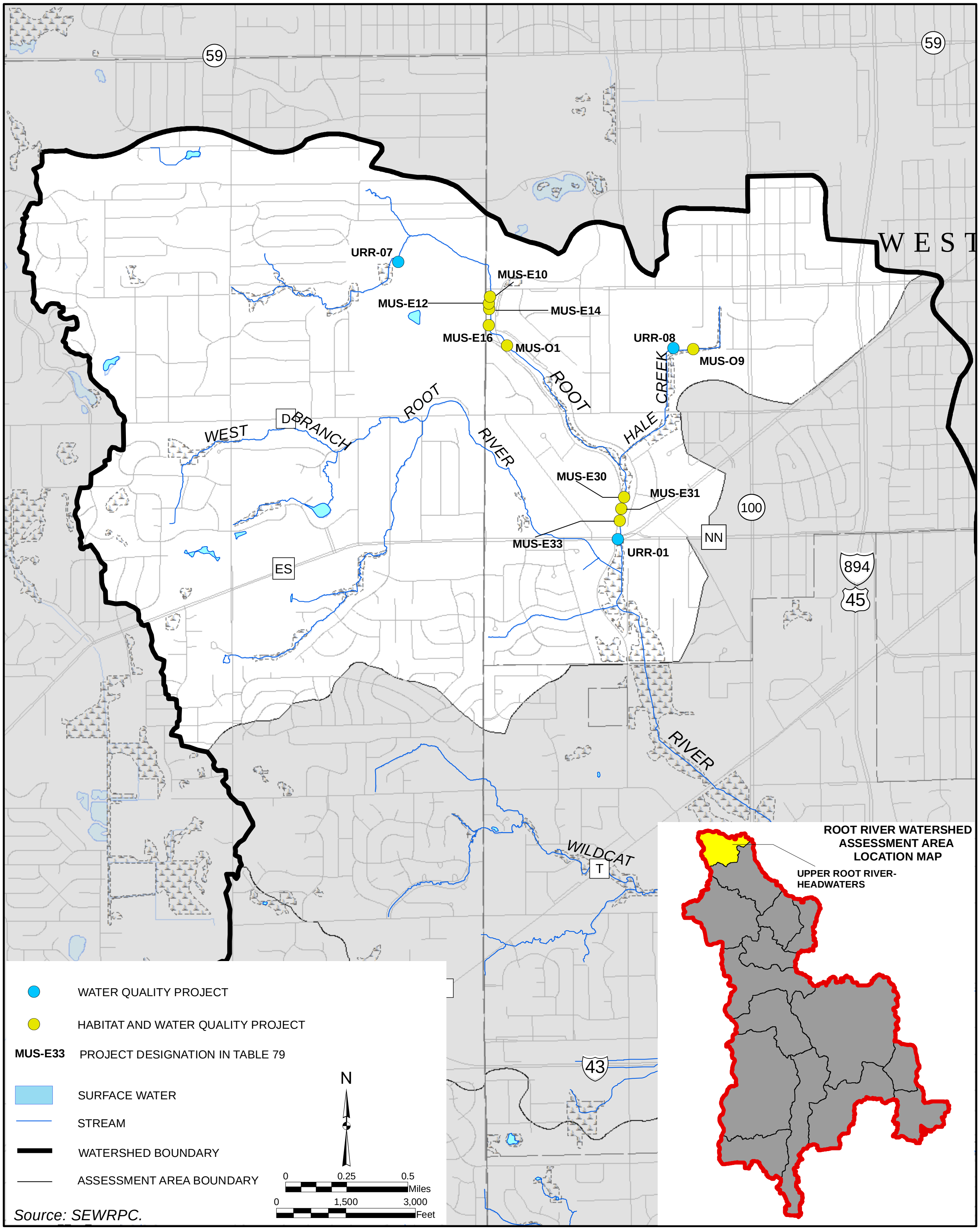
[v]*This project applies to all communities with municipal separate storm sewer systems in the watershed and is not shown on Maps 74 through 88.*

[w]*Such an audit of municipal codes and ordinances has been completed for the Cities of Greenfield, Milwaukee, and West Allis, which are partially located in the Root River watershed, as part of a project conducted by the MMSD, Milwaukee County, and the Southeastern Wisconsin Watersheds Trust, Inc., (Sweet Water) in the Menomonee River watershed.*

Source: 1000 Friends of Wisconsin; AECOM; City of Racine; City of Greenfield; Milwaukee County Department of Parks, Recreations and Culture; Root River Watershed Restoration Plan Advisory Group; Root River Restoration Planning Group; Racine County Land Conservation Division; Racine Health Department; and SEWRPC.

Map 74

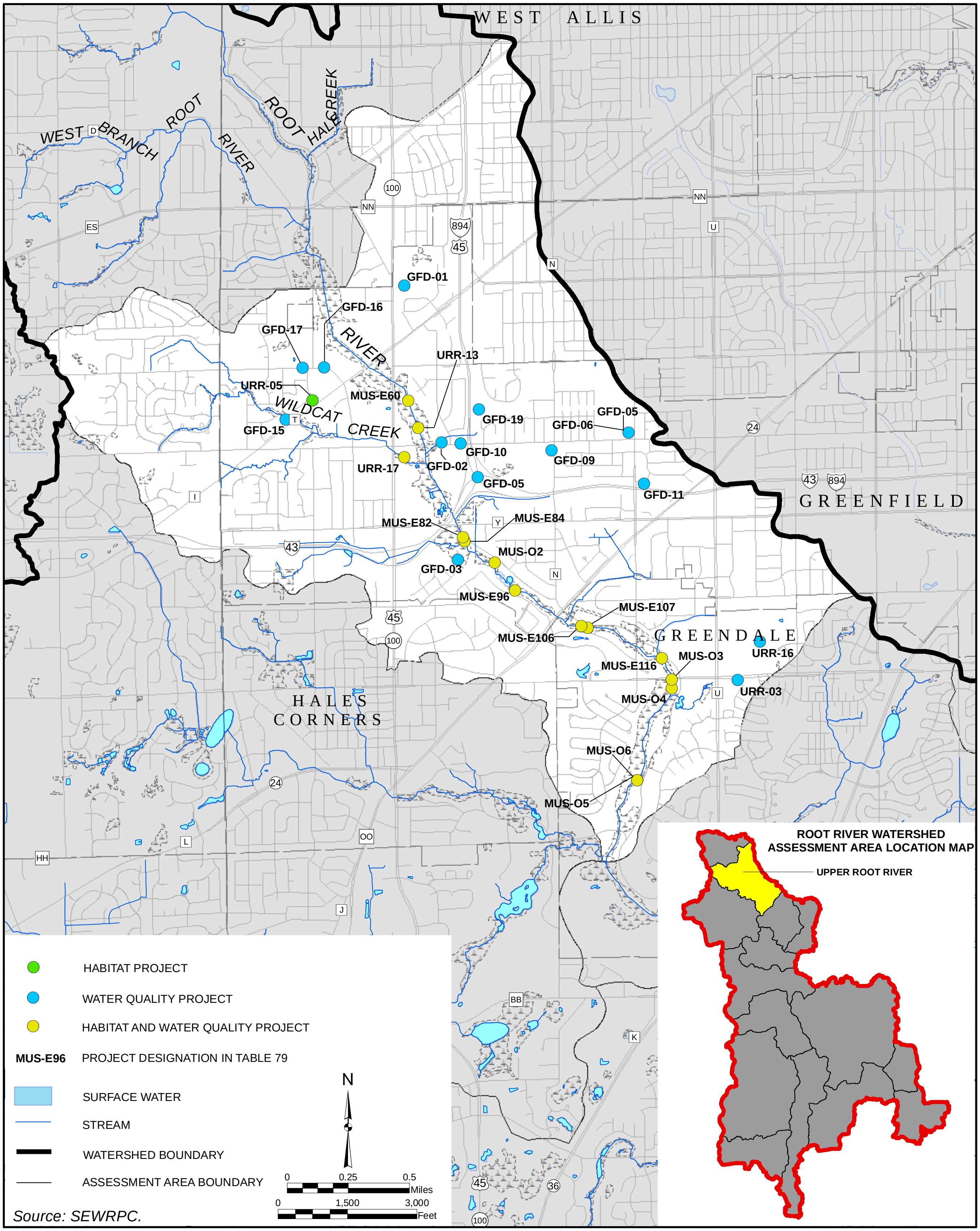
PROJECTS WITHIN THE UPPER ROOT RIVER-HEADWATERS ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 75

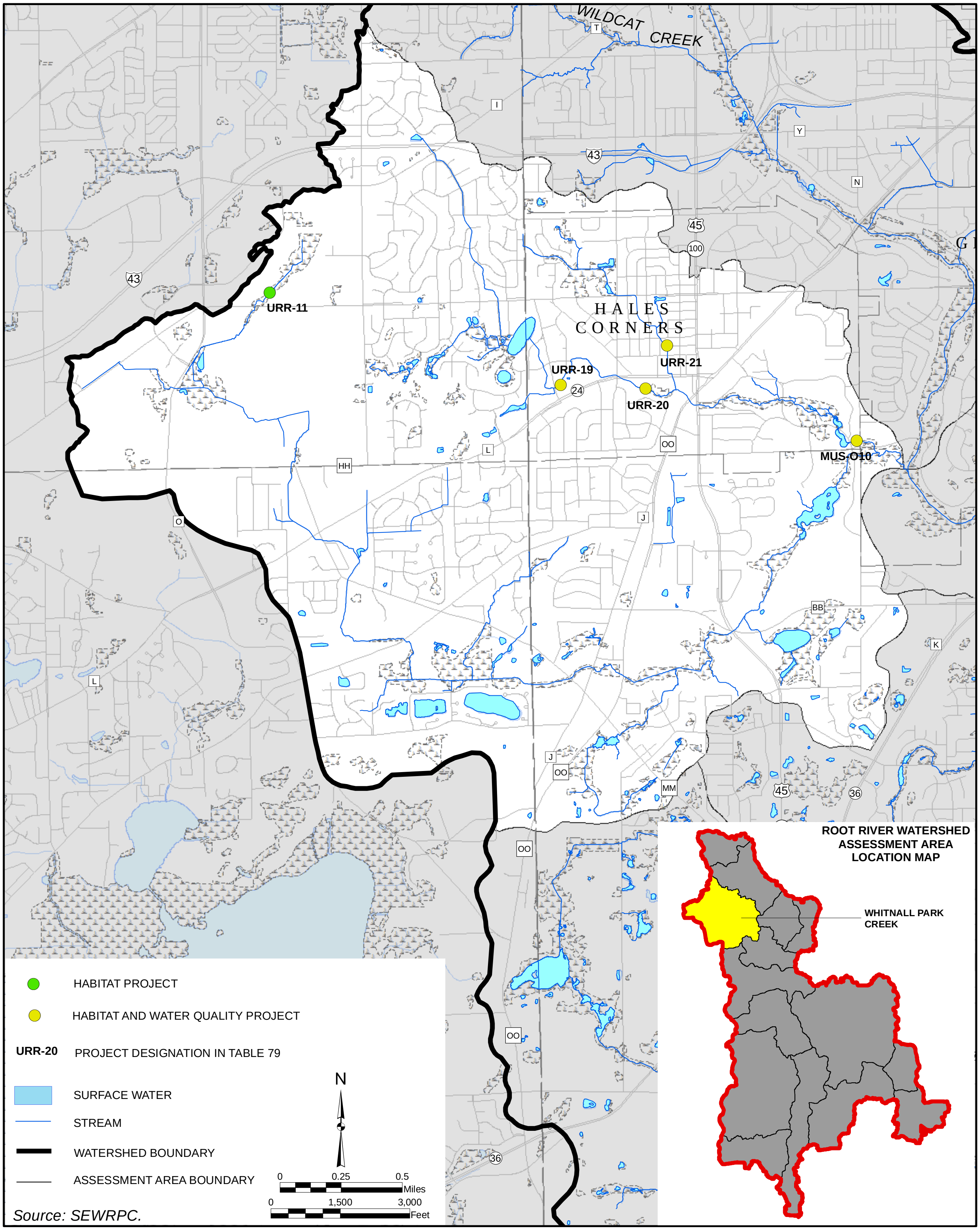
PROJECTS WITHIN THE UPPER ROOT RIVER ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 76

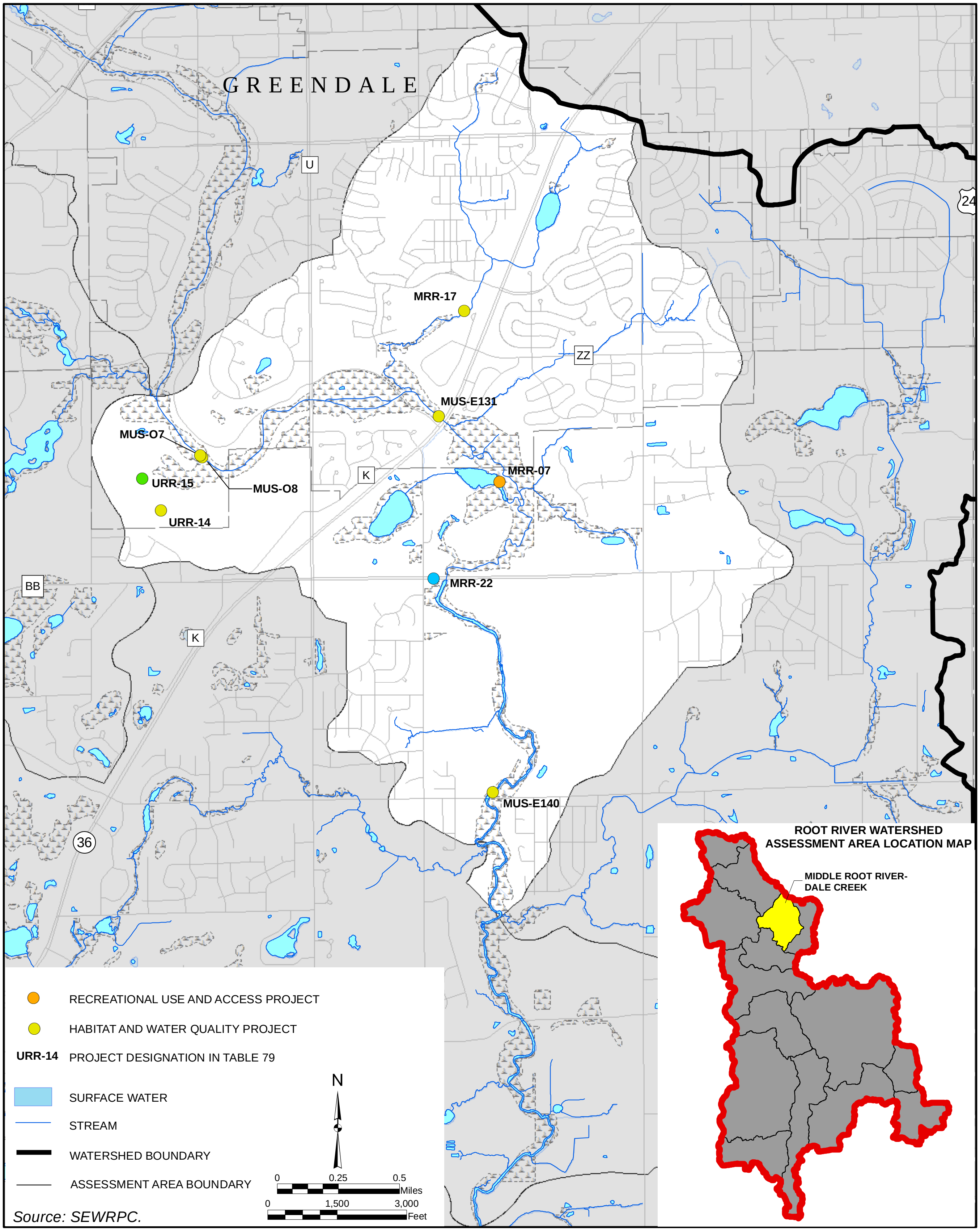
PROJECTS WITHIN WHITNALL PARK CREEK ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 77

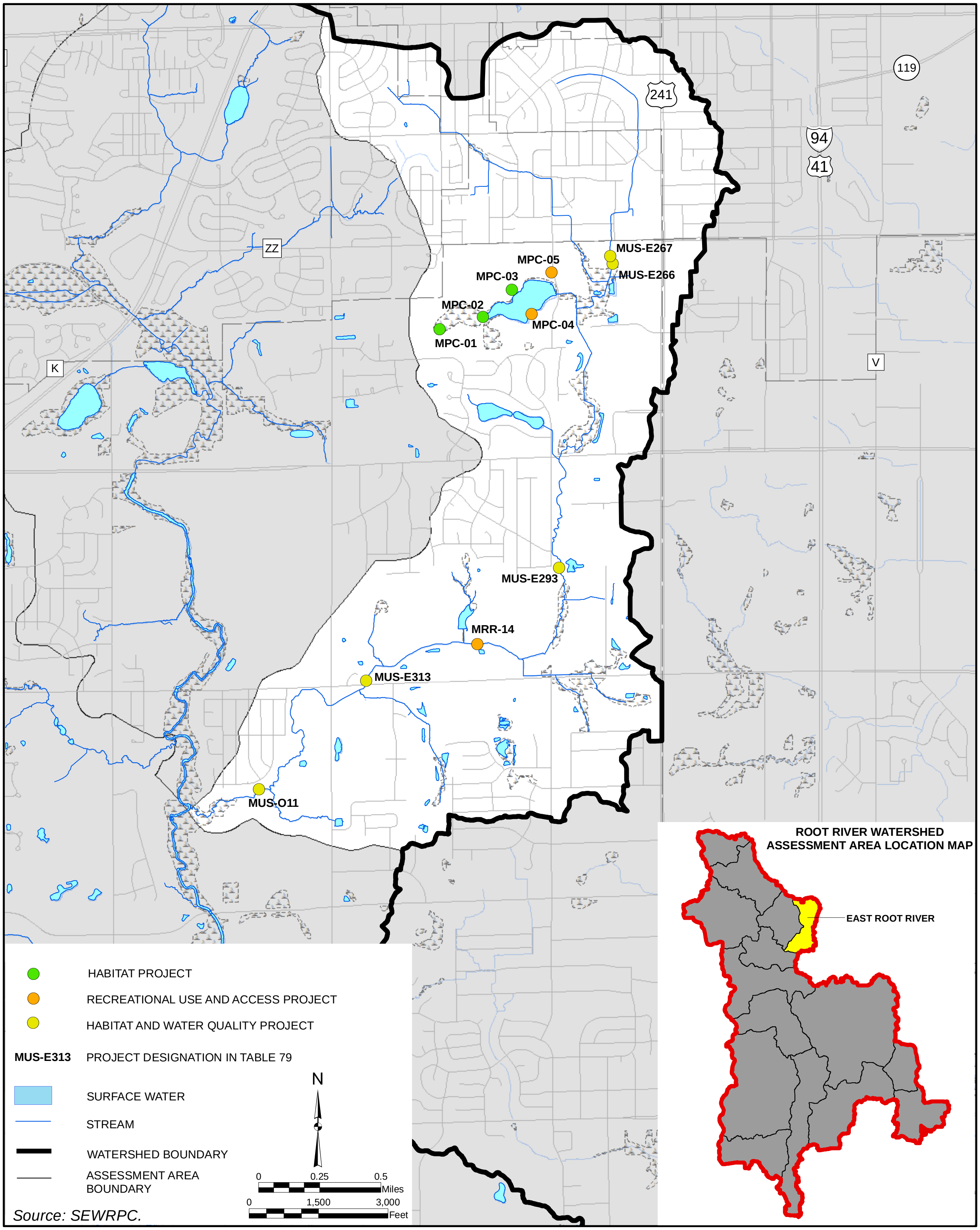
PROJECTS WITHIN THE MIDDLE ROOT RIVER-DALE CREEK ASSESSMENT AREA
OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 78

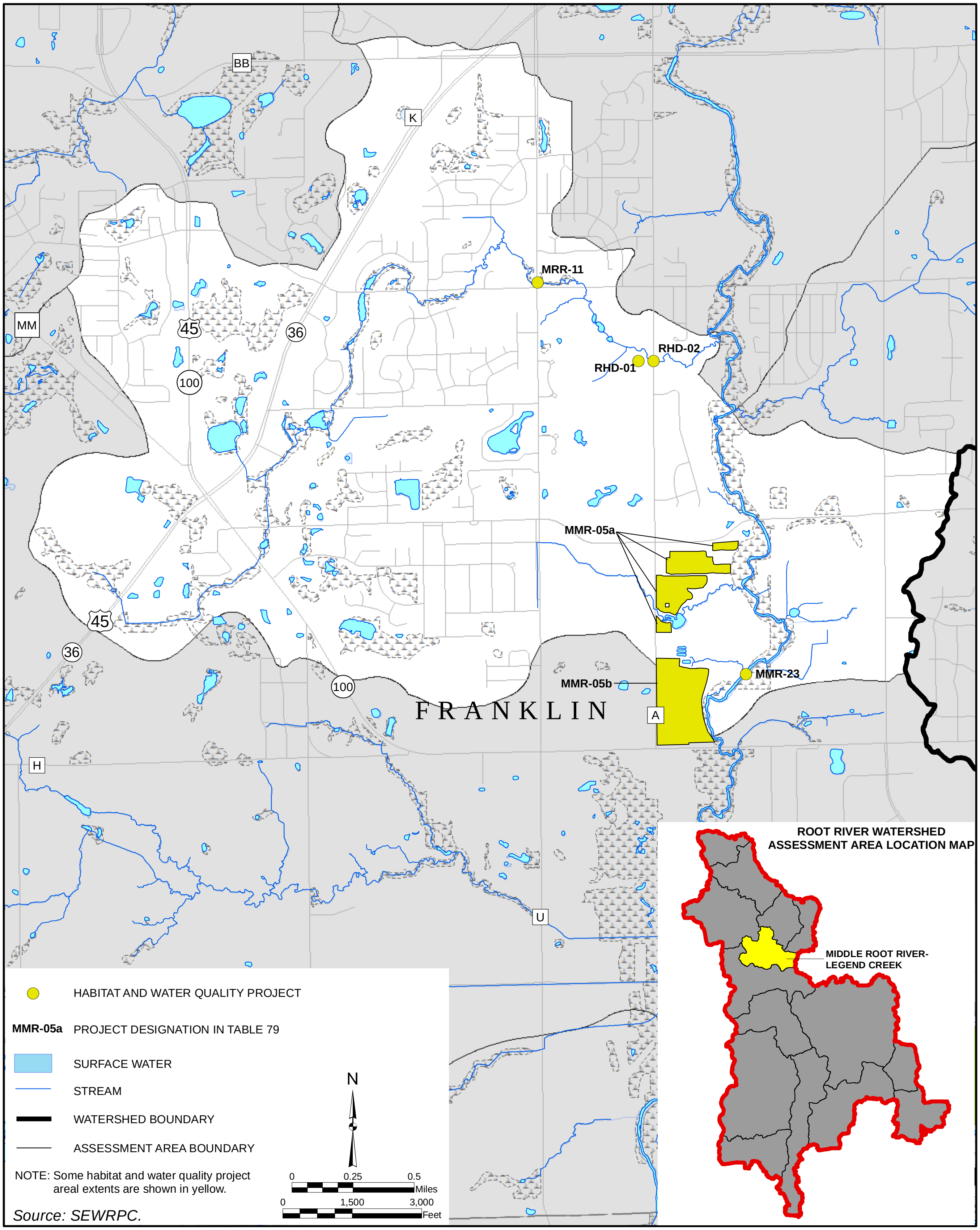
PROJECTS WITHIN THE EAST BRANCH ROOT RIVER ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 79

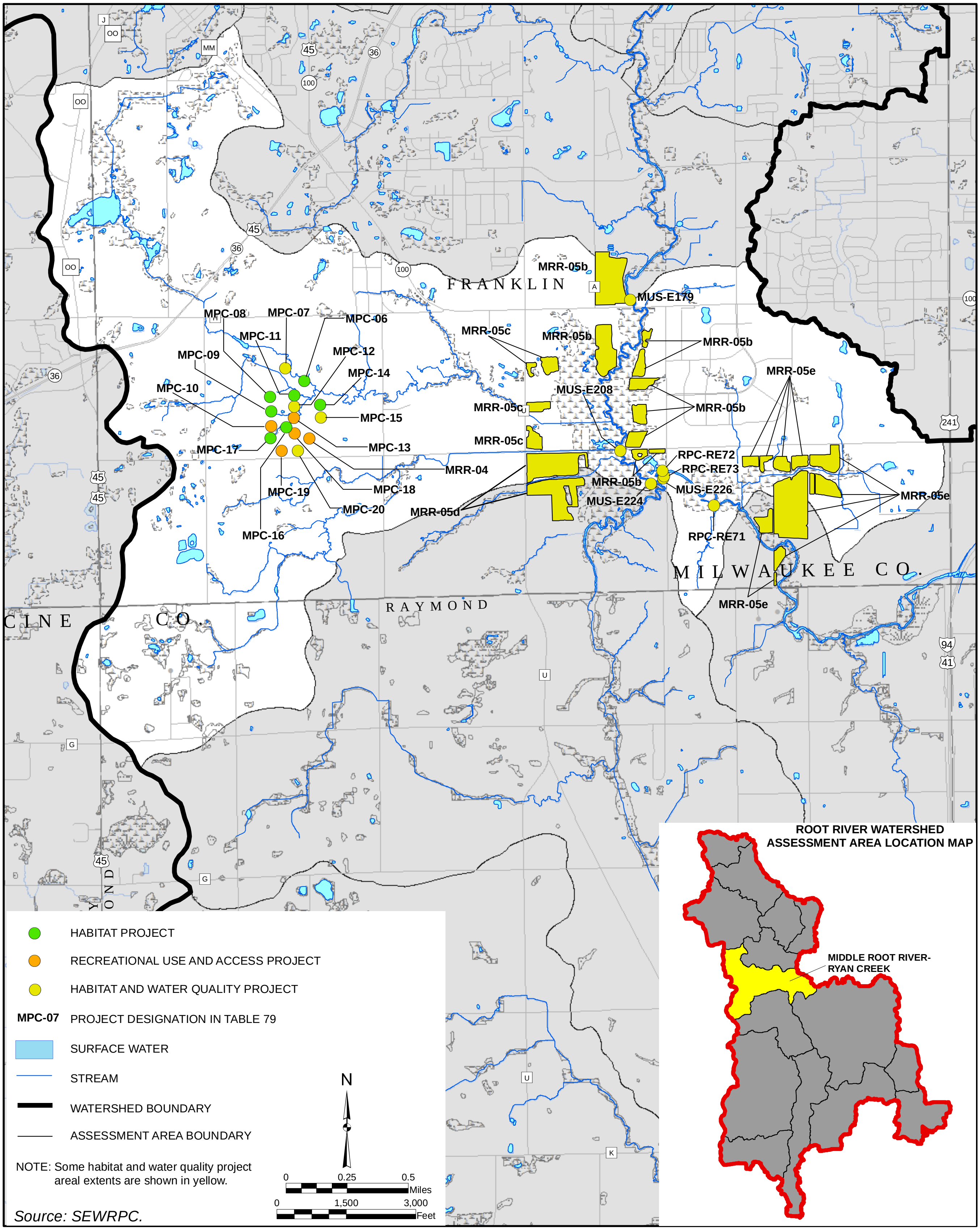
PROJECTS WITHIN THE MIDDLE ROOT RIVER-LEGEND CREEK ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 80

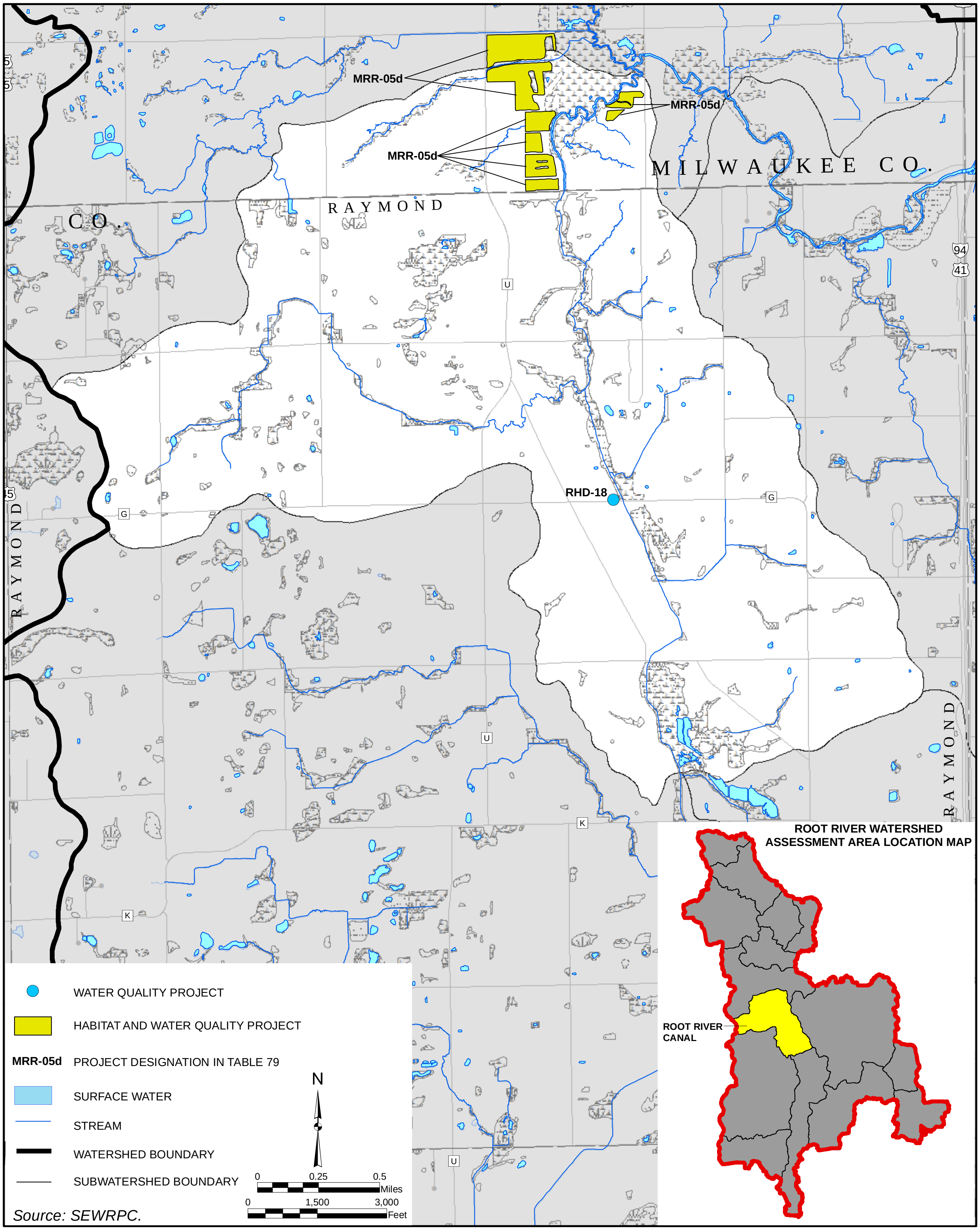
PROJECTS WITHIN THE MIDDLE ROOT RIVER-RYAN CREEK ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 81

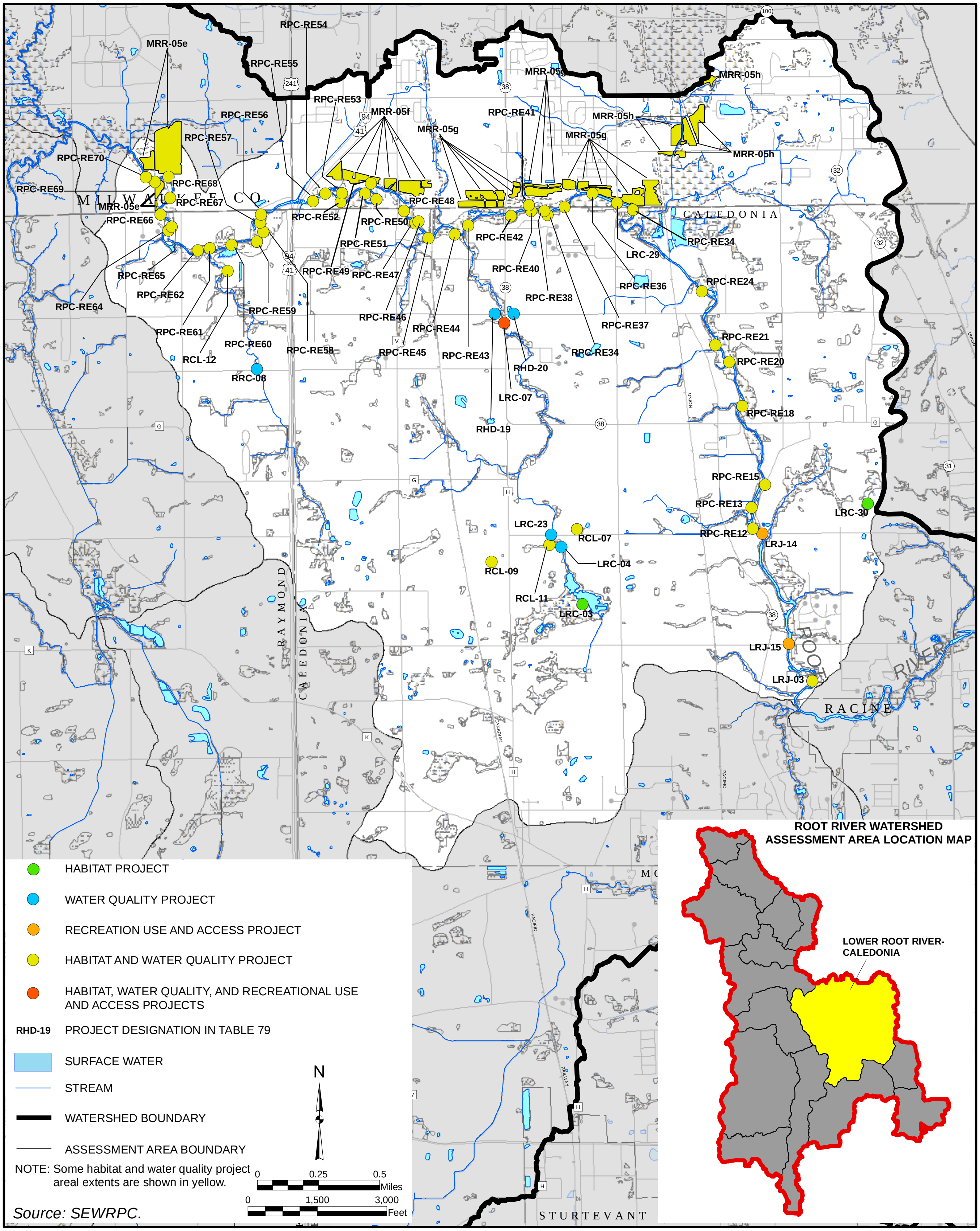
PROJECTS WITHIN THE ROOT RIVER CANAL ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

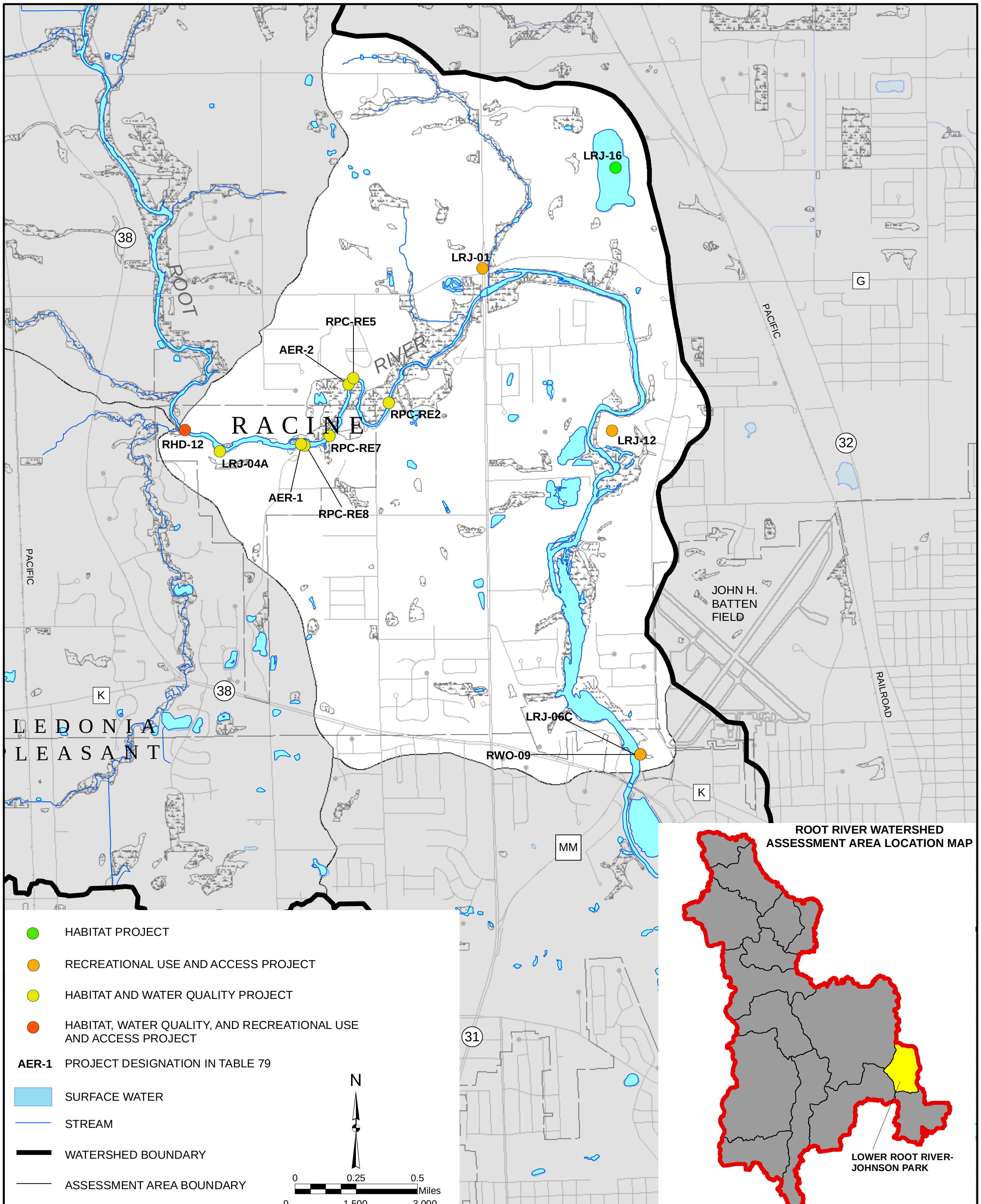
Map 82

PROJECTS WITHIN THE LOWER ROOT RIVER-CALEDONIA ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Map 83

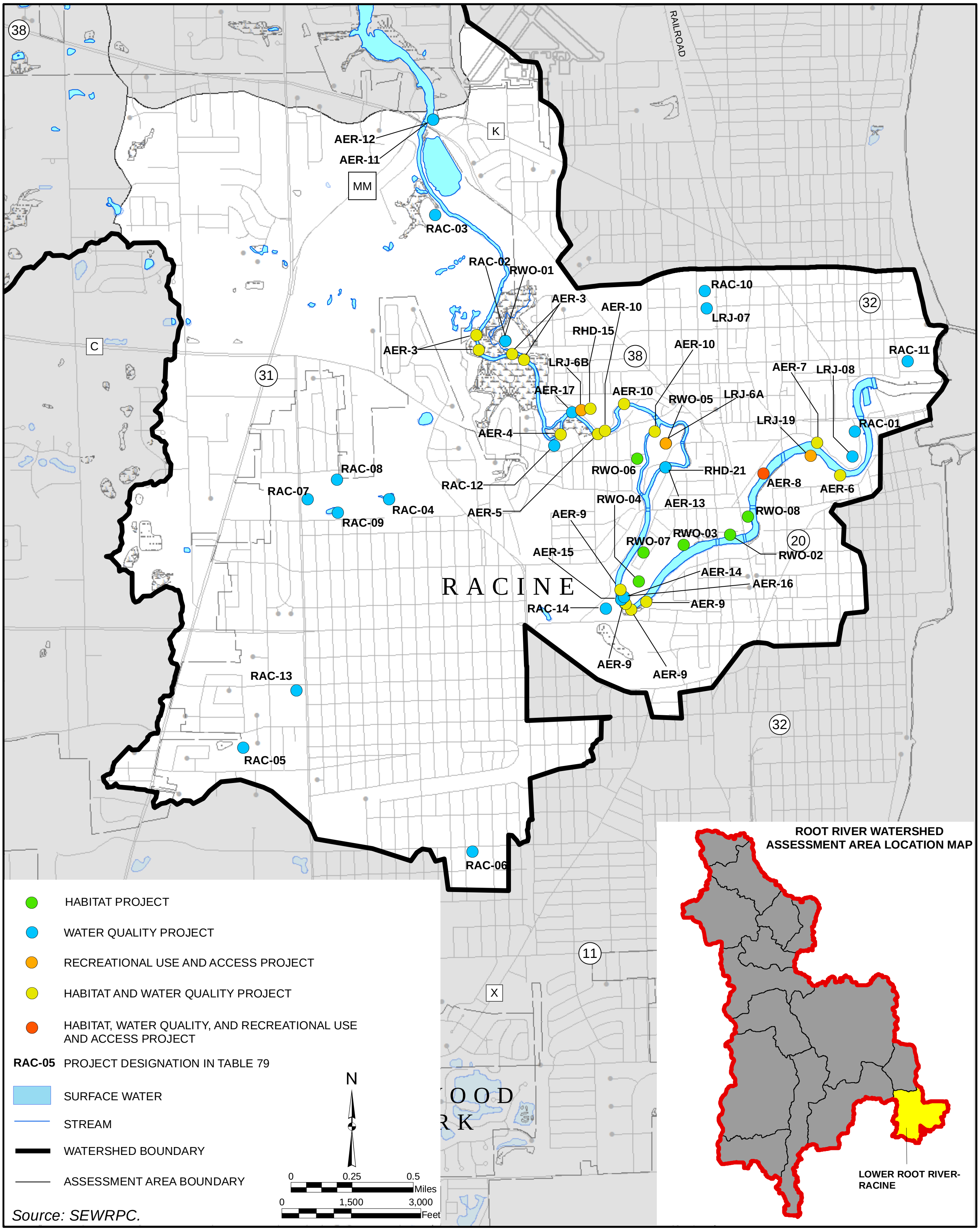
PROJECTS WITHIN THE LOWER ROOT RIVER-JOHNSON PARK ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 84

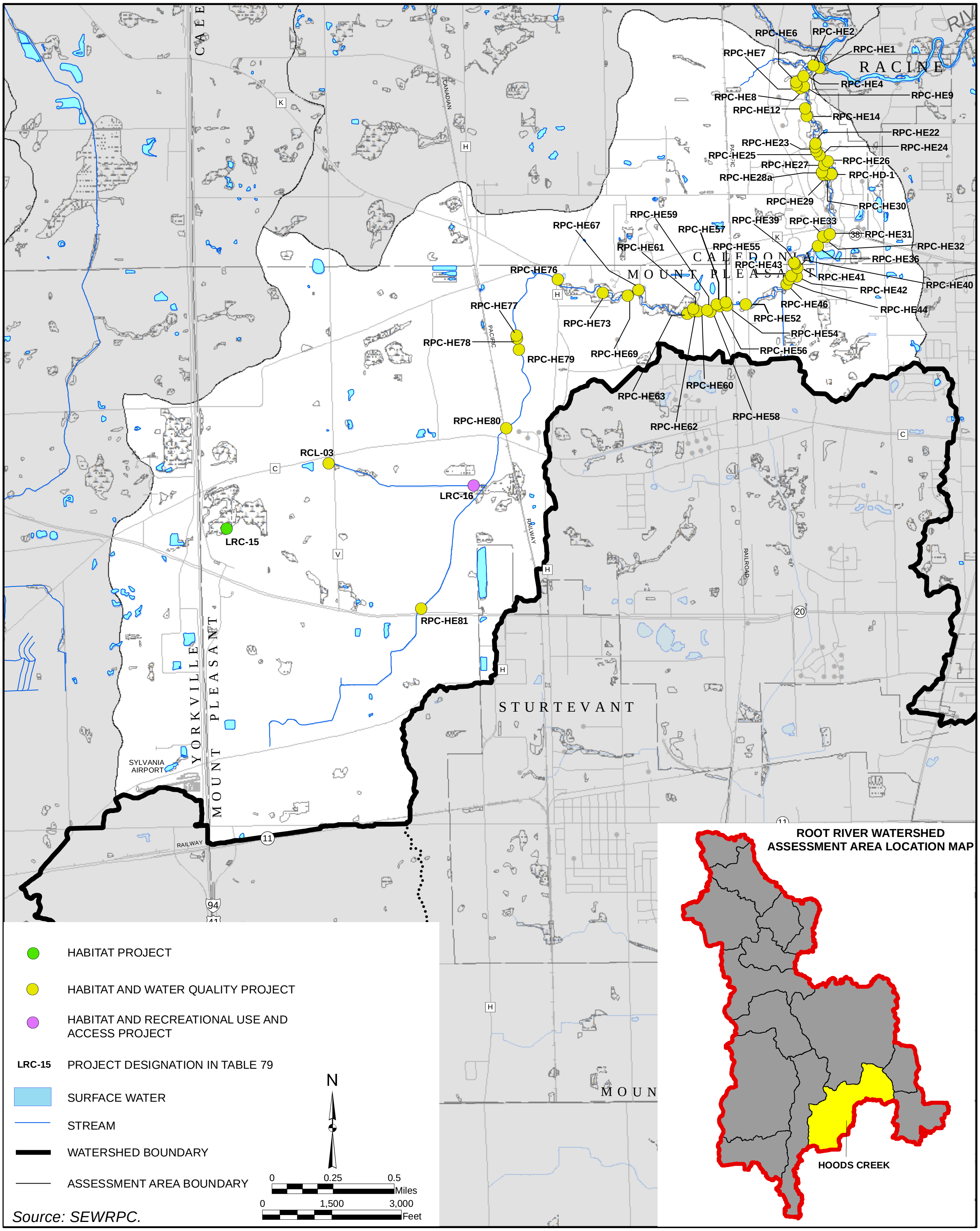
PROJECTS WITHIN THE LOWER ROOT RIVER-RACINE ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 85

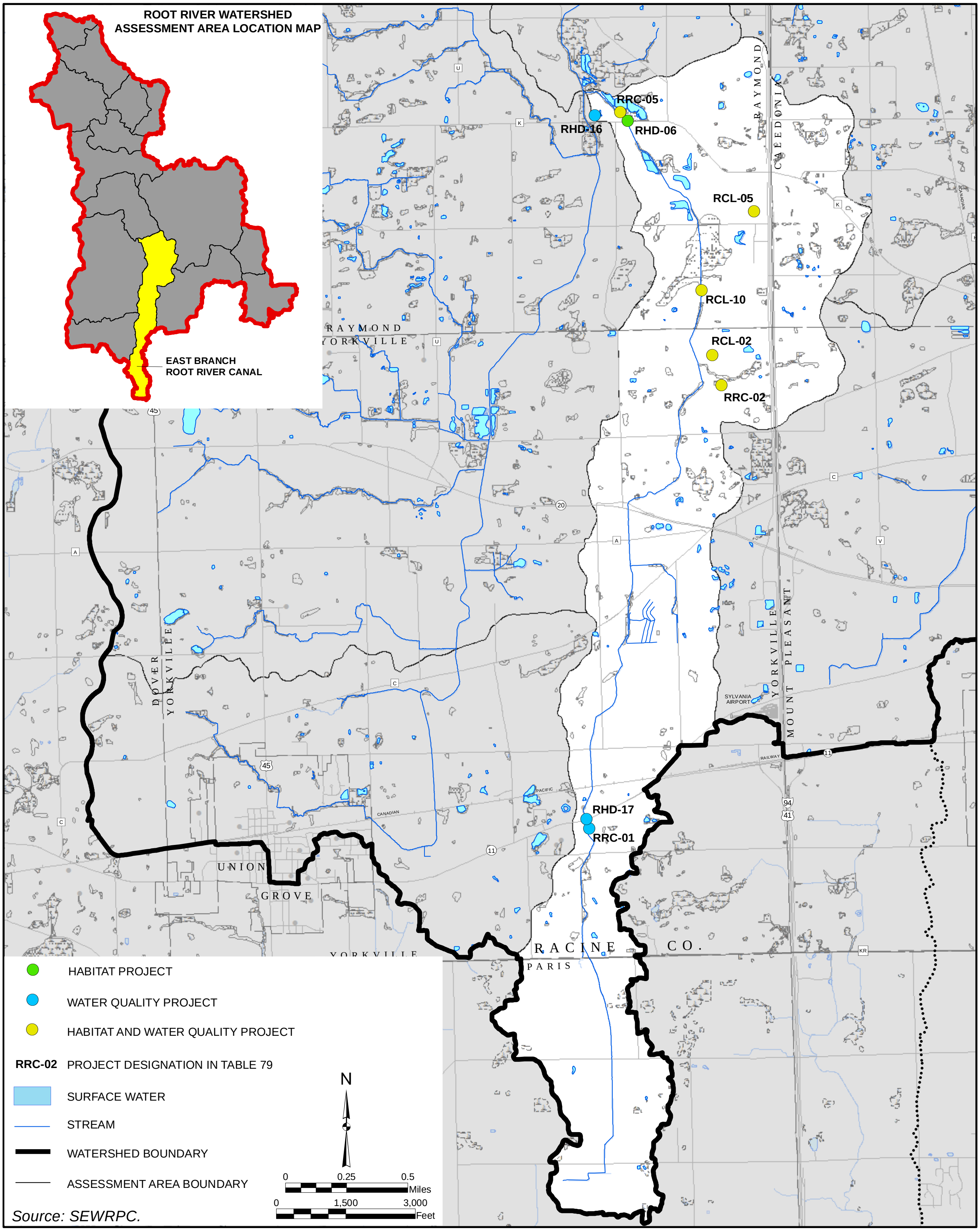
PROJECTS WITHIN THE HOODS CREEK ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

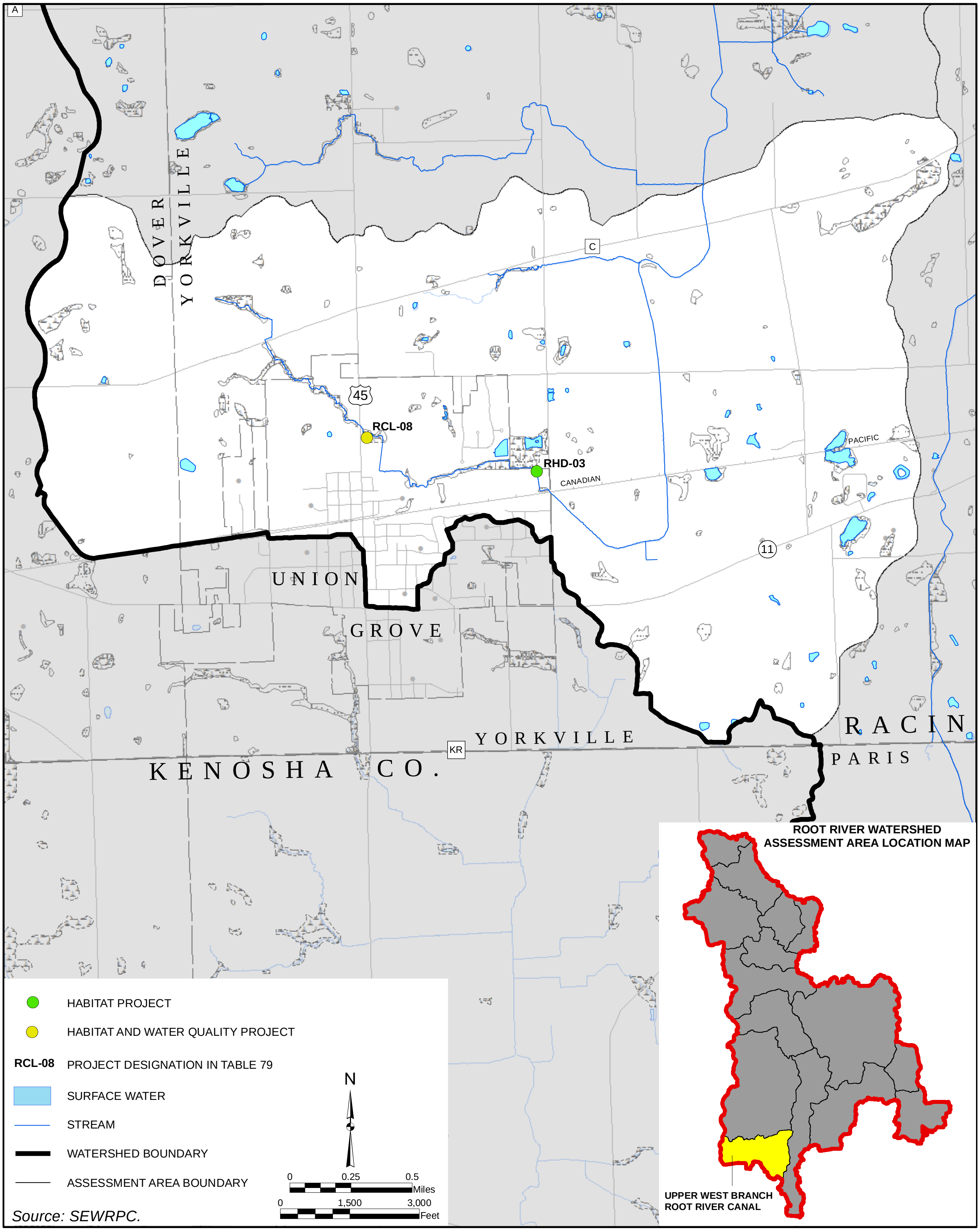
Map 86

PROJECTS WITHIN THE EAST BRANCH ROOT RIVER CANAL ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Map 87

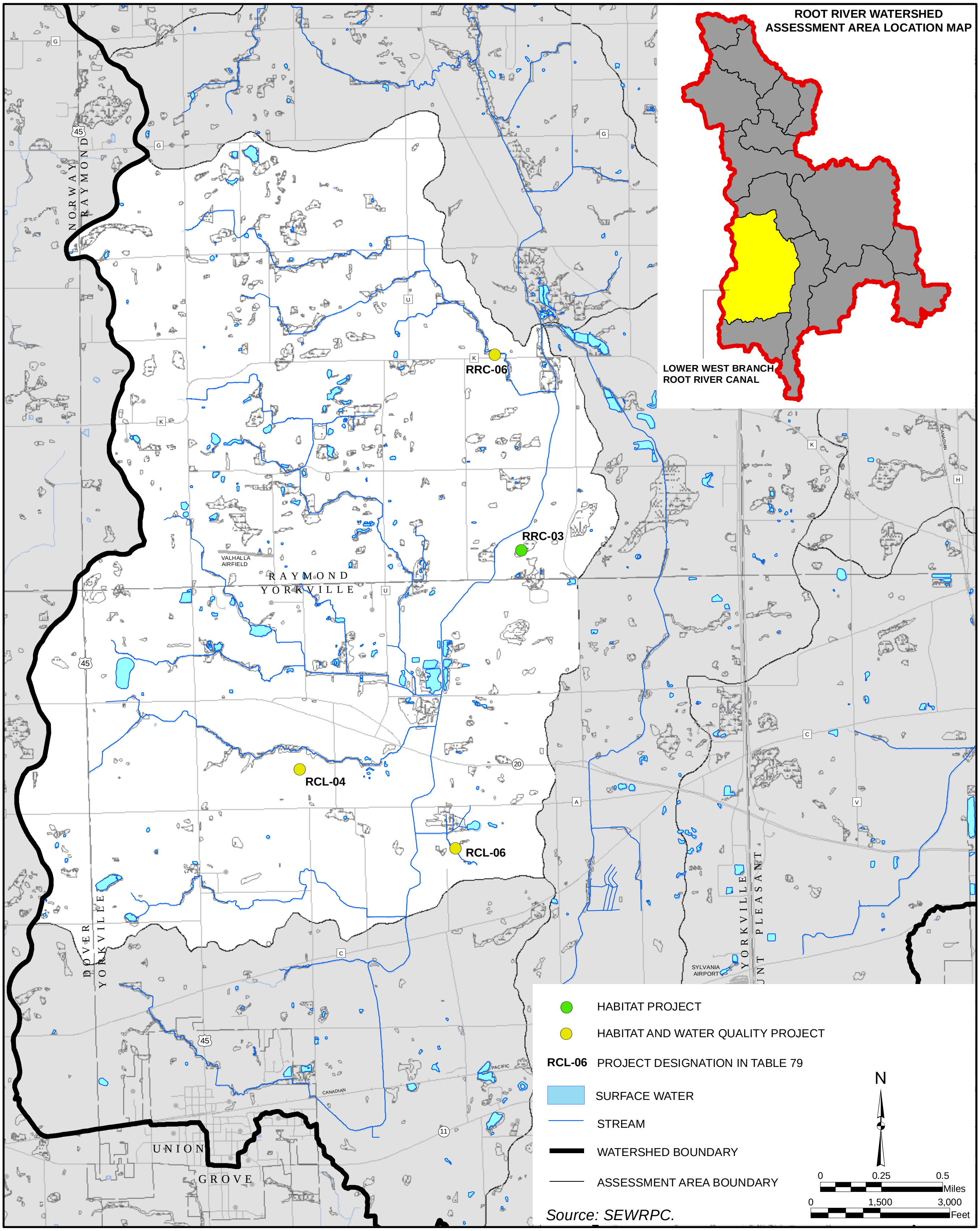
PROJECTS WITHIN THE UPPER WEST BRANCH ROOT RIVER CANAL ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map 88

PROJECTS WITHIN THE LOWER WEST BRANCH ROOT RIVER CANAL ASSESSMENT AREA OF THE ROOT RIVER WATERSHED



- Estimates of annual pollutant load reductions that would result from implementing the project. These are given where they were either developed in modeling results presented in engineering reports or where enough information regarding the project was available to allow for the development of an estimate.

- Identification of the party responsible for implementing the recommended project.

- Estimates of capital and annual operation and maintenance (O&M) costs. These are given where they were available or where sufficient information about the project is available to develop an estimate. All costs are given in 2013 dollars.

- Potential sources of funding and technical assistance that could be sought in order to facilitate implementation of the recommended project. Potential funding sources are indicated by the identification numbers used in the inventory tables given in Chapter VII of this report.

- An indication of the priority that should be given to each project for implementation.

WATER QUALITY MANAGEMENT RECOMMENDATIONS

Development of Recommendations to Improve Water Quality

Relationship to the Regional Water Quality Management Plan

As noted previously in this report, the Root River watershed restoration plan is a second-level plan that builds on the framework established under the 2007 SEWRPC regional water quality management plan update (RWQMPU) for the Greater Milwaukee watersheds.[4] Chapter II of this watershed restoration plan summarizes 1) the recommendations of the RWQMPU as they relate to the Root River watershed and 2) the status of implementation of those recommendations within the watershed. The following paragraphs summarize the water quality modeling analyses conducted under the RWQMPU, and describe how the modeling results for the Root River component of the recommended RWQMPU can be applied directly to estimate water quality improvements that would be expected from implementation of the recommended watershed restoration plan set forth in this chapter.

Water Quality Modeling

Under the RWQMPU, a comprehensive, watershed-based, calibrated and validated U.S. Environmental Protection Agency HSPF continuous simulation model was developed to simulate pollutant loads and instream water quality conditions in the streams of the Root River watershed. The HSPF model is particularly suited to modeling water quality conditions in the Root River watershed because it:

- Can be used on watersheds with both rural and urban land uses;

- Can be used to simulate all of the constituents of interest for this project;

- Allows long-term continuous simulations to predict hydrologic and water quality variability;

- Provides adequate temporal resolution to facilitate a direct comparison to water quality standards;

- Simulates surface runoff and subsurface flows; and

- Simulates receiving stream water quality processes in addition to land surface loads.

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[4]*SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan for the Greater Milwaukee Watersheds, *December 2007 and* Amendment to the Regional Water Quality Management Plan for the Greater Milwaukee Watersheds, *May 2013.*

Under the RWQMPU, the HSPF model was applied to estimate pollutant loads and instream pollutant concentrations over a 10-year simulation period representing meteorological conditions from 1988 through 1997.[5] The HSPF model of the Root River watershed was applied to represent then-existing year 2000 land use conditions and also planned year 2020 (baseline) land use conditions. Water quality conditions were simulated and evaluated at 22 assessment points along the Root River mainstem and tributaries. As shown on Map 7 in Chapter IV of this report, 15 of the assessment points were selected for establishing the outflow locations from the assessment areas established under this watershed restoration plan.

Water Quality Results of the RWQMPU Modeling Analyses

Under the RWQMPU, alternative plans were developed to represent different approaches to improving water quality under planned 2020 land use conditions through combinations of point pollution source controls and implementation of agricultural and urban best management practices and green infrastructure.

Three of the four pollutants identified for abatement under this watershed restoration plan—total suspended solids, total phosphorus, and fecal coliform bacteria—were modeled under the RWQMPU along with several other pollutants.[6] The pertinent water quality indicators used to compare the plans are set forth in Table 80. The RWQMPU alternative plans were evaluated as to their ability to cost-effectively meet a set of planning objectives related primarily to water quality management, land use development, and outdoor recreation and open space preservation.

The recommended RWQMPU plan was synthesized from the most effective components of the alternatives, and it consists of a combination of point source controls and urban and rural nonpoint source controls. The USEPA HSPF water quality model developed to represent recommended plan conditions explicitly accounted for the following rural and urban nonpoint source pollution control measures:

- Reducing soil erosion from cropland to the tolerable soil loss rate as determined by the U.S. Natural Resources Conservation Service;

- Providing six months of manure storage;

- Establishing riparian buffers with a minimum width of 75 feet on each side of streams;

- Converting 10 percent of existing cropland to wetland or prairie conditions;

- Expanding oversight of private onsite wastewater treatment systems;

- Implementing nonagricultural (urban) performance standards established by the State of Wisconsin in Chapter NR 151, “Runoff Management,” of the *Wisconsin Administrative Code*;

- Establishing coordinated programs to detect and eliminate illicit discharges to storm sewer systems and to control urban-sourced pathogens that are harmful to human health; and

- Infiltrating residential roof drain runoff in rain gardens, or similar green infrastructure practices.

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[5]*That simulation period was selected because it was determined to be representative of the long-term precipitation statistics as measured at the National Weather Service General Mitchell International airport weather station for the 63-year period from 1940 through 2002.*

[6]*The fourth pollutant considered under this planning effort is chloride. Chloride loads and concentrations were not computed by the RWQMPU water quality model.*

Table 80

WATER QUALITY INDICATORS USED TO COMPARE ALTERNATIVE PLANS

Parameter	Indicator
Fecal Coliform Bacteria over Entire Year	Arithmetic mean concentration of fecal coliform bacteria
	Proportion of time fecal coliform bacteria concentration is equal to or below single sample standard
	Geometric mean concentration of fecal coliform bacteria
	Days per year geometric mean of fecal coliform bacteria is equal to or below geometric mean standard
Fecal Coliform Bacteria from May to September[a]	Arithmetic mean concentration of fecal coliform bacteria
	Proportion of time fecal coliform bacteria concentration is equal to or below single sample standard
	Geometric mean concentration of fecal coliform bacteria
	Days per year geometric mean of fecal coliform bacteria is equal to or below geometric mean standard
Total Phosphorus	Mean concentration of total phosphorus
	Median concentration of total phosphorus
	Proportion of time total phosphorus concentration is equal to or below the recommended planning standard
Total Suspended Solids	Mean concentration of total suspended solids
	Median concentration of total suspended solids

[a]*This time period represents the body contact recreation season when bacteria concentrations are of the greatest interest.*

Source: SEWRPC.

These measures are also generally included in the recommended watershed restoration plan described in this report chapter. Thus, the degree to which implementation of the watershed restoration plan described below would be expected to improve instream water quality can be inferred from the comprehensive water quality modeling results set forth in the report documenting the regional water quality management plan for the greater Milwaukee watersheds[7] and briefly summarized in the next paragraph.

Implementation of the recommended RWQMPU plan, and of the recommended watershed restoration plan which is set forth in this chapter and which adds detail to the RWQMPU recommendations, would be expected to result in significant reductions in instream mean and median concentrations of total suspended solids[8] and total phosphorus[9] and in mean and geometric mean concentrations of fecal coliform bacteria. Relative to then-existing year 2000 conditions, implementation of the recommended plan would be expected to result in significant

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[7]*SEWRPC Planning Report No. 50,* op. cit., *and* Amendment to the Regional Water Quality Management Plan for the Greater Milwaukee Watersheds, *May 2013 (*http://www.sewrpc.org/SEWRPCFiles/Publications/pr/pr-050_part-2_water_quality_plan_for_greater_mke_watersheds.pdf*).*

[8]*See Table 65 in Chapter V of this report.*

[9]*See Table 64 in Chapter V of this report.*

improvements in the levels of compliance with the geometric mean standard for fecal coliform bacteria, and generally more modest increases in the level of compliance with the single sample standard along the mainstem of the Root River and many tributaries.[10]

At the time that the RWQMPU was prepared, the State of Wisconsin had not promulgated instream water quality criteria for total phosphorus. In the absence of a regulatory criterion, a planning standard of 0.1 mg/l was applied. Following completion of the RWQMPU, the State adopted phosphorus criteria as set forth in Chapter NR 102, "Water Quality Standards for Wisconsin Surface Waters," of the *Wisconsin Administrative Code.* Chapter NR 102 establishes the applicable total phosphorus criterion for the Root River and tributaries as a concentration of 0.075 milligrams per liter (mg/l) (see Table 28 in Chapter IV of this report). The degree to which the recommended RWQMPU would be expected to meet the new regulatory 0.075 mg/l water quality criterion was assessed when subsequent water quality planning work to evaluate the possible effects of climate change on water quality conditions in the greater Milwaukee watersheds was undertaken by SEWRPC in collaboration with the University of Wisconsin-Milwaukee (UW-M) School of Freshwater Sciences, the UW-M College of Engineering and Mechanics, the University of Wisconsin-Madison Center for Climatic Research, and Tetra Tech, with funding from the National Oceanic and Atmospheric Administration.[11] The water quality modeling results representing implementation of those components of the recommended RWQMPU that relate to the Root River watershed, and also, as described above, the elements of the recommended watershed restoration plan, indicate the following anticipated levels of compliance with water quality criteria:

- Along the mainstem of the Root River (assessment points RT-1, 2, 3, 4, 8, 10, 17, 18, 21, and 22), 1) the total phosphorus water quality criterion of 0.075 mg/l would be expected to be met from about 55 to 85 percent of the time during an average year, with the degree of compliance decreasing from upstream to downstream. The single sample fecal coliform bacteria criterion of 400 cells per 100 ml would be expected to be met from about 65 to 85 percent of the time during an average recreation season (May through September), with the degree of compliance generally higher in the upper reaches of the River. The geometric mean criterion of 200 cells per 100 ml would be expected to be met on from 18 to 71 days, depending on location along the River, during an average 153-day May through September recreation season.

- For Whitnall Park Creek (assessment points RT-5 and 7), the total phosphorus water quality criterion would be expected to be met about 75 percent of the time during an average year. The single sample fecal coliform bacteria criterion of 400 cells per 100 ml would be expected to be met about 70 percent

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[10]*Very large reductions in fecal coliform bacteria loads would be needed to achieve a high level of compliance with water quality criteria. While implementation of plan recommendations would be expected to achieve significant reductions in instream bacteria concentrations, those reductions would not always be sufficient to achieve compliance with water quality criteria. The presence of fecal coliform bacteria is considered to be an indicator of potential threats to human health from disease-causing pathogens and also from pharmaceuticals and personal care products that may be associated with human sewage; however, the existence of an actual threat depends on the source of the bacteria. Thus, a significant focus of the recommended plan is on controlling pathogens and pharmaceuticals and personal care products from human sources through the recommended illicit discharge detection and elimination program. As a result, the recommended plan employs an effective approach that focuses on reducing sources of pathogens and pharmaceuticals and personal care products that are most likely to be threats to human health, rather than on indiscriminately reducing fecal coliform bacteria loads. Through adopting that approach, the recommended plan would be expected to achieve greater water quality benefits, thereby better protecting human health and aquatic organisms, than might be inferred from the level of reduction in bacteria concentrations without consideration of the source of the bacteria.*

[11]*S. McLellan, H. Bravo, and M. Hahn, with contributions from K. Kratt and J. Butcher, "Climate change risks and impacts on urban coastal water resources in the great lakes," October 29, 2013.*

of the time during an average recreation season (May through September). The geometric mean criterion of 200 cells per 100 ml would be expected to be met on 34 to 41 days, depending on location along the River, during an average 153-day recreation season.

- For Tess Corners Creek (assessment point RT-6), the total phosphorus criterion would be expected to be met about 80 percent of the time during an average year. The single sample fecal coliform bacteria criterion of 400 cells per 100 ml would be expected to be met about 76 percent of the time during an average recreation season (May through September). The geometric mean criterion of 200 cells per 100 ml would be expected to be met on 54 days during an average 153-day recreation season.

- For the East Branch of the Root River (assessment point RT-9), the total phosphorus criterion would be expected to be met about 79 percent of the time during an average year. The single sample fecal coliform bacteria criterion of 400 cells per 100 ml would be expected to be met about 79 percent of the time during an average recreation season (May through September). The geometric mean criterion of 200 cells per 100 ml would be expected to be met on 59 days during an average 153-day recreation season.

- For the West Branch of the Root River Canal (assessment points RT-11, 12, and 13), the total phosphorus criterion would be expected to be met from about 30 to 60 percent of the time during an average year. The degree of compliance increases from upstream to downstream. The single sample fecal coliform bacteria criterion of 400 cells per 100 ml would be expected to be met from about 75 to 80 percent of the time during an average recreation season (May through September). The geometric mean criterion of 200 cells per 100 ml would be expected to be met on 62 to 90 days, depending on location along the stream, during an average 153-day recreation season.

- For the East Branch of the Root River Canal (assessment points RT-14 and 15), the total phosphorus criterion would be expected to be met from about 60 to 65 percent of the time during an average year. The degree of compliance increases from upstream to downstream. The single sample fecal coliform bacteria criterion of 400 cells per 100 ml would be expected to be met from about 80 to 85 percent of the time during an average recreation season (May through September). The geometric mean criterion of 200 cells per 100 ml would be expected to be met on 109 to 126 days, depending on location along the stream, during an average 153-day recreation season.

- For the Root River Canal (assessment point RT-16), the total phosphorus criterion would be expected to be met about 65 percent of the time during an average year. The single sample fecal coliform bacteria criterion of 400 cells per 100 ml would be expected to be met about 75 percent of the time during an average recreation season (May through September). The geometric mean criterion of 200 cells per 100 ml would be expected to be met on 66 days during an average 153-day recreation season.

- For Ives Grove Ditch (assessment point RT-19), the total phosphorus criterion would be expected to be met about 15 percent of the time during an average year. The single sample fecal coliform bacteria criterion of 400 cells per 100 ml would be expected to be met about 86 percent of the time during an average recreation season (May through September). The geometric mean criterion of 200 cells per 100 ml would be expected to be met on 147 days during an average 153-day recreation season.

- For Hoods Creek (assessment point RT-20), the total phosphorus criterion would be expected to be met about 30 percent of the time during an average year. The single sample fecal coliform bacteria criterion of 400 cells per 100 ml would be expected to be met about 80 percent of the time during an average recreation season (May through September). The geometric mean criterion of 200 cells per 100 ml would be expected to be met on 138 days during an average 153-day recreation season.

The State of Wisconsin has not established regulatory water quality criteria for total suspended sediment, so levels of compliance cannot be assessed, but the potential for significant reductions in total suspended solids (TSS) concentrations under the recommended plan relative to then-existing year 2000 conditions are indicated by the modeling results.

The load reductions required to achieve recommended RWQMPU conditions, and which have been adopted as reduction targets under this watershed restoration plan, are set forth in Tables 62, 63, and 66 in Chapter V of this report.

Quantification of Load Reductions under the Recommended Watershed Restoration Plan

This watershed restoration plan has multiple objectives that are reflected in the four focus areas related to water quality, habitat, recreation, and flooding. Thus, consistent with the Federal Clean Water Act (CWA), the plan is designed to address the physical, chemical, and biological health of the watershed and its water resources. The plan is intended to provide a guide to improving water quality in the watershed over a five-year period; however, because of 1) the relatively large size of the watershed, 2) the long time scales needed for reductions in pollutant loads to be measurable in a complex natural system, and 3) limitations on the financial resources available for plan implementation, the plan will realistically be implemented over a time period longer than five years. The plan recommendations include 1) specifically identified measures to advance the achievement of overall plan objectives in the near term[12] and 2) somewhat more broadly targeted measures that would be implemented as opportunities arise over a longer time frame. The effects of various plan recommendations on reducing pollutant loads to the waterbodies in the watershed are addressed in several ways:

- For specific priority water quality improvement projects, the total suspended solids, total phosphorus, and fecal coliform bacteria load reductions are estimated where feasible, enabling those reductions to be compared to the RWQMPU/watershed restoration plan target reductions set forth in Tables 62, 63, and 66 in Chapter V of this report.

- Certain plan recommendations to improve water quality may be applicable to targeted stream reaches or areas of the watershed, but are not specific enough for their load reduction potential to be practically quantified individually. However, those recommendations represent refinements of the recommendations from the RWQMPU, and their effects on reducing pollutant loads and instream concentrations are specifically represented within the USEPA HSPF water quality model developed under the RWQMPU. Thus, the potential water quality improvement effects of implementing those actions have been quantified at a more-detailed level than by simply estimating load reductions. This is because the loads have been combined with streamflows and routed through the watershed stream network, producing pollutant concentrations at multiple locations, which can readily be compared with regulatory water quality criteria.

- Other plan recommendations, particularly some of those targeted to habitat improvement, may be primarily directed to improving physical and biological conditions in the watershed consistent with the CWA. While in many cases these recommendations may produce ancillary water quality benefits, such benefits may not be directly quantifiable in terms of a pollutant load reduction.

[12]*These specific recommendations largely were identified during plan Advisory Group and stakeholder meetings held throughout the duration of the planning process, but particularly during the December 4, 2013, stakeholder meeting. The objective of that meeting was to obtain specific project ideas from residents of the watershed, representatives of the municipalities within the watershed, and nongovernmental organizations with interests in the watershed.*

Recommendations to Reduce Stormwater Runoff Pollution

Nonpoint source pollution contributed by urban stormwater runoff and rural stormwater runoff constitute major sources of pollution in the Root River watershed. The following recommendations are targeted at reducing the contributions of pollutants from these sources through a variety of strategies.

Recommended Urban Nonpoint Source Pollution Control Measures

The recommendations of the 2007 SEWRPC RWQMPU as they relate to urban nonpoint source pollution in the Root River watershed were reviewed (see Chapter II of this report) and reevaluated under this watershed restoration planning effort. Based on that review and reevaluation, which included consideration of the additional water quality monitoring data collected since the RWQMPU was issued and of recommendations that have already been implemented, the current applicability of the recommendations of the RWQMPU was confirmed. Thus, the following RWQMPU recommendations are reiterated with some refinements under this plan:

1. **It is recommended that urban nonpoint source controls be implemented that are consistent with the standards set forth in NR 151.** It should be noted that most of the municipalities in the watershed are, or will be, required to meet the NR 151 standards to the maximum extent practicable under the conditions of their Wisconsin Pollutant Discharge Elimination System (WPDES) municipal stormwater discharge permits issued pursuant to Chapter NR 216 of the *Wisconsin Administrative Code*. By implementing controls to meet the standards of NR 151, municipalities will address the control of construction site erosion; the control of stormwater pollution from areas of existing and planned urban development, redevelopment, and infill; and infiltration of stormwater runoff from areas of new development. Urban best management practices to be installed under this recommendation could include 1) runoff infiltration/evapotranspiration and/or pollutant filtration devices such as grassed swales, infiltration basins, bioretention facilities, rain gardens, green roofs, and porous pavement; 2) stormwater treatment facilities, such as wet detention basins, constructed wetlands, and sedimentation/flotation devices; and 3) maintenance practices such as vacuum sweeping of roads and parking lots. The benefits of full implementation of the urban performance standards set forth in NR 151 in the reduction of fecal coliform bacteria, total suspended solids, and total phosphorus loads delivered to the streams of the watershed were explicitly represented in the water quality modeling analyses conducted for the RWQMPU. These results and the impact of the recent changes in the enforcement of the urban performance standards in NR 151 are reflected in the pollutant loadings and water quality results presented in Chapter V of this report.

2. The RWQMPU recommended the implementation of coordinated programs to detect and eliminate illicit discharges to storm sewer systems and to control urban-sourced pathogens that are harmful to human health. As a refinement of this recommendation, **it is recommended that those municipalities in the watershed with municipal separate storm sewer systems (MS4s) regulated under the Wisconsin Pollutant Elimination Discharge System (WPDES) modify their illicit discharge detection and elimination (IDDE) programs. Under this modification, some of the effort currently expended to monitor major outfalls that show no evidence of illicit discharges would be transferred to monitoring outfalls of any size that are considered likely to be conveying water contaminated with sanitary wastewater.** Because this recommendation targets the control of waterborne pathogens and the fecal indicator bacteria used to test for their likely presence, this recommendation is discussed relative to recreational use and access later in this chapter in the subsection on “Coordinated Programs to Detect and Eliminate Illicit Discharges to Storm Sewer System.” It should be noted that while this recommendation primarily targets pathogens and fecal indicator bacteria, implementation of it would also reduce inputs of nutrients to surface waters through MS4s.

3. **It is recommended that the municipalities and counties in the watershed continue to evaluate their practices regarding the application of chlorides for ice and snow control and strive to obtain optimal application rates to ensure public safety without applying more chlorides than necessary for that purpose. It is also recommended that municipalities consider alternatives to**

current ice and snow control programs. It if further recommended that education programs be implemented to provide information about 1) alternative ice and snow control measures in public and private parking lots and 2) optimal application rates in such areas. Educational programs should target both county and municipal staff and private applicators.

4. **It is recommended that information and education programs required under municipal WPDES stormwater discharge permits promote voluntary practices that optimize urban fertilizer application consistent with the requirements of Wisconsin Department of Natural Resources (WDNR) Technical Standard No 1100, "Interim Turf Nutrient Management."** As a refinement of this recommendation from the RWQMPU, **it is recommended that these programs should also promote voluntary compliance with the existing restrictions under Wisconsin Law on the sale, use, and display of fertilizers containing phosphorus.**[13]

5. **It is recommended that all municipalities in the watershed have pet litter control ordinance requirements and that those requirements be enforced. Further measures to address pet litter should be considered on a site-specific basis in response to identified water quality problems resulting from pets.**

6. **It is recommended that existing litter and debris control programs along the urban streams of the watershed be continued and that opportunities to expand such efforts be explored.**

7. **It is recommended that existing pump-out facilities for holding tanks and marine sanitation devices on recreational boats docked along or using the Root River be maintained and upgraded and expanded as necessary.** As a refinement of this recommendation from the RWQMPU, **it is also recommended that those marinas located along the Root River that are not certified as clean marinas under the Wisconsin Clean Marina Program should be encouraged to seek certification.**

Specific projects recommended to address urban nonpoint source pollution are included in Table 79.

Green Infrastructure
The Root River watershed restoration plan encourages the use of green infrastructure to manage stormwater. The U.S. Environmental Protection Agency (USEPA) defines green infrastructure as "an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure management approaches and technologies infiltrate, evapotranspire, capture, and reuse stormwater to maintain or restore natural hydrologies."[14] This is an approach that helps store, convey, and use rainwater in more natural ways. Green infrastructure complements the gray infrastructure, such as sewer pipes, storage tunnels, and water reclamation facilities that have been, and will continue to be, the backbone for meeting water quality and flood management goals. While green infrastructure cannot entirely replace the capacity of gray infrastructure in urban areas, it can add needed capacity.

Municipal codes and ordinances have a broad impact on the use of green infrastructure. Depending on their specifics, they can provide incentives for, or present barriers to, the implementation of green infrastructure by the private and public sectors. Modifications to local codes, ordinances, and review processes can encourage municipalities, builders, and developers as well as property owners to implement green infrastructure practices. **It is recommended that the counties and municipalities in the Root River watershed review their codes to**

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[13]*These restrictions are set forth in Section 94.643 of the* Wisconsin Statutes.

[14]*U.S. Environmental Protection Agency,* Reducing Stormwater Costs through Low Impact Development Strategies and Practices, *2007.*

identify barriers to the implementation of green infrastructure practices within their jurisdictions. A systematic review and audit of municipal codes and ordinances for barriers to green infrastructure implementation has recently been conducted for the Menomonee River watershed by MMSD, the Milwaukee County Environmental Services Division, the Southeastern Wisconsin Watersheds Trust (Sweet Water), and eight municipalities in the watershed.[15] **It is recommended that such an audit of municipal codes and ordinances for barriers to green infrastructure implementation be conducted in the Root River watershed.** The results of such an audit could be used by municipalities in the consideration of revisions to their codes and ordinances that would remove barriers to the implementation of green infrastructure strategies. Some economy of scale could be achieved by the municipalities of the watershed collaborating on an audit, and perhaps involving experts in the fields of green infrastructure and code and ordinance development. The total estimated cost of this audit is $75,000.

A consideration in the implementation of green infrastructure in urban areas is the presence of brownfields. Brownfields are abandoned, idle, or underused commercial or industrial properties. In some instances, the redevelopment and reuse of these properties is hindered by the presence of contamination related to previous activities. The presence of contaminated soils or other contamination on these sites can limit the use of some green infrastructure strategies. Specifically, strategies that rely on infiltration of stormwater are generally not usable on brownfield sites, as they may facilitate the transportation of contaminants into groundwater. Green roofs, cisterns, and rain barrels would be the most appropriate strategies to use on these sites, although in some cases limited infiltration may be accomplished if uncontaminated fill is placed on a site, or runoff is directed to areas of uncontaminated soil. Previous studies have inventoried brownfields and contaminated sites, both within the City of Racine[16] and the Root River Corridor in downtown Racine.[17] More recent information and information on other areas in the watershed can be obtained from the WDNR.[18] A guidance document is available from the USEPA to assist communities, developers, and other stakeholders in determining the appropriateness of implementing stormwater management practices that promote infiltration at vacant parcels and brownfield sites.[19]

Green Infrastructure in the MMSD Planning Area

The MMSD has developed a green infrastructure plan for its planning area.[20] As shown on Map 89, this planning area includes all of the portions of the Root River watershed that are located within Milwaukee and Waukesha Counties as well as the former Caddy Vista Sanitary District in the Village of Caledonia in Racine County. In developing this plan, the District undertook a detailed data analysis of the opportunities and constraints for implementing green infrastructure strategies. Extensive data collection and mapping were conducted as part of this planning effort. These analyses include quantification of the numbers of roads, buildings, and parking lots in the planning area that can be treated with green infrastructure.

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[15]*It should be noted that the Cities of Greenfield, Milwaukee, and West Allis, which are partially located in the Root River watershed, are among the municipalities included in this review and audit of municipal codes.*

[16]*SEWRPC Community Assistance Planning No. 305,* A Comprehensive Plan for the City of Racine: 2035, *November 2009.*

[17]*River Alliance of Wisconsin,* Root River Planning Property Boundary Inventory, *August 2010.*

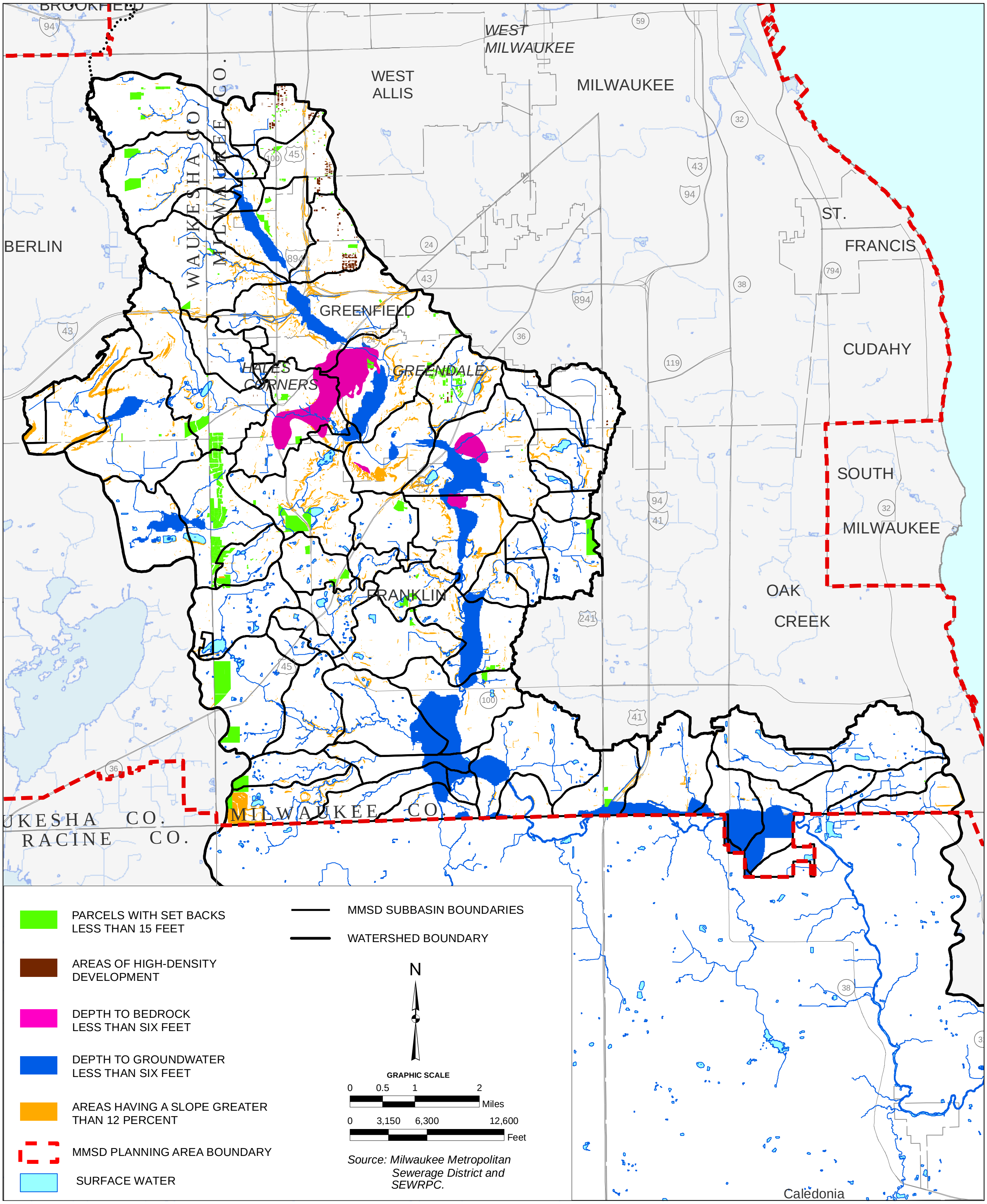
[18]*Available on the WDNR website at* http://dnr.wi.gov/topic/Brownfields/clean.html.

[19]*U.S. Environmental Protection Agency,* Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfield Sites, *USEPA Publication No. 905F13001, July 2013.*

[20]*Milwaukee Metropolitan Sewerage District,* Regional Green Infrastructure Plan, *June 2013.*

Map 89

POTENTIAL CONSTRAINTS TO USE OF GREEN INFRASTRUCTURE STRATEGIES WITHIN THE PORTION OF THE ROOT RIVER WATERSHED LOCATED IN THE MILWAUKEE METROPOLITAN SEWERAGE DISTRICT PLANNING AREA



The objectives of the MMSD green infrastructure plan include:

1. Capturing the first 0.5 inch of rainfall from impervious surfaces through green infrastructure;

2. Striving toward a rainwater harvest goal of capturing the first 0.25 gallon per square foot of area of rainfall for reuse;

3. Complementing MMSD's Private Property Infiltration and Inflow Program and Integrated Regional Stormwater Management Program;

4. Helping municipalities and other entities prioritize green infrastructure actions;

5. Helping to meet receiving water quality standards by acknowledging watershed restoration plan recommendations; and

6. Meeting MMSD's WPDES discharge permit requirements for green infrastructure volume capture.

As part of its approach to meeting these objectives, the plan developed watershed-specific recommendations for the installation of green infrastructure over the plan implementation period of 2014 through 2035. These recommendations were based on individual characteristics of each watershed. Specific recommendations for the Root River watershed include:

- Porous pavement: The installation or retrofitting of porous pavement equivalent to 1,260 average city blocks (6,300 acres) having 25 percent porous pavement.[21]

- Bioretention/rain gardens: The installation of bioretention and rain gardens equivalent to 25,000 150-square foot rain gardens.

- Stormwater trees: The planting of nine new trees per average city block.

- Green roofs: The installation or retrofitting of 1,000 buildings with green roofs.[22]

- Cisterns: The installation of cisterns with a capacity of 1,000 gallons at 280 large buildings.[23]

- Native landscaping: The conversion of an area equivalent to 200 average city blocks (1,000 acres) to native landscaping.

- Rain barrels: Installation of one rain barrel at 22,400 homes.

- Soil amendments: The addition of soil amendments to soil over an area equivalent to 500 average city blocks (2,500 acres).

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[21]*For purposes of the MMSD green infrastructure plan, the area of the average city block is estimated to be five acres.*

[22]*The plan estimates the average green roof size to be 5,000 square feet.*

[23]*The plan defines large buildings as those with roof areas greater than 6,500 square feet.*

Table 81

GREEN INFRASTRUCTURE STRATEGIES RECOMMENDED FOR IMPLEMENTATION BY 2035 IN THE PORTION OF THE ROOT RIVER WATERSHED LOCATED IN THE MMSD PLANNING AREA

Green Infrastructure Strategy	Units	Number of Units	Average Annual Stormwater Volume Captured (million gallons)	Cost (dollars)
Porous Pavement	Average city blocks[a]	1,260	17,837.8	$ 44,000,000
Bioretention/ Rain Gardens	150-square-foot rain gardens	25,000	600.0	49,000,000
Stormwater Trees	Trees[b]	82,710	116.2	12,000,000
Green Roofs	Buildings with 5,000-square-foot green roofs	1,000	85.0	25,000,000
Cisterns	Large buildings with 1,000-gallon cisterns[c]	280	15.9	1,000,000
Native Landscaping	Average city blocks[a]	200	566.3	3,000,000
Rain Barrels	Number	22,400	68.6	3,000,000
Soil Amendments	Average city blocks[a]	500	1,197.9	8,000,000
Total	- -	- -	20,487.7	$145,000,000

[a]*The area of an average city block is estimated as being five acres.*

[b]*The MMSD Green Infrastructure Plan recommends the planting of nine new trees per average city block. The area of the portion of the Root River watershed that is located within the MMSD planning area is about 9,190 average city blocks.*

[c]*The plan defines large buildings as those with roof areas greater than 6,500 square feet.*

Source: Milwaukee Metropolitan Sewerage District.

When fully implemented, recommended green infrastructure strategies would capture an average of about 20,488 million gallons of stormwater in the portions of the Root River watershed that are located within the MMSD planning area each year. This would result in average annual loading reductions of about 1,855,600 pounds total suspended solids (TSS) and 6,450 pounds total phosphorus.[24] The capital costs of full implementation in the Root River watershed are estimated as being $145 million. The stormwater capture volumes, stormwater storage, and costs associated with full implementation of the recommendations for the watershed are broken down by green infrastructure strategy in Table 81.

The MMSD green infrastructure plan envisions that implementation of its recommendations will begin slowly with higher levels of implementation occurring later in its implementation period. The MMSD plan's timeline for achieving an equivalent 0.5-inch rainwater volume capture indicates that the plan envisions that about 1 percent of the green infrastructure strategies it recommends will be installed by the end of 2018 and about 7 percent of the green infrastructure strategies it recommends will be installed by the end of 2019. Table 82 shows the implementation benchmarks for the MMSD green infrastructure plan.

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[24]*It is estimated that full implementation of the MMSD green infrastructure plan would result in average annual TSS load reductions of 15,109,000 pounds and average annual total phosphorus load reductions of 54,450 pounds in the MMSD planning area. To estimate the portion of these reductions that would occur in the Root River watershed, the load reductions attributable to reduced combined sewer overflow volumes that would result from the implementation of green infrastructure strategies was subtracted from the total load. The resulting total was multiplied by the percentage of the impervious area in the MMSD planning area that is represented by impervious areas in the portion of the Root River watershed that is located in the MMSD planning area.*

Table 82

TIMELINE FOR ACHIEVING AN EQUIVALENT 0.5-INCH RAINWATER CAPTURE VOLUME ENVISIONED IN THE MMSD GREEN INFRASTRUCTURE PLAN: 2013-2035

Year	Level of Implementation (percent)
2013	0.0
2015	0.4
2018	1.1
2019	7.0
2020	12.0
2025	42.0
2030	71.0
2035	100.0

Source: Milwaukee Metropolitan Sewerage District.

As part of the Root River watershed restoration plan, it is recommended that green infrastructure strategies be implemented within the portions of the Root River watershed that are located within the MMSD planning area in accordance with and on the schedule given in the MMSD green infrastructure plan. This would require implementation of about 7 percent of the green infrastructure strategies recommended in the green infrastructure plan by the end of the watershed restoration plan's five-year implementation period at the end of 2019. For each recommended green infrastructure strategy, Table 83 presents the number of units that would need to be installed through 2019 in order to meet the target established by this recommendation and the attendant costs. The capital costs associated with this recommendation are about $10.2 million. This level of implementation of green infrastructure would result in the average annual capture of about 1,426 million gallons of stormwater and average annual loading reductions of about 130,000 pounds total suspended solids (TSS) and 450 pounds total phosphorus.[25]

The MMSD green infrastructure plan notes that some areas within the Root River watershed have characteristics that may limit the use of some green infrastructure strategies. These characteristics include areas having land slopes greater than 12 percent, areas where the depth to bedrock is less than six feet, areas where the depth to groundwater is less than six feet, small parcels in areas of high-density urban development, and areas where parcels have setback from the street right-of-way of less than 15 feet. The areas in the Root River watershed that have these limitations are shown on Map 89. The plan specifically notes the presence of shallow bedrock and high groundwater within the Villages of Greendale and Hales Corners. The plan indicates that the design of green infrastructure projects in these areas should include measures to protect groundwater quality. It recommends the use of green infrastructure strategies that do not rely solely, or at all, on infiltration, such as green roofs, rain barrels, and cisterns, within these areas.[26]

The MMSD green infrastructure plan includes a prioritization of areas within the Root River watershed for installation of green infrastructure. This prioritization identified subbasins of the surface water drainage system that presented the greatest opportunities for installation of green infrastructure and the greatest potential benefits from installing green infrastructure. This prioritization was conducted for the entire MMSD service area and was based on 11 factors, six of which were related to opportunities for installation of green infrastructure and five of which were related to potential benefits from installing green infrastructure. These factors include:

[25]*These estimated load reductions represent about 7 percent of the reductions that would occur in the Root River watershed with full implementation of the MMSD green infrastructure plan.*

[26]*While rain water collected in rain barrels and cisterns would ultimately be used to water vegetation, it is likely that much of the water applied would be transpired by plants.*

Table 83

GREEN INFRASTRUCTURE STRATEGIES RECOMMENDED FOR IMPLEMENTATION BY 2019 IN THE PORTION OF THE ROOT RIVER WATERSHED LOCATED IN THE MMSD PLANNING AREA

Green Infrastructure Strategy	Units	Number of Units	Average Annual Stormwater Volume Captured (million gallons)	Cost (dollars)
Porous Pavement	Average city blocks[a]	88	1,245.8	$ 3,080,000
Bioretention/ Rain Gardens	150-square-foot rain gardens	1,750	42.0	3,430,000
Stormwater Trees	Trees[b]	5,790	8.1	840,000
Green Roofs	Buildings with 5,000-square-foot green roofs	70	1.2	1,750,000
Cisterns	Large buildings with 1,000-gallon cisterns[c]	20	1.1	70,000
Native Landscaping	Average city blocks[a]	14	39.6	210,000
Rain Barrels	Number	1,570	4.8	210,000
Soil Amendments	Average city blocks[a]	35	83.9	560,000
Total	- -	- -	1,426.5	$10,150,000

[a]*The area of an average city block is estimated as being five acres.*

[b]*The MMSD Green Infrastructure Plan recommends the planting of nine new trees per average city block. The area of the portion of the Root River watershed that is located within the MMSD planning area is about 9,190 average city blocks.*

[c]*The plan defines large buildings as those with roof areas greater than 6,500 square feet.*

Source: Milwaukee Metropolitan Sewerage District.

A. Opportunities for green infrastructure implementation:

1. The presence and amount of vacant land in the subbasin;

2. The presence and amount of potential redevelopment areas in the subbasin;

3. The presence and amount of existing areas of green infrastructure in the subbasin;

4. The presence and amount of parks in the subbasin;

5. The presence and number of selective sewer separation opportunities in the subbasin;[27] and

6. The presence and number of potential stream corridor restoration locations in the subbasin;

B. Areas with multiple potential benefits from green infrastructure implementation:

7. Subbasins with high inflow to the Inline Storage System (deep tunnel);[28]

[27]*This factor does not relate to the Root River watershed because there are no combined sewers in the watershed.*

[28]*This factor does not relate to the Root River watershed because there are no sewers tributary to the deep tunnel in the watershed.*

8. Subbasins containing areas of basement backups;

9. Subbasins containing potential drainage problem areas;

10. Subbasins containing areas with potentially high inflow and infiltration into sanitary sewers; and

11. Subbasins located within high pollutant loading areas.[29]

The analysis classified subbasins as having high, medium, or low priority for implementation of green infrastructure strategies. This classification is shown on Map 90. It identifies 11 subbasins as being high-priority areas, 45 subbasins as being medium priority areas, and 14 subbasins as being low-priority areas for the implementation of green infrastructure strategies. The plan uses these results to identify the 10 subbasins in the watershed with the highest priority for installation of green infrastructure strategies. These subbasins are shown on Map 91. **For the 2015-2019 implementation period of the Root River watershed plan, it is recommended that efforts to implement green infrastructure in the portions of the Root River watershed located in the MMSD planning largely focus on the 10 subbasins identified as high priority on Map 91.**

Green Infrastructure Outside of the MMSD Planning Area

It is recommended that the installation of green infrastructure strategies be pursued in the urban areas outside of the MMSD planning area. This would include installation of these strategies in portions of the City of Racine and the Villages of Caledonia, Mt. Pleasant, Sturtevant, and Union Grove that are located within the Root River watershed.

As part of redevelopment planning for the Root River corridor in downtown Racine, the RootWorks plan identifies about 16 acres of rooftop that could be used for rainwater harvesting through cisterns or green roofs.[30] It notes that these areas are privately owned buildings and would require the involvement and cooperation of the property owners. These potential for installing appropriate green infrastructure strategies at these buildings should be evaluated.

Green Infrastructure Throughout the Watershed

As noted in Chapter IV, at a threshold connected impervious range of 8 to 12 percent changes in properties of streams—such as increased temperature and turbidity, reduced dissolved oxygen concentration, and increased concentrations of pollutants—can occur. These changes can lead to a decline in the biological integrity of the stream.

Based on evaluation of the connected impervious area percentages by assessment area for existing year 2010 and planned year 2035 land use conditions as set forth in Table 20 in Chapter IV of this report, **it is recommended that sufficient green infrastructure projects be implemented for new development to capture significant volumes of precipitation in the Hoods Creek assessment area—which currently exceeds the low end of the threshold range but is anticipated to experience significant development—and in the four assessment areas that could transition to exceeding the limit between 2010 and 2035 (Upper West Branch Root River Canal,**

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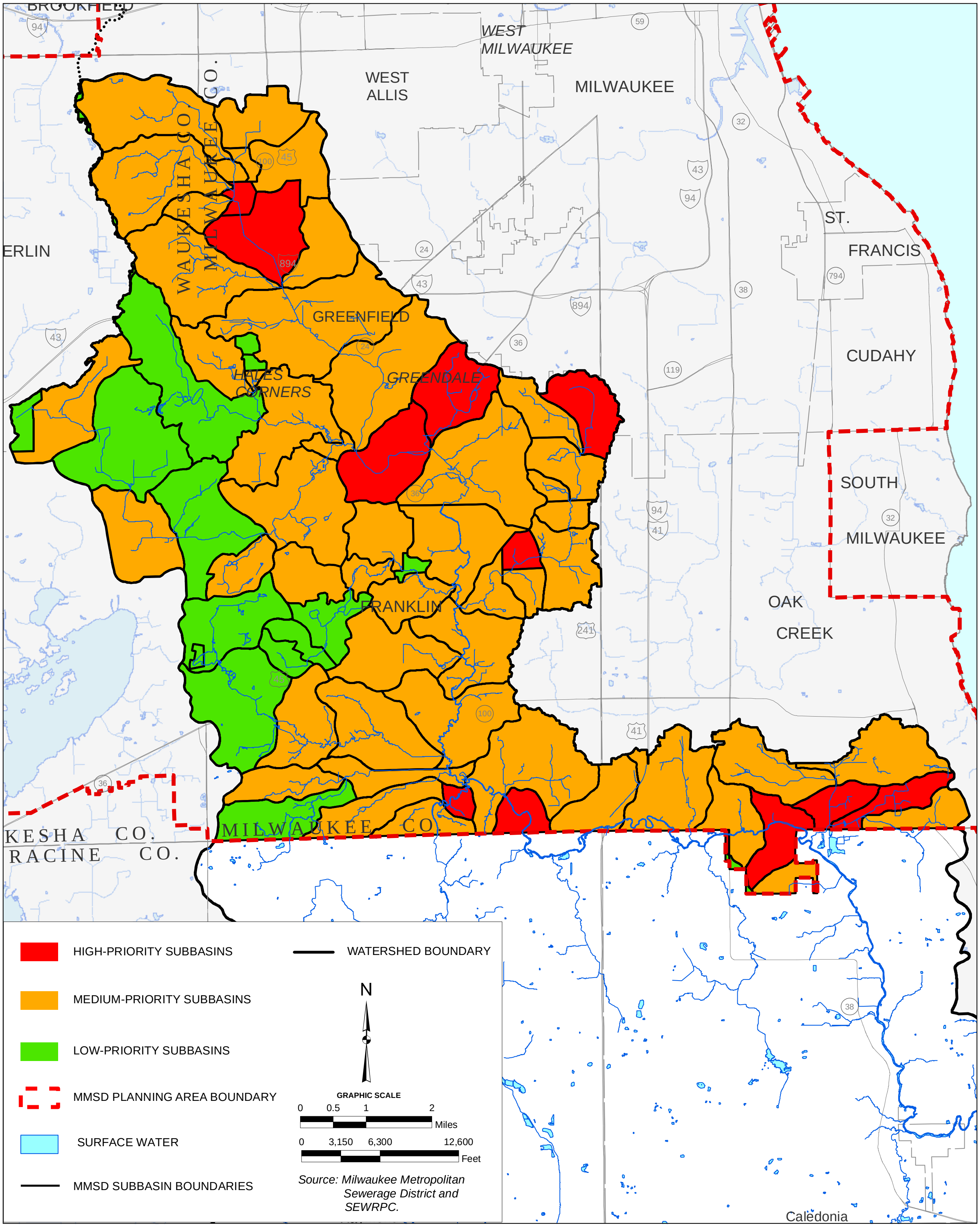
[29]*High pollutant loading areas were identified from the results of the calibrated water quality model that are presented in SEWRPC Planning Report No. 50,* op. cit*.*

[30]*Root River Council, City of Racine, and River Alliance of Wisconsin*, RootWorks—Revitalizing Racine's Urban River Corridor, *July 2, 2012.*

Map 90

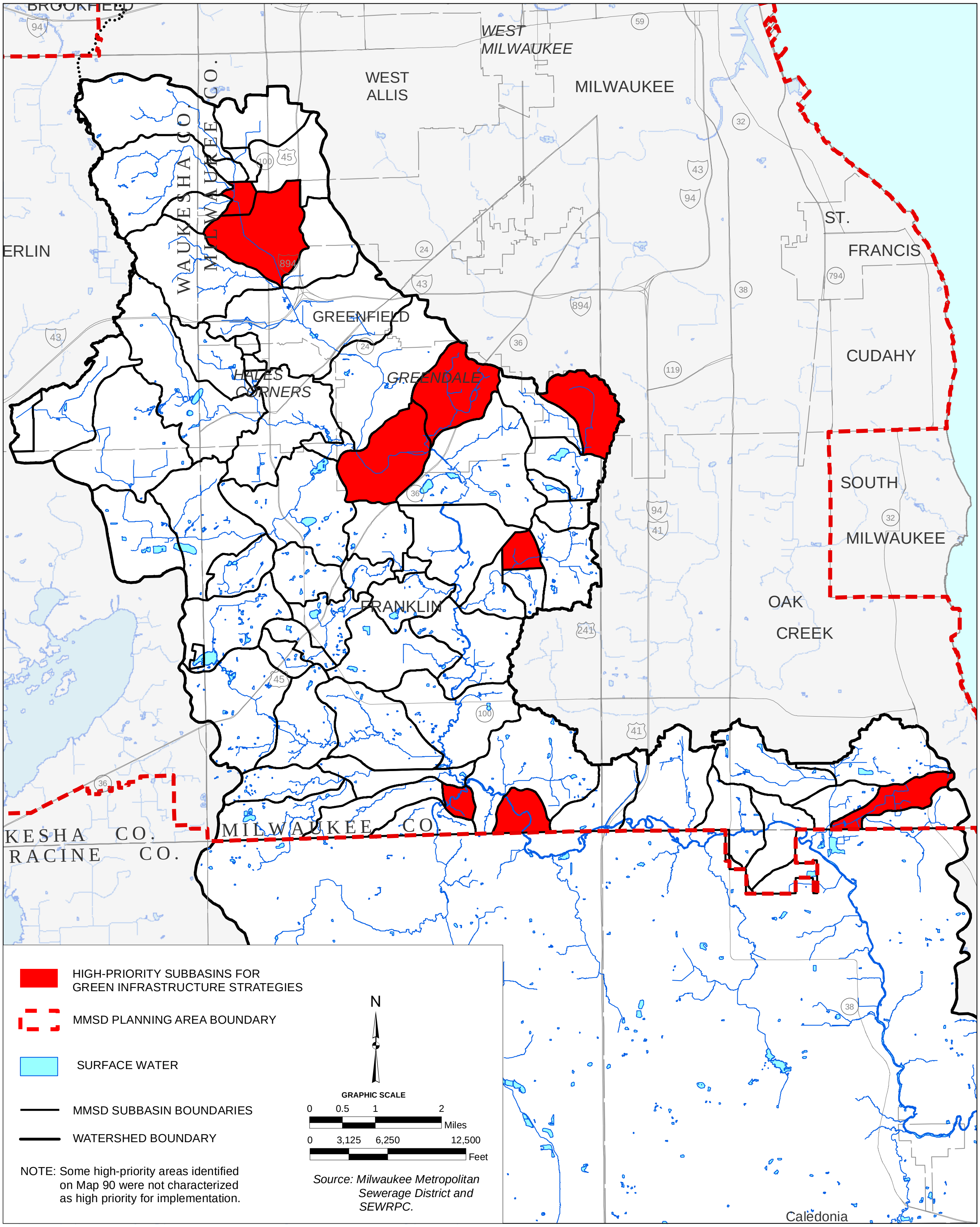
COMBINED BENEFIT AND OPPORTUNITY RANKS FOR THE USE OF GREEN INFRASTRUCTURE STRATEGIES WITHIN THE PORTION OF THE ROOT RIVER WATERSHED LOCATED IN THE MMSD PLANNING AREA



Source: Milwaukee Metropolitan Sewerage District and SEWRPC.

Map 91

HIGH-PRIORITY SUBBASINS FOR THE IMPLEMENTATION OF GREEN INFRASTRUCTURE STRATEGIES WITHIN THE PORTION OF THE ROOT RIVER WATERSHED LOCATED IN THE MILWAUKEE METROPOLITAN SEWERAGE DISTRICT PLANNING AREA



NOTE: Some high-priority areas identified on Map 90 were not characterized as high priority for implementation.

Source: Milwaukee Metropolitan Sewerage District and SEWRPC.

East Branch Root River Canal, Middle Root River-Ryan Creek,[31] and Lower Root River-Caledonia). Also, **it is recommended that green infrastructure be implemented to manage stormwater through infiltration of runoff from existing and new development to mitigate the effects of connected impervious area in those other assessment areas that have existing 2010 and planned 2035 impervious percentages that are above, or within, the threshold range (see Table 20 in Chapter IV of this report).**

Recommended Rural Nonpoint Source Pollution Control Measures
The recommendations of the 2007 SEWRPC RWQMPU as they relate to rural nonpoint source pollution in the Root River watershed were reviewed (see Chapter II of this report) and reevaluated under this watershed restoration planning effort. Based on that review and reevaluation—which included consideration of the additional water quality monitoring data collected since the RWQMPU was issued and of recommendations that have already been implemented—the current applicability of the recommendations of the RWQMPU was confirmed. Thus, the following RWQMPU recommendations are reiterated under this plan:

1. **Expand the application of practices to reduce soil loss from cropland to attain erosion rates less than "T," the tolerable soil loss rate.**[32] The RWQMPU called for implementation of this recommendation by 2020. This could be accomplished through a combination of practices, including, but not limited to, expanded conservation tillage, grassed waterways, use of cover crops, and riparian buffers. The applicable measures should be determined by the development of farm management plans which are consistent with the county land and water resource management plans. It should be noted that the benefits of expansion of these practices in reducing sediments and nutrients delivered to the streams of the watershed were explicitly represented in the water quality modeling analyses conducted for the RWQMPU and are reflected in the water quality results presented in Chapter V of this report.

2. **The provision of six months of manure storage is recommended for all livestock operations in the watershed with 35 combined animal units or more.**[33,34] This would enable manure to be spread on fields twice annually during periods when the ground would not be frozen prior to spring planting and after summer and fall harvest. It would thus reduce loadings of nutrients such as phosphorus to waterbodies.

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[31]*As shown on Map 89, the Middle Root River-Ryan Creek assessment area includes some areas with potential constraints on implementing green infrastructure, but there are considerable areas with no identified constraints. While there are not significant lands in this assessment area that are identified as high priority under the MMSD green infrastructure plan (see Map 91), under this watershed restoration plan the area is given a high priority because of the need to mitigate the potential effects of anticipated development.*

[32]*"T-value" is the tolerable soil loss rate—the maximum level of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely, as determined by the U.S. Natural Resource Conservation Service. "Excessive" cropland erosion refers to erosion in excess of the tolerable rate, or T-value.*

[33]*Section NR 243.05 of the* Wisconsin Administrative Code *sets forth two methods for calculating animal units: one method based on "combined animal units" and one based on "individual animal units." In determining the number of animals for which the manure storage recommendation of RWQMPU applies, the RWQMPU recommends that the method be applied that yields the lowest number of animals for a given category. For example, based on that approach, 35 animal units are equivalent to 25 milking cows, 35 steers, 87 55-pound pigs, and 1,050 to 4,375 chickens, depending on the type and whether the manure is liquid or nonliquid.*

[34]*Also see the "Agricultural Manure and Barnyard Runoff Management" subsection on pages 594-595 in this chapter.*

3. **It is recommended that nutrient management plans be prepared for all agricultural operations in the watershed that do not currently have them and that application of manure and other nutrients to fields occur only in accordance with nutrient management plans.**

4. **The provision of barnyard runoff control systems is recommended for all livestock operations in the watershed.** Such systems consist of facilities or practices used to contain, divert, retard, or otherwise control the discharge of runoff from outdoor areas of concentrated livestock activity.

5. **It is recommended that practices be installed to exclude livestock from waterbodies and adjacent riparian areas.** This should be implemented as part of the provision of barnyard runoff control systems and should consist of both installing fences along narrow strips of land along the waterbodies and providing animals with alternative sources of drinking water to reduce the amount of time they spend near waterbodies.

6. **It is recommended that marginal cropland and pastureland be converted into wetlands and prairies.** The RWQMPU recommended that a total of 10 percent of existing farmland and pasture be converted to either wetland or prairie conditions and that the focus of this effort should be on marginally productive lands, which are defined as agricultural lands other than those highly productive lands designated as Class I and Class II lands by the U.S. Natural Resources Conservation Service. The RWQMPU identified candidate areas to be given first consideration when identifying marginally productive lands to be converted to wetlands and prairies.[35] Approximately 8,685 acres of candidate areas were identified in the Root River watershed. These candidate areas are shown on Map 3 in Chapter II of this report. It should be noted that the benefits of expansion of this practice in reducing fecal coliform bacteria, total suspended solids, and total phosphorus loads delivered to the streams of the watershed were explicitly represented in the water quality modeling analyses conducted for the RWQMPU and are reflected in the water quality results presented in Chapter V of this report. These conversions can be used to create new, and augment existing, riparian buffers.

7. **It is recommended that measures be taken to ensure proper handling and treatment of milking center wastewater from dairy farms.**

The RWQMPU made three additional recommendations related to rural nonpoint source pollution control measures that are refined herein for the Root River watershed under this watershed restoration plan.

First, the RWQMPU recommended that, at a minimum, county-enforced inspection and maintenance programs be implemented for all new or replacement private onsite wastewater treatment systems (POWTS) constructed after the date on which the counties adopted private sewage system programs, that voluntary county programs be instituted to inventory and inspect POWTS that were constructed prior to the dates on which the counties adopted private sewage system programs, and that the WDNR and the counties work together to strengthen oversight and enforcement of regulations for disposal of septage and to increase funding to adequately staff and implement such programs. As described in Chapter V of this report, regulations regarding POWTS set forth by the Wisconsin Department of Safety and Professional Services in Section SPS 383.255 of the *Wisconsin Administrative Code* mandate an expansion of county and municipal POWTS programs. Under the current rules, units of government

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[35]*It should be noted that the MMSD conservation and greenway connection plans program (Greenseams) provides for the purchase, from willing sellers, of natural wetlands to retain stormwater with the intention of reducing the risk of flooding, protecting riparian land from development, and providing increased public access. The MMSD facilities plan recommends that these programs continue and be integrated with the regional water quality management plan update recommendations regarding environmental corridors and conversion of cropland and pasture to wetland and prairie conditions.*

are required to complete inventories of POWTS in their jurisdictions by October 1, 2017, and have the other elements of the program in place by October 1, 2019.[36] Given that these dates are within the implementation period of this watershed restoration plan, it was judged that it would be acceptable for POWTS programming to be implemented in accordance with the deadlines given in SPS 383.255. Thus, **it is recommended that counties and municipalities in the watershed implement expanded POWTS programs in accordance with the deadlines given in SPS 383.255**.

Second, the RWQMPU recommends that nutrient management requirements for concentrated animal feeding operations (CAFOs) be based upon the permit conditions for those operations under the WPDES.[37] The inventories conducted as part of this planning effort indicate that there are currently no CAFOs located within the Root River watershed. **Should any CAFOs be established within the watershed, it is recommended that nutrient management requirements for such operations be based upon the conditions given in their WPDES permits.**

Third, the RWQMPU makes several recommendations relative to riparian buffers, including:

- Where existing riparian buffers adjacent to crop and pasture lands are less than 75 feet in width, expanding the buffer to a minimum width of 75 feet;

- Pursuing opportunities to expand riparian buffers beyond the recommended minimum 75-foot width along high-quality stream systems, including those that can support and sustain the life cycles of economically important species such as salmon, walleye, and northern pike; and

- Limiting the number of stream crossings and configuring them to minimize the fragmentation of streambank habitat.

Recent research has revealed much about the beneficial role of riparian buffers in protecting water quality, groundwater quality and recharge, fisheries, wildlife, and ecological resilience to invasive species.[38] In view of the results of this research, the general recommendations of the Root River watershed restoration plan consists of the following refinements of the general buffer recommendations in the RWQMPU:

- **It is recommended to protect and expand riparian buffer regions to the greatest extent possible with a minimum 75-foot width and an optimum 1,000-foot-width goal.** The literature has revealed that a 75-foot setback width can provide highly productive instream habitat and significant pollution reduction. It also shows that the protection of a 400-foot minimum and 900-foot optimum riparian buffer width has significant benefits to wildlife populations. Given this information it has been decided that the protection and expansion of riparian buffers to 1,000 feet from the ordinary high water mark, or within the boundaries defined by floodplains or wetlands, whichever is greater, should be a priority for this watershed.

- **It is recommended that the continuity and connectivity of riparian buffers be protected and increased.** Fragmentation of riparian buffers by roads, railways, and utilities, combined with encroachment by development, impacts the structure and function of riparian corridors and reduces

[36]*It should be noted that the State Legislature has twice extended these deadlines.*

[37]*Chapter NR 243, "Animal Feeding Operations," of the* Wisconsin Administrative Code *sets forth nutrient management requirements for CAFOs.*

[38]*For example, see the review in SEWRPC Riparian Buffer Management Guide No. 1,* Managing the Water's Edge: Making Natural Connections, *2010, which is included as Appendix B in this report.*

their ability to adequately protect waterways and wildlife habitat. Stream crossings also tend to have a cumulative impact on the stream and associated lands, as well as an impact on the quality of water and the fishery. Therefore, it is important to reduce the linear fragmentation of the existing riparian buffers by either removing crossings where possible or by not increasing the number of crossings where practical. It is recognized that police, fire protection, and emergency medical service access is an overriding consideration that must be applied in determining whether the objective of removing a crossing is feasible. This recommendation is only meant to apply to situations where more road crossings are present than are necessary to ensure adequate access for emergency services.

More detailed recommendations are given in the section on recommendations for habitat later in this chapter.

Specific projects recommended to address rural nonpoint source pollution are included in Table 79.

Agricultural Best Management Practice (BMP) Pilot Projects

It is recommended that pilot projects be conducted to evaluate the performance of several agricultural best management practices (BMPs) under field conditions in the Root River watershed in order to determine whether these practices would be useful in reducing contributions of pollutants, especially nutrients, from agricultural fields in the watershed. Several of these BMPs are designed to treat drainage from agricultural drain tile to surface waters.

Because of the nature of the soils present in portions of the watershed, much of the agricultural land in the Root River watershed is artificially drained through the use of subsurface drain tile. These tiles often discharge directly into streams or into ditches that discharge into streams. Because they provide a direct pathway from fields to surface waterbodies, drain tiles can allow water and pollutants to bypass agricultural BMPs, especially riparian buffers. This bypass effect acts to reduce the effectiveness of the BMPs. Research conducted at the University of Wisconsin-Discovery Farms illustrates this bypass effect.[39] In fields with intact drain tile, between 15 to 34 percent of the total phosphorus, 78 to 87 percent of the nitrogen, and about 25 percent of the sediment leaving the field moved through the drain tile. In fields with damaged drain tile (i.e., tile blow outs), about 65 percent of the total phosphorus and the majority of sediment leaving the fields traveled through drain tile. These results show that drain tiles can constitute a major pathway through which sediment and nutrients travel from agricultural fields to surface waters.

Several practices could be used to address the contributions of sediment and nutrients to surface waters from drain tile; however, the performance of these practices with respect to phosphorus and with respect to the types of conditions present within the Root River watershed are not well understood. Because of this, it would be desirable to conduct pilot projects in the watershed in which these practices could be installed and tested and their performance evaluated. County conservation staff could use the results of such pilot projects to devise strategies for addressing the “bypassing effect” of drain tiles. Three strategies for treating tile drainage that could be evaluated—drainage water management, saturated buffers, and woodchip bioreactors—are discussed below.

DRAINAGE WATER MANAGEMENT

Drainage water management is the practice of using a water control structure in a main, submain, or lateral drain to vary the depth of the drainage outlet. When this is done, the water table must rise above the outlet depth for drainage to occur. This allows the minimum depth of the water table under the field to be controlled through use of the control structure in order to reduce tile flow during periods when a higher water table would not present a problem for crop production. For example, for a field managed using a corn-soybean rotation, the outlet depth, as determined by the control structure, would be:

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[39]*Eric Cooley, “Nutrients Discharging from Drain Tiles in Eastern Wisconsin,” Presentation at the Eighth Annual Clean Rivers, Clean Lake Conference, Milwaukee, Wisconsin, April 30, 2012.*

- Raised after harvest to limit drainage outflow and reduce the delivery of nutrients to ditches and streams during the off-season;
- Lowered in early spring and again in the fall so the drain can flow freely before field operations, such as planting or harvest; and
- Raised again after planting and spring field operations to create the potential to store water for the crop to use during the summer.

Drainage water management can reduce nutrient loads in drain flow. Studies have found reductions in annual nitrate loads ranging between 15 percent and 75 percent, depending upon location, climate, soil type, and cropping practice.[40] Few data are available regarding the performance of this practice with respect to phosphorus. Because of this, it would be useful to conduct a small number of pilot projects in agricultural areas of the Root River watershed that are drained by drain tiles in order to evaluate this practice's performance with respect to phosphorus and the practicality and utility of this practice for reducing nutrient contributions to surface waters.

SATURATED BUFFERS

Saturated buffers, unlike ordinary riparian buffers, capture and treat water from tile drainage. A saturated buffer has a control structure that redirects flow from a main tile line through a lateral distribution line into the buffer. Once within the buffer soils, the water redirected from the tile percolates deeper into the soil or gets taken up by vegetation. In its study at Bear Creek in Iowa, the Leopold Center for Sustainable Agriculture at Iowa State University found that the use of a saturated buffer reduced annual nitrate loads by about 55 percent. While no data have yet been collected regarding the performance of saturated buffers with respect to phosphorus, it would be expected that uptake by plants growing within the buffers would reduce the amount of phosphorus contributed to streams. Because of this, it would be useful to conduct a small number of pilot projects in agricultural areas of the Root River watershed that are drained by drain tiles in order to evaluate this practice's performance with respect to phosphorus and the practicality and utility of this practice for reducing nutrient contributions to surface waters.

WOODCHIP BIOREACTORS

Woodchip bioreactors are constructed by routing drainage water through an underground trench filled with wood chips. Anaerobic soil bacteria within the bioreactor convert nitrate to gaseous nitrogen. The design includes inflow and outflow control structures which control the amount of water entering the bioreactor and ensure that water remains in the bioreactor long enough for denitrification to occur. Studies have shown that woodchip bioreactors can reduce annual loads of nitrate contributed to streams by drain tiles by between 40 and 65 percent.[41] Fewer data are available regarding the performance of woodchip bioreactors with respect to phosphorus. A study in Minnesota found that this practice produced reductions of total phosphorus ranging between 0 and 30 percent during snow melt and up to 54 percent during spring and summer.[42] The same study found that woodchip bioreactors produced reductions in loads of fecal indicator bacteria ranging between 60 and 69 percent. Because of this, it would be useful to conduct a small number of pilot projects in agricultural areas of the Root River watershed that are drained by drain tiles in order to evaluate the practicality and utility of this practice for reducing nutrient contributions to surface waters.

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[40]*Purdue University Cooperative Extension Service,* Drainage Water Management for the Midwest, *Purdue University Cooperative Extension Service Publication No. WQ-44, August, 2006.*

[41]*See literature review in Laura Elizabeth Christianson,* Design and Performance of Denitrification Bioreactors for Agricultural Drainage, *Ph.D. Dissertation, Iowa State University, Ames, Iowa, 2011.*

[42]*Andry Ranaivoson, John Moncrief, Rod Venteraea, Mark Dittrich, Yogesh Chandler, and Pamela Rice, "Bioreactor Performance in Minnesota," Presentation at the 11th Annual Drainage Research Forum, Owatonna, Minnesota, November 23, 2010.*

Recommendations to Reduce Point Source Pollution

The recommendations of the 2007 SEWRPC RWQMPU as they relate to point source pollution in the Root River watershed were reviewed (see Chapter II of this report) and reevaluated under this watershed restoration planning effort. Based on that review and reevaluation, which included consideration of the additional water quality monitoring data collected since the RWQMPU was issued and of recommendations that have already been implemented, the current applicability of the recommendations of the RWQMPU was confirmed. Thus, the following RWQMPU recommendations are reiterated under this plan:

1. **That unrefined sanitary sewer service areas in the Root River watershed be refined.**[43]

2. **That the City of Racine and the Village of Union Grove maintain and operate wastewater treatment plants.**

3. **That the municipalities in the watershed construct and maintain local sewer systems.** In Milwaukee County, this recommendation applies to all of the municipalities that are wholly or partially located in the watershed, all of which are served by MMSD. In Racine County, this recommendation applies to the City of Racine; the Villages of Mt. Pleasant, Sturtevant, and Union Grove; the Caledonia East and West Utility Districts;[44] the Mt. Pleasant Utility District No. 1; and the Yorkville Sewer Utility District No. 1. In Waukesha County, this recommendation applies to the Cities of Muskego and New Berlin, both of which are served by MMSD.

4. **That detailed facilities planning be undertaken to establish what new conveyance, pumping, and storage facilities would be needed to provide service to the areas in the Villages of Caledonia and Mt. Pleasant that were added to the Racine and environs planned sewer service area in 2007.**[45]

5. **That, when the Yorkville Sewer Utility District No. 1 wastewater treatment plant reaches the end of its useful life, the entire Yorkville sewer service area be connected to the sewerage system tributary to the Racine wastewater treatment plant and the Yorkville treatment plant be abandoned.**[46]

6. **That the municipalities operating local sewerage systems evaluate the need to reduce clearwater infiltration and inflow into sewers and implement Capacity, Management, Operations, and Maintenance (CMOM) programs.**[47]

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[43]*Most of the sanitary sewer service areas within the Root River watershed have been refined. Areas served by MMSD in the Cities of Greenfield, Milwaukee, and West Allis, and the Villages of Greendale and Hales Corners, and a portion of the Yorkville Sewer Utility District's service area, have not been refined.*

[44]*The Caledonia West Utility District includes the Caddy Vista sewer service area, which is served by MMSD.*

[45]*SEWRPC,* Amendment to the Regional Water Quality Management Plan – Villages of Caledonia and Mt. Pleasant, *June 2007.*

[46]*Based on population and sewage flow information available at the time, the RWQMPU concluded that this would likely happen sometime after the year 2020.*

[47]*CMOM is a program initiated by USEPA that provides a framework for municipalities to identify and incorporate widely accepted wastewater industry practices in order to better manage, operate, and maintain collections systems; investigate capacity constrained areas of the collection system; and respond to sanitary sewer overflow events. MMSD rules require that the communities within its service area implement CMOM programs. Section NR 210.23, "Capacity, Management, Operation and Maintenance Programs," of the* Wisconsin Administrative Code *requires that units of government that have WPDES permits for operation of sewerage systems and/or wastewater treatment plants implement CMOM programs by August 1, 2016.*

7. **That discharges from all points of sewerage flow relief in sewerage systems be eliminated.**

8. **That operation of the privately owned wastewater treatment plant that serves Fonk's Mobile Home Park in the Town of Yorkville be continued, that this plant be upgraded as necessary, and that the level of treatment be formulated as part of the Wisconsin Pollutant Discharge Elimination System (WPDES) permitting process.**

9. **That wastewater treatment plant and industrial discharges to surface waters continue to be regulated through the WPDES program, with effluent concentrations of pollutants being controlled to acceptable levels on a case-by-case basis through the operation of the WPDES.**[48]

Wisconsin has recently made two additional compliance options available to point sources permitted under the WPDES system: adaptive management and water quality trading.

Adaptive management is a phosphorus compliance option that allows point and nonpoint sources (*e.g.*, agricultural producers, storm water utilities, and developers) to work together to improve water quality in those waters not meeting phosphorus water quality standards. This option recognizes that the excess phosphorus accumulating in lakes and streams comes from a variety of sources, and that reductions in both point and nonpoint sources are frequently needed to achieve water quality goals. By working in their watershed with landowners, municipalities, and counties to target sources of phosphorus runoff, point sources can minimize their overall investment while helping achieve compliance with water quality-based criteria and improving water quality. Guidance is available from the WDNR that describes adaptive management and how to develop a successful adaptive management strategy.[49] Adaptive management is only applicable to phosphorus discharges.

Water quality trading may be used by WPDES permit holders to demonstrate compliance with water quality-based effluent limitations. This approach may be used for several different pollutants, including phosphorus. Generally, water quality trading involves a point source facing relatively high pollutant reduction costs compensating another party to achieve less costly pollutant reduction with the same or greater water quality benefit. Water quality trading provides point sources with the flexibility to acquire pollutant reductions from other sources in the watershed to offset their point source load so that they will comply with their own permit requirements. Guidance is available from the WDNR that describes water quality trading and developing trades.[50]

There are important differences between these two options. Water quality trading can be applied to a range of pollutants, whereas adaptive management can be applied only to phosphorus. Water quality trading focuses on offsetting pollutants in discharges in order to comply with effluent limitations. Adaptive management focuses on

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[48]*As described in Chapter V of this report: 1) disinfection of wastewater effluent is required only where the WDNR has made a determination that the discharge of wastewater poses a risk to human and animal health, 2) the WPDES permits for the three wastewater treatment plants in the watershed do not require disinfection of effluent, and 3) an evaluation by the SEWRPC staff concluded that adding disinfection to the treatment processes at the three wastewater treatment plants that discharge to surface waters of the Root River watershed would have only a small effect on concentrations of fecal indicator bacteria in the streams receiving discharges from these plants and on downstream waters and the expense of such modifications could be considerable. Therefore, consistent with the current WPDES permits, it is not recommended that the three plants disinfect their effluent.*

[49]*Wisconsin Department of Natural Resources,* Adaptive Management Technical Handbook: A Guidance Document for Stakeholders, *Guidance Number 3800-2013-01, January 7, 2013.*

[50]*Wisconsin Department of Natural Resources,* A Water Quality Trading How To Manual, *Guidance Number 3400-2013-03, September 9, 2013; Wisconsin Department of Natural Resources,* Guidance for Implementing Water Quality Trading in WPDES Permits, *Guidance Number 3800-2013-04, August 21, 2013.*

achieving water quality criteria within the receiving water. These options have different eligibility requirements. They also result in different permit requirements.

Recommended Water Quality Monitoring Plan

Monitoring and information collection programs are invaluable at helping planners, local officials, agency staff, and community members better understand what is taking place within the water resources of the Root River watershed. These programs are necessary in order to assess and evaluate conditions within the watershed. They can provide information to determine where management efforts should focus, help better target management programs, and help determine project feasibility. When conducted on an ongoing basis, monitoring programs can reveal trends and changes in watershed conditions, detect new and emerging water quality problems, assess long-term progress in plan implementation, and provide data for evaluating the success of management projects.

At a conceptual level, future monitoring in the Root River watershed needs to address two different questions:

1. What are the conditions in the watershed?

2. What is the status of implementation of the recommendations of this watershed restoration plan?

Addressing the first question will require ongoing water quality monitoring within the watershed. This monitoring should encompass a number of indicators, including, but not limited to, water chemistry, stream flow, fecal indicator bacteria, and indicators of biological conditions. Several organizations are presently conducting this type of monitoring within the watershed.

Addressing the second question will require keeping track of all the projects that are undertaken in the Root River watershed that implement the recommendations of this plan. This monitoring will allow for the assessment and evaluation of the state of implementation of recommended measures. It will also avoid duplication of effort and ensure that all efforts are conducted in ways that maximize their positive effects on conditions in the watershed.

It should be noted that many particular monitoring activities may provide data that address more than one focus area of this plan. For example, monitoring of fish and macroinvertebrate communities in the watershed provides direct measures of both the state of water quality and the state of fishing-related recreational opportunities in the watershed, as well as indirect measures of the state of the habitat. Similarly, measurements of suspended solids or turbidity provide both direct measures of water quality conditions and indirect measures of habitat conditions. In view of this, the recommendations related to monitoring will be presented by type of monitoring and program, rather than by individual focus issue.

Water Quality Monitoring

Evaluation of Existing Water Quality Monitoring and Data Collection Programs

Considerable effort is currently being expended on water quality monitoring in the Root River watershed. During the period from 2010 through 2012, the most recent period examined by this plan, several agencies conducted monitoring in the watershed. Table 84 lists and Map 92 shows the stations regularly sampled as part of these monitoring efforts and types of water quality indicators sampled at each station.

MILWAUKEE METROPOLITAN SEWERAGE DISTRICT AND U.S. GEOLOGICAL SURVEY

The Milwaukee Metropolitan Sewerage District (MMSD) currently monitors water chemistry and bacteria at six sampling stations along the mainstem of the Root River in Milwaukee County. One to two samples are collected at these stations each month, with more frequent sampling occurring during warmer months. In addition, as part of the MMSD Corridor Study, the District in partnership with the U.S. Geological Survey (USGS) collects biological samples, including fish, macroinvertebrates, and algae, at two sampling stations along the mainstem of the Root River at about three-year intervals. The Corridor Study also includes assessments of aquatic toxicity.

Table 84

STREAM AND LAKE WATER QUALITY SAMPLING STATION NETWORK IN THE ROOT RIVER WATERSHED: 2010-2012

Sampling Station	River Mile[a]	Water Chemistry	Stream Flow	Bacteria	Biological	Secchi Depth
Milwaukee Metropolitan Sewerage District						
Root River at Cleveland Avenue	41.5	Y	N	Y	N	- -
Root River at W. National Avenue and W. Oklahoma Avenue	41.0	Y	N	Y	N	- -
Root River at W. Coldspring Road	39.2	Y	N	Y	N	- -
Root River at W. Grange Avenue	36.7	Y	N	Y	Y[b]	- -
Root River at W. Ryan Road	28.0	Y	N	Y	Y[b]	- -
Root River at County Line Road	23.8	Y	N	Y	N	- -
U.S. Geological Survey						
Root River at S. Seymour Place (extended)	41.4	Y	N	N	N	- -
Root River at W. Beloit Road	39.8	Y	N	N	N	- -
Root River at W. Layton Avenue	38.6	Y	N	N	N	- -
Root River at W. Grange Avenue	36.7	N	Y	N	Y[b]	- -
Root River at W. Ryan Road	28.0	Y	Y	N	Y[b]	- -
Root River below Horlick Dam	5.9	N	Y	N	N	- -
Root River Canal at 6 Mile Road	3.7	N	Y	N	N	- -
Wisconsin Department of Natural Resources						
Root River at W. Beloit Road	39.8	N	N	N	Y	- -
Root River at W. Layton Avenue	38.6	Y	N	N	N	- -
Root River at W. Grange Avenue	36.7	Y	N	N	Y	- -
Root River at W. Rawson Avenue	32.4	N	N	N	Y	- -
Root River at W. Puetz Road	28.7	Y	N	N	N	- -
Root River at W. Ryan Road	28.0	Y	N	N	Y	- -
Root River at W. Oakwood Road	26.2	Y	N	N	Y	- -
Root River at S. 60th Street	25.5	Y	N	N	Y	- -
Root River at CTH V	20.5	N	N	N	Y	- -
Root River at STH 38	18.6	N	N	N	Y	- -
Root River at 6 Mile Road	14.5	N	N	N	Y	- -
Root River at 5 Mile Road	13.6	Y	N	N	Y	- -
Root River at 4 Mile Road	12.4	N	N	N	Y	- -
Root River at Johnson Park	11.5	Y	N	N	Y	- -
Root River at STH 31	9.4	N	N	N	Y	- -
Root River below Horlick Dam	5.9	N	N	N	Y	- -
Root River at Lincoln Park	3.8	N	N	N	Y	- -
Crayfish Creek at County Line Road	0.4	N	N	N	Y	- -
Dale Creek at Southway	0.5	N	N	N	Y	- -
East Branch Root River near W. Claire Street	0.5	N	N	N	Y	- -
East Branch Root River Canal at STH 11	8.1	N	N	N	Y	- -
East Branch Root River Canal at CTH A	5.5	N	N	N	Y	- -
East Branch Root River Canal at 2 Mile Road	2.8	N	N	N	Y	- -
East Branch Root River Canal at 4 Mile Road	0.5	N	N	N	Y	- -
Hoods Creek at STH 20	6.5	N	N	N	Y	- -
Hoods Creek at CTH H	4.7	N	N	N	Y	- -
Hoods Creek at STH 38	1.7	N	N	N	Y	- -
Hoods Creek at Brooks Road	0.5	Y	N	N	Y	- -
Husher Creek at 7 1/2 Mile Road	0.3	N	N	N	Y	- -
Husher Creek at 5 Mile Road	1.0	Y	N	N	Y	- -
Kilbournville Tributary at CTH G	2.7	N	N	N	Y	- -
Kilbournville Tributary at 7 Mile Road	0.9	N	N	N	Y	- -
Legend Creek at S. 68th Street	0.5	N	N	N	Y	- -
Raymond Creek at 4 Mile Road	0.8	N	N	N	Y	- -
Root River Canal at 5 Mile Road	4.8	N	N	N	Y	- -
Root River Canal at 7 Mile Road	2.6	N	N	N	Y	- -
Root River Canal Upstream from Confluence with Root River	0.1	Y	N	N	Y	- -

Table 84 (continued)

Sampling Station	River Mile[a]	Water Chemistry	Stream Flow	Bacteria	Biological	Secchi Depth
Wisconsin Department of Natural Resources (continued)						
Ryan Creek at S. 92nd Street	2.0	N	N	N	Y	- -
Tess Corners Creek Upstream from Whitnall Park Lagoon	0.8	N	N	N	Y	- -
Tess Corners Creek Upstream from Confluence with Whitnall Park Creek	0.1	N	N	N	Y	- -
West Branch Root River Canal at 67th Drive	9.3	N	N	N	Y	- -
West Branch Root River Canal at 2 Mile Road	2.6	N	N	N	Y	- -
West Branch Root River Canal at 4 Mile Road	0.3	Y	N	N	Y	- -
Whitnall Park Creek Downstream from Confluence with Tess Corners Creek	0.4	N	N	N	Y	- -
Wildcat Creek at STH 100	0.2	N	N	N	Y	- -
Yorkville Creek at STH 20	0.4	N	N	N	Y	- -
City of Racine Health Department						
Root River at STH 38 (S. Howell Avenue)	18.6	Y	N	Y	N	- -
Root River at 5 Mile Road	13.6	Y	N	Y	N	- -
Root River at Johnson Park	11.5	Y	N	Y	N	- -
Root River at STH 31 and 4 Mile Road	9.4	Y	N	Y	N	- -
Root River below Horlick Dam	5.9	Y	N	Y	N	- -
Root River at WDNR Steelhead Facility	3.9	Y	N	Y	N	- -
Root River at Island Park Bridge to Liberty Street	3.1	Y	N	Y	N	- -
Root River at REC Center	1.6	Y	N	Y	N	- -
Root River near Mouth	0.0	Y	N	Y	N	- -
East Branch Root River Canal at STH 11	8.1	Y	N	Y	N	- -
East Branch Root River Canal at 4 Mile Road	0.5	Y	N	Y	N	- -
Hoods Creek at Brooks Road	0.5	Y	N	Y	N	- -
Husher Creek at 7 Mile Road	1.0	Y	N	Y	N	- -
Legend Creek at S. 68th Street	0.5	Y	N	Y	N	- -
Raymond Creek at 4 Mile Road	0.8	Y	N	Y	N	- -
Root River Canal at CTH G	3.7	Y	N	Y	N	- -
West Branch Root River Canal at 67th Road	9.3	Y	N	Y	N	- -
West Branch Root River Canal at 4 Mile Road	0.5	Y	N	Y	N	- -
Quarry Lake East Beach Site	- -	N	- -	Y	N	N
Quarry Lake West Beach Site	- -	N	- -	Y	N	N
University of Wisconsin-Extension Water Action Volunteers						
Root River near 7 Mile Road and W. River Road	15.7	Y	N	N	Y	- -
Root River at 5 Mile Road	13.6	Y	N	N	Y	- -
Root River at STH 38 and 4 Mile Road	12.4	Y	N	N	Y	- -
Root River above Horlick Dam	6.0	Y	N	N	Y	- -
Kelly Lakes Association						
Upper Kelly Lake—Deep Hole	- -	Y	- -	N	N	Y

[a]*River mile is measured as the distance upstream from the confluence with the waterbody into which a stream flows.*

[b]*Biological sampling was conducted at this station under a joint project between the U.S. Geological Survey and the Milwaukee Metropolitan Sewerage District.*

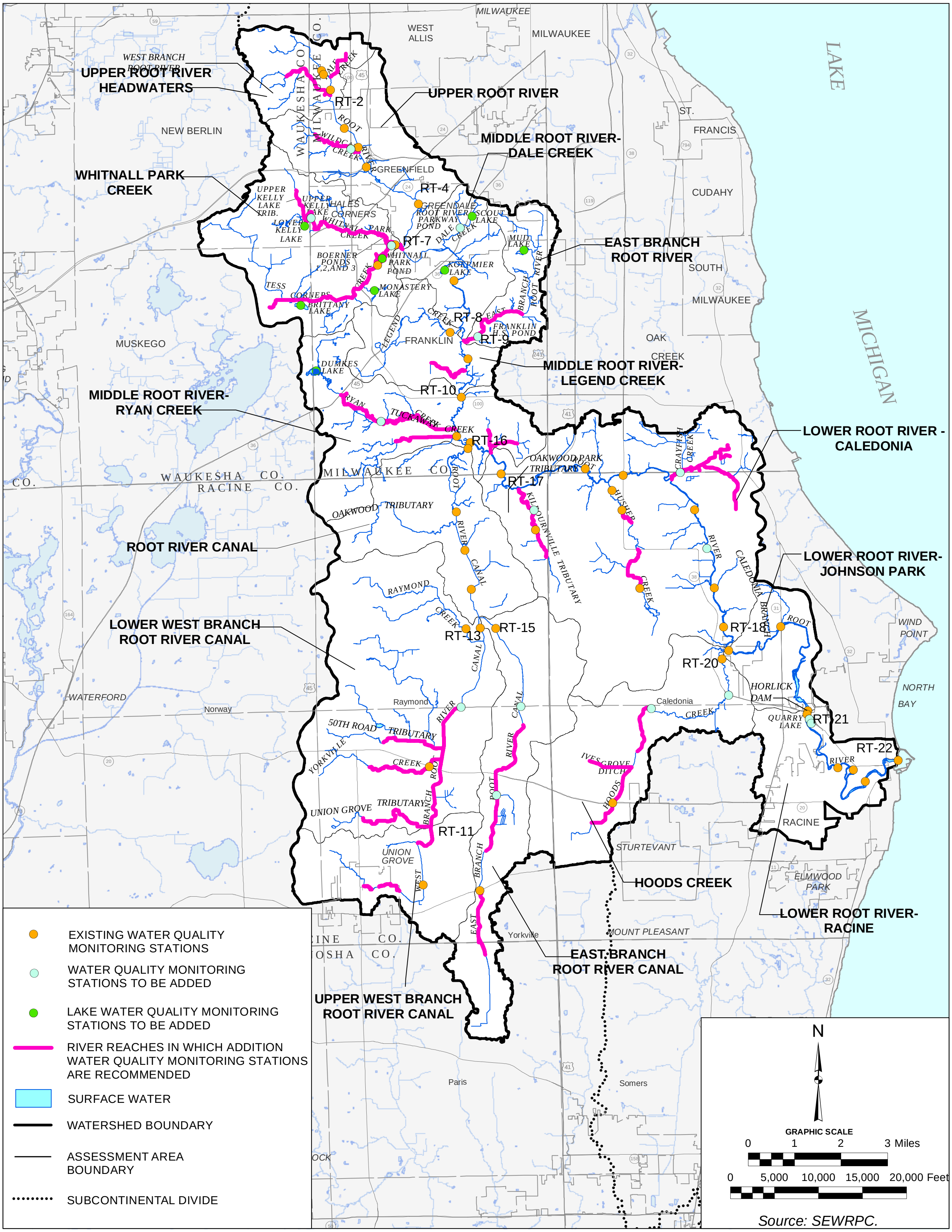
Source: SEWRPC.

U.S. Geological Survey

The USGS monitors stream flow at four continuous recording stream gaging stations in the watershed, three along the mainstem of the Root River and one along the Root River Canal. During the period 2010 through 2012, the USGS also conducted water chemistry monitoring related to specific short-duration projects at three additional sites along the mainstem of the Root River.

Map 92

RECOMMENDED WATER QUALITY MONITORING STATIONS FOR THE ROOT RIVER WATERSHED



Source: SEWRPC.

CITY OF RACINE HEALTH DEPARTMENT

The City of Racine Health Department (RHD) conducts regular sampling for water chemistry and bacteria at 18 sampling stations—nine along the mainstem of the Root River and nine along seven tributary streams. Samples were collected at these stations twice per week. This sampling was conducted specifically in support of this watershed restoration planning effort. In cooperation with Racine County, the RHD also monitored fecal indicator bacteria concentrations at two stations on Quarry Lake. The RHD also conducted additional sampling at several stations. Some of this sampling was related to previous studies. Other sampling was conducted to address specific questions.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

The Wisconsin Department of Natural Resources (WDNR) periodically conducts biological sampling in the watershed. In 2011, it conducted macroinvertebrate surveys at 42 sampling stations in the watershed—14 along the mainstem of the Root River and 28 along 16 tributary streams. During 2011, the WDNR conducted fisheries surveys at 12 sampling stations—seven along the mainstem of the Root River and five along four tributary streams. In addition to this monitoring, the WDNR monitors populations of trout and salmon at the Root River Steelhead Facility. The WDNR also samples water chemistry along the mainstem of the Root River at Johnson Park.

UNIVERSITY OF WISCONSIN-EXTENSION'S (UWEX) WATER ACTION VOLUNTEERS PROGRAM (WAV) AND WISCONSIN CITIZEN LAKE MONITORING NETWORK

During the period 2010 through 2012, volunteers from the University of Wisconsin-Extension's (UWEX) Water Action Volunteers (WAV) Program conducted water chemistry and biological sampling at four stations along the mainstem of the Root River. The Kelly Lakes Association, in cooperation with the Wisconsin Citizen Lake Monitoring Network, monitored Upper Kelly Lake for Secchi depth and water chemistry.

MISCELLANEOUS SINGLE-PURPOSE MONITORING EFFORTS

In addition to monitoring programs described above, several one-time monitoring projects were conducted in the watershed that examined fairly specific issues. Examples of these include a study that surveyed the mainstem of the Root River for the presence and abundance of freshwater mussels, a highway-based survey of invasive terrestrial plants, and a survey of physical conditions in Hoods Creek and a portion of the mainstem of the Root River. More information on these efforts is presented in Chapter IV of this report.

Identification of Additional Monitoring Needs

The 2007 SEWRPC regional water quality management plan update for the greater Milwaukee watersheds (RWQMPU) included an evaluation of the existing water quality monitoring and data collection programs in the watersheds within its study area, including the Root River watershed.[51] This evaluation was subsequently refined for the Root River watershed in a SEWRPC Staff Memorandum developed during this watershed restoration planning process.[52] These evaluations identified several data gaps in the water quality monitoring data available for the Root River watershed. The following data gaps were noted in these evaluations:

- Most of the water quality monitoring conducted within the watershed had focused on the mainstem of the Root River.

- Relatively few samples were collected from tributary streams and few tributary streams had been sampled. Between 2005 and 2009, samples were collected from only three tributary streams.

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[51]*SEWRPC Planning Report No. 50*, op. cit.

[52]*SEWRPC Staff Memorandum,* Water Quality Sampling in the Root River Watershed: 1964-2009, *April 28, 2010.*

- The mainstem of the Root River included a 12-mile section from County Line Road and Johnson Park in which no sampling had been conducted during the period from 1998 through 2009.

- Relatively few samples had been collected during winter months.

The monitoring conducted during the development of this watershed restoration plan made substantial progress toward filling these data gaps. During the period from 2010 through 2013, regular monitoring was conducted at two stations within the 12-mile-long unmonitored section of the mainstem of the Root River and at stations along seven tributary streams. Winter sampling was conducted at several mainstem and tributary sampling stations, although not as frequently as it was during other seasons. These efforts have improved our knowledge of conditions in the watershed. Despite the considerable effort described above, the following gaps still remain in the water quality data set for the Root River watershed:

- Several tributary streams are not routinely monitored. This is especially the case in the portions of the watershed in Milwaukee and Waukesha Counties.

- Few monitoring data are available for most of the lakes and ponds in the watershed.

- The amount of sampling conducted in the winter has not been sufficient to determine the extent of the problems posed by chloride concentrations in surface waters of the Root River watershed or the nature of the causes of these problems.

Recommendations Regarding Water Quality Monitoring

It is important to assess the condition of water quality, biological communities, and habitat in the watershed and determine whether these conditions are improving or deteriorating. It is, therefore, important to establish and maintain a robust program to monitor and assess conditions within the watershed. Such a monitoring program should integrate and coordinate the use of the monitoring resources of multiple agencies and groups, generate monitoring data that are scientifically defensible and relevant to the decision-making process, and manage and report data in ways that are meaningful and understandable to decision makers and other affected parties. This watershed restoration plan recommends maintaining the existing monitoring network and expanding monitoring in the watershed to continue to fill data gaps. Toward these ends, the plan includes the following recommendations for water quality monitoring:

MAINTENANCE OF CURRENT MONITORING ACTIVITIES

It is recommended that current monitoring activities in the Root River watershed continue and the efforts of the agencies conducting these activities be supported and maintained. This includes several specific recommendations:

1. **The current USGS stream gaging program should be continued in the watershed.** Stage and discharge monitoring should continue at all four of the currently active gages.

2. **The MMSD Root River survey monitoring program should be continued.** Monitoring of water chemistry and fecal indicator bacteria should continue at all six of the District's existing sampling stations. As a minimum sampling frequency, the current sampling schedule in which samples are collected two times a month during summer months and monthly during the remaining months of the year should be continued.

3. **The joint MMSD/USGS biological and toxicity sampling program should be continued in the watershed.** Sampling should be conducted at the existing two sampling stations at three-year intervals.

4. **The City of Racine Health Department's Root River stream monitoring program should be continued in the watershed.** Monitoring of water chemistry and fecal indicator bacteria should continue at all 18 of the Department's current sampling stations. **At the nine sampling stations located within the City of Racine, samples should be collected weekly,** rather than the current twice per week schedule. **At the nine sampling stations located outside of the City, samples should be collected every two weeks,** rather than the current twice per week schedule.

5. **The monitoring of fecal indicator bacteria at the beach along Quarry Lake should be continued.** Monitoring of fecal indicator bacteria should continue at both sampling sites along the beach twice weekly during the swimming season.

6. **The WDNR's biological monitoring in the Root River watershed should be continued.** Monitoring of macroinvertebrates should continue at the 42 sampling stations monitored in the Department's 2011 survey and monitoring of fish should continue at the 12 sampling stations monitored in the 2011 survey. At a minimum, sampling should occur every three-to-five years. In order to accomplish this amount of biological monitoring, consideration should be given to sampling sites on a rotating basis, with one-third to one-fifth of sites being sampled each year. The WDNR's monitoring of trout and salmon populations at the Root River Steelhead Facility should be continued.

7. **The WDNR's water chemistry monitoring at the Johnson Park sampling stations should be continued.** Sampling should continue to be conducted at this site on a monthly basis.

8. **The UWEX WAV program's water quality and biological monitoring in the Root River watershed should be continued.** Monitoring of water chemistry should continue at the four sampling stations. At a minimum, sampling for macroinvertebrates should be conducted at each station annually in the fall.

9. **The Kelly Lakes Association's monitoring of Upper Kelly Lake through the Wisconsin Citizen Lake Network should be continued.** At a minimum, Secchi depth should be monitored every two weeks during the months May through September and monthly during other months when the Lake is free of ice and total phosphorus and chlorophyll-*a* should be monitored annually during the period when the Lake is thermally stratified.

Table 85 summarizes the monitoring stations at which it is recommended that existing monitoring efforts be continued.

EXPANSION OF WATER QUALITY MONITORING ACTIVITIES

It was previously noted that several gaps still remain in the water quality data set for the Root River watershed. Several tributary streams are not routinely monitored, and few monitoring data are available for most of the lakes and ponds in the watershed. **It is recommended that the water quality monitoring network in the Root River watershed be expanded to fill these data gaps.** This includes the following specific recommendations which are also summarized on Map 92:

1. **At least one water quality monitoring station should be established on each of the following streams which are not currently being sampled for water chemistry and bacteria:** 50th Road Tributary, Caledonia Branch, Crayfish Creek, Dale Creek, East Branch Root River, Hale Creek, Ives Grove Ditch, Kilbournville Tributary, Oakwood Park Tributary, Oakwood Tributary, Scout Lake Tributary to Dale Creek, Tuckaway Creek, Union Grove Tributary, West Branch Root River, Wildcat Creek, and Yorkville Creek. Samples should be collected every two weeks and analyzed for water chemistry and fecal indicator bacteria.

Table 85

STREAMS, LAKES, AND PONDS RECOMMENDED MONITORING IN THE ROOT RIVER WATERSHED

Waterbody	Stations Monitored 2010-2012[a]		Major Stations to be Retained[b]					Stations to be Added	Potential Station Locations[c]
	Major	Minor	USGS	WDNR	MMSD	RHD	WAV or CLMN		
Upper Root River-Headwaters									
Root River Mainstem	2	1	- -	- -	2	- -	- -	0	
Hale Creek	0	0	- -	- -	- -	- -	- -	1	Root River Parkway or W. Cleveland Avenue
West Branch Root River	0	0	- -	- -	- -	- -	- -	1	Historically monitored sites include at the Root River Parkway Road, S. 124th Street, and S. 132nd Street
Upper Root River									
Root River Mainstem	2	2	1	2	2	- -	- -	0	
Wildcat Creek	0	0	- -	1	- -	- -	- -	1	Kulwicki Park or S. 108th Street
Whitnall Park Creek									
Brittany Lake	0	0	- -	- -	- -	- -	- -	1	At deepest point
Lower Kelly Lake	0	0	- -	- -	- -	- -	- -	1	At deepest point
Monastery Lake	0	0	- -	- -	- -	- -	- -	1	At deepest point
Tess Corners Creek	2	0	- -	2	- -	- -	- -	2	Historically monitored immediately upstream from Whitnall Park Pond, other potential sites include crossings at S. Lovers Lane, W. Forest Home Avenue, S. North Cape Road, and W. St. Martins Road
Upper Kelly Lake	1	0	- -	- -	- -	- -	1	0	
Whitnall Park Creek	1	0	- -	1	- -	- -	- -	2	Historically monitored at Root River Parkway, Whitnall Park, STH 100, STH 24, and S. Kurtz Road
Whitnall Park Pond	0	0	- -	- -	- -	- -	- -	1	At deepest point
Middle Root River-Dale Creek									
Root River Mainstem	1	0	- -	1	- -	- -	- -	0	
Dale Creek	1	0	- -	1	- -	- -	- -	1	Southway or Clover Lane
Koepmier Lake	0	0	- -	- -	- -	- -	- -	1	At deepest point
Scout Lake	0	0	- -	- -	- -	- -	- -	1	At deepest point
Scout Lake Tributary to Dale Creek	0	0	- -	- -	- -	- -	- -	1	Historically monitored at Scout Lake Park, above and below Scout Lake

Table 85 (continued)

Waterbody	Stations Monitored 2010-2012[a]		Major Stations to be Retained[b]					Stations to be Added	Potential Station Locations[c]
	Major	Minor	USGS	WDNR	MMSD	RHD	WAV or CLMN		
East Branch Root River									
East Branch Root River	1	0	- -	1	- -	- -	- -	1	S. 51st Street, W. Drexel Avenue, W. Rawson Avenue
Mud Lake	0	0	- -	- -	- -	- -	- -	1	At deepest point
Middle Root River-Legend Creek									
Root River Mainstem	2	0	1	1	1	- -	- -	0	
Legend Creek	1	0	- -	1	- -	1	- -	0	
Tuckaway Creek	0	0	- -	- -	- -	- -	- -	1	S. 68th Street
Upper West Branch Root River Canal									
West Branch Root River Canal	2	2	- -	1	- -	1	- -	1	Upstream of Union Grove WWTP
Lower West Branch Root River Canal									
50th Road Tributary	0	1	- -	- -	- -	- -	- -	1	50th Road or CTH U
Raymond Creek	1	0	- -	1	- -	1	- -	0	
Union Grove Tributary	0	1	- -	- -	- -	- -	- -	1	61st Drive, 67th Drive, or 52nd Road
West Branch Root River Canal	1	3	- -	2	- -	1	- -	1	Historically monitored at STH20, recent minor stations at 50th Road and 3 Mile Road
Yorkville Creek	1	1	- -	1	- -	- -	- -	1	Recent minor station at STH 20, alternatively at crossing at 63rd Drive
East Branch Root River Canal									
East Branch Root River Canal	2	3	- -	4	- -	2	- -	2	One upstream from Fonks Mobile Home Park WWTP, another at either STH 20 or 3 Mile Road
Lower Root River-Ryan Creek									
Root River Mainstem	2	1	- -	2	1	- -	- -	0	
Dumkes Lake	0	0	- -	- -	- -	- -	- -	1	At deepest point
Oakwood Tributary	0	0	- -	- -	- -	- -	- -	1	76th Street, 92nd Street
Oakwood Park Tributary	0	0	- -	- -	- -	- -	- -	1	Oakwood Road
Ryan Creek	1	0	- -	1	- -	- -	- -	2	76th Street, 92nd Street, CTH H, STH 36

Table 85 (continued)

Waterbody	Stations Monitored 2010-2012[a]		Major Stations to be Retained[b]					Stations to be Added	Potential Station Locations[c]
	Major	Minor	USGS	WDNR	MMSD	RHD	WAV or CLMN		
Root River Canal									
Root River Canal	3	1	1	3	- -	1	- -	0	
Unnamed Tributary to Root River Canal	0	0	- -	- -	- -	- -	- -	1	Waukesha Road, CTH U, 7 Mile Road, 92nd Street
Lower Root River-Caledonia									
Root River Mainstem	4	3	- -	4	- -	3	2	0	
Caledonia Branch	0	0	- -	- -	- -	- -	- -	1	S. 10th Avenue, County Line Road
Crayfish Creek	1	0	- -	1	- -	- -	- -	1	Elm Road, County Line Road
Husher Creek	2	0	- -	2	- -	1	- -	2	5 Mile Road, 6 Mile Road
Kilbournville Tributary	2	0	- -	2	- -	- -	- -	1	Historically monitored at 6 1/2 Mile Road, other potential sites include 6 Mile Road and 7 Mile Road
Hoods Creek									
Hoods Creek	4	0	- -	4	- -	1	- -	2	Historically monitored at STH 20, other potential sites include STH 38, Airline Road, N. Fancher Road and CTH C
Ives Grove Ditch	0	0	- -	- -	- -	- -	- -	1	CTH V, CTH C
Lower Root River-Johnson Park									
Root River Mainstem	3	1	1	3	- -	2	1	0	
Lower Root River Racine									
Root River Mainstem	4	17	- -	2	- -	4	- -	0	
Quarry Lake	2	0	- -	- -	- -	2	- -	0	

[a]*Major stations were sampled on a regular, recurring basis. Minor stations were either sampled occasionally on a less regular basis or were sampled as part of a short-term project.*

[b]*Sampling is conducted at some stations by more than one agency.*

[c]*Listing of sites for potential sampling stations is based upon examination of maps and locations where sampling has been conducted in the past. While the availability of historical monitoring data is an important consideration in selecting sampling station locations, accessibility and safety considerations should also be considered in the final choice of sampling sites, especially if monitoring is to be done by volunteers.*

Source: SEWRPC.

2. **At least two water quality monitoring stations should be established on** each of the following streams which are not currently being sampled for water chemistry and bacteria: **Ryan Creek, Tess Corners Creek, and Whitnall Park Creek.** Samples should be collected every two weeks and analyzed for water chemistry and fecal indicator bacteria.

3. **Two additional water quality monitoring stations should be established on each of the following streams.** Samples should be collected every two weeks and analyzed for water chemistry and fecal indicator bacteria.

   a. **East Branch Root River Canal:** One of these stations should be located upstream of the Fonk's Mobile Home Park wastewater treatment plant.

   b. **Hoods Creek:** One of these stations should be located upstream from the confluence with Ives Grove Ditch.

   c. **Husher Creek:** One of these stations should be located upstream from the recently restored stream reach at the CTH G crossing.

   d. **West Branch Root River Canal:** One of these stations should be located upstream of the Village of Union Grove wastewater treatment plant.

   Agencies capable of conducting the recommended monitoring of water chemistry and bacteria at new stream stations as described in Recommendations 1 through 3 above include MMSD, the WDNR, the City of Racine Health Department, and the UWEX WAV Program. It should be noted that the implementation of the changes in sampling frequency recommended for the City of Racine Health Department's existing stream sampling program would allow the Department to conduct the expanded stream sampling described above using about the same level of staff effort as required by their existing program because the recommended level of effort for data collection at the sites that have been recently monitored has been reduced somewhat.

4. **Water quality monitoring stations should be established on each of the following lakes and ponds: Brittany Lake, Dumkes Lake, Koepmier Lake, Lower Kelly Lake, Monastery Lake, Mud Lake, Scout Lake, and Whitnall Park Pond.** At a minimum, Secchi depth should be monitored every two weeks during the months May through September and monthly during other months when the lake or pond is free of ice. At a minimum, total phosphorus and chlorophyll-*a* should be monitored annually during the period when the Lake is thermally stratified.

   Monitoring of lakes and ponds could be conducted through the Wisconsin Citizen Lake Monitoring Network. Monitoring of Lower Kelly Lake could be conducted in cooperation with the Kelly Lakes Association. Monitoring of lakes and ponds in Milwaukee County Parks could be conducted by Parks Department staff or by volunteers from friends groups associated with the Parks.

5. **Water quality monitoring at Quarry Lake should be expanded** to include monitoring of Secchi depth every two weeks during the months May through September and monthly during other months when the lake is free of ice. At a minimum, total phosphorus and chlorophyll-*a* should be monitored annually during the period when the Lake is thermally stratified.

   The recommended limnological monitoring of Quarry Lake could be conducted by the City of Racine Health Department in conjunction with the bacteriological monitoring that the Department currently conducts.

6. **Water quality monitoring in the Root River watershed should be expanded to include continuous monitoring with telemetry to automatically transfer the data.** Two to four "real-time" stations should be established in the watershed. These should collect data on water temperature, specific conductance, dissolved oxygen, turbidity, flow, and stream stage at five-minute intervals 24 hours per day. In order to facilitate collection of stream flow and stage, these stations should be located at the existing USGS stream gages, with highest priority being given to establishing stations along the mainstem of the Root River at W. Grange Avenue and W. Ryan Road.

   The recommended continuous monitoring of water quality could be conducted by MMSD and the USGS at the W. Grange Avenue and W. Ryan Road gages as an expansion of their existing joint real-time monitoring program. Continuous monitoring of water quality could be conducted by USGS at the gage on the mainstem of the Root River below Horlick dam and at the gage on the Root River Canal at CTH G, perhaps in conjunction with local government cooperators.

7. **The Root River watershed should be surveyed for freshwater mussels every 10 years.** A standard protocol should be used to ensure the comparability of results among surveys.

   Mussel surveys could be conducted by the WDNR or by a consultant. It is suggested that future surveys record and report the amount of time spent surveying each sample site. This information would allow for the computation of the catch per unit effort at each site, which would make it possible to compare relative population sizes among sites.

8. **Ambient environmental data should be collected or obtained from an appropriate source each time water quality samples are collected.** Such data should include rainfall, flow rates (where representative data are readily available), and general weather observations.

Table 85 and Map 92 summarize the recommended expansion of the water quality monitoring network for the Root River watershed. They also identify potential locations for establishing the additional sampling stations along tributary streams. Several factors should be considered when siting these stations, including the suitability of the stream for the type of sampling contemplated at the potential stations, the availability of past monitoring data from the site of the potential station, accessibility of the site, and safety considerations. The final selection of sites for monitoring stations should include a field examination of the sites.

The recommended expansion of water quality monitoring in the Root River watershed will provide several benefits related to the management of surface waters in the watershed. First, this expansion of monitoring activities to additional tributaries, lakes, and ponds will allow for the development of a more complete picture of the state of water quality conditions in the watershed. This more complete picture may be useful for determining the sources of local water quality problems. In addition, observed water quality data are essential to the calibration and validation of water quality models used to assess anticipated future water quality conditions. Expansion of the observed water quality database for the watershed would enable future refinement of the water quality models though additional calibrations. The addition of continuous monitoring stations, in particular, will yield a better picture of the dynamics of chloride concentrations within surface waters of the watershed.

Second, expansion of monitoring activities to additional tributaries, lakes, and ponds will allow assessment of whether these waterbodies are meeting the water quality criteria that support their designated use objectives. This is particularly important given that the SEWRPC regional water quality management plan update for the greater Milwaukee watersheds recommends that the WDNR consider upgrading the water use objectives for Hoods Creek, Tess Corners Creek, and Whitnall Park Creek from limited forage fish to fish and aquatic life and Ives Grove Ditch from limited aquatic life to limited forage fish.

Third, this expansion of monitoring activities to additional tributaries, lakes, and ponds will provide information needed for informing the management of these waterbodies.

Water Quality Constituents to be Monitored

There are numerous indicators available for measuring and describing water quality, including physical indicators such as water temperature, chemical indicators such as concentrations of dissolved substances, and biological indicators such as the abundance and taxonomic identities of the macroinvertebrates present. Historically, many different indicators have been used to assess the state of water quality in the Root River watershed. Table 86 lists those physical and chemical indicators that were routinely monitored in the Root River watershed by at least one monitoring program during the period 2010-2012.

As previously described, several agencies and organizations are currently conducting monitoring activities in the Root River watershed. While there is overlap among these monitoring programs in which water quality constituents they sample and analyze, each program monitors a unique suite of indicators. There are several reasons for this.

In part, this reflects the natures of the constituents. Some constituents, such as water temperature, pH, and water transparency, can be assessed relatively easily and inexpensively in the field. Others, such as total phosphorus and fecal indicator bacteria, require that water samples be transported to laboratory facilities for chemical or biological analysis. Sampling and analysis of some constituents, such as many metals and cyclic organic compounds, may require the use of highly specialized sampling techniques and analytical equipment.

The differences in the constituents monitored by the different programs also reflect differences in the capacities of these programs. Some of the programs have greater analytical capabilities and more resources than others. It should also be noted that the need to use highly specialized techniques and equipment for sampling and analyzing some constituents imposes differences upon monitoring programs in their abilities to monitor these constituents. For example, programs that rely upon volunteers to conduct sampling will be less suited to monitoring constituents that require highly specialized sampling techniques than those that rely upon highly trained professional staff.

Finally, it is important to recognize that each monitoring program has its own monitoring goals. These goals may differ from program to program and achieving different goals may require different monitoring strategies, including monitoring different constituents.

In an ideal situation, there would be coordination among monitoring programs such that a consistent set of water quality constituents would be monitored throughout the watershed. Because of the considerations discussed in the previous three paragraphs, it seems unlikely that this ideal could be achieved in the Root River watershed in the foreseeable future. Despite this, it should be possible to achieve some additional convergence among the sets of constituents monitored by the various programs active within the watershed.

It is recommended that each of the programs conducting water quality monitoring within the Root River watershed continue monitoring the constituents that they are currently monitoring.

The list of physical and chemical indicators given in Table 86 is meant to provide guidance to monitoring programs in the Root River watershed when they consider adding constituents to the suites of constituents they currently monitor. The table lists these in five tiers that roughly correspond to the priority for adding them to the suite of constituents in an existing program, with Tier 1 representing constituents of the highest priority for addition and Tier 5 representing constituents of the lowest priority.

The constituents listed in Tier 1 are either easy enough to sample or important enough to sample that it is desirable that they be sampled by all monitoring programs in the watershed. Several of the constituents listed in Tier 1 can be assessed in the field using hand-held meters or other field techniques. The main exceptions to this generalization are fecal indicator bacteria and total suspended solids—which require that samples be transported to a laboratory for analysis. It should be noted that turbidity and water transparency assess the same factor. While assessment of turbidity gives a more precise measure, it generally requires that samples be transported to a

Table 86

TIERED LIST OF CHEMICAL AND RELATED WATER QUALITY CONSTITUENTS FOR MONITORING

Tier 1			
Dissolved Oxygen	pH	Suspended solids, total	Water temperature
Fecal indicator bacteria[a]	Specific conductance	Turbidity	Water transparency
Tier 2			
5-day biochemical oxygen demand	Chloride	Chlorophyll-*a*	Phosphorus, total
Tier 3			
Alkalinity, total	Hardness	Kjeldahl nitrogen, total[b]	Nitrate-nitrogen[b,d]
Ammonia-nitrogen[b,c]	Dissolved phosphorus, total	Magnesium, total	Nitrite-nitrogen[b,d]
Calcium, total			
Tier 4			
20-day biochemical oxygen demand	Copper, total[e]	Nickel, total[e]	Silver, total
Arsenic, total	Dissolved silica, total	Mercury, total	Solids, total
Cadmium, total[e]	Dissolved solids, total	Organic carbon, total	Volatile solids, total
Carbon, total	Inorganic carbon, total	Organic carbon, total dissolved	Zinc, total[e]
Chromium, total[e]	Lead, total[e]	Selenium, total	
Tier 5			
Acenaphthene	Fluoranthene	2,2',4,4'-tetrachloorbiphenyl	2,2',3,3',4,5,5',6'-octachlorobiphenyl
Acenaphthylene	Fluorene	3,3',4,5'-tetrachlorobiphenyl	2,2',3,3',4,5,6',6'-octachlorobiphenyl
Anthracene	Indeno-(1,2,3-c,d)-pyrene	2,2',3',4,6-pentachlorobiphenyl	PCB-1016
Benzo-(a)-anthracene	Naphthalene	2,2',4,5',6-pentachlorobiphenyl	PCB-1221
Benzo-(a)-pyrene	Phenanthrene	3,3',4,4',5-pentachlorobiphenyl	PCB-1232
Benzo-(b)-fluoranthene	Pyrene	2,2',3,4,5,5'-hexachlorobiphenyl	PCB-1242
Benzo-(g,h,i)-perylene	2,3-dichlorobiphenyl	2,2'4,4'5,6'-hexachlorobiphenyl	PCB-1248
Benzo-(k)- fluoranthene	2,4,5-trichlorobiphenyl	3,3'4,,4',5,5'-hexachlorobiphenyl	PCB-1254
Chrysene	3,3',5-trichlorobiphenyl	2,2',3,3',4,4',6'-heptachlorobiphenyl	PCB-1260
Dibenzo-(a,h)-anthracene			

[a]*Fecal indicator bacteria include fecal coliform bacteria and* Escherichia coli*, which have both been routinely monitored in the Root River watershed, and* Enterococcus*, which has not been routinely monitored in the Root River watershed.*

[b]*In order to fully characterize nutrient conditions related to nitrogen, ammonia, total Kjeldahl nitrogen, nitrate, and nitrite should be collected together.*

[c]*The toxicity of ammonia to fish and other aquatic organisms is dependent upon temperature and pH. Because of this, always sampling for temperature and pH when ammonia samples are collected would aid in the interpretation of ammonia concentration data.*

[d]*Some monitoring programs sample for and report a combined total concentration of nitrate plus nitrite.*

[e]*The toxicity of cadmium, chromium, copper, lead, nickel, and zinc to fish and other aquatic organisms is dependent upon the hardness of the water. Because of this, always sampling for hardness when samples are collected for any of these metals would aid in the interpretation of the metal concentration data.*

Source: SEWRPC.

laboratory for analysis. Water transparency can be measured in the field using a turbidity tube at stream and river sites or a Secchi disk at lake and pond sites. As part of Tier 1, one of these two constituents should be assessed.

The constituents listed in Tier 2 represent the minimum set of additional water quality constituents that would be necessary to make assessments of those water quality that are most critical to the water quality focus area of this plan. Assessing these constituents requires that samples be transported to a laboratory for analysis. As noted in Chapter V of this report, the major approach that this plan takes to address the chronically low dissolved oxygen concentrations found in much of the Root River is to reduce phosphorus inputs into the surface water system. Monitoring of total phosphorus allows for a direct evaluation of the success of this approach. Monitoring five-day biochemical oxygen demand and chlorophyll-*a* provides a check on this because these constituents address other factors that can potentially impact dissolved oxygen concentrations in surface waters. Finally, monitoring chloride concentrations would both fill the data gap related to chloride concentrations in surface waters of the watershed and allow for the refinement of statistical models relating specific conductance to chloride.

The constituents listed in Tier 3 comprise those constituents needed to give a complete picture of the status of major plant nutrients within the surface water system and several constituents whose chemistries affect the chemistry of other substances in water. Assessing these constituents requires that samples be transported to a laboratory for analysis. There are three issues that should be noted about the nitrogen-related constituents in this tier. First, the toxicity of ammonia to fish and other aquatic organism depends upon ambient water temperature and pH, as well as the ambient concentration of ammonia. Whenever sampling is conducted for ammonia, sampling should also be conducted for water temperature and pH. Second, some laboratories analyze and report combined concentrations of nitrate and nitrite. In order to get a complete picture of nitrogen conditions, sampling should be conducted either for combined nitrate-plus-nitrite or for both nitrate and nitrite. Third, complete characterization of nitrogen conditions within surface waters requires that ammonia, Kjeldahl nitrogen, nitrate, and nitrite be sampled simultaneously. This allows for the calculation of organic nitrogen and total nitrogen. These four constituents should be sampled together.

Tier 4 includes those constituents not included in higher priority tiers required to characterize conditions related to minor plant nutrients, solids, and several toxic metals in surface waters. Assessing these constituents requires that samples be transported to a laboratory for analysis. Assessment of several of these constituents also requires the use of highly specialized techniques and equipment for conducting sampling and analysis. It should be noted that the toxicity of cadmium, chromium, copper, lead, nickel, and zinc to fish and other aquatic organisms depends upon the pH of the water, as well as the concentration of the metal. Whenever sampling is conducted for these metals, sampling should also be conducted for pH.

The constituents listed in Tier 5 consist of toxic cyclic organic compounds that are classified either as polycyclic aromatic hydrocarbons (PAHs), individual polychlorinated biphenyl compounds (PCB congeners), or commercial mixtures of PCB congeners. Assessing these constituents requires both that samples be transported to a laboratory for analysis and the use of highly specialized techniques and equipment for conducting sampling and analysis.

While this watershed management plan envisions that monitoring programs will add constituents to the suites they sample on a tier-by-tier basis, it recognizes that particular management issues and the goals and objectives of individual monitoring programs may require that some constituents be added to sampling suites without regard to their locations in this tiered list. **It is recommended that, in the absence of other such considerations, monitoring programs in the Root River watershed follow this tiered scheme when adding constituents to the suite of constituents that they sample and analyze.**

Periodically Analyze Monitoring Data and Report Results

Data analysis is an integral component of the water quality management process. For monitoring programs to be useful in guiding management decisions, generating good data is not enough. The data must be processed and presented in a manner that aids understanding of the spatial and temporal patterns in water quality. The data must be placed into a context that reveals the existing state of water quality conditions and any changes or trends occurring in those conditions. This should be a context that takes the natural processes and characteristics of the watershed into account, that allows the impact of human activities upon the watershed to be understood, and that enables the consequences of management action to be predicted. Establishing such a context requires that monitoring data be periodically analyzed, interpreted, and summarized. This should be done at a frequency that provides decision makers and managers with reasonably current information while recognizing the substantial effort that is required to analyze and interpret data from a watershed the size of the Root River watershed.

Since 1964, nine studies, including this watershed restoration plan, have presented analyses, interpretations, and summaries of water quality conditions in the Root River watershed. These studies are listed in Table 87. Most of these studies were conducted either as part of, or in conjunction with, major planning efforts, including efforts that developed and updated the regional water quality management plan, that developed a comprehensive watershed plan, that developed and evaluated the results of a priority watershed nonpoint source pollution abatement plan, and that developed the State's basin plan. The water quality analyses of two of these studies—the 1966 comprehensive plan for the watershed and the 1980 priority watershed plan—consisted largely of reiterations and extensions of the analyses in other studies. It should be noted that some of these studies examined subsets of the data that were available at the time of the study. Two sorts of data subsets have been examined. Some studies examined a subset of available water quality indicators. An example of this is the 1992 evaluation of the water quality effects of the priority watershed program which looked largely at macroinvertebrate and fisheries data. Other studies examined data from only a portion of the available record, generally incorporating data collected since about 1976. Despite the narrow focus of some of these studies, there has been a tendency over time for studies examining water quality in the Root River watershed to examine a larger set of water quality indicators and to incorporate data from a greater variety of sources.

The intervals between the conduct and release of studies examining water quality in the Root River watershed have been irregular. The interval between the release of this watershed restoration plan and the last major examination of water quality in the Root River watershed is about seven years. This is the shortest interval between studies that included examination of water chemistry. By contrast, the interval between the release of SEWRPC TR No.17 and SEWRPC MR No. 93 (see Table 87) was about 17 years. Other such intervals were on the order of 11 to 12 years.

It is recommended that monitoring data for the Root River watershed be collated, analyzed, and placed into context at an interval no greater than once every 10 years. This effort should include review and analysis of a wide variety of data and should include data from all publically available sources. While the full range of data to be incorporated into these studies will depend upon data availability, these studies should seek to include those data that have become available since the previous study, including such indicators as streamflow, water chemistry, fecal indicator bacteria, biological conditions, land use, stream channel conditions, habitat conditions, recreational use, and abundance and distribution of aquatic invasive species, as well as other indicators for which data that are deemed important or informative are available at the time the study is conducted. As part of the collation and analysis of these data, they should be compared to historical data. Such a comparison is necessary, both to assess trends in conditions within the watershed and to determine and document whether those conditions are improving or worsening. These analyses should include an assessment of the achievement of water use objectives through a comparison of the data to the applicable water quality criteria. These studies should assess the adequacy of the data and identify any gaps in the data. Finally, the analyses, results, and conclusions of these studies should be published and made available to the public and to the agencies and organizations involved in the management of the Root River watershed.

Monitoring of Plan Implementation

The ultimate test of whether watershed restoration activities are having a beneficial effect on water quality is the evidence of improvement in water quality conditions shown in instream and in-lake monitoring data. Unfortunately, while this is simple in concept, several factors make it difficult to detect the impacts of these activities upon water quality over a relatively short period.

Table 87

STUDIES PRESENTING ANALYSES OF WATER QUALITY IN THE ROOT RIVER WATERSHED

Study	Period of Record Examined	Sources of Water Quality Data	Water Quality Indicators Analyzed	Comments
SEWRPC Technical Report No. 4, *Water Quality and Flow of Streams in Southeastern Wisconsin,* April 1967	1964	SEWRPC, USGS	Water chemistry, stream flow	Initial regional benchmark study
SEWRPC Planning Report No. 9, *A Comprehensive Plan for the Root River Watershed,* July 1966	1964	SEWRPC, USGS	Water chemistry, stream flow	Reiterated and expanded on analyses in SEWRPC TR-4
SEWRPC Technical Report No. 17, *Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975,* June 1978	1964-1975	SEWRPC, WDNR, USGS	Water chemistry, stream flow, bacteria	Study supporting development of regional water quality management plan (SEWRPC PR-30)
SEWRPC Community Assistance Planning Report No. 37, *A Nonpoint Source Water Pollution Control Plan for the Root River Watershed,* March 1980	1964-1975	SEWRPC, WDNR, USGS	Water chemistry, stream flow, bacteria, macroinvertebrates	Nonpoint source priority watershed plan. Summarized and added to analyses in SEWRPC TR-17
M. Miller, J. Ball, and R. Kroner, *An Evaluation of Water Quality in the Root River Priority Watershed,* Wisconsin Department of Natural Resources Publication WR-298-92, January 1992	1981-1990	WDNR	Macroinvertebrates, fisheries	Final report for priority watershed program
SEWRPC Memorandum Report No. 93, *A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report,* March 1995	1976-1993	USGS, WDNR	Water chemistry, stream flow, bacteria, macroinvertebrates	Updating and status report on regional water quality management plan
Wisconsin Department of Natural Resources, *The State of the Root-Pike River Basin,* Wisconsin Department of Natural Resources Publication WT-700-2002, May 2002	Not specified	WDNR	Assessment of use impairments	WDNR basin plan for Root-Pike Basin
SEWRPC Technical Report No. 39, *Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds,* November 2007	1976-2004	MMSD, USGS, WDNR, RHD	Water chemistry, stream flow, bacteria, fisheries macroinvertebrates, toxicology	Study supporting development of RWQMPU (SEWRPC PR-50)
SEWRPC Community Assistance Planning Report No. 316, *A Restoration Plan for the Root River Watershed,* 2014	1964-2012	MMSD, SEWRPC, USGS, WDNR, RHD, WAV	Water chemistry, stream flow, bacteria, fisheries macroinvertebrates	Watershed restoration plan

NOTE: MMSD = Milwaukee Metropolitan Sewerage District
RHD = City of Racine Health Department
SEWRPC = Southeastern Wisconsin Regional Planning Commission
USGS = U.S. Geological Survey
WAV = University of Wisconsin-Extension Water Action Volunteers Program
WDNR = Wisconsin Department of Natural Resources

Source: SEWRPC.

First, many water quality indicators show high variability. This variability can obscure changes and trends. As a result, long-term data sets comprised of large numbers of samples can be required to detect the changes in water quality conditions resulting from the implementation of watershed restoration activities.

Second, there are likely to be reservoirs of pollutants stored within the watershed. Examples of these reservoirs include phosphorus contained in sediment deposits on streambeds and lakebeds, and chloride contained in groundwater. It can take time, sometimes years or decades, for these stored pollutants to pass through the system. Mobilization of pollutants from these reservoirs can cause reductions in water quality, even in the presence of reduced loadings from point and nonpoint sources. As a result, the presence of these reservoirs can produce time lags between the implementation of a watershed restoration activity and the impact of the activity upon ambient conditions.

Third, the pollutant load reductions produced by any single practice installed in the watershed are relatively small when compared to the pollutant load reductions needed to produce the level of water quality envisioned in the RWQMPU. For example, the results of the calibrated water quality model indicated that an annual reduction in the load of total suspended solids (TSS) of about 35 million pounds would be necessary to produce the envisioned level of water quality in the Root River watershed. Preliminary studies of potential stormwater ponds for the Cities of Greenfield and Racine indicate that the range of reduction in TSS washed off the land surface each year achieved by these ponds could be expected to be between about 4,000 and 37,000 pounds TSS, depending upon factors such as pond size, location, tributary land use, and contributing area.[53] On a watershed basis, these reductions each represent much less than 1 percent of the needed reductions. While these reductions may represent somewhat larger fractions of the required load reductions on a subwatershed basis, they are still small relative to the needed reductions.

Fourth, it is important to recognize that water quality conditions at any site in a watershed reflect the cumulative effects of all the influences at the site and at all points in the watershed that are directly upstream of the site. Monitoring data will always reflect an integration of these influences.

As a result, though a management practice may be functioning to greatly improve the future water quality of a waterbody, the visible effects of the practice, such as an increase in water clarity or a reduction in the concentrations of a nutrient, may not be immediately apparent and may only become apparent at some future time as part of the cumulative effects of many projects. Because of this, it will be useful to have a measure of progress in addition to the water quality monitoring data. To address this, **it is recommended that monitoring be conducted to track the implementation of this watershed restoration plan**.

Tracking Mechanism

In order for this plan to be most effective, it is important to track the projects and recommendations that are implemented. This could be best accomplished by having a reporting mechanism in which the organizations implementing recommendations of this plan report the initiation and completion of projects to some agency or agencies that would oversee the monitoring of implementation. The role of the overseeing agency or agencies would be to receive these reports, periodically compile this information, and evaluate the status of the implementation of the watershed restoration plan.

It is recommended that the Southeastern Wisconsin Watersheds Trust, Inc. (Sweet Water) act as the entity overseeing monitoring of plan implementation for those portions of the watershed that are located within the MMSD planning area, and it is recommended that the Root-Pike Watershed Initiative Network act as the entity overseeing monitoring of plan implementation for those portions of the watershed in Kenosha and Racine Counties outside of the MMSD planning area.

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[53]*AECOM,* Storm Water Quality Management Analysis, *Final Report to City of Greenfield, December 2008; AECOM,* Storm Water Quality Management Plan Update/TMDL Preparedness Assessment, *Final Report to City of Racine, December 2013.*

It is further recommended that all organizations acting to implement this plan report the initiation and completion of projects implementing plan recommendations to the entity overseeing monitoring for the portion of the watershed in which the project is conducted.

Evaluating the State of Plan Implementation

Since the evaluation of plan implementation is a continuing function, a body should be designated to periodically evaluate the state of plan implementation. Given the continuing nature of planning, it would also be desirable that this body be available to coordinate and advise on the execution of this watershed restoration plan and to undertake plan updating as necessitated by changing events. Given the roles of local governments and private organizations in plan implementation, the active participation of representatives from these organizations in such a body is crucial.

Based on these considerations, **it is recommended that the Root River Watershed Plan Advisory Group be maintained as a continuing advisory committee to provide advice and coordination for and to evaluate the state of implementation of this watershed restoration plan.** Consideration should be given to adding members to this group as needed, with these additional members being drawn primarily from local units of governments and private organizations that are actively implementing plan recommendations.

It is recommended that the Advisory Group meet annually at the request of Sweet Water and Root-Pike WIN in order to evaluate the status of plan implementation. This evaluation will include review of the project reports received by Sweet Water and Root-Pike WIN as well as other available information relevant to evaluating plan implementation. Examples of such information include, but are not limited to, annual reports that are submitted by land conservation departments and MS4 communities to the applicable regulatory agencies, annual reports submitted by parks departments to the public, summaries of water quality data, and land use data.

The Advisory Group will evaluate progress in plan implementation against the milestones set forth in Table 88. These milestones reflect the schedule for plan implementation given in Chapter VII of this report. Based upon its evaluation, the Advisory Group will make a determination as to whether plan implementation is proceeding in accordance with the schedule. Based upon this determination it will provide advice to organizations implementing the plan regarding implementation strategies.

As part of its review process the Advisory Group will examine the plan and efforts to implement it to determine whether any adjustments or modifications in plan recommendations or priorities are warranted. The issues that should be addressed in this review include, but are not limited to:

- Whether conditions within the watershed have changed in ways that require adjustment of the plan,
- Whether public priorities with respect to the focus areas of the plan have changed,
- Whether the regulatory environment with respect to the focus areas of the plan has changed,
- The degree and extent of progress made in implementing recommended actions,
- Whether the elements and priorities of the plan should remain unchanged or need modification,
- Whether new plan elements are needed, and
- Whether applicable funding programs and levels of funding have changed.

Table 88

IMPLEMENTATION MILESTONES FOR THE ROOT RIVER WATERSHED RESTORATION PLAN

Action	Milestones
Specific Projects Listed in Table 79	
High-priority projects	30 projects initiated by the end of 2019
	41 projects completed by end of 2024
Medium priority projects	10-15 projects initiated by end of 2019
	25-30 projects completed by end of 2024
	55-65 projects completed by end of 2029
	80-90 projects completed by end of 2034
	All 120 projects completed by end of 2039
Green Infrastructure Installation	
Within MMSD service area[a]	7 percent of recommended practices by end of 2019
	42 percent of recommended practices by end of 2025
	100 percent of recommended practices by end of 2035
Outside of MMSD service area	35-50 rain gardens installed by end of 2019
	70-100 rain gardens installed by end of 2024
	175-250 rain gardens installed by end of 2039
Rural Nonpoint Source Measures	
Transect surveys to monitor crop land erosion levels, farming practices, and crop rotations[b]	One per county by 2019
Inventorying of priority farm landowners to evaluated compliance with agricultural performances standards of NR 151[c]	At least two farms per year
Implementation of county private onsite wastewater treatment system programs[d]	
Completion of inventories	Completed by October 2017
Implementation of other program elements	In place by October 2019
Water Quality Monitoring	
Stream monitoring stations	63 active stream monitoring station by end of 2019
Lake and pond monitoring stations	10 active lake and pond monitoring stations by end of 2019
Mussel monitoring	One survey by 2022
Collation and analysis by monitoring data	One report by 2024
Recreational Access	
Canoe/kayak landings	One additional landing by 2039
Provision of additional parking at Upper Kelly Lake access site	Provision by 2024
Debris jam removal feasibility study	Study completion by 2024
Additions to Oak Leaf Trail	Completion by 2035
Instream Habitat	
Fish passage assessments[e]	
Sites in Tier 1 areas	Completion of assessments by end of 2019
Sites in Tier 2 areas	Completion of assessments by end of 2024
Sites in Tier 3 areas	Completion of assessments by end of 2039
Large Woody Debris	
Assessments	Completion of assessments by end of 2019
Management	Completion of management activities by end of 2024

Table 88 (continued)

Action	Milestones
Horlick Dam	
Dam removal	Completion by April 22, 2024
Information and Education Plan	Benchmarks are given in outcomes column of Table 100 in Chapter VII

[a] *The implementation timeline for the MMSD green infrastructure plan is given in Table 82. Elements constituting full implementation are given in Table 81.*

[b] *This is recommended in county land water resource management plans and evaluates whether soil erosion rates are less than "T," the tolerable rate of soil erosion.*

[c] *On a Countywide basis, the Racine County Land and Water Resource Management Plan recommends inventorying at least five farms per year. About 36 percent of the County is located in the Root River watershed, suggesting about two farms per year in this watershed. This helps to evaluate the implementation of rural nonpoint source measures.*

[d] *Benchmark dates are the deadlines set forth in Section SPS 383.255 of the* Wisconsin Administrative Code.

[e] *The tiered approach to fish passage is shown in Figure 116.*

Source: SEWRPC.

RECOMMENDATIONS FOR RECREATIONAL USE AND ACCESS

This section presents recommendations related to recreational use and access of the surface water system in the Root River watershed. These include recommendations related to trails, boating access, fishing access, and nature centers. Because an overriding consideration related to the recreational use of surface waters is whether the water is safe for human contact, this section also presents recommendations for reducing instream concentrations of fecal indicator bacteria and the pathogens for which these bacteria act as a surrogate.

Recommendations to Reduce Instream Concentrations of Fecal Indicator Bacteria

Concentrations of bacteria indicative of fecal contamination, such as fecal coliform bacteria and the bacterium *Escherichia coli* (*E. coli*), are generally used to assess the suitability of waters for human contact. The description of surface water quality given in Chapter IV indicates that high concentrations of these indicator bacteria are often present in surface waters of the watershed. This indicates that these waters may not be safe for human contact because of the possible presence of waterborne disease agents. This reduces the recreational potential of the surface waters of the watershed. Targets for reductions of fecal coliform bacteria, as developed in the RWQMPU, are presented in Chapter V of this report.[54]

This subsection presents several recommended measures for the reduction of inputs of fecal indicator bacteria—and the pathogenic organisms for which they serve as surrogates—to surface waters of the Root River watershed. These recommendations are intended to produce the reductions needed to meet the targets set in Chapter V. It should be kept in mind that these targets were established for the watershed restoration plan based upon the water quality model used in the RWQMPU. As discussed in Chapter V, meeting these targets will result in improve-

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[54] *Targets for reduction of fecal indicator bacteria are expressed in terms of fecal coliform bacteria both because State recreational use water quality standards are based upon fecal coliform bacteria concentrations and the modeling for the RWQMPU simulated fecal coliform bacteria concentrations. It should be noted that* E. coli *is one of several species of fecal coliform bacteria.*

ments in the bacterial water quality of surface waters in the Root River watershed; however, even with full implementation, surface waters of the watershed will not achieve full compliance with the applicable water quality criteria for recreational use.

Coordinated Programs to Detect and Eliminate Illicit Discharges to Storm Sewer Systems

It is recommended that those municipalities in the watershed with MS4s regulated under the WPDES system modify their illicit discharge detection and elimination (IDDE) programs to transfer some of the effort currently expended to monitor major outfalls that show no evidence of illicit discharges to outfalls of any size that are considered likely to be conveying water contaminated with sanitary wastewater.

The MS4 discharge permits under which most of the permitted municipalities in the Root River watershed operate their MS4s require that annual dry-weather field screening be conducted at major outfalls, including field analysis of any dry-weather flows from those outfalls.[55] Under this recommendation, **the permitted communities would develop an analysis procedure to identify those stormwater outfalls of all sizes that are most likely to be conveying water contaminated with sanitary wastewater**. This analysis procedure should take into account what is known about the age and condition of the associated stormwater and sanitary wastewater conveyance systems, water quality conditions within receiving waters, and other available relevant information. The Menomonee River Watershed MS4 Permittees, which include the Cities of Greenfield, Milwaukee, and West Allis in the Root River watershed, have developed a draft analysis procedure of this type. This procedure is described in Appendix S of this report. It should also be noted that the WDNR has issued guidance recommending that municipalities adopt a more targeted approach to illicit discharge detection and eliminations in which outfalls are prioritized based upon their potential for conveying illicit discharges rather than solely on the size of the pipe or contributing drainage area.[56]

The analysis procedure developed by the communities would be used to target outfalls for field screening. Outfalls would be screened on the following schedule:

- Those major outfalls that had shown no evidence of illicit discharges during the term of the community's previous MS4 permit would be required to be screened at least once during the five-year permit term, with at least one-fifth of all major outfalls being screened each year on a rolling basis.

- Those major outfalls for which the last two samplings conducted showed evidence of illicit discharge would be required to be screened a minimum of once per year.

- All other outfalls identified for screening under the analysis procedure developed by the communities would be required to be screened annually.

- Outfalls identified for annual screening would be screened each year until no evidence of illicit discharge is found for two consecutive years.

- Outfalls with indeterminate sources and nonstormwater discharge would be screened annually.

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[55]*Major outfalls are defined as those outfalls having the equivalent of an inside diameter equal to or larger than 36 inches which are associated with a drainage area of more than 50 acres and those outfalls that receive stormwater runoff from lands zoned for industrial activity with a drainage area of more than two acres or from other lands with more than two acres of industrial activity.*

[56]*Wisconsin Department of Natural Resources, "Illicit Discharge Detection and Elimination," Program Guidance Memorandum #3800-2012-01, March 15, 2012.*

Upon detection of an illicit discharge, the municipality would continue to be required to immediately begin an investigation of the sewershed in order to find and eliminate the source of the discharge.

This change in procedure is intended to target sources that are likely to be contaminated with human-sourced wastewater. Given this, it would be useful for field screening to explicitly test for fecal contamination. Therefore, **it is recommended that field analysis conducted when dry-weather flow is detected during field screening include sampling for fecal indicator bacteria such as fecal coliform bacteria or *Escherichia coli*.** Adding this indicator to the suite of indicators used in field screening will give additional data for determining whether dry-weather flows represent discharges contaminated with human wastes. Should additional data be required, the municipalities should consider utilizing microbial source tracking techniques, such as screening for human-sourced *Bacteroides*.

For most of the municipalities in the Root River watershed, implementation of this recommendation will require that the WDNR authorize a change in their MS4 discharge permits. This would be best accomplished during the regular reissuance of their permit at the end of a five-year permit cycle. The Cities of Franklin, New Berlin, and Racine and the Villages of Caledonia, Greendale, Hales Corners, and Mt. Pleasant are covered under the Root River Group permit. This permit will expire on September 9, 2018. The City of Oak Creek is covered under its own permit, which expires on June 11, 2018. The City of Muskego and the Village of Sturtevant are currently covered and the Town of Norway is being considered for coverage under the State's MS4 general permit, which expired on December 31, 2010, and, as of February 10, 2014, is in the process of being reissued. The Cities of Greenfield, Milwaukee, and West Allis are currently covered under the Menomonee River Watershed-Based Permit and are in the process of implementing this recommendation. This permit will expire on December 1, 2017.

Urban Stormwater Runoff Management

Design Considerations Related to Fecal Indicator Bacteria and Pathogens for Urban Stormwater BMPs

It would be expected that some urban stormwater management practices previously recommended would also act to reduce contributions of fecal indicator bacteria and the pathogens for which they are a surrogate to surface waterbodies. Table 89 summarizes data on the performance of several urban stormwater management practices with respect to three commonly used types of fecal indictor bacteria: fecal coliform bacteria, *Escherichia coli* (*E. coli*), and enterococcus.[57] There are considerable differences among BMPs in the median reductions of fecal indicator bacteria concentration resulting from treatment by the BMP. The data also show differences in how particular types of BMPs perform when assessed using different types of fecal indicator bacteria.

Several things should be kept in mind when interpreting the performance values given in Table 89. First, for any given BMP the assessment given in the table is based upon a small number of studies. Second, review of the literature shows that the performance of BMPs with respect to fecal indicator bacteria is highly variable. This variability shows up in at least three different ways. The table suggests that the performance may differ depending upon which type of fecal indicator bacteria is used. In addition, there can be large differences in performance among individual examples of the same practice. For example, the values for the percentage of fecal indicator bacteria removed by retention ponds reported in the literature ranges between 5 percent and 99 percent.[58] An

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[57]*Two of these indicators, fecal coliform bacteria and* E. coli, *are monitored in the Root River watershed. While enterococcus is not currently monitored in the watershed, it is recommended for use as an indicator in freshwater by the U.S. Environmental Protection Agency.*

[58]*Thomas R. Schueler and Heather K. Holland, "Microbes and Urban Watersheds: Ways to Kill 'Em," Article 67,* The Practice of Watershed Protection, *Center for Watershed Protection, Volume 3, Pages 566-574, 2000; Stephen R. Pennington, Michael D. Kaplowitz, and Scott G. Witter, "Reexamining Best Management Practices for Improving Water Quality in Urban Watersheds,* Journal of the American Water Resources Association, *Volume 39, Pages 1027-1041, 2003; Lisa Tilman, Andrea Plevan, and Pat Conrad,* Effectiveness of Best Management Practices for Bacteria Removal: Developed for the Upper Mississippi River Bacteria TMDL, *Report to the Minnesota Pollution Control Agency, June 2011.*

Table 89

MEDIAN PERCENT REDUCTIONS IN FECAL INDICATOR BACTERIA REPORTED FOR STORMWATER BEST MANAGEMENT PRACTICES

Practice	Fecal Coliform Bacteria		*Escherichia coli*		Enterococcus	
	Reduction (percent)	Number of Studies	Reduction (percent)	Number of Studies	Reduction (percent)	Number of Studies
Bioretention..............................	- -	- -	70	3	61	3
Bioswale	-6[a]	10	-5[a]	5	- -	- -
Detention (dry) Pond................	30	13	67	3	- -	- -
Grass Strip...............................	27	2	- -	- -	- -	- -
Green Roof	- -	- -	93	3	- -	- -
Retention (wet) Pond	63	11	95	4	- -	- -
Wetland Basin..........................	53	5	20	3	- -	- -
Manufactured Device- Disinfection	99	1	- -	- -	99	1
Manufactured Device- Inlet Filtration Insert................	-295[a]	5	- -	- -	-67[a]	5
Manufactured Device- Physical Settling/Straining......	-24[a]	6	- -	- -	- -	- -

[a]A negative reduction indicates that effluent concentrations of fecal indicator bacteria from the practice were higher than influent concentrations.

Source: International Stormwater Best Management Database and SEWRPC.

individual example of a practice can show different levels of performance at different times or under different conditions. For example, a detention basin in Houston, Texas showed performance levels that ranged between 72 percent reductions and 1,858 percent increases in *E. coli* concentrations during different storm events.[59] Third, it is important to keep in mind that fecal indicator bacteria are not themselves pollutants of concern. Instead, they act as surrogate measures indicating the likelihood that surface waters are contaminated with fecal wastes and may contain disease-causing agents. The performance of stormwater BMPs with respect to fecal indicator bacteria may not be representative of their performance with respect to disease-causing agents. In general, it is reasonable to expect that the performance data in Table 89 likely give a better representation of BMP performance with respect to pathogenic bacteria than they give of performance with respect to pathogenic viruses, protozoa and protozoan cysts, or helminth eggs. Unfortunately, relatively few data are available regarding the performance of stormwater BMPs with respect to disease agents.

Several factors appear to be important to the fate and transport in aquatic environments of fecal indicator bacteria and the pathogens for which they serve as surrogates.[60] These factors include natural die-off, exposure to sunlight

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[59]*Hanadi Rifai,* Study on the Effectiveness of BMPs to Control Bacteria Loads*, Final Report to the Texas Commission on Environmental Quality, August 2006.*

[60]*Reviewed in J.D. Brookes, J. Antenucci, M. Hipsey, M.D. Burch, N.J. Ashbolt, and C. Ferguson, "Fate and Transport of Pathogens in Lakes and Reservoirs,* Environment International, *Volume 30, Pages 741-759, 2004; C. M. Ferguson, A.M. de Roda Husman, N. Altavilla, D. Deere, and N. Ashbolt, "Fate and Transport of Surface Water Pathogens in Watershed,"* Critical Reviews in Environmental Science and Technology, *Volume 33, pages 299-361, 2003; and W.A.M. Hijnen, E.F. Beerendonk, and G. J. Medema, "Inactivation Credit of UV Radiation for Viruses, Bacteria and Protozoan (Oo)cysts in Water: A Review,"* Water Research, *Volume 40, Pages 3-22, 2006.*

and its ultraviolet component, temperature, the presence of predatory microorganisms, availability of nutrients, sorption to particles, turbidity, and flow rates. Sorption to particles and sedimentation may have complex effects. Sorption to particles tends to increase the rates at which indicator bacteria and pathogens settle out of the water column. While indicator bacteria and pathogens can be removed from the water through sorption and sedimentation, there is evidence that at least some of these species are able to survive in sediment. Because of this, resuspension of sediment may act as a source of indicator bacteria and pathogens to the water and removal of indicator bacteria and pathogens through sedimentation may not constitute permanent removal.

This suggests several elements that should be considered in the design of stormwater BMPs in order to reduce concentrations of indictor bacteria and pathogens in water.

- BMPs should be designed in such a way as to maximize exposure to sunlight to promote inactivation of indicator bacteria and pathogens by sunlight and ultraviolet light.

- BMPs should be designed in such a way as to provide habitat for microorganisms and very small animals that prey upon bacteria, protozoa, protozoan cysts, and helminth eggs.

- BMPs should be designed in such a way as to promote sorption of indicator bacteria and pathogens to particles and sedimentation of these particles. When sorption of bacteria and pathogens is a treatment process, the BMP should be designed to reduce resuspension of sediment.

- BMPs with open water should be designed in such a way as to discourage their use by nuisance waterfowl. This will be discussed more in the following subsections.

It should be noted that practices that infiltrate stormwater will reduce bacteria loading by reducing the volume component of the load. Practices that infiltrate stormwater also typically provide treatment processes enabling sorption and filtration. Where infiltration is used, it is important to recognize that groundwater pollution can also occur, if adequate sorption and filtration do not occur prior to the infiltrated water reaching groundwater.

Reducing Impacts of Nuisance Waterfowl

It is recommended that programs to control nuisance animals be conducted on an "as needed" basis in response to identified water quality problems resulting from nuisance animals. Measures to discourage use of stormwater BMPs by nuisance animals should be incorporated into the design of urban stormwater BMPs.

Several techniques can be used to discourage nuisance waterfowl from congregating in areas adjacent to waterbodies or stormwater BMPs. They tend to work best in combination with one another.

Availability of food is a major reason why geese and gulls are attracted to certain areas and remain there for long periods of time. Methods of reducing food availability, such as enclosing trash containers and enacting and enforcing "no feeding" policies, can make these areas less attractive to geese, gulls, and other unwanted birds and animals.

Geese, in particular, prefer nicely groomed lawns adjacent to water and normally like to walk out of the water on bare, flat, or gently sloping banks. Measures that reduce the amount of these habitat features in riparian areas and adjacent to stormwater BMPs that include permanent pools will make these areas less attractive to geese. These measures include installing vegetative buffer strips, placing rock barriers consisting of boulders at least two feet in diameter along the shoreline,[61] or installing fence barriers that physically prevent geese from walking out of the water into feeding areas.

[61]*It should be noted that riprap and smaller rock around a pond will not deter geese.*

Reducing the availability of breeding and resting areas will also discourage nuisance waterfowl. Islands and peninsulas are ideal nesting sites for waterfowl. These areas are surrounded by water and offer protection and security from predators. When creating new ponds or retention basins, any islands or peninsulas should be constructed in such a way as to discourage use by waterfowl.

While there are more aggressive measures that can be taken regarding nuisance waterfowl, it is important to note that they are Federally protected under the Migratory Bird Treaty Act of 1918. This act places restrictions on some of the methods that can be used and, in particular, requires a permit from the U.S. Fish and Wildlife Service in order to use methods that would depredate these animals. Prior to using more aggressive measures, it is important to consult with the U.S. Department of Agriculture Wildlife Services.

Reducing Impacts of Pet Waste

It is recommended that all municipalities in the watershed have pet litter control ordinance requirements and that those requirements be enforced. Further measures to address pet litter should be considered on a site-specific basis in response to identified water quality problems resulting from pets.

Measures that could be taken to address pet waste in response to an identified water quality problem include:

- Revising existing pet litter control ordinances to apply to any public property or private property other than that belonging to the owner, caretaker, or person in control of the animal;

- Stricter enforcement of existing ordinances;

- Installing pet waste stations in parks and along trails that are either near waterbodies or near inputs to stormwater management systems that discharge to waterbodies;

- Locating any new dog parks away from waterbodies or inputs to stormwater management systems that discharge to waterbodies; and

- Public outreach and educational programs regarding pet waste management.

Agricultural Manure and Barnyard Runoff Management

Several measures are recommended for the management of agricultural manure and barnyard runoff in the Root River watershed:

- **It is recommended that nutrient management plans be prepared for all agricultural operations in the watershed that do not currently have them.**

- **It is recommended that manure and other nutrients be applied to fields only in accordance with nutrient management plans.**

- **The provision of six months of manure storage is recommended for all livestock operations in the watershed with 35 combined animal units or more.** This would enable manure to be spread on fields twice annually during periods when the ground would not be frozen prior to spring planting and after summer and fall harvest.

- **The provision of barnyard runoff control systems is recommended for all livestock operations in the watershed.** Such systems consist of facilities or practices used to contain, divert, retard, or otherwise control the discharge of runoff from outdoor areas of concentrated livestock activity. Examples of these are given in Table 71 in Chapter V of this report.

- **Installation of practices to exclude livestock from waterbodies and adjacent riparian areas.** This should be a part of the provision of barnyard runoff control systems and should consist of both installing fences along narrow strips of land along the waterbodies and providing animals with alternative sources of drinking water to reduce the amount of time they spend near waterbodies.

It should be noted that existing agricultural operations are excluded from many of the requirements of Chapters NR 151 “Runoff Management” and ATCP 50 “Soil and Water Resource Management Program” of the *Wisconsin Administrative Code* if cost-share funding is not available for implementation of management practices. Because of the limited amount of such funding that is available annually, many existing livestock operations are not compelled to comply with Administrative Code provisions related to barnyard runoff. In order to attain a greater level of control of barnyard runoff, **it is recommended that consideration be given to increasing levels of cost-share funding to enable a higher level of implementation of the best management practices needed to meet the NR 151 performance standards.** To facilitate this **it is recommended that the WDNR consider increasing levels of cost-share funding to enable a higher level of implementation of the best management practices needed to meet the NR 151 performance standards, and that county land conservation departments assist farmers in obtaining additional Federal and local grants that might be combined with additional State funds to implement controls on barnyard runoff.**

Recommendations Related to Trails

As described in Chapter IV of this report, the Root River watershed contains about 70 miles of major recreational trails. Parks within the watershed contain over 13 miles of additional trails. As described in Chapter, the Root River watershed restoration plan’s target for trails is for the watershed to contain an interconnected trail system that, to the extent practicable, provides connections to local, county, and regional trail systems within adjacent watersheds. Examination of Map 64 in Chapter IV shows poor continuity of trails within the watershed. In particular, trails located in the downstream portion of the watershed in and around the City of Racine are not connected to trails in the upstream portions of the watershed. In addition, the major trails within the watershed are only partially connected to trails in adjacent watersheds and communities. The following recommendations are intended to promote the development of a more highly interconnected trail system within the watershed that is better connected to trails outside of the watershed. The recommended additions to the trail system within the watershed are shown on Map 93. The locations of proposed recreation corridor trails shown on the map are general in nature and are subject to refinement based on detailed facility planning and negotiations with landowners to purchase land for the trails.

It is recommended that Milwaukee County expand its Oak Leaf Trail system within the Root River watershed by adding 16 miles of additional trails. This expansion includes:

1. **Extending the Oak Leaf Trail along the Root River from its current terminus at W. Ryan Road to where another section begins at S. Howell Avenue (STH 38),**

2. **Extending the Oak Leaf Trail to the west along Ryan Creek to connect with the City of Franklin’s recreational trails, and**

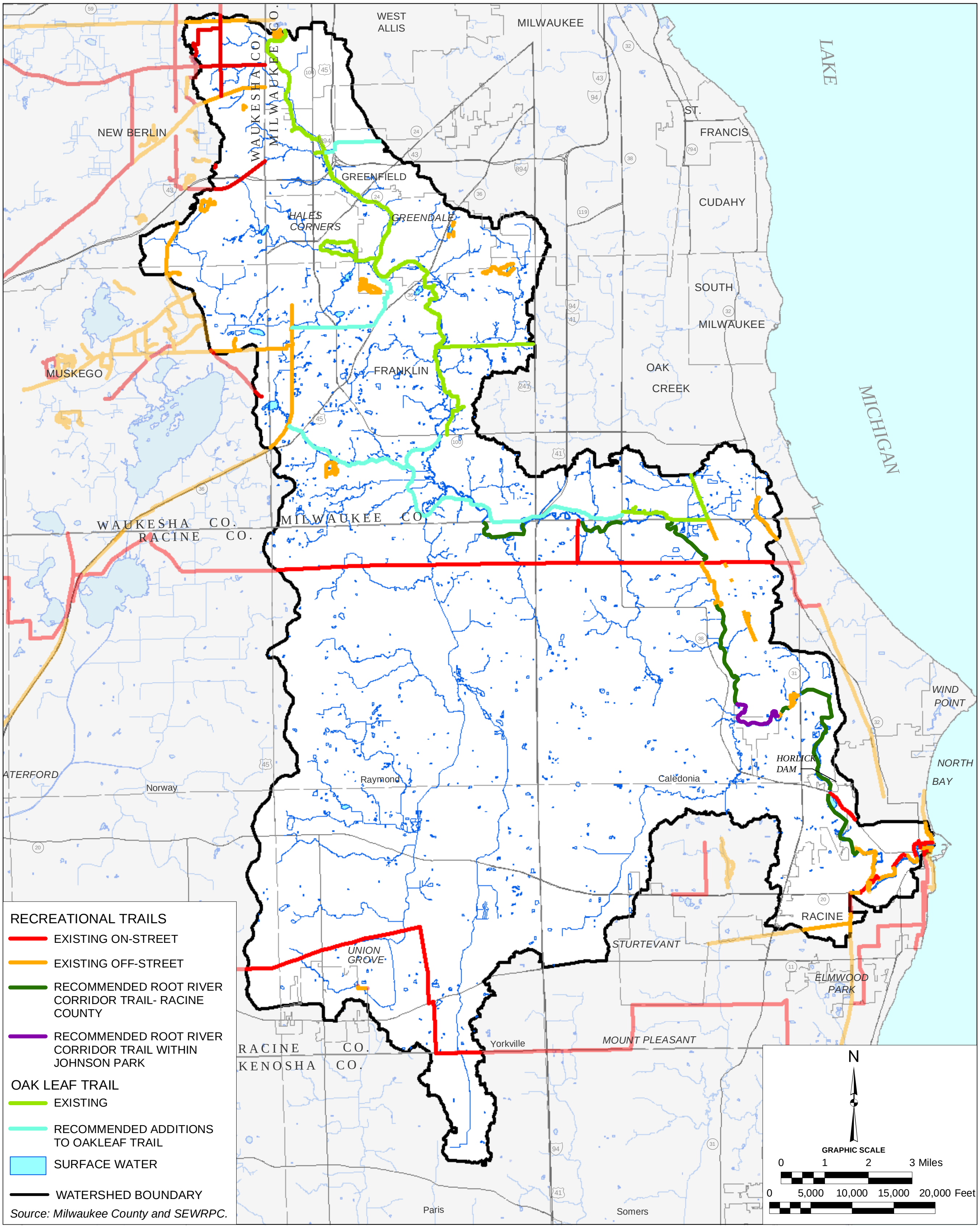
3. **Extending the Oak Leaf trail to the west along a route that is located to the south of Whitnall Park to connect with the City of Franklin’s recreational trails.**

This recommendation is consistent with the recommendation given in the Milwaukee County park and open space plan.[62] Much of this trail would run through the Root River Parkway and other County parks. The estimated capital cost of this recommendation is $3,227,000. This cost includes the cost of land acquisition that would be

[62]*SEWRPC Community Assistance Planning Report No. 132, 2nd Edition,* A Park and Open Space Plan for Milwaukee County, *in review.*

Map 93

RECOMMENDED RECREATIONAL TRAILS WITHIN THE ROOT RIVER WATERSHED



necessary specifically to complete the recommended additions to the trail; however, it does not include costs associated with acquiring other lands recommended for addition to the Root River Parkway in the County park and open space plan. Completion of this portion of the Oak Leaf Trail would complete the Root River Corridor within Milwaukee County and provide connections to local trails and to proposed trails in Racine County.

It is recommended that Racine County develop a Root River corridor consisting of about 14.6 miles of recreation corridor trails along the Root River. The general location of this corridor is shown on Map 93. This recommendation is consistent with the recommendation given in the Racine County park and open space plan.[63] This proposed trail would be connected to the existing Root River Pathway in the City of Racine and to the existing Milwaukee County Oak Leaf Trail in the City of Oak Creek. It would also provide a connection the portion of the Lake Michigan Corridor proposed in the Racine County park and open space plan.[64] The Racine County park and open space plan estimated the capital cost of developing this trail at $786,300. This does not include the cost of any land acquisition that would be needed. Should Horlick dam be removed, portions of the current impoundment may become available as a potential route for the recommended recreational corridor. As shown on Map 71 in Chapter V of this report, the majority of the Horlick dam impoundment is not in private ownership, and the majority of the private property lines end at the water's edge of the current impoundment. A final determination of changes to Horlick impoundment property boundaries would require a review of the individual deed language.

It is recommended that the City of Racine develop about one mile of trail along the Root River in Johnson Park. Development of this trail should occur in areas that would not disturb the golfers using the golf course in Johnson Park or pose a hazard to the trail users. Development of this portion of trail would provide continuity for the proposed Racine County Root River Corridor discussed above. Development of this trail is consistent with the recommendations of the City of Racine park and open space plan.[65] Based upon the costs for Root River Corridor trail development given in the County park and open space plan, it is estimated that the capital costs of developing this portion of trail would be $54,000.

It is recommended that counties and municipalities consider developing other connections among trails within the watershed to connect local trail systems and smaller trails to the regional trail system. An example of this is given in Table 79 and Maps 74 through 88 as project MRR-14. This would connect the City of Franklin trails to the Oak Leaf trail through Victory Park.

Recommendations Related to Surface Water Access

As described in Chapter IV of this report, the Root River watershed provides recreational opportunities for canoeing, kayaking, and fishing. The following recommendations are intended to maintain and enhance public access to the surface waters of the watershed.

Access to the Mainstem of the Root River

As described in Chapter IV, access to the mainstem of the Root River is available at several boat launches and canoe/kayak landings. In the section of the River below Horlick dam there is a boat launch at Clayton Park and canoe landings at Island Park, Lincoln Park, and 6th Street Park South. Lincoln Park contains two landings that allow canoers and kayakers to portage around the weir at the WDNR Root River Steelhead Facility. Upstream of

[63]*SEWRPC Community Assistance Planning Report No. 134, 3nd Edition,* A Park and Open Space Plan for Racine County, *February 2013.*

[64]Ibid.

[65]*SEWRPC Community Assistance Planning Report No. 270, 2nd Edition,* A Park and Open Space Plan for the City of Racine, Racine County, Wisconsin, *December 2011.*

Horlick dam, there is a boat launch at Horlick Park and canoe landings at Linwood Park and River Bend Nature Center. As described in Chapter V of this report, the Root River watershed restoration plan's target for boating access to the River calls for one carry-in access site per 10 miles of river. Based upon this, it was concluded that one or two additional access sites should be established upstream from Horlick dam.

It is recommended that a canoe landing be installed on the mainstem of the Root River between the existing sites at Horlick and Linwood Parks. Table 79 lists and Maps 74 through 88 show two projects to install canoe landings within this section of the Root River. One of these projects, LRJ-01, calls for the installation of a canoe landing in County-owned right-of-way along STH 31 at 4 Mile Road in the Village of Caledonia. This site is located about 3.4 miles upstream from Horlick Park and 4.2 miles downstream from Linwood Park. The other project, LRJ-15, calls for the installation of a canoe landing 4 Mile Road in the Blue River Preserves, a conservation subdivision in the Village of Caledonia located at about 6.4 miles upstream from Horlick Park and 1.2 miles downstream from Linwood Park. These sites are shown on Map 94. Based upon its location relative to the existing canoe landings, it would be preferable to place this canoe landing at the STH 31 site; however, it is recognized that the final decision of where to install this landing will require detailed investigations of these sites.

It should be noted that the existing set of boat launches and canoe landings does not provide safe portage around Horlick dam for canoers and kayakers. The boat landing at Horlick Park provides access to the River immediately upstream from the dam, but there is no landing immediately downstream from the dam. Given that this watershed restoration plan recommends the removal of this dam, the installation of a landing immediately downstream is not recommended. It should be noted that the final decision regarding Horlick dam rests with Racine County, subject to regulatory oversight from the WDNR. If the County should decide not to remove the dam, or would be unable to do so, it would be desirable to revisit the question of portage around the dam. In that case, it is recommended that the County examine the feasibility of installing a canoe landing immediately downstream of the dam and developing a portage route between such a downstream landing and the boat launch at Horlick Park.

As noted in Chapter V of this report, the Milwaukee County park and open space plan recommends developing a canoe/carry-in boat access along the Root River on existing parkway lands.[66] Field surveys by SEWRPC staff during 2013 documented that water depths in the mainstem of the River between the confluence of the Root River with the Root River Canal and the confluence of the Root River with Crayfish Creek are sufficiently deep to permit navigation by canoes or kayaks during at least a portion of the year. The field surveys also documented the presence of numerous large woody debris jams in this section of the River. These are shown on Map I-10 in Appendix I. The presence of these debris jams precludes the use of this section of the River for canoe- and kayak-based recreation. Thus, installation of the recommended canoe landing would also require either removal of these debris jams or removal of a large enough portion of each debris jam to create a debris-free channel through the River that could pass small watercraft such as canoes. This clearing would need to be done on an ongoing basis. Keeping this section of the River open to navigation by canoes and kayaks could potentially add as much as eight miles of the River that are available for this sort of recreational activity.

Several issues would need to be evaluated prior to conducting any project to clear this section of the Root River for navigation by canoes and kayaks. Such a project may require permits from the WDNR, the U.S. Army Corps of Engineers, or both of these agencies. In addition, the riparian areas along this section of the River that are located within the Root River Parkway contain many small, ephemeral wetlands. These wetlands may hold water for a few weeks in the spring and summer, or following heavy rains, but can be dry the rest of the year. Despite their temporal nature, these wetlands can be extremely productive and provide important sources of food and breeding habitat for many organisms. In particular, amphibians and certain invertebrates rely on these ponds for breeding and maturing. The ephemeral wetlands along this section of the Root River are known to serve as

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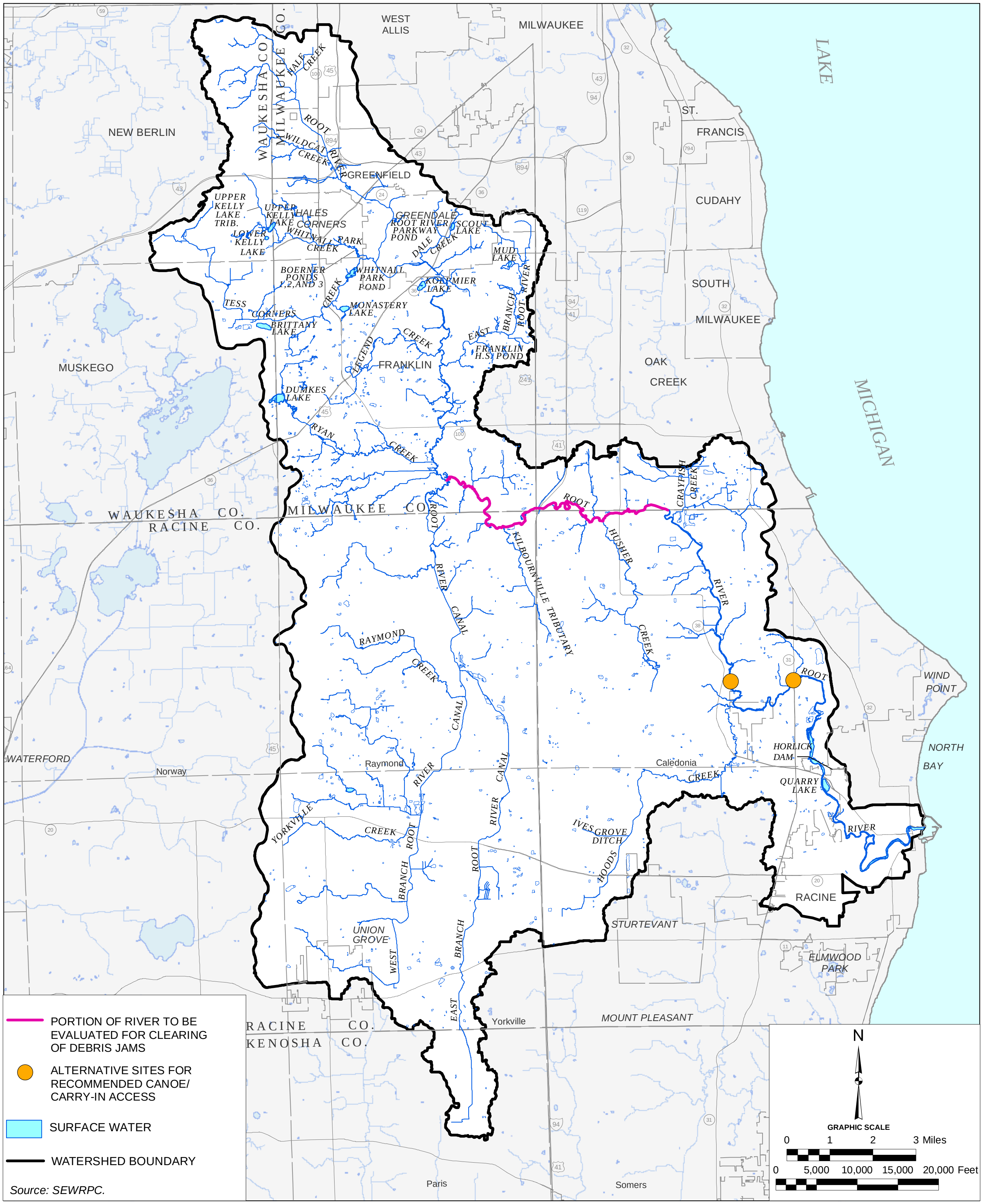
[66]*SEWRPC Community Assistance Planning Report No. 132, 2nd Edition,* op. cit.

Map 94

SURFACE WATER ACCESS RECOMMENDATIONS WITHIN THE ROOT RIVER WATERSHED



Source: SEWRPC.

breeding habitat for several sensitive amphibian species.[67] The impacts of a project to remove debris jams or create a navigation channel upon these wetlands and the organisms that depend upon them would need to be assessed. In addition, the presence of these wetlands may place restrictions of the use of the riparian area for disposal of materials removed from the River as part of clearing operations.

Since this section of the River traverses parkway lands in both Milwaukee and Racine Counties, **it is recommended that Milwaukee and Racine Counties jointly evaluate the feasibility of removing debris jams or clearing a channel through the debris jams for navigation in the section of the mainstem of the Root River between the confluence with the Root River Canal and the confluence with Crayfish Creek. The evaluation should include an assessment of the feasibility of maintaining this channel. Should it be found feasible to make and keep this section of the River navigable for canoes and kayaks, it is recommended that such a channel be created and maintained and that Milwaukee County install a canoe/carry-in boat access along the Root River on existing parkway lands.** The section of River to be evaluated under this recommendation is shown on Map 94.

Based on the costs given in the Milwaukee County park and open space plan,[68] the cost of installation of a canoe/carry-in boat access site, including related parking, is estimated at $30,600. This cost does not include the cost of land acquisition.

Access to Lakes

Upper Kelly Lake, with a surface area of 12 acres, falls in the one-to 50-acre category for recreational use lakes established in Section NR 1.91 of the *Wisconsin Administrative Code* (see Table 69 in Chapter V of this report). Within this category, the minimum and maximum standards are the same; namely, one carry-in access site for five vehicles plus a handicapped accessible unit, for a total of six units. As described in Chapter V, while this Lake has adequate carry-in access, no parking is currently provided at or near the access site and onstreet parking is currently very limited.

It is recommended that provision of adequate public parking be considered for the existing public recreational boating access site at the S. Kurtz Avenue right-of-way. It is recommended that parking be provided for six vehicles, including one handicapped accessible unit. The proposed parking facilities should conform to the guidance on accessibility contained in Wisconsin Department of Natural Resources Publication No. CA-003-88, *Handbook for Accessibility...A Reference to Help Develop Outdoor Recreation Areas to Include People with Disabilities*. Such access facilities would provide for greater convenience of the residents of Upper Kelly Lake as well as for the convenience and safety of the public at large by providing an improved public launch site with adequate parking facilities. This recommendation is consistent with the Kelly Lakes protection plan.[69]

Potential Root River Water Trail

It is recommended that Milwaukee and Racine Counties and the City of Racine consider the development of a water trail along the Root River. A “water trail” is a designated trail on a lake or stream that regularly contains sufficient water level to navigate small watercraft such as a canoe or kayak with unobstructed passage-ways while providing safe and convenient access points, and may contain support facilities such as parking areas,

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[67]*Brian Russart, Trails and Natural Areas Coordinator, Milwaukee County Department of Parks, Recreation, and Culture, personal communication.*

[68]*SEWRPC Community Assistance Planning Report No. 132, 2nd Edition,* op. cit.

[69]*SEWRPC Memorandum Report No. 135,* A Lake Protection Plan for the Kelly Lakes, Milwaukee and Waukesha Counties, Wisconsin, *(2nd Edition), April 2007.*

restrooms, and picnic areas. This water trail would identify parts of the Root River as a waterway that could accommodate low-impact, nonmotorized watercraft such as canoes and kayaks.

Important factors for establishing water trails include safe and convenient access to a waterway with unobstructed passageways, adequate support facilities, and safe portaging areas. Identifying and providing signs indicating scenic, historical, and natural view points along the waterway should also be considered. The establishment of a water trail would promote the responsible use and enjoyment of the Root River and would further serve as a place for solitude and respite from the urban environment, while providing educational and recreational opportunities for outdoor enthusiasts.

The general route of the proposed Root River Water Trail is shown on Map 95. It is recommended that canoe access and support facilities along this section of the River be maintained. The inclusion of the portion of the River between the confluence of the Root River with Crayfish Creek and the confluence of the Root River with the Root River Canal should be contingent upon 1) a finding that creating and maintaining a channel for canoes and kayaks within this section of the River is feasible and 2) a decision by Milwaukee and Racine Counties to create and maintain such a channel (see previous section on access to the mainstem of the Root River). This section of the River is shown on Map 94.

As part of developing the proposed water trail, Milwaukee and Racine Counties and the City of Racine should consider preparing user-friendly maps for water trail users to identify support facilities and points of interest along the water trail. Nonprofit conservation organizations, such as the Root-Pike Watershed Initiative Network, may assist with these efforts.

Recommendations Related to Fishing Access

Recreational fishing is an important recreational and economic activity in the Root River watershed. As discussed in Chapter IV, fishing from shore was the most commonly observed water-based recreational activity during the recreational use surveys conducted in 2013. The surface waters of the Root River watershed may be accessed for fishing through a number of means. Several public boat launches and carry-in access sites for canoes and kayaks provide access to the River for fishing from boats. The carry-in sites that are recommended in the section on recommendations for surface water access will provide additional access to the River for anglers. In addition, fishing access to the surface waters of the Root River watershed is currently available from shorelines within public lands adjacent to the River and its tributary streams. For the most part, the River and its tributaries can be accessed from any adjacent public lands that the angler can legally access and where local ordinances do not prohibit fishing.

Urban Fishing Waters Program

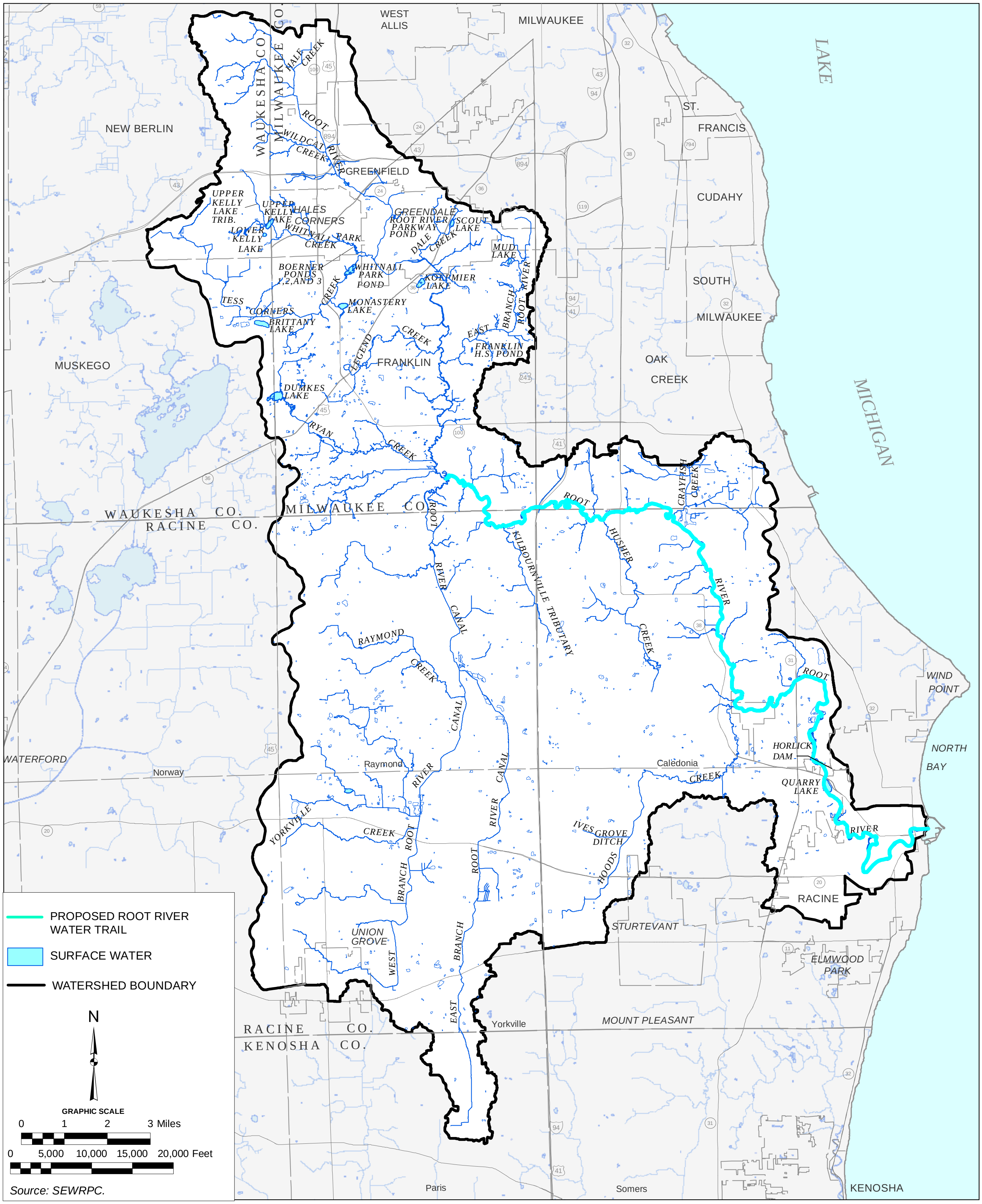
As described in Chapter II, seven small lakes and ponds in the watershed are cooperatively managed by the WDNR and participating counties and municipalities to provide fishing opportunities in urban areas. These lakes and ponds include Franklin High School Pond in the City of Franklin, Gorney Park Pond in the Village of Caledonia, Lockwood Park Pond and Johnson Park Pond in the City of Racine, Quarry Lake in the Village of Mt. Pleasant, Scout Lake in the Village of Greendale, and Shoetz Park Pond in the Village of Hales Corners. Management of these lakes and ponds includes fish stocking. **It is recommended that WDNR and participating municipalities continue to cooperatively manage these lakes and ponds as urban fishing waters. It is further recommended that the WDNR continue to determine the appropriate rates of fish stocking and the appropriated fishing regulations and daily bag limits for these waters.**

Recommendations Related to Nature Centers

There are currently three nature centers located within the Root River watersheds: Wehr Nature Center in Milwaukee County and River Bend Nature Center and the Root River Environmental Education Community Center in Racine County. In addition, several nature centers are located outside the watershed in the counties that contain the watershed. These include Bong State Recreation Area, Hawthorn Hollow Nature Sanctuary and Arboretum, and Pringle Nature Center in Kenosha County; Havenwoods Environmental Awareness Center,

Map 95

POTENTIAL ROOT RIVER WATER TRAIL



Hawthorn Glen, and the Urban Ecology Center in Milwaukee County; and Retzer Nature Center in Waukesha County. According to the outdoor recreation and open space planning standards used to develop county park and open space plans in the Southeastern Wisconsin Region, there should be a minimum of one nature study center per county.[70] Because the Root River watershed and the counties that contain the watershed exceed this standard, there is not currently a need to develop additional nature centers within the watershed.

It is recommended that the Milwaukee County Parks continue to maintain and operate Wehr Nature Center and accommodate resource-oriented activities.

In June 2012, Racine County acquired the River Bend Nature Center property from the Racine YWCA. This 78-acre property provides trails for hiking and cross-country skiing, river access, and environmental education programs. It is currently operated by River Bend Nature Center, Inc., a nonprofit corporation, through a public-private partnership with the County. **It is recommended that Racine County continue to maintain this facility and accommodate resource-oriented activities through a public-private partnership with a nonprofit organization**.

The Root River Environmental Education Community Center (REC Center) is located along the Root River in the City of Racine. The REC Center is operated through a partnership between the City of Racine Department of Parks, Recreation, and Cultural Services and the University of Wisconsin-Parkside. The facility also serves as a public boat launch for small watercraft and provides public access to the Root River Pathway. **It is recommended that the City of Racine and the University of Wisconsin-Parkside continue to maintain this facility and accommodate resource-oriented activities.** During public meetings related to the development of this watershed restoration plan, several members of the public expressed a desire for this nature center to increase its level of service, especially with regard to its hours of operation. In view of this, it may be desirable for the City and the University to explore options and funding sources that could enable an expansion of operations.

Disabled Accessibility of Recreational Facilities

The Federal Americans with Disabilities Act, adopted by the U.S. Congress in 1990, requires that "reasonable accommodation" be made to provide persons with disabilities equal opportunities for access to jobs, transportation, public facilities, and services—including access to recreational facilities. All new or renovated park and recreation facilities must be designed and constructed to comply with the requirements of the Act. **Existing public park and recreation facilities should be evaluated by the unit of government concerned to determine if improvements are needed to meet Federal accessibility requirements.** Accessibility standards and guidelines are available from several agencies regarding specific types of recreational facilities.[71]

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[70]*SEWRPC Community Assistance Planning Report No. 134, 3rd Edition*, A Park and Open Space Plan for Racine County, *February 2013.*

[71]*Guidelines for boating facilities are available from the National Park Service at* http://www.nps.gov/ncrc.programs/rtca/helpfultools/launchguide/3.pdf *and the U.S. Access Board at* http://www.access-board.gov/guidelines-and-standards/recreation-facilities/boating-facilities/. *Guidelines for recreational trails can are available from the U.S. Access Board at* http://www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-aba-standards/Chapter-10-recreational-facilities/, *the U.S. Forest Service at* http://www.fs.fed.us/programs/accessibility/pubs/htmlpubs/htm1232806/index.htm, *and the U.S. Department of Transportation Federal Highway Administration at* http://www.fhwa.dot.gov/environment/recreational_trails/guidance/accessibility_guidance/. *Guidelines for fishing piers and platforms are available from the U.S. Access Board at* http://www.access-board.gov/attachments/article/590/fishing.pdf.

Land Acquisition Considerations for Recreational Facilities

It is the intent of this plan that all land acquisitions occur on a willing-seller, willing-buyer basis and that landowners receive fair market value for their property. Transactions funded with WDNR grants should follow the WDNR acquisition procedures, which include an appraisal by the WDNR.

The recommended acquisition may occur in full fee simple interest or in less-than-fee-simple interest, such as through the purchase of conservation easements. Where a conservation easement is utilized, the landowner retains title to the property; the easement typically precludes mowing or other disturbance of the area by the owner and provides access for site management purposes, such as the removal of woody vegetation which may shade out desired plant species and removal of other nuisance vegetation.

The recommended acquisition may also occur through land subdivision dedication as well as through donation of fee simple title or of conservation easements. Donations may yield income-tax advantages to those who donate since the value of the land or easement donated generally may be deducted from taxable income as an itemized deduction for Federal income-tax purposes and may be considered in calculating the itemized deduction credit for State income-tax purposes.

RECOMMENDATIONS FOR HABITAT

Recommendations for the Control and Management of Invasive and Nonnative Species

As described in Chapter IV of this report, at least six species of aquatic invasive species are present in surface waters of the Root River watershed. These include invasive fish species, such as common carp and goldfish; invasive crustacean species, such as rusty crayfish; invasive mollusks, such as zebra mussel; and invasive plants, such as Eurasian water milfoil and curly-leaf pondweed. In addition, the available survey data suggest that wetland and terrestrial invasive plant species are widespread within uplands, wetlands, and riparian areas of the watershed. The presence of an exotic invasive species in a habitat can produce alterations in physical and biological characteristics of that habitat. Many of these species are capable of producing dense populations, which can crowd out native species. Many of these species are strong competitors for nutrients, space, and other resources, allowing them to displace native species from habitats. As a result, these species have the potential to degrade the remaining high-quality natural areas within the watershed. The following recommendations are intended to more effectively control and manage and spread of nonnative and invasive species in the Root River watershed.

1. **It is recommended that county land conservation departments, the University of Wisconsin-Extension, the Wisconsin Department of Natural Resources, and relevant nongovernmental organizations continue educational activities related to nonnative and invasive species and the control of these organisms.** Such educational activities should include, but not be limited to, the distribution of informational materials, presentation of workshops, installation of signage, and answering of direct inquiries from landowners and residents.

2. **It is recommended that aquatic plant management plans be developed and periodically updated for lakes and park ponds in the watershed.**[72] Aquatic plant surveys should be conducted as part of the development and updating of these plans. **It is recommended that nuisance aquatic plants be managed in accordance with these plans.**

[72]*Such plans have been developed for Upper and Lower Kelly Lakes and for park ponds in the Milwaukee County Parks. The Root River watershed restoration plan recognizes that aquatic plant management planning may be conducted either as stand-alone plans or within the context of park system pond and lagoon planning.*

3. **It is recommended that current monitoring for aquatic and terrestrial invasive species in the watershed be continued and expanded.** This should include conducting inventories of parks and natural areas for species listed as prohibited or restricted under Chapter NR 40, “Invasive Species Identification, Classification and Control,” of the *Wisconsin Administrative Code*. Given that it is important that observations of invasive species be compiled and collated, all new observations of invasive species in waterbodies or habitats should be reported to the Wisconsin Department of Natural Resources.[73]

4. **It is recommended that State agencies, counties, local governments, and land trusts prioritize the lands and waterbodies that they manage for invasive species management.** Factors that should be considered in this prioritization include, but are not limited to, the presence of high-quality natural areas and/or critical species habitat sites, riparian buffer areas, and corridors, such as highway right of ways, that may facilitate the spread of invasive species.

5. **It is recommended that invasive species be removed and/or managed using accepted management methods.** Examples of accepted methods can be found in the Milwaukee County Department of Parks, Recreation & Culture’s invasive species management guide.[74] A copy of this guide is included in Appendix T of this report.

6. New information is constantly becoming available regarding the biology and management of invasive species. Because this information may be valuable in more effectively managing these pests, **it is recommended that the Milwaukee County Department of Parks, Recreation & Culture continue to update its management guide as new techniques and knowledge becomes available.**

7. It is recognized that some methods of invasive species control can be very labor-intensive. Because of this **it is recommended that State agencies, counties, municipalities, and land trusts conduct invasive species work days in parks and natural areas, utilizing community volunteers.** As part of this, they should consider partnerships with relevant nongovernmental organizations such as park friends groups, weed-out groups, and the Southeastern Wisconsin Invasive Species Consortium.

8. Many invasive species thrive in and are capable of rapidly invading disturbed environments. To minimize the impacts of this on invasive species management efforts, **it is recommended that native plants communities be restored at infested sites following invasive plant species removal.**

9. In order to minimize introductions of invasive species, **it is recommended that regularly used roads, trails, landings, and recreation facilities in areas managed for recreation be located away from sensitive habitats, migration corridors, and transitional zones between adjacent habitats. It is also recommended that entrances to these recreational areas be limited to as few points as feasible.**

10. The Milwaukee County Department of Parks, Recreation, & Culture has been developing and implementing site-specific invasive species management plans for County-managed properties. **It is recommended that the County continue the development and implementation of these plans for the County-managed properties in the Root River watershed.**

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[73]*This can be done through the WDNR website at* http://dnr.wi.gov/topic/Invasives/report.html*. This website also describes the specific information that should accompany such reports.*

[74]*Milwaukee County Department of Parks, Recreation & Culture and University of Wisconsin-Extension,* Quick Reference Guide: Phenology and Control of Common Invasive Plant Species Found in Southeastern Wisconsin, *updated May 2012.*

11. **It is recommended that counties and municipalities in the watershed review their municipal ordinances pertaining to the management of noxious weeds and consider revisions that would strengthen these ordinances with respect to requirements for the management of invasive species.**

Recommendations to Protect and Expand Riparian Buffers

As discussed in Chapters IV and V, preservation and development of riparian buffers are key to the existing and future economic, social, and recreational well being of the Root River watershed. Riparian buffers protect water quality, groundwater quality and recharge, fisheries, wildlife, and ecological resilience to invasive species, and they reduce potential flooding of structures and harmful effects of climate change.

While, as discussed above, this plan generally recommends protecting and expanding riparian buffer regions to a minimum 75-foot width and an optimum 1,000-foot-width goal, it is important to note that the presence of a buffer is always better than the absence of one, even if only to prevent some pollution or allow for better aquatic habitat. Therefore, **it is recommended that all efforts be made to develop buffered areas, to the maximum extent practicable up to and beyond the optimum width.**

To guide the implementation of the riparian buffer recommendations set forth in this report, see the maps in Appendix C and the associated figure that identifies examples of areas that should be identified on the maps in order to implement the recommendations. These 23 maps show the vulnerable riparian buffers in the watershed and were developed as a tool for project identification. These maps highlight the existing riparian buffers, as well as the areas where buffers could potentially be expanded to 75-foot, 400-foot, and 1,000-foot widths. These potential expansions would be targeted to land uses that are currently (as of the most-recent existing SEWRPC land use inventory in 2010) not developed in urban uses, and which could be preserved in open space uses in the future, or perhaps developed in a way to maximize preservation of buffers. These maps also identify the existing buffers and potential buffer areas, within the 1,000-foot optimum width core, which are designated as "vulnerable." Areas are designated as "vulnerable" when they are not located within the 1-percent-annual-probability regulatory floodway boundary, are not designated as ADID wetlands, and are not under protected ownership (public ownership, nonprofit ownership, or conservation organization ownership).[75]

These maps provide individuals and organizations attempting to implement this plan with guidance on vulnerable existing riparian buffer areas which should be prioritized for protection either through land purchases, easements, and/or voluntary measures. They also provide guidance as to where new buffers could potentially be established throughout the watershed. Additionally, the maps indicate the areas within the watershed where large buffers may not be feasible due to existing development, thereby indicating where smaller buffers and other green infrastructure measures could potentially be implemented to protect the streams of the Root River watershed.

The maps in Appendix C provide the information necessary to begin planning buffer protection and expansion projects, and in turn meet the targets identified above. Specifically land managers and policy makers should focus on the following recommendations in regards to riparian buffers:

1. **It is recommended that "vulnerable" existing buffer and potential buffer areas be acquired, purchased, and protected** (See Figure C-1 in Appendix C, Examples C and D, which illustrate areas that should be identified on Maps C-1 through C-23 in Appendix C, to implement this recommendation). Specific measures that can be taken to accomplish this recommendation include:

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[75]*Digital floodway boundaries do not exist within Racine County, so the 1-percent-annual-probability regulatory floodplain boundary in the County was considered to be "vulnerable," unless it coincides with lands in a protected category. This boundary is susceptible to generally limited adjustment under a floodplain zoning ordinance variance process that enables placement of fill within the flood fringe if that filling is offset by the provision of an equal volume of excavated floodwater storage.*

- Public land acquisition via donation or purchase and establishment of public or private conservation easements on critical lands;

- Consistent and effective application and updating of the regulatory framework including local zoning ordinances, shoreland zoning requirements, State wetland regulations, and U.S. Army Corps of Engineers permit program for wetlands;

- Continued application of limits on development within SEWRPC-delineated primary environmental corridors and connection of "vulnerable" existing and potential buffer lands to primary environmental corridors, secondary environmental corridors, and isolated natural resource areas. Additional buffer lands may be added to primary environmental corridors if they meet the criteria for inclusion in a corridor, thus extending the restrictions on development that are inherent to primary environmental corridors;

- Enforcement of local zoning regulations to discourage development within the 1-percent-annual-probability floodplain; and

- Educational campaigns and general promotion of low-impact use of existing buffer areas.

2. **It is recommended that existing buffers be managed, maintained, and promoted** (see Figure C-1 in Appendix C, Example A, which illustrates areas that should be identified on Maps C-1 through C-23 in Appendix C in order to implement this recommendation). Specific measures that can be taken to accomplish this recommendation include:

   - Purple loosestrife, common buckthorn, phragmites, and other nonnative invasive species should be eradicated to the extent possible to allow native plant species to become established. Partnerships between communities, schools, volunteer groups, service organizations, local governments, and through participation in programs offered by the WDNR are critical in managing a healthy buffer system (see Exotic Invasive Species section in Chapter IV of this report).

   - Restoration and establishment of native vegetation where needed. Vegetation with a high capability to sequester nitrogen and phosphorous should be considered.

   - Promote low-impact public use and recreational access to riparian buffer areas where possible.

   - Promote awareness and education regarding management of these areas to prevent damage from introduction of invasive species.

3. **It is recommended that riparian buffers be developed to the greatest extent practicable throughout the watershed with a minimum goal of a 75-foot width and an optimal goal of a 1,000-foot width** (see Figure C-1 in Appendix C, Examples B and D, which illustrates areas that should be identified on Maps C-1 through C-23 in Appendix C, to implement this recommendation). Specific measures that can be taken to accomplish this recommendation include:

   - Establish undisturbed vegetation along perennial, intermittent, and ephemeral waterways in both urban and rural areas to the extent practicable, preferably using native species in accordance with WDNR and Natural Resource Conservation Service (NRCS) technical standards for filter strips as may be applicable, and SEWRPC guidance for riparian buffers (see Appendix B).

- Provide informational materials to shoreland property owners on the environmental, social, and economic benefits of installing riparian buffers and best management practices (BMPs) (see Stormwater Management section), including instructions on how to proceed with their implementation.

- Promote incentive programs available to private landowners to establish riparian buffers on their lands such as the Conservation Reserve Program (CRP), the Environmental Quality Incentives Program (EQIP), the Wildlife Habitat Incentives Program (WHIP), and Conservation Stewardship Program (CSP), among others (see Conservation Programs in Chapter III of this report).

4. **Establish connections and pathways between riparian buffer areas to ensure connectivity and continuity of buffers.** Specific measures that can be taken to accomplish this recommendation include:

   - Remove abandoned or nonessential roads and other stream crossings where appropriate;

   - Develop and implement educational or incentive-based programs to encourage existing homes or businesses within the 1,000-foot zone to consider landscaping that would enhance wildlife habitat by providing connections or lanes through the lots to larger buffer areas. These programs should encourage the use of native plants which provide cover and food for wildlife;

   - Where possible, limit creation of new road crossings of the mainstem and tributary streams within the Root River watershed; and

   - Preserve, restore and/or expand, to the extent practicable, small wetlands, woodlands, and prairies that are not identified as part of an environmental corridor or an isolated natural resource area and link such features by providing corridors connected to larger buffer areas, as determined in county and local plans.

Recommendations to Protect Areas of High Groundwater Recharge

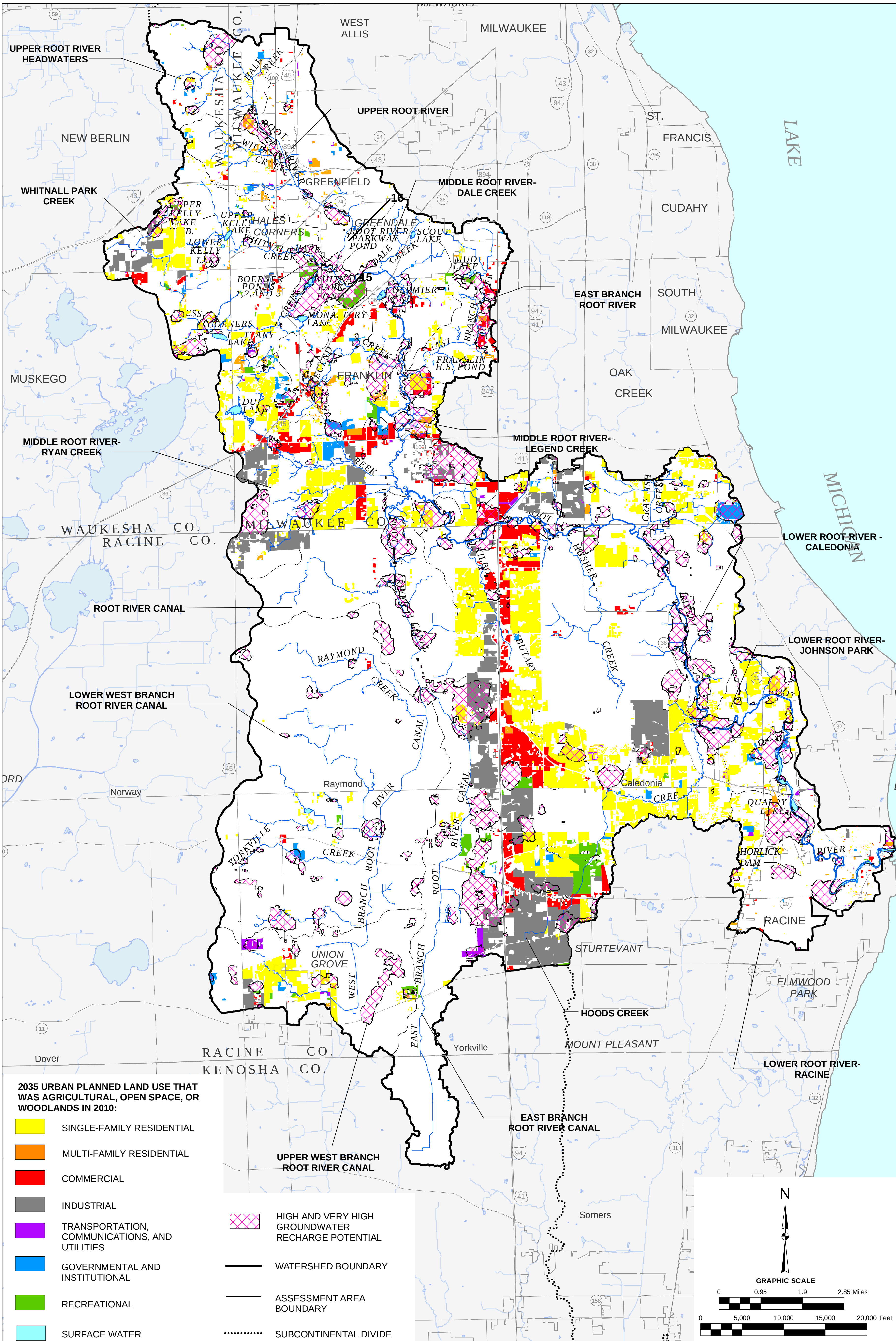
Groundwater recharge within the Root River watershed supplies water to the shallow aquifers within the watershed, which, in turn, provide the baseflow to the River and its tributaries. Baseflow is invaluable to maintaining the natural hydrology, instream habitat, and the overall health of the River, particularly during the droughts and low-flow conditions which may occur more frequently as climate change occurs. This indicates that the maintenance and improvement of groundwater recharge is a crucial part of any plan that hopes to maintain or improve water quality and instream habitat conditions within the Root River watershed.

Traditional urban development increases the area of impervious surfaces which, in the absence of green infrastructure or other land development measures to promote infiltration of runoff, reduces infiltration volumes into the shallow aquifer. This reduction in infiltration reduces the baseflows provided by the shallow groundwater system. This loss of baseflow can lead to substantial loss in stream depth and volume, increased water temperatures, loss of critical fish and other aquatic organism habitat, increased potential for summer fish kills caused by low dissolved oxygen concentrations, and loss or degradation of the intermittent, coolwater and warmwater fishery. The 2035 planned land use data presented in Chapter IV of this report show that some planned land use changes are located in areas that have been identified as having high and very high groundwater recharge potential (see Map 96). Maintaining the groundwater recharge provided by these areas is important in order to preserve baseflows to the surface water system of the watershed.

1. **It is recommended that planned new urban development be encouraged to take place outside of high groundwater recharge areas, with the creation of open space and buffer regions, followed by agriculture being favored within these areas. If new urban development is to take place in**

Map 96

AREAS OF HIGH GROUNDWATER RECHARGE AND 2010 AGRICULTURAL, OPEN LANDS, AND WOODLANDS IN URBAN USES UNDER 2035 PLANNED LAND USE CONDITIONS



these areas, it is recommended that this development incorporate green technologies designed to maintain the infiltration functions of high groundwater recharge areas. Specific measures that can be taken to accomplish this recommendation include:

- Examination of the latest maps and models that identify areas of high groundwater recharge prior to the approval of new development plans by local governments;

- Protection and preservation of areas classified as high and very high groundwater recharge through conservation easements, land purchases, or voluntary incentive based measures. Such protection should also incorporate preservation of environmental corridors, isolated natural resource areas, prime and other agricultural areas, and open lands that are associated with conservation developments that facilitate groundwater recharge;

- Consideration of groundwater conditions when locating new buildings. This consideration should include review of development proposals to avoid locating buildings and other infrastructure in groundwater discharge areas that are prone to flooding as a result of high groundwater levels; and

- Consideration of groundwater recharge areas during the siting, design, and installation of sewers, water lines, and other buried utilities which could intercept groundwater flows.

It is recognized that in some cases, it will not be possible to avoid siting urban development on or near areas of high groundwater recharge. In these cases, it is even more crucial to take measures to maintain both groundwater levels and groundwater quality.

2. **It is recommended that mitigation measures be implemented to reduce the impacts of any future urban development on groundwater recharge quality and quantity.** Specific measures that can be taken to accomplish this recommendation include:

- Reviewing and updating as necessary, local and county land use regulations to promote where appropriate, conservation development practices that provide for the clustering of new development within the watershed so as to minimize potential reductions in groundwater recharge.

- Maintaining infiltration and recharge rates as close to existing rates as practicable by incorporating runoff management recommendations for enhancing infiltration using low-impact design standards in accordance with the regional water supply plan.[76,77] Some examples of infiltration techniques and low-impact design include:

  - Bioretention cells
  - Curb and gutter elimination
  - Grassed swales
  - Green parking design
  - Infiltration trenches
  - Permeable pavement

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[76]*SEWRPC Planning Report No. 52,* A Regional Water Supply Plan for Southeastern Wisconsin, *December 2010.*

[77]*SEWRPC Technical Report No. 48,* Shallow Groundwater Quantity Sustainability Analysis Demonstration for the Southeastern Wisconsin Region, *November 2009.*

- Rain barrels and cisterns
- Riparian buffers
- Sand and organic filters
- Soil amendments
- Tree boxes
- Vegetated filter strips
- Vegetated roofs

Under current conditions, the extent of urban development within the Root River watershed is enough to negatively affect the groundwater quantity and groundwater quality in shallow aquifers, and in turn water quantity and water quality within the Root River and its tributaries. Implementing projects that seek to restore the natural flow patterns have the potential to mitigate these effects.

3. **It is recommended that measures be taken to reduce the impact of existing urban development on groundwater recharge and groundwater quality.** Specific measures that can be taken to accomplish this recommendation include:

   - Increasing the infiltration of urban runoff at those sites where it can be achieved without degrading groundwater quality;

   - Retrofitting current urban development to improve infiltration of rainfall and snowmelt using innovative BMPs that are associated with low-impact development including bioretention and rain garden projects,[78] disconnection of downspouts from sewer systems, installation of porous pavement, and other green infrastructure practices, as recommended above (also see the previous Green Infrastructure section in this chapter); and

   - Applying the stormwater management technical standards developed by the WDNR in the design of stormwater management facilities. In particular, the potential for pollutants to enter groundwater through infiltration should be considered in the design of infiltration facilities such as, infiltration trenches, infiltration basins, bioretention facilities, rain gardens, grassed swales, and stormwater detention basins. This consideration is especially important in areas with shallow depths to groundwater.

Although infiltration into soils provides some level of pollution reduction, shallow aquifers can be vulnerable to pollution. Within the Root River watershed there are specific areas associated with particular land uses that could potentially contribute pollutants to groundwater. These areas include golf courses and agricultural fields associated with high groundwater recharge areas which could act as sources of pollution due to over-fertilization and pesticide use. They also include urban and residential areas, which could act as sources of a variety of urban runoff pollutants, including gasoline, heavy metals, fertilizers, and pesticides. Pollutants contributed by these areas can infiltrate into groundwater during rain events. This pollution needs to be prevented to the greatest extent possible to avoid contaminating the groundwater and the baseflow of the Root River and its tributaries.

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[78] *Roger Bannerman, WDNR and partners; Menasha Biofiltration Retention Research Project, Middleton, WI, 2008; N.J. LeFevre, J.D. Davidson, and G.L. Oberts,* Bioretention of Simulated Snowmelt: Cold Climate Performance and Design Criteria, *Water Environment Research Foundation (WERF), 2008; William R. Selbig and Nicholas Balster,* Evaluation of Turf Grass and Prairie Vegetated Rain Gardens in a Clay and Sand Soil: Madison, Wisconsin, Water Years 2004-2008, *In cooperation with the City of Madison and Wisconsin Department of Natural Resources, USGS Scientific Investigations Report, in draft.*

4. **It is recommended that pollution reduction measures be implemented in those agricultural areas and other areas, such as golf courses, that are located in areas of high groundwater recharge** (see Figure D-1 in Appendix D, Examples C and E, which illustrate areas that should be identified on Maps D-1 through D-23 in Appendix D to implement this recommendation). Specific measures that can be taken to accomplish this recommendation include:

   - Evaluate agricultural operations located in areas of high groundwater recharge for compliance with State standards for control of barnyard runoff, manure storage, and application of integrated nutrient and pest management practices, and undertake corrective measures on those operations that are not in compliance. To facilitate this, County and UWEX agricultural conservation staff should continue to work with landowners to secure cost-share funding required to install practices, such as those provided through the NRCS programs (see Recommended Rural Nonpoint Source Pollution section above and Runoff from Agricultural Development section in Chapter IV of this report); and

   - Reduce or eliminate the application of fertilizers and pesticides to the extent practicable on other land uses prone to nutrient and chemical pollution which are located in areas of high groundwater recharge. It is particularly important that nutrient and chemical applications not occur during periods when groundwater levels are known to be high.

Recommendations to Maintain and Re-Establish Natural Surface Water Hydrology

Both urbanization and agricultural development have brought significant changes to the landscape and have produced profound effects on the surface water hydrology within the Root River watershed. These landscape changes historically have included modification of the drainage patterns, especially with respect to tributaries; hardening of surfaces; alteration of groundwater infiltration within urbanized areas; straightening and ditching of streams; and installation of drainage tile systems in agricultural areas. These changes to the landscape generally act to increase the volume and rate of runoff from precipitation events, leading to flashiness in stream flow. This flashiness reduces streambank and streambed stability, increases pollutant loading, and changes the sediment dynamics within the stream system. These changes in turn reduce the availability of habitat and degrade its quality.

The objective of recommendations in the following subsections is to restore surface hydrology in streams of the watershed so that stream discharges in response to rainfall events emulate the levels that are thought to have occurred prior to urbanization or agricultural development, to the extent possible. Specifically, decreases in average-flow magnitude, high-flow magnitude, high-flow event frequency, and/or high-flow duration are sought to provide potential improvements to the algal, invertebrate, and fish communities within the Root River watershed. Many of the recommendations necessary to meet the goal of restoring surface hydrology were made in sections of this chapter that address green infrastructure, riparian buffers, and groundwater recharge. Those recommendations that were discussed in detail in previous sections will be noted in this section. For implementation purposes, it is important to note that those recommendations will serve multiple purposes.

Recommendations Related to Urban Surface Water Hydrology

Historically, the approach to managing increases in rates and volumes of runoff within urbanized areas often involved the construction of storm sewer and/or open channel systems to convey stormwater as quickly and efficiently as possible to streams and ultimately to Lake Michigan. In recent years, flooding, water quality impairment, and environmental degradation have demonstrated the need for an alternative approach to urban stormwater management. Consequently, current approaches to stormwater management seek to manage runoff using a variety of measures, including detention, retention, infiltration, and filtration, better mimicking the disposition of precipitation on an undisturbed landscape.

1. **It is recommended to restore natural surface hydrology by reducing impervious cover and associated runoff in urbanized areas.** Specific measures that can be taken to accomplish this recommendation include:

- Implement the recommendations previously described in Groundwater Recommendations 1 and 2 that emphasize the siting of urban development away from high groundwater recharge areas and install infiltration practices in high groundwater recharge areas where development is necessary or already exists.

2. **It is recommended to restore natural landscape elements that "slow down water" and reduce the magnitude of flashiness in stream flow and its negative effects on aquatic habitat quality.** Specific measures that can be taken to accomplish this recommendation include:

   - Implement the recommendations previously discussed in Riparian Buffer Recommendations 1 and 3 regarding protection, purchase, and acquisition of "vulnerable" existing buffer and potential buffer areas, and develop new riparian buffers with a minimum goal of 75-foot widths and an optimal goal of 1,000-foot widths.

   - Protect existing wetlands and expand them where feasible.

Recommendations Related to Agricultural Surface Water Hydrology

Most stream channels located in agricultural areas of the watershed have been deepened and straightened to facilitate the flow of water from agricultural subsurface drainage outlets, to maximize conveyance of this water, to maximize the amount of land available for cultivation, and to make the land easier to cultivate.[79] In addition, extensive networks of drainage tile have been installed over large amounts of land in agricultural areas of the watershed to clear fields of rainwater as rapidly as possible and keep them productive. The following recommendations seek to mitigate the impacts of channelization and installation of drain tile on the surface water hydrology:

1. **It is recommended to restore natural surface hydrology by reducing, to the extent feasible, unnecessary drainage tile systems and retrofitting needed systems.** Specific measures that can be taken to accomplish this recommendation include:

   - Investigate drainage patterns and available drainage tile system maps to determine whether there are operational systems that are no longer necessary and remove or disconnect any unneeded tile systems that are found.

   - Integrate water control structures within drainage tile systems to reduce tile flow during periods when a higher water table would not present a problem for crop production. A more detailed description of this practice is presented in the previous agricultural best management practices section. It is recommended in that section that pilot projects be conducted to evaluate effectiveness in reducing contributions of pollutants, especially nutrients from agricultural fields in the watershed. The effectiveness of this practice in reducing flashiness in these streams should also be evaluated in the pilot projects.

2. **It is recommended to restore natural landscape elements that "slow down water" and reduce the magnitude of flashiness and its negative effects on aquatic habitat quality.** Specific measures that can be taken to accomplish this recommendation include:

   - Implement the recommendations associated with Riparian Buffer Recommendations 1 and 3 regarding protection, purchase, and acquisition of "vulnerable" existing buffer and potential buffers as well as development of new riparian buffers with a minimum goal of 75-foot widths and an optimal goal of 1,000-foot widths;

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[79]*Andy Ward and Dan Mecklenburg,* Two-Stage Channel Design.

- Protect existing wetlands and expand them where feasible;

- Consider discontinuing the cultivation of existing farmed wetlands and restore these areas to their natural wetland condition, particularly when these lands are being converted from agriculture to urban uses; and

- Install saturated buffers in agricultural areas of the watershed that are drained by drainage tile systems. Saturated buffers redirect flows from main drain tile lines through a lateral distribution line into a buffer allowing the water to percolate into the soil and get taken up by vegetation. A more detailed description of this practice is presented in the previous agricultural best management practices section above. It is recommended in that section that pilot projects be conducted to evaluate effectiveness in reducing contributions of pollutants, especially nutrients from agricultural fields in the watershed. Effectiveness of this practice in reducing flashiness in these streams should also be evaluated in the pilot projects.

3. **It is recommended to retrofit traditional trapezoidal ditches found in the agricultural portions of the watershed with two-stage channel systems. Priority areas for this retrofitting include the West and East Branches of the Root River Canal, the streams tributary to the branches of the Canal, and the upper reaches of Hoods Creek.**

The trapezoidal configuration used in ditches found in the agricultural areas of the watershed was designed to move water downstream as quickly as possible during runoff events. While this design can provide sufficient flood conveyance, its ecological performance is rather poor. Several factors related to its design leads to this poor performance. The channels are typically oversized relative to the amount of baseflow discharge passing through them. This produces baseflows that lack adequate depth and velocity to move sediment through the reach. This leads to sediment deposition and often requires costly maintenance to maintain the designed flow capacity. The shallow depths and slow velocities in these channels do not provide sufficient habitat for aquatic organisms. In addition, the shallow depths and slow water velocities allow summer water temperatures to rise above the temperatures that many aquatic organisms are able to tolerate. As a result, these channels often have poor quality communities of aquatic organisms. Finally, these channels typically have steeply sloped banks that abut the edge of the stream, leading to unstable banks as sediment deposits force flows into one bank or the other.[80]

Two-stage channels are designed based on geomorphic principles. This design incorporates benches that function as floodplains and attempt to restore or create some natural alluvial channel processes. Figure 115 shows that under most flow conditions the main channel in this design is the low-flow channel. By limiting the width of this channel, enough flow can be maintained in the channel during low-flow periods to keep nutrient rich sediments moving and prevent sediment deposition and accumulation. The upper benches allow space for the stream to flow out of its banks and spread out during heavy runoff events. This dissipates the energy and erosive potential of larger flows. During heavy runoff events, finer sediments are allowed to settle out over the newly created floodplain instead of clogging the main channel, reducing maintenance costs. The stability of the ditch banks are improved because the toe of the ditch bank meets the bench rather than the channel bottom.

In addition to providing improved drainage functions, the two-stage channel design has the potential to create and maintain improved aquatic habitat. The narrower and deeper main channel provides greater water depth during low-flow periods. Grasses on the benches can provide cover and shade the

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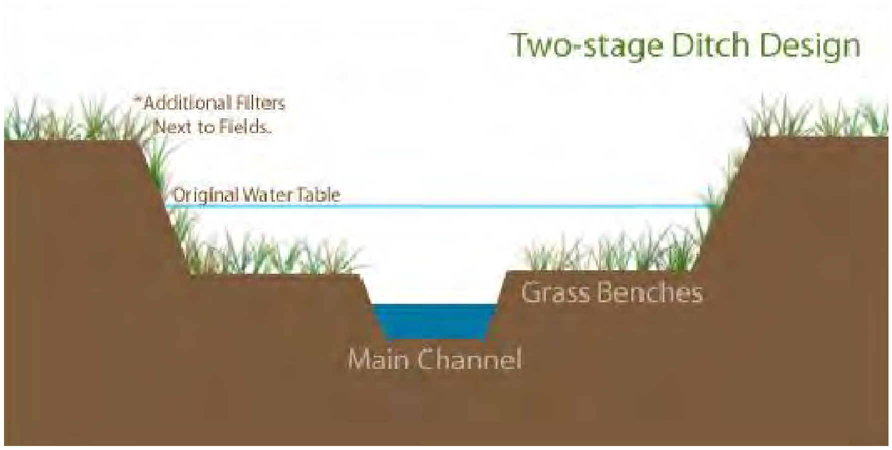
[80]*U.S. Department of Agriculture Natural Resources Conservation Service, "Two Stage Channel Design," Part 654* Stream Restoration Design National Engineering Handbook, *August 2007.*

Figure 115

SCHEMATIC OF A TWO-STAGE DESIGN CHANNEL



Source: The Nature Conservancy.

low-flow channel. This combination of factors results in reduced water temperatures within the low-flow channel. Substrates within the main channel are improved because the narrower channel allows for better conveyance of sediments during low-flow periods and allows for the fine sediments to be deposited on the benches during higher flows. This results in a channel bed consisting of coarser materials, which are more favorable spawning areas for fish. Two-stage channel designs have also been known to restore the natural meander patterns of streams over time, creating pool habitat that fish use for resting.

Several factors should be considered when designing and constructing a two-stage channel.[81] These factors include:

- Project areas should be selected based on need. Stream reaches with severe erosion, sedimentation issues, or drainage concerns should be addressed first.
- Streambed slopes within project areas should be less than 0.5 percent.
- Each project site is different and pre-project surveying and engineering should be conducted to determine the optimal width and elevation of the floodplain benches.
- Because moist soils can be more prone to instability than dry soils, construction should not occur during times of the year when soils have excessive moisture levels.
- In order to reduce project costs, construction should occur during a time of the season where excavated soils can be spread on adjacent farm fields.

[81]*National Institute of Food and Agriculture, U.S. Department of Agriculture, National Integrated Water Quality Program, "Selecting and Sizing a Two-stage Channel System in an Agricultural Landscape," 2011.*

- o The low-flow channel should remain undisturbed during construction. As much of the existing vegetation as possible should be left adjacent to the stream to provide stability and facilitate the narrowing process of the stream.

- o All existing drain tile outlets within the project site should be located prior to excavation and preserved to the extent possible. Drain tile outlets should be retrofitted to empty at the base of the benches, allowing drainage to be filtered through the vegetated benches. A saturated buffer system in combination with a two-stage design may increase effectiveness of nutrient uptake by vegetation.

- o The stability of two-stage systems is highly dependent on the amount and quality of vegetation on the benches. Benches and side slopes should be seeded with long-rooted native grasses as soon as possible after construction. The use of woody vegetation as the dominant vegetation type is discouraged because trees and shrubs tend to shade sunlight needed for grasses to grow.

- o A vegetated buffer between the top of the side slope and the cultivated field should be preserved if present or installed if none exists.

Recommendations to Preserve and Expand Healthy Wildlife Populations

The presence of healthy wildlife communities, including populations of animals such as deer, amphibians, reptiles, birds, and small mammals, is the ultimate indication of a healthy watershed. This is largely because wildlife populations require large, well-connected natural areas, which are associated with good water quality and good aquatic and terrestrial habitat. The presence of healthy wildlife populations provides recreational opportunities, such as bird watching, hunting, fishing, and nature hiking. In order to maintain and improve wildlife populations in the Root River watershed, the following recommendations have been developed:

1. **It is recommended that wildlife habitat be preserved and expanded through protection of riparian buffer areas considered to be "vulnerable" to development throughout the watershed** (see Maps C-1 through C-23 in Appendix C) **and through establishment of additional riparian buffers. Establishment of riparian buffers should occur particularly at those sites where development of a buffer can be located contiguous with an environmental corridor and may result in a potential expansion of such corridor areas** (see Maps E-1 through E-23 in Appendix E). Specific measures that can be taken to accomplish this recommendation include:

   - Implement measures described under Riparian Buffer Recommendations 1 and 3, specifically focusing on expansion of buffer widths to the 400-foot minimum for wildlife and the 1,000-foot optimum width for wildlife;

   - Implement measures described under Groundwater Recharge Recommendations 1 through 3;

   - Implement measures described under Urban Surface Water Hydrology Recommendation 2 and Agricultural Surface Water Hydrology Recommendations 1 through 3; and

   - Implement recommendations for the acquisition and protection of wetland and woodland areas that have been identified for acquisition in the adopted regional natural areas and critical species habitat protection and management plan.[82] Implementation of these recommendations,

[82]*SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997*; *SEWRPC,* Amendment to the Natural Areas and Critical Species Habitat Protection and Management Plan for the Southeastern Wisconsin Region, *December 2010*.

in addition to those set forth in the adopted park and open space plan for Racine County,[83] would complement the protection and preservation of environmentally sensitive lands.

2. **It is recommended that habitat fragmentation be reduced by preserving and further enhancing connections between riparian buffer areas, open spaces, critical species habitat sites, and natural areas.** Specific measures that can be taken to accomplish this recommendation include:

- Implement measures described under Riparian Buffer Recommendations 3 and 4;

- Establish corridors and buffers of natural habitat connecting isolated wetlands to nearby upland wooded areas to allow reptiles and amphibians safe access to uplands necessary for certain life history stages;

- Maintain connections between streams and overbank floodplains so as to continue to protect and preserve fish and wildlife habitat and water quality benefits, making use of open space lands, riparian corridors, and park lands in floodprone areas, as appropriate; and

- Maintain connections between streams and wetlands, wetland and upland complexes, wetlands and ephemeral and/or perennial ponds, and multiple ponds, all of which provide redundancy in available habitat quality and quality necessary to help ensure wildlife diversity.

- Implement educational or incentive-based programs meant to encourage existing homes or businesses within the 1,000-foot optimal habitat zone to consider landscaping that would enhance wildlife by providing connections (see Appendix B) or lanes through the lots. These programs should encourage the use of native plants that provide cover and food for wildlife.

3. **It is recommended that best management practices aimed at maintaining wildlife be implemented. These practices should consist of voluntary, educational, or incentive-based programs.** Specific measures that can be taken to accomplish this recommendation include:

- Encourage agricultural landowners to enroll in Federal agricultural incentive programs such as the Conservation Reserve Program, the Wetland Reserve Program, the Wildlife Habitat Incentives Program, or the Landowner Incentive Program, which provide financial incentives to restore habitats;

- Encourage homeowners and landowners to implement BMPs on their property. Some of these BMPs include:

  o Installing fences to control access by livestock to rivers, streams, wetlands, and other waterbodies. Projects that address livestock access to waterbodies should also either provide alternative watering sources or concentrate livestock watering and shading needs in a small area, leaving the majority of habitat intact.

  o Following label directions and using the minimum amounts necessary when using fertilizers, herbicides, and insecticides on agricultural lands, lawns, or golf courses.

[83]*SEWRPC Community Assistance Planning Report No. 134,* A Park and Open Space Plan for Racine County, *February 2013.*

- Restoring natural fire frequency, intensity, and seasonality to the extent practicable. Where feasible, the use of fire should be favored over the use of herbicides as a vegetation management tool, especially in drier upland ecosystems.

- Identifying and protecting embedded, adjacent, and sensitive habitat features such as seasonal wetlands, springs, caves, and rock outcroppings.

- Minimizing soil disturbances, such as tire ruts and soil compaction, when using heavy equipment. Methods to accomplish this include using low-pressure tires and limiting equipment-use to drier seasons or periods when ground is frozen.

- Incorporating missing habitat features back into the landscape. For example, loafing, basking, or escape structures may be absent from the habitat. To remedy this, consider strategically placing downed trees, brush, or rock to provide more diverse habitat.

- Allowing dead trees and other coarse woody materials to decompose naturally, and after timber harvests, leaving residue such as stumps, blowovers, logs, and dead standing snags.

- Formulating forest regeneration plans before harvesting activities start.

- Using native plant species from as local a source as possible when implementing restoration efforts. Implement management strategies to increase native flowering plants (which encourages healthy insect food base for amphibians) and prevent the introduction and spread of exotic species.

- Maintaining a diversity of forest age classes, densities, and structures either within the same stand or among adjacent stands. Consider thinning, burning, and extended rotations to optimize the time herbaceous and shrub layer vegetation is available. Consider a mosaic of smaller, adjacent patches of varying management regimes.

- Leaving large cull trees or patches of trees on harvested sites whenever practical.

- In areas managed for recreation, locate regularly used roads, trails, landings, and recreational facilities away from sensitive habitats, migration corridors, and transitional zones between adjacent habitats. Limit entrances to these recreational areas to as few points as feasible to reduce possible introduction of invasive species.

- Avoid mowing wetlands, shorelines, and ditches from mid-spring through mid-fall. When mowing fields, raise deck to a height of at least eight inches.

- Use of native species, wood chip berms, hay bales and staggered siltation fencing for erosion control in areas surrounding wetlands and terrestrial buffers.

- Avoiding precision land leveling where possible in order to allow for the existence and maintenance of shallow depressional wetlands which are primary breeding habitats for many amphibians.

- Avoiding storage of silage, manure, salts, and other contaminants near wetlands.

- Using effective nutrient management (timing, amounts, mechanisms of spreading) including considering crop rotation and burning to add nutrients rather than use of chemicals.

- Avoiding the use of plastic mesh netting.

- Avoiding introducing nonnative insects such as fire ants and flatworms by inspecting potted plants and landscaping materials.

- Using curved, graduating road curbs instead of steep vertical curbs in order to allow amphibians, reptiles, and other small wildlife to climb off of roads.

- Installing permanent signage that can be displayed seasonally at roadways to promote awareness of any known amphibian or reptile breeding habitat as well as to promote awareness of tendencies of these species to cross roadways at certain times of the year.[84]

- Installing a garden pool. If it is stocked with fish, establishment of a minimal population of native fish should be considered.

- Creating a compost pile in natural landscaping.

Recommendations to Maintain and Restore Instream Habitat
Since at least the early 1900s the Root River system has been substantially altered through channelization, agricultural and urban development, road construction, stormwater conveyance systems, placement of fill, and other actions related to agricultural and urban development. These changes have physically, chemically, and hydrologically degraded aquatic habitat.

Aquatic organisms, including fish, mussels, and insects, are essential to maintaining aquatic health by assuring an ecological balance and are also the sources of extensive recreation, especially related to fisheries. To maintain these assets within the Root River watershed it is important to ensure good aquatic habitat, as well as good water quality and quantity.

The recommendations set forth in the preceding sections have far-reaching functions that improve many dimensions of aquatic habitat including:

- Implementation of the recommendations to protect and expand riparian buffers, to protect areas of high groundwater recharge, and to maintain and re-establish natural surface water hydrology will improve instream habitat by:

  - Filtering nutrients, such as phosphorus and nitrogen; chemicals, such as fertilizers and pesticides; and total suspended solids from water entering streams, resulting in reductions in pollutant loading;

  - Helping to maintain stream baseflows and stream depths and volumes;

  - Reducing peak streamflows during heavy rainfall events;

  - Regulating maximum summer water temperatures;

  - Restoring natural flow patterns such as stream meandering, which will provide a variety of crucial instream habitats including pool and riffle structures;

  - Promoting conditions favorable to native aquatic plant species.

[84]*The signs could be hinged to permit them to be opened during critical seasons.*

- In addition, implementation of the recommendations to protect and expand riparian buffers and maintain and re-establish natural surface water hydrology will improve instream habitat by:

  - Increasing dissolved oxygen concentrations;

  - Promoting variable substrate composition necessary for various life stages of aquatic organisms;

  - Providing cover for organisms in the form of overhanging vegetation and woody debris input; and

  - Increasing streambank stability, thus reducing erosion.

In addition to the broad recommendations discussed above, several other measures are recommended in order to improve aquatic habitats in very specific ways. They are described in the following three subsections.

Recommendations Related to Aquatic Organism Passage

Fishing, both recreational angling and commercial harvesting of fishes, is an important economic activity in the Southeastern Wisconsin Region and Lake Michigan. The maintenance and continuity of the species of economic importance and those species on which they depend is associated to a large degree with the protection and restoration of appropriate habitat. To this end, efforts to remove obstructions to fish migration along the mainstem and tributaries of the Root River are key considerations for the long-term restoration of the fishery. Examples of these obstructions include dams, drop structures, culverts at roadways, and channelized river reaches. Removal and/or retrofitting of these obstructions should be accompanied by the restoration or re-creation of habitat within the stream and riparian corridor that is essential for resting, rearing, feeding, and spawning of fishes and other organisms. This will help to restore the biotic integrity of the streams within the Root River watershed.

Studies by Mussetter Engineering, Inc.[85] and SEWRPC found seven dams and spillways in the Root River watershed.[86] In addition, there are hundreds of roadway bridges and culverts in the watershed that could potentially act as barriers to passage of aquatic organisms. To maintain and restore fish and aquatic organism passage throughout the Root River watershed, the following recommendations have been developed:

1. **It is recommended that fish passage assessments be conducted at all roadway bridges and culverts throughout the watershed, using the three-tier prioritization strategy (described below) to determine which roadways to assess first.** Within the three-tier prioritization strategy, due to the large number of roadway crossings within the watershed, it is advised that passage be assessed on a stream reach basis, with all stream crossings being assessed within a reach area before moving onto another reach area. In doing so, limitations to aquatic habitat passage can be evaluated on a reach basis indicating where work needs to be done to allow connections to high-quality habitat areas and to the mainstem of the Root River. Thus, it is recommended that fish passage assessment be completed on a reach-by-reach basis within the 23 reach areas shown in Map 22 in Chapter IV of this report (see fish passage guidelines for stream crossings in Appendix U).

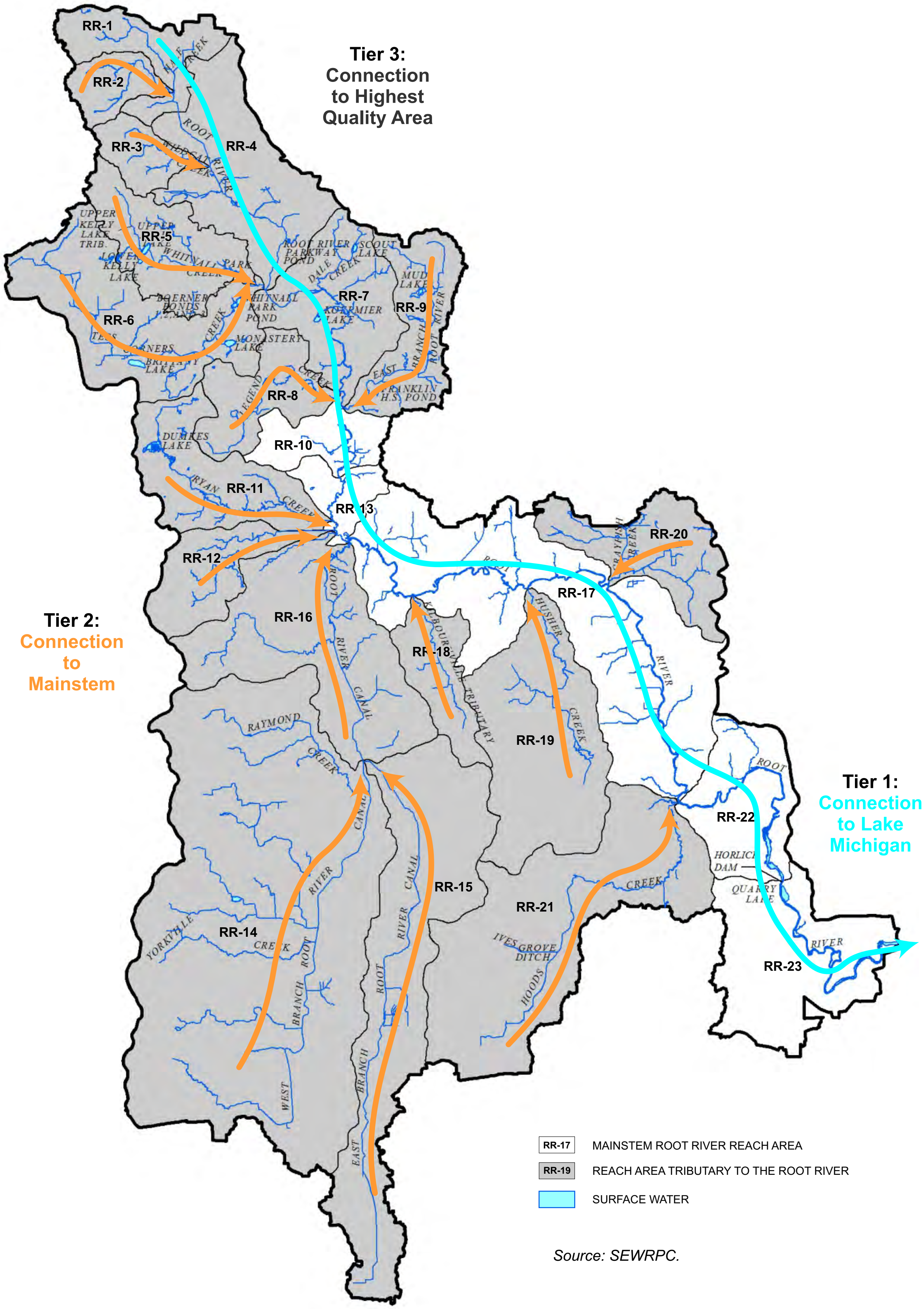
2. **It is recommended that plans be developed for the replacement and/or retrofitting of those road culverts determined to be obstructions through the assessments described above. Improvements to aquatic organism passage should be implemented as opportunities present themselves**

[85]*Mussetter Engineering, Inc., Root River Sediment-Transport Planning Study, Report to the Milwaukee Metropolitan Sewerage District, September 2007.*

[86]*It is likely that additional dams and spillways that were not found by these studies are present in the watershed.*

Figure 116

INSTREAM THREE-TIER PRIORITIZATION STRATEGY WITHIN THE ROOT RIVER WATERSHED



Source: SEWRPC.

(e.g., structure failure, major blockage, or scheduled bridge or culvert reconstruction or replacement under municipal capital improvements programs) (see fish passage guidelines for stream crossings in Appendix U)**.**

The following prioritization strategy for reducing fragmentation within the stream system is predicated upon a tiered approach. As indicated in Figure 116, the three components of this strategy, in the order of their importance, are:

- Tier 1—Restoring connectivity and habitat quality between the mainstem of the Root River and Lake Michigan;

- Tier 2—Restoring connectivity and habitat quality between the tributary streams and the mainstem of the Root River, and

- Tier 3—Expanding the connection of the highest-quality fish, mussels, and other invertebrates, and habitat within subwatersheds.

A decision regarding the future of the Horlick dam has yet to be made. Should Racine County decide to maintain the dam in its current form, then Tier 2 and Tier 3 (described above) would take precedence. Alternatively, should it be decided to remove Horlick dam, or to modify the dam in a manner that would improve fish passage, the planning for, and implementation of, the removal or modification of the dam could take considerable time. During the interim, Tier 2 and Tier 3 projects should be the focus of programs to improve the free movement of aquatic organisms.

Within this framework, opportunities will arise that should be acted upon. For example, even though it is a general principle of this strategy that activities progress from downstream to upstream, the completion of an action in a headwaters area or on a tributary stream should not be passed up or ignored simple because it does not conform to the downstream-to-upstream strategy. Rather, all opportunities should be acted upon as they become available. However, where multiple opportunities exist, and where limited funds are available, this strategic framework is intended to assist decision-makers in allocating resources where they would be most appropriate and effective in achieving the goals of this watershed restoration plan.

The Tier 1 prioritization is based upon the understanding that Lake Michigan is the most diverse resource and greatest asset available to the watershed for the maintenance of high-quality recreation as well as a sustainable fishery. As identified in SEWRPC Technical Report 39, the most diverse fishery in the Root River watershed is the reach connected to Lake Michigan downstream of Horlick dam.[87]Thus, Horlick dam separates the Root River system from achieving its fullest fisheries potential by being separated from Lake Michigan. This prioritization is also based upon the understanding that within river systems the widest and deepest downstream areas are generally associated with a greater abundance and diversity of fishes than the narrower and shallower upstream areas.[88] Position within a stream network also is an important determinant of fish species assemblage structure, with greater abundance and diversity generally associated with tributary streams located in lower portions of the stream network.[89] Therefore, the highest priority, or Tier 1, approach focuses on restoring continuity of passage

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[87]*SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007.*

[88]*I.J. Schlosser, "A Conceptual Framework for Fish Communities in Small Warmwater Streams," pages 17-24 in W.J. Matthews and D.C. Heins (editors),* Community and Evolutionary Ecology of North American Stream Fishes*, University of Oklahoma Press, 1987.*

[89]*L.L. Osborne and M.J. Wiley, "Influence of Tributary Spatial Position on the Structure of Warmwater Fish Communities,"* Canadian Journal of Fisheries and Aquatic Sciences*, Volume 49, pages 671-681, 1992.*

and habitat restoration for native fishes on the mainstem of the Root River from its mouth at Lake Michigan to its headwaters as shown in Figure 116. This approach is designed to maintain and expand the fishery through what has been found to be the strongest determinant of overall fish species diversity and assemblage structure, reconnection to Lake Michigan.

The Tier 2 prioritization is based upon the understanding that, through their connection with the mainstem of the Root River, the tributaries are the next most diverse resources and greatest assets that have the potential to restore and maintain a sustainable fishery. Particular fish species need access to a variety of habitats over their lives. For a fish to successfully progress from egg to adult, it has to be able to get to each of these habitats at the appropriate time in its life cycle. Tributary streams that are connected to the associated mainstem have a greater potential for increased fish abundance and diversity via access to feeding, rearing, and spawning, as well as refuge from thermal stress or low-water periods. Hence, the second tier approach is focused on addressing fish passage continuity and habitat quality from the tributary streams to the mainstem of the Root River. The Tier 2 prioritization component is illustrated graphically in Figure 116.

The Tier 3 approach is designed to focus on improving fish passage and habitat quality throughout the entire watershed. Prioritization of projects to improve the fishery quality should be based upon areas where fish passage obstructions have been identified to be a problem and where improvement in ecosystem structure and function can be attained. Factors to be considered include connection to one or more tributaries, length of stream between structures, and/or connection to high-quality fish and habitat areas. It is anticipated that new development or redevelopment may provide opportunities for interventions that do not conform to the first and second tier approaches. These opportunities should not be ignored; rather, where there are opportunities to enhance passage of fish and aquatic organism and/or to improve instream habitat, and where funds can be obtained, it is recommended that actions be taken to implement those opportunities.

Recommendations Related to Large Woody Debris

Branches, tree limbs, root wads, and entire trees that fall into, and collect along, streams are commonly referred to as large woody debris (LWD). LWD plays a vital role in the hydraulic, geomorphic, and biological function of the streams and floodplains within the Root River watershed.[90] LWD helps control the shape of the channel and provides cover, shelter, resting areas, and feeding opportunities for aquatic organisms. In addition, the interaction between LWD, water, and sediment has a significant effect on channel form and process, increasing geomorphic complexity and the quality of aquatic habitat.[91] Contrary to popular belief, LWD can often help prevent erosion by slowing water down as well as armoring banks and preventing down cutting. In most cases, removal of LWD can be detrimental to fish and other aquatic organism habitats downstream. By removing LWD, sedimentation can occur in pools and on top of gravels that are located downstream. Gravels that are covered by sediment become unsuitable as sites for fish spawning. For these reasons, **it is recommended that, removal of LWD from streams within the Root River watershed should be discouraged, unless it is located in a reach used for recreational paddling and is a barrier to navigation, or is causing streambank erosion. It is recognized that this will need to be balanced with reasonable removal efforts that are required to maintain safety, reduce the risk of property damage, and maintain aquatic organism passage.**

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[90]*Mussetter Engineering, Inc.,* Root River Sediment-Transport Planning Study*, Report to the Milwaukee Metropolitan Sewerage District, September 2007.*

[91]*C.J. Brummer, T.B. Abbe, J.R. Sampson, and D.R. Montgomery, "Influence of Vertical Channel Change Associated with Wood Accumulations on Delineating Channel Migration Zones,"* Geomorphology*, Volume 80, pp. 295-309, 2006.* Cited in *Mussetter Engineering, Inc., 2007,* op. cit.

In some cases, woody debris can form massive jams that span the entire width of the stream and extend completely to the bed of the channel. These debris jams can persist for decades. In these extreme instances, woody debris jams can act as fish passage barriers. The following recommendations have been developed for the management of woody debris jams in the Root River watershed:

1. **It is recommended that assessments be conducted of all major woody debris jams within the Root River watershed to determine if they act as fish passage barriers.**

    - While assessments are most likely to be done during low-flow periods, it is necessary to evaluate whether the woody debris jam would be submerged during high-flow periods, thus allowing for fish passage. It is also important to examine whether the jam extends completely to the channel bed. Some jams, even if not overtopped by high flow, will raft upwards allowing for passage of aquatic organisms. Woody debris jams fitting this description should not be altered.

2. **It is recommended that selective removal of small sections of woody debris be conducted on those debris jams that are found to be fish passage barriers.** Removing only small sections of the debris jams will provide adequate fish passage without sacrificing the benefits associated with having the woody debris in the stream.

Most of the bridges on the mainstem of the Root River appear to be capable of passing wood transported by the River.[92] Some bridges on the mainstem and roadway culverts on the tributary streams have the potential to be blocked by LWD accumulations which act to impede flow. Culverts in particular are vulnerable to this. These accumulations of LWD have the potential to promote bank erosion, bed scour, and localized roadway flooding.

3. **It is recommended that roadway culverts be periodically examined and that any woody debris blockages at culverts be removed. It is further recommended that roadway bridges be periodically examined and that large trees that have collected on those bridges be removed as needed**.

The occurrence of pests and diseases affecting tree populations is an emerging issue within the Southeastern Wisconsin region. Of particular concern is the rapid emergence and spread of the emerald ash borer. The presence of emerald ash borer has been confirmed in all counties that make up the Root River watershed. Ash trees are plentiful within the riparian lands along the mainstem of Root River as well as its tributaries. Substantial ash tree die-off has been reported within the watershed, particularly within riparian lands along the mainstem of the Root River that are owned by Milwaukee County.[93] As these trees continue to die, it can be expected that the amount of woody debris that enters the Root River will increase. While in most cases this woody debris provides beneficial aquatic habitat, the accumulation of too much woody debris in the River can cause larger debris jams to form, leading to blockage of roadway bridges and culverts. To reduce the likelihood of this occurring, this plan recommends the following:

4. **It is recommended that periodic thinning of both diseased ash trees and healthy ash trees be carried out within riparian lands located along the Root River, with an emphasis on removal of diseased trees. These efforts should be conducted in Milwaukee County parkway lands located in the Cities of Franklin and Oak Creek and in Racine County parkway lands located in the Village of Caledonia and the Town of Raymond.**

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[92]*Mussetter Engineering, Inc., 2007,* op. cit.; *The bridges at W. Drexel Avenue and W. Oakwood are notable exceptions to this generalization.*

[93]*Personal communication with Brian Russart, Trails and Natural Areas Coordinator, Milwaukee County Department of Parks Recreation and Culture, December 4, 2013.*

Recommendations Related to Streambank and Streambed Erosion

The energy of flowing water in a stream is dissipated along the stream length by turbulence, streambank and bed erosion, and sediment resuspension. In general, increases in the amount of both urban development and land alterations associated with agricultural land use may be expected to result in increases in stream flow rates and discharge volumes that results in an increased potential for streambank and streambed erosion. Streambank and streambed erosion destroys aquatic habitat, spawning areas, and feeding areas; contributes to downstream water quality degradation by releasing sediments to the water; and provides material for subsequent sedimentation downstream. This sedimentation, in turn, covers valuable benthic habitats, impedes navigation, and fills wetlands.

Three separate surveys of streambank erosion were recently conducted by Mussetter Engineering, Inc.,[94] AECOM,[95] and SEWRPC (see Map 52 in Chapter IV of this report). These surveys examined much of the Root River watershed. Each survey uses slightly different methods and collected slightly different data. For the most part, the stream sections examined by these three surveys did not overlap.

The AECOM study surveyed streambank erosion and stormwater outfall conditions within the City of Racine. It ranked the severity of erosion sites based on an index developed using a combination of factors that included the Bank Erodibility Hazard Index (BEHI), the Pfankuch Channel Stability Analysis, visual observations, and adjacent land use. It used these parameters to calculate an erosion severity index that assessed both active erosion and erosion potential.

The Mussetter Engineering survey also surveyed streambank erosion. It assessed the severity of erosion sites based on their proximity to infrastructure.

The survey conducted by SEWRPC staff assessed erosion sites based on length and height of active erosion at each site. In order to rank priority streambank stability sites, SEWRPC staff estimated the annual load of sediment contributed to the River by each site.

Results of these surveys are summarized in Table 48 in Chapter IV of this report. Streambank erosion sites that have been surveyed by one of the three studies mentation above are shown on Map 52 in Chapter IV of this report. The most severe erosion sites are detailed in Table 79, and the highest priority projects relating to streambank erosion are summarized in Table 90 (see Figure 117 for examples of high-priority streambank erosion sites).

All capital costs for individual recommended streambank stabilization projects within the Root River watershed are reported in Table 79 and were developed based on year 2013 unit construction costs provided in the AECOM study. The estimation of costs of streambank stability projects was based on an assumed typical stabilization approach, and the costs include mobilization, regrading and revegetating banks, and rock toe stabilization. Additional costs of engineering, permitting, inspection, and other contingency costs were included as well. There are many state-of-the-art methods available to address issues related to streambank stability besides the standard approach assumed for cost-estimating purposes (see Tables 91 and 92). Each streambank erosion site should be evaluated on an individual basis to determine the most effective method based on environmental and economic factors, among others.

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[94]Ibid.

[95]*AECOM*, Root River Streambank Erosion and Outfall Assessment, *December 2013*.

Table 90

HIGH-PRIORITY STREAMBANK EROSION PROJECTS FOR THE ROOT RIVER WATERSHED RESTORATION PLAN[a]

Identification Number (see Maps 74 through 88	Location	Management Action	Focus Areas Addressed	Potential Benefit from Project	Capital Cost (dollars)	Responsible Party	Priority[b]
AER-10	Island and Lincoln Parks, City of Racine	Bank stabilization to address three sections of bank erosion along the Root River with about 728-foot-long erosional area	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 174,000 pounds TSS	174,000	City of Racine	1
AER-07	Case Corporation property, southeast of Liberty Street and Superior Street, City of Racine	Bank stabilization to address erosion along a 500-foot section of the Root River	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 280,000 pounds TSS	182,000	Case Corporation	2
AER-08	Mainstem of Root River adjacent to Mound Avenue between Marquette Street and 6th Street, City of Racine	Bank stabilization to address erosion along a 1,500-foot section of the Root River. The area has also been identified as a place to connect and expands the City's bike/pedestrian paths	Habitat, Water Quality, Recreational Use and Access	Stabilization of riverbank, estimated annual pollutant load reduction of 720,000 pounds TSS, additional recreational space	538,000	City of Racine and private landowners (?)	3
RPC-RE69,70	Root River in tax parcel 98-09-999-000 in City of Franklin	Bank stabilization to address two sections of bank erosion along the Root River with about 725-foot-long erosional area	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 215,000 pounds TSS	239,250	Private landowner	4
RPC-RE66,67,68,71,72,73	Root River in tax parcels 98-09-998-000, 94-89-999-001, and 94-79-998-000 in City of Franklin	Bank stabilization to address six sections of bank erosion along the Root River with about 1,580-foot-long erosional area	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 410,400 pounds TSS	521,400	Private landowner	5
RPC-RE45, 46, 47, 48	Root River in tax parcels 104-04-22-05-016-000 and 104-04-22-05-024-000 in Village of Caledonia	Bank stabilization to address four sections of bank erosion along the Root River with about 680-foot-long erosional area	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 176,000 pounds TSS	224,400	Racine County	6
RPC-HE26, 27, 28a, 29, 30	Hoods Creek in tax parcels 104-04-22-350-190-00 and 104-04-22-350-200 (same owner) in Village of Caledonia	Bank stabilization to address five sections of bank erosion along Hoods Creek with about 840-foot-long erosional area	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 193,600 pounds TSS	277,200	Private landowner	7

Table 90 (continued)

Identification Number (see Maps 74 through 88	Location	Management Action	Focus Areas Addressed	Potential Benefit from Project	Capital Cost (dollars)	Responsible Party	Priority[b]
RPC-RE13	Root River in tax parcels 104-04-22-140-640-01 and 104-04-22-140-610-00 in Village of Caledonia	Bank stabilization to address of bank erosion along a 500-foot section of the Root River	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 120,000 pounds TSS	165,000	Racine County and private landowner	8
RPC-RE49, 50, 51, 52, 53, 54, 55	Root River in tax parcels 97-69-996-000, 97-79-997-000 in City of Oak Creek	Bank stabilization to address nine sections of bank erosion along the Root River with about 1,550-foot-long erosional area	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 319,200 pounds TSS	511,500	City of Oak Creek	9
RCL-08	Erosion sites along West Branch of the Root River Canal east of STH 45 and south of 58th Road in tax key 186-03-21-29-00-60-11 in Village of Union Grove	Streambank protection structures to address bank erosion along two sections of the West Branch of the Root River Canal with about 140-foot-long erosional area	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 319,200 pounds TSS	19,470	Private landowner	10
RPC-HE31, 32, 33	Hoods Creek on tax parcel 104-04-22-353-009-51 in Village of Caledonia	Bank stabilization to address three sections of bank erosion along Hoods Creek with about 225-foot long erosional area	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 61,200 pounds TSS	74,250	Jamestown Limited	11[c]
RPC-RE64, 65	Root River in tax parcel 012-04-21-02-0190-00 in Town of Raymond	Bank stabilization to address of bank erosion along a 250-foot section of the Root River	Habitat, Water Quality	Stabilization of riverbank, estimated annual pollutant load reduction of 66,800 pounds TSS	82,500	Private landowner	11[c]

[a]*Table 79 provides more details on the priority projects.*

[b]*Prioritization based on total cost, length of erosional area, total load reduction of total suspended solids, and cost-effectiveness of load reduction of total suspended solids.*

[c]*These projects had identical rankings in the prioritization.*

Source: SEWRPC.

Figure 117

EXAMPLES OF HIGH-PRIORITY STREAMBANK EROSION SITES WITHIN THE ROOT RIVER WATERSHED: 2013

Source: SEWRPC.

Table 91

ALTERNATIVE STREAMBANK STABILIZATION PRACTICES

Instream Practices
Vanes or J-Hook Vanes
Cross Vanes
Streambank Treatment
Bank Shaping and Planting
Branch Packing
Brush Mattresses
Coconut Fiber Roll
Dormant Post Plantings
Vegetated Gabions
Joint Plantings
Live Cribwalls
Live Stakes
Live Fascines
Log, Rootwad, and Boulder Revetments
Riprap
Stone Toe Protection
Tree Revetments
Vegetated Geogrids

Source: AECOM, City of Racine, and SEWRPC.

Table 92

COST FOR ALTERNATIVE STREAMBANK STABILIZATION PRACTICES

BMP	Unit	Unit Cost (dollars)
Vanes and J-Hook Vanes	Each	1,000-2,000
Cross Vanes	Each	2,000-6,000
Bank Shaping and Planting	Square yard	40-50
Brush Mattress	Square yard	200-500
Coconut Fiber Roll	Square yard	10-20
Coir Fabric	Square yard	3-7
Live Stakes	Square yard	20-60
Gabion (2 high)	Foot	150-200
Green Gabion (2 high)	Foot	150-205
Riprap	Square foot	10-15
Toe Protection	Foot	25-50
Joint Plantings	Square foot	20-30
Live Cribwall	Foot	100-150
Live Fascines	Foot	20-60
Rootwad	Each	35-50
Tree Revetment	Foot	15-30
Vegetated Geogrid	Foot	50-100

Source: AECOM, City of Racine, and SEWRPC.

Based on the results of the three surveys conducted within the Root River watershed, this plan makes the following recommendations regarding streambank erosion:

1. **It is recommended that the actively eroding streambanks identified in Table 79 and on Maps 74 through 88 be stabilized, beginning with high-priority projects listed in Table 90.**

    - For each streambank erosion site there are many different factors that determine the most appropriate method to use to stabilize the streambank. Individual site assessments and proper pre-project engineering should be performed to determine the most appropriate approach. These assessments should take both environmental considerations and the cost effectiveness of remedial methods into account (see Table 91 for streambank stabilization methods). In all cases it is recommended that revegetation of the banks using bioengineering techniques be employed as part of the stabilization method, to the extent possible (see Table 93 for examples of streambank buffer seed mixture).

2. **It is recommended that the design and implementation of the streambank stabilization project ensure that the stream is reconnected to its floodplain whenever practicable.**

3. **Following completion of streambank stabilization projects, it is recommended that assessments be conducted periodically to evaluate the condition and functioning of the stabilization project.**

Table 93

EXAMPLES OF STREAMBANK BUFFER SEED MIXTURE

Seed Mix	Pounds per Acre
Andropogon scoparius	4.00
Anemone Canadensis	0.07
Aster lateriflorus	0.13
Bouteloua curtipendula	4.30
Calamagrostis Canadensis	0.13
Carex cristatella	1.33
Carex tribuloides	0.16
Echinacea pupurea	1.00
Eleocharis erythropoda	0.06
Elymus Canadensis	3.33
Elymus virginicus	1.50
Epilobium Coloratum	0.06
Eupatorium perfoliatum	0.07
Juncus dudleyi	0.01
Juncus torreyi	0.06
Leersia oryzoides	0.75
Liatris pycnostachya	0.18
Lobelia cardinalis	0.01
Leebelia silphitica	0.01
Physostegia virginiana	0.06
Poa palustris	1.67
Rudbeckia subtomentosa	0.06
Scirpus atrovirens	0.77
Scutellaria epilobifolia	0.13
Spartina pectinata	0.55
Sporobolus heterolepis	0.30
Sorghastrum nutans	3.67

Source: AECOM, City of Racine, and SEWRPC.

While the studies described previously have assessed a large portion of the stream network in the Root River watershed for streambank erosion, many miles of stream remain unassessed. The unassessed portions consist mostly of tributary streams. Sediment from these streambank erosion sites in portions of the watershed that have not been assessed for streambank erosion undoubtedly affect downstream aquatic habitat. The presence of this sediment may offset gains made through bank stabilization projects located downstream. To address this possibility, this plan makes the following recommendation:

It is recommended that streambank stability surveys be conducted on streams in the watershed that have not yet been assessed. Due to the large number of stream miles within the watershed that have yet to be surveyed for streambank erosion, it is recommended that assessments be conducted on a stream reach basis, with all streams within a reach area being assessed before beginning assessments in other reach areas. In addition, the remedial actions to reduce sediment from streambank erosion should be accomplished from upstream to downstream within a given reach area. This approach will help prevent upstream eroded sediment from degrading high-quality habitat areas downstream and within the mainstem of the Root River.

RACINE COUNTY FLOODING RECOMMENDATIONS

Approaches to addressing flooding problems in Racine County are set forth in Chapter V of this report. Those approaches were considered in developing the following recommendations to characterize and/or mitigate flooding and stormwater drainage problems in Racine County municipalities:[96]

Root River Mainstem in the City of Racine

- The City should consider working with the Federal Emergency Management Agency (FEMA) and the Wisconsin Department of Natural Resources (WDNR) under the FEMA Risk Mapping, Assessment, and Planning (RiskMAP) program to conduct flood mitigation planning to develop alternatives that address the concentrated flood problem along the mainstem of the Root River.[97]

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[96]*As noted previously, MMSD has jurisdiction for developing and implementing flood mitigation plans along designated streams with the District. Necessary flood mitigation measures are identified through preparation by MMSD of watercourse system plans.*

[97]*A hydrologic model is being developed to compute flood flows throughout the Root River watershed, including the Racine County portion, as part of a study by SEWRPC to update floodplain delineations along the Root River mainstem and tributaries in Milwaukee County. Development of that model is underway, and the flood flows resulting from that process could be coupled with hydraulic models developed under the RiskMAP program, and applied to delineate revised floodplain boundaries and to analyze flood mitigation alternatives.*

Flooding of Roadways in the County

- Either the 2012 FEMA flood insurance study for Racine County, or updated flood profile information possibly developed in the future under the RiskMAP program, would provide information that can be used for municipalities to identify roadways that could overtop during floods. Municipalities should consider bridge or culvert modifications, and any necessary ancillary actions, to provide adequate hydraulic capacity to meet road overtopping standards as part of their capital improvements programs.

Scattered Buildings in the Floodplain Throughout the Watershed in Racine County

- In the case of widely scattered floodprone buildings, the most feasible approach to providing flood damage mitigation is generally to determine the most cost-effective combination of nonstructural approaches such as elevating potentially flooded buildings, floodproofing buildings, or demolishing and removing buildings. It is recommended that:

    - The County and affected municipalities request that nonstructural alternatives be given primary consideration under future FEMA RiskMAP activities.

    - If the RiskMAP program does not proceed in the Root River watershed, or if the County and affected municipalities want to address certain scattered flooding problems prior to implementation of the RiskMAP process, it is recommended that they seek FEMA Hazard Mitigation Grant Program funds, or funds from other sources to evaluate nonstructural flood mitigation alternatives.

Stormwater Runoff Problems

In locally identified areas that experience stormwater flooding, as distinguished from flooding due to the overflow of streams and rivers, it is recommended that:

- The affected municipalities, stormwater utility districts, and/or the Racine County Drainage Board prepare stormwater management plans designed to develop alternatives leading to a recommended plan to specifically address the problem areas by reducing the exposure of people to drainage-related inconvenience and to health and safety hazards and to reduce the exposure of real and personal property to damage through inundation.

- Stormwater management plans provide:

    - A minor stormwater management system with adequate capacity to infiltrate, store, and/or convey the runoff from a 10-percent-annual-probability (10-year recurrence interval) storm while providing acceptable levels of access to property and traffic service,

    - A major system to adequately infiltrate, store, and/or convey the runoff from the 1-percent-probability storm without causing significant property damage and safety hazards, and

    - An emergency overflow route to convey the peak rate of runoff to receiving streams during rain events with probabilities less than 1 percent.

HORLICK DAM

Review of Alternatives

Due to the inadequate Horlick dam spillway capacity as discussed in the “Horlick Dam Alternatives” subsection in Chapter V, structural modifications to the dam would be necessary if the dam is to be maintained. Thus, a “no action” alternative is not a viable option for the Horlick dam. Following issuance of a WDNR order to the County, the WDNR staff has indicated that Racine County, the owner of the dam, will have up to 10 years to implement modifications to meet spillway capacity requirements, or to remove the dam.

As set forth in detail in Chapter V of this report, the following five systems-level alternatives were developed to meet the regulatory requirements associated with the low hazard rating assigned to Horlick dam by WDNR:

- Alternative 1—Lower Current Dam Spillway Crest for One-Percent-Annual-Probability (100-year) Flood Capacity

- Alternative 2—Modify Current Fishway in Addition to Alternative 1 Changes

- Alternative 3—Lengthen Current Dam Spillway and Raise Abutments for One-Percent-Annual-Probability (100-year) Flood Capacity

- Alternative 4—Full Notch of Current Dam Spillway

- Alternative 5—Full Removal of Dam

The Horlick Dam Alternatives subsection in Chapter V provides a complete, comparative description of the groundwater and surface water quantity, water quality, natural resources, social, and cost considerations for each of the five alternatives. Summary information related to the alternative plans is set forth in Table 76 (fish passage and invasive species), Table 77 (costs), and Table 78 (major issues of concern) in Chapter V of this report. Drawings depicting each of the five alternatives considered are set forth in Figures 110 through 114 in Chapter V. In general terms, the evaluation categories can be reclassified into three broad categories:

- **Environmental considerations:** water quality, fish community effects, and flooding
- **Cultural considerations:** recreation, safety, and riparian landowner issues
- **Cost**

Bases for Evaluation of Alternatives and Development of a Recommendation

The conceptual, systems-level alternatives analysis set forth in Chapter V was developed to assist the County in deciding on what actions to take in response to an order from WDNR calling for upgrades to the dam if the dam is to remain. That WDNR order, which was issued on April 22, 2014, establishes a low hazard rating for the dam (see Appendix V).

The SEWRPC staff has formulated a recommendation based on its evaluation of the environmental considerations listed above. Cultural and cost considerations that will be factored into the County's final decision on how to proceed regarding the dam would be best assessed by the County staff and the County Board given their knowledge of local attitudes and preferences and the County fiscal situation, and considering the evaluation of alternatives set forth in this report and input from other affected units of government and the public. This recommendation and the evaluation of alternatives set forth in Chapter V are based on the assignment by WDNR of a low hazard rating under which it is required that the dam have adequate spillway capacity to safely pass the peak flow during a 1-percent-annual-probability (100-year recurrence interval) flood.

Table 78 in Chapter V of this report sets forth an evaluation of the major issues related to the alternatives developed for Horlick dam. Each issue is rated individually according to its potential positive or negative effect relative to the baseline, or existing, condition. When considering an individual alternative, it is necessary to evaluate the net effect of "competing issues" (e.g., the potential positive effects on fish passage and overall fish community improvement versus the potential negative effects of increased mobility for aquatic invasive species and upstream transmission of viral hemorrhagic septicemia). It is also necessary to consider "competing issues" when comparing different alternatives. The selection of a recommended plan as described below incorporated such considerations.

Recommendations
Based on the relative evaluations of flooding conditions upstream of the dam, water quality, fish passage and effects on the overall fish community, the possibility for aquatic invasive species and viral hemorrhagic septicemia to be transmitted upstream from the dam, and downstream movement of sediment accumulated in the impoundment, as summarized in Table 78, it is concluded that, on balance, Alternative 5—Full Dam Removal would have the greatest net positive environmental effect; therefore, **based on environmental considerations alone, it is recommended that the dam be abandoned and removed**. Again, as noted above, cultural and cost considerations that will be factored into the County's final decision on how to proceed regarding the dam would be best assessed by the County staff and the County Board.

The potential positive environmental effects of dam removal include long-term improvements in water quality upstream and downstream of the dam; overall improvement in the quality and abundance of the fishery through reconnection of the reaches of the River and tributaries upstream of the dam to Lake Michigan; reduced upstream flood levels in the impoundment area, which extends upstream to the vicinity of STH 31; and no change in flood levels downstream of the dam location. Implementation of Alternative 5 would restore the reach of the River upstream of the dam site to a free-flowing stream condition, and would be expected 1) to enable fish passage to occur under the broadest range of streamflow conditions relative to the other alternatives[98] and 2) to result in the greatest long-term improvement in water quality of any of the other alternatives. Under Alternative 4—Full Notch of Current Dam Spillway fish passage opportunities would be similar to those under Alternative 5; however, WDNR would still regulate the structure as a dam if Alternative 4 were implemented, and the County would have attendant regulatory compliance and maintenance responsibilities.

Under each of the five alternatives considered except Alternative 3—Lengthen Current Dam Spillway and Raise Abutments for One-Percent-Annual-Probability (100-year) Flood Capacity, the possibility for fish passage from the downstream to the upstream side of the dam would be increased to varying degrees relative to the existing condition, and both desirable species of fish and aquatic life and undesirable aquatic invasive species would be afforded increased access to the upstream reaches of the River and its tributaries. As documented in Appendix R, during a June 13, 2013, meeting between the WDNR and SEWRPC staffs for the purpose of discussing issues related to fish passage in streams tributary to Lake Michigan, the WDNR staff noted that, based on case law, WDNR could not stop abandonment of a dam if the owner no longer wanted to own, operate, and maintain the dam.[99] However, in such a case, WDNR could seek a new owner to maintain the dam. The WDNR staff has indicated that such transfer of ownership of a dam that was proposed to be abandoned has not yet occurred in the State.

The two environmental issues that have potential negative effects under a dam removal scenario are the possibility for aquatic invasive species (AIS) and viral hemorrhagic septicemia (VHS) to be transmitted upstream from the dam and the potential for downstream transport of sediment that has accumulated in the impoundment over many years. Those two issues are evaluated below in the overall context of the dam removal alternative.

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[98]*If the dam were removed, the natural shelf itself could represent somewhat of a barrier to fish passage, depending on its height and whether it is configured to concentrate or distribute flow.*

[99]*Another meeting between the WDNR and SEWRPC staffs was held on April 24, 2014, for the purpose of further discussing issues related to fish passage, passage of aquatic invasive species, and viral hemorrhagic septicemia in the context of the recently-issued WDNR fish passage guidance. Wisconsin Department of Natural Resources, Bureau of Fisheries Management, Bureau of Water Quality, Bureau of Watershed Management,* Fish Passage Guidance, *effective January 1, 2014.*

As noted above, the potential negative issue of movement of AIS and transmittal of VHS "competes" with the positive issue of the potential effects on fish passage and overall fish community improvement. Based on studies of the effect of dam removals on improvements in upstream fishery conditions[100] and on the local example of the positive effects of the fishery in the Milwaukee River following removal of the North Avenue dam,[101] it can be concluded that removal of the Horlick dam would be expected to create more healthy, diverse, and abundant populations of fishes by connecting Lake Michigan to the upper reaches of the Root River and its tributaries. Such a viable fish population would be more likely to be sustained and to remain viable in the presence of a pathogen such as VHS and to survive population losses due to AIS. For example, despite the presence of both VHS and AIS within the Milwaukee River, the North Avenue dam removal led to development of a more "vital and diverse fish community" as reported by WDNR staff.[102] In addition, WDNR staff noted that "the removal of the North Avenue dam has significantly enhanced fishing opportunities by opening up several river miles for migratory salmonids and resident native species," which is also expected to occur in the case of the removal of Horlick dam. The SEWRPC staff is not aware of any published information regarding AIS or VHS eliminating a native fish population following dam removal.

In the case of the Milwaukee River, recent monitoring data demonstrates that round goby have been observed upstream of the Mequon-Thiensville dam in 2013, which is nearly 10 miles upstream of Kletzsch dam where the round goby were known to occur in the Milwaukee River.[103] Therefore, despite dams, the round goby is expanding its range on the Milwaukee River, which is probably the result of being transferred by bait buckets used by fisherman.[104]

U.S. Fish and Wildlife Service (USFWS) records of young-of-year sampling for 1959, 1976, 1977, and 2000 (the only such records available) show that no sea lampreys were detected in the Root River. This is significant because sea lampreys are considered to be the greatest potential threat to the fishery. The USFWS provided comments to WDNR regarding the Horlick dam's function as a barrier to sea lampreys in their May 5, 2014, letter, which is included as Appendix Q. The USFWS stated their determination that the Horlick dam is "the first effective barrier to sea lamprey migration on the system," and that the Sea Lamprey Control Program (Program), which the USFWS works to implement in partnership with the Great Lakes Fishery Commission, "does not support full removal of the Horlick dam due to the risk of sea lamprey recruitment in the upper Root River watershed and associated assessment and treatment costs." Finally the letter stated that "[i]f modification to the dam is pursued, the Program requests review of the plans during the design phase to ensure that the barrier remains an effective block to sea lamprey migration." It is the understanding of the SEWRPC staff that the USFWS does not have the authority to unilaterally block removal of a dam.

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[100]*Jesse Lance Robbins and Lynne Y. Lewis, "Demolish it and They Will Come: Estimating the Economic Impacts of Restoring a Recreational Fishery,"* Journal of the American Water Resources Association*, Volume 44, No. 6, December 2008, pp. 1488-1499; Luis A. Velez-Espino, Robert L. McLaughlin, Michael J. Jones, and Thomas C. Pratt, "Demographic Analysis of Trade-offs With Deliberate Fragmentation of Streams: Control of Invasive Species Versus Protection of Native Species,"* Biological Conservation*, Volume 144, 2011, pp. 1068-1080.*

[101]*Pradeep S. Hirethota, Thomas E. Burzynski, and Bradley T. Eggold,* Changing Habitat and Biodiversity of the Lower Milwaukee River and Estuary*, PUB-FH-511-2005, August 2005. The area between the site of the former North Avenue dam and the Estabrook dam (next upstream dam) changed from a very poor to excellent fishery within a few years after removal of the North Avenue dam.*

[102]Ibid.

[103]*WDNR, 2013 Milwaukee River Round Goby Survey,*

[104]*Personal observation, William Wawrzyn, WDNR fisheries biologist.*

A potential short-term negative impact of dam removal would be the possibility of erosion of accumulated sediment from the exposed streambed and banks in the former impoundment upstream of the dam, the transport of that sediment downstream, and the ultimate deposition of some of the sediment in the Racine harbor.[105] To minimize the effect of sediment transport and deposition in downstream reaches of the River and the harbor, it is recommended that the dam crest be lowered incrementally over time in such a way as to minimize the potential for a large-scale loss of settled sediment. Erosion of the accumulated sediment could also be mitigated by establishing vegetative cover on the exposed banks as soon as possible after the commencement of the drawdown of the impoundment and providing structural erosion protection where needed. It is documented in Chapter IV that contaminated sediment in the impoundment does not appear to be a concern based on testing to date; however, additional testing should be conducted if the County chooses to remove the dam.

Considerations during the County Decision-Making Process

This advisory recommendation is provided by the SEWRPC staff to assist Racine County in making a decision regarding Horlick dam. As the County staff and the County Board consider how to proceed, the cultural and cost considerations described in Chapter V of this report can be addressed. Any County decision regarding the status of Horlick dam will be subject to review and approval by WDNR. It is recommended that the County work closely with WDNR staff from the beginning to the end of the County deliberations, and that the County take no official action and not commit any funds or make any significant expenditures without assurance that the actions for which such commitments or expenditures would be made are actions that WDNR would be able to approve.

There are several additional issues to be considered during County deliberations and/or the preliminary engineering phase, depending upon which course of action the County chooses to pursue, including, but not limited to (the applicable alternatives are listed in parentheses):

- Additional sampling of impoundment sediment for potential contamination. (Alternatives 1, 2, 4, and 5)

- Evaluation of structural integrity of right dam abutment at Riverside Inn. (Alternative 5)

- Evaluation of structural issues related to lowering or notching the current Horlick dam structure. (Alternatives 1, 2, and 4)

- Investigation of the structural integrity of the rock in the fishway area. (Alternatives 2 and 3)

- Determination of the prevalence of active shallow private wells in the impoundment area that would be affected by impoundment modifications. (Alternatives 1, 2, 4, and 5)

- Determination of the exact nature of the natural 1,000-foot shelf—related to unknowns for impoundment area to predict sediment movement and riparian restoration potential. (Alternatives 4 and 5)

- Collection of additional detailed survey data in the reach between the dam and STH 38 to determine if water depths and streambed slopes will allow fish and aquatic invasive species to migrate upstream. (Alternatives 4 and 5)

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[105] *As noted in Chapter IV, the total volume of sediment accumulated behind the dam is estimated to be 109,000 cubic yards.*

- Any proposal to maintain a dam structure must include a provision to provide for a reliable means of drawing down the impoundment level[106] for maintenance or other reasons. That requirement was stated in a December 8, 2011, WDNR response to a November 18, 2011, Racine County dam inspection report. The alternative cost estimates set forth in Chapter V include a component for replacement of the existing stop log gate with a more readily accessible and operable drawdown gate, assuming the gate would be provided in the existing stop log gate location. (Alternatives 1, 2, 3, and 4)

Summary
Based on review of environmental considerations associated with the five alternatives analyzed, the SEWRPC staff recommends that the dam be abandoned and removed. Cultural and cost considerations that will be factored into the County's final decision on how to proceed regarding the dam would be best assessed by the County staff and the County Board, given their knowledge of local attitudes and preferences and the County fiscal situation, and considering the technical evaluation of alternatives set forth in this report, and input from other affected units of government and the public.

PRIORITY PROJECTS FOR IMPLEMENTATION

As previously described, Table 79 identifies specific projects that could be undertaken to partially implement the general recommendations given in this chapter and produce improvements relative to the four focus areas of this watershed restoration plan. This list of projects was assembled from several sources including plans, engineering reports, and surveys developed for local governments; discussions with staff from State agencies, county and municipal departments, MMSD, and interested nongovernmental organizations; findings of an instream survey conducted by SEWRPC staff; and suggestions from members of the public. Because of the large number of projects listed in Table 79, it would be useful to identify a smaller number of high-priority projects that could be implemented early in the plan's implementation period and that would provide substantial benefits relative to the focus areas of the plan. This section presents the results of an identification and prioritization for projects related to urban stormwater management, streambank erosion remediation, riparian buffer establishment and expansion, and riparian invasive species control.

This prioritization identifies high-priority projects that should be pursued either because they would provide substantial benefits or because they allow the full effects of other recommended actions to be realized. Within this prioritization framework, other opportunities may arise that should be acted upon. For example, even though it is a general principle of the strategy suggested for fish passage projects that activities progress from downstream to upstream, the completion of an action in a headwaters area or on a tributary stream should not be passed up or ignored simply because it does not conform to the downstream-to-upstream strategy. Rather, all opportunities should be acted upon as they become available. However, where multiple opportunities exist, and where limited funds are available, this prioritization is intended to assist decision-makers in allocating resources where they would be most appropriate and effective in achieving the goals of this watershed restoration plan.

The prioritization was conducted for several different types of projects. In general, the prioritization sought to identify those projects that give a "relatively big bang for the buck." While slightly different criteria were used to prioritize each type of project, the prioritization gave priority to projects that could be expected to result in high levels of benefits at a relatively low cost.

Table 94 lists the 10 urban stormwater management projects with the highest priority for implementation and summarizes the benefits that would be expected to result from completing these projects. Table 79 provides additional details on these projects. These projects were prioritized based upon the total cost of each project, the loading reductions of TSS and fecal coliform bacteria that would result from each project, and the cost-

[106]*This would include provisions for access to the drawdown gate.*

effectiveness of the reductions in loading of TSS, total phosphorus, and fecal coliform bacteria.[107] Two additional overriding considerations entered into the prioritization of urban stormwater management projects. First, it is judged that illicit discharge detection and elimination efforts to locate and eliminate the source of the water quality "hot spot" detected on the mainstem of the Root River between W. Cleveland Avenue and W. National Avenue are critical actions required in order to reduce contributions of fecal indicator bacteria to the River (see the discussion of this "hot spot" in Chapter IV). Second, given that the installation of green infrastructure constitutes a major component of this plan's approach to the management of urban stormwater, it is judged that assessing whether municipal codes and ordinances constitute barriers to the installation of green infrastructure is of vital importance. To address this, the recommendation that municipal codes and ordinances be reviewed and audited is included among the high-priority projects. It should also be noted that the previously discussed recommended change in the approach to screening outfalls for illicit discharge detection and elimination is considered to be of very high importance; however, it is envisioned that this change will occur as part of the issuance or renewal of municipal stormwater discharge permits through the WPDES.

Table 90 lists the 12 projects addressing streambank erosion with the highest priority for implementation and summarizes the benefits that would be expected to result from completing these projects. Table 79 provides additional details on these projects. These projects were prioritized based upon the total cost of each project, the length of the erosion area that each project would address, the loading reductions of TSS that could result from each project, and the cost-effectiveness of the reductions in loading of TSS.

Table 95 lists the nine riparian buffer addition projects with the highest priority for implementation and summarizes the benefits that would be expected to result from completing these projects. Table 79 provides additional details on these projects. These projects were prioritized based upon the total cost of each project, the amount of riparian buffer created by each project, the loading reductions of TSS that could result from each project, the per-acre cost of the project, and the cost-effectiveness of the reductions in loading of TSS and total phosphorus.

Table 96 lists the 10 riparian and terrestrial invasive species management projects with the highest priority for implementation and summarizes the benefits that would be expected to result from completing these projects. Table 79 provides additional details on these projects. These projects were prioritized based upon the area of the site, the site's natural area and critical species habitat classification, and the severity of the infestation based upon the WDNR's satellite-based survey of wetlands for reed canary grass and the Southeastern Wisconsin Invasive Species Consortium's roadside surveys of teasel, common reed grass, Japanese knotweed, and wild parsnip.

[107]*Load reductions for total phosphorus were not used in this prioritization for two reasons. First, the total phosphorus reductions for recommended stormwater ponds in the City of Greenfield were calculated based upon a linear regression model developed using the TSS and total phosphorus reduction estimates given for stormwater ponds in the City of Racine given in AECOM,* Storm Water Quality Management Plan Update/TMDL Preparedness Assessment*, Final Report to the City of Racine, December 2013. Second, the rank order of projects based upon total phosphorus reductions was identical to the rank order based upon TSS reductions.*

Table 94

HIGH-PRIORITY URBAN STORMWATER MANAGEMENT PROJECTS FOR THE ROOT RIVER WATERSHED RESTORATION PLAN[a]

Identification Number (see Maps 74 through 88	Location	Management Action	Focus Areas Addressed	Potential Benefit from Project	Capital Cost (dollars)	Responsible Party	Priority[b]
URR-01	Root River between W. Cleveland Avenue and W. National Avenue and Hale Creek	Illicit discharge detection and elimination effort to locate and eliminate the source of the water quality hot spot at W. National Avenue	Recreational Use and Access, Water Quality	Reduction of instream fecal indicator bacteria concentrations, reduction in pollutant loads	- -[c]	City of West Allis	1
- -	MS4 municipalities in the watershed[d]	Review and audit of municipal codes and ordinances to assess barriers to the implementation of green infrastructure strategies	Water Quality	Facilitate installation of green infrastructure leading to reductions in pollutant loadings	75,000	MS4 municipalities in the watershed[d]	2
RAC-14	Washington Park in City of Racine	Installation of stormwater pond to treat runoff from a 1,398-acre contributing area	Water Quality	Annual pollutant load reductions of 31,000 pounds TSS, 56 pounds, and 83.90 trillion cells fecal coliform bacteria	365,000	City of Racine	3
RAC-11	Michigan Boulevard Brownfield in City of Racine	Installation of stormwater pond to treat runoff from a 160-acre contributing area	Water Quality	Annual pollutant load reductions of 36,400 pounds TSS, 67 pounds, and 9.58 trillion cells fecal coliform bacteria	553,000	City of Racine	4
GFD-16	North of W. Beloit Road along Wildcat Creek near S. 119th Street in City of Greenfield	Installation of stormwater pond to treat runoff from a 121-acre contributing area	Water Quality	Annual pollutant load reductions of 16,200 pounds TSS, 31 pounds, and 16.00 trillion cells fecal coliform bacteria	358,000	City of Greenfield	5
GFD-19	East of I-894 north of W. Coldspring Road in City of Greenfield	Installation of stormwater pond to treat runoff from a 213-acre contributing area	Water Quality	Annual pollutant load reductions of 37,000 pounds TSS, 73 pounds, and 28.10 trillion cells fecal coliform bacteria	1,527,000	City of Greenfield	6
RAC-03	Open space between Racine Country Club and Quarry Lake Park in City of Racine and Village of Caledonia	Installation of stormwater pond to treat runoff from a 129-acre contributing area	Water Quality	Annual pollutant load reductions of 24,800 pounds TSS, 39 pounds, and 7.73 trillion cells fecal coliform bacteria	240,000	City of Racine	7
GFD-10	Northwest of W. Coldspring Road and S. 100th Street in City of Greenfield	Installation of stormwater pond to treat runoff from a 49-acre contributing area	Water Quality	Annual pollutant load reductions of 6,800 pounds TSS, 12 pounds, and 6.47 trillion cells fecal coliform bacteria	153,000	City of Greenfield	8

Table 94 (continued)

Identification Number (see Maps 74 through 88	Location	Management Action	Focus Areas Addressed	Potential Benefit from Project	Capital Cost (dollars)	Responsible Party	Priority[b]
RAC-06	Humble Park in City of Racine	Installation of stormwater pond to treat runoff from a 142-acre contributing area	Water Quality	Annual pollutant load reductions of 28,400 pounds TSS, 47 pounds, and 8.54 trillion cells fecal coliform bacteria	560,000	City of Racine	9
GFD-11	East of S. 84th Street and north of I-43 in City of Greenfield	Installation of stormwater pond to treat runoff from a 47-acre contributing area	Water Quality	Annual pollutant load reductions of 7,800 pounds TSS, 14 pounds, and 6.20 trillion cells fecal coliform bacteria	153,000	City of Greenfield	10

[a] *Table 79 provides more details on the priority projects.*

[b] *Prioritization based on total cost; total load reductions of total suspended solids and fecal coliform bacteria; and cost-effectiveness of load reductions of total suspended solids, total phosphorus, and fecal coliform bacteria.*

[c] *Being conducted under the conditions of City of West Allis' MS4 permit.*

[d] *Such an audit of municipal codes and ordinances has been completed for the Cities of Greenfield, Milwaukee, and West Allis, which are partially located in the Root River watershed, as part of a project conducted in the Menomonee River watershed.*

Source: SEWRPC.

Table 95

HIGH-PRIORITY RIPARIAN BUFFER PROJECTS FOR THE ROOT RIVER WATERSHED RESTORATION PLAN[a]

Identification Number (see Maps 74 through 88	Location	Management Action	Focus Areas Addressed	Potential Benefit from Project	Capital Cost (dollars)	Responsible Party	Priority[b]
RCL-12	Farm field along Kilbournville Tributary west of the 7 Mile Fair in tax key 01-20-42-10-10-34-000 in Town of Raymond	Conversion of 6.4 acres of agricultural land to increase riparian buffer	Habitat, Water Quality	Expansion of buffer by 6.4 acres, estimated annual loading reductions of 1,143 pounds TSS and three pounds total phosphorus	1,300	Private landowner[c]	1
MPC-15	Franklin State Natural Area in City of Franklin	Prairie restoration on 19 acre agricultural field creating riparian buffer along Ryan Creek	Habitat, Water Quality	Expansion of buffer by 19 acres, estimated annual loading reductions of 3,390 pounds TSS and eight pounds total phosphorus	5,700	Milwaukee County Parks	2[d]
MPC-20	Franklin State Natural Area in City of Franklin	Prairie restoration on 20 acre agricultural field creating riparian buffer along Ryan Creek	Habitat, Water Quality	Expansion of buffer by 20 acres, estimated annual loading reductions of 3,580 pounds TSS and eight pounds total phosphorus	6,000	Milwaukee County Parks	2[d]
RCL-10	Farm field along East Branch Root River Canal west of I-94 and north of 2 Mile Road in tax key 104-04-22-20-00-10-00 in Town of Raymond	Conversion of 6.2 acres of agricultural land to increase riparian buffer	Habitat, Water Quality	Expansion of buffer by 6.2 acres, estimated annual loading reductions of 1,106 pounds TSS and two pounds total phosphorus	1,950	Private landowner[c]	4
MPC-07	Franklin State Natural Area in City of Franklin	Prairie and savanna restoration on 36 acres agricultural field creating 14 acres new riparian buffer along Ryan Creek	Habitat, Water Quality	Expansion of buffer by 14 acres, estimated annual loading reductions of 3,690 pounds TSS and nine pounds total phosphorus	6,000	Milwaukee County Parks	5
MPC-12	Franklin State Natural Area in City of Franklin	Savanna restoration on 52-acre riparian buffer along Ryan Creek	Habitat, Water Quality	Estimated annual loading reductions of 120 pounds TSS and 2 pounds total phosphorus	22,100	Milwaukee County Parks	6

Table 95 (continued)

Identification Number (see Maps 74 through 88	Location	Management Action	Focus Areas Addressed	Potential Benefit from Project	Capital Cost (dollars)	Responsible Party	Priority[b]
RCL-11	Farm field along Husher Creek south of 5 Mile Road and east of S. Howell Avenue in tax keys 104-04-22-21-00-8000 and 104-04-22-21-00-7000 in Village of Caledonia	Conversion of 0.8 acres of agricultural land to increase riparian buffer	Habitat, Water Quality	Expansion of buffer by 0.8 acre, estimated annual loading reductions of 950 pounds TSS and 0.4 pound total phosphorus	$ 950	Private landowner[c]	7
MPC-17	Franklin State Natural Area in City of Franklin	Savanna restoration on 11-acre riparian buffer along Ryan Creek	Habitat, Water Quality	Estimated annual loading reductions of 24 pounds TSS and 0.4 pound total phosphorus	4,463	Milwaukee County Parks	8[e]
MRR-23	Hidden Oaks Savanna along Root River north of W. Ryan Road in City of Franklin	Restoration of 15 acres of wetland, prairie, oak savanna along mainstem of Root River	Habitat, Water Quality	Estimated annual loading reductions of 2,680 pounds TSS and six pounds total phosphorus	70,316	Hunger Task Force and Milwaukee County Parks	8[e]

[a]*Table 79 provides more details on the priority projects.*

[b]*Prioritization based on total cost, amount of area added to the buffer, total load reduction of total suspended solids, per acre cost of buffer addition, cost-effectiveness of load reduction of total suspended solids, and cost-effectiveness of load reduction of total phosphorus.*

[c]*Cost-share and technical assistance to be provided by Racine County Land Conservation Division.*

[d]*These projects had identical rankings in the prioritization.*

[e]*These projects had identical rankings in the prioritization.*

Source: SEWRPC.

Table 96

HIGH PRIORITY RIPARIAN AREA INVASIVE SPECIES CONTROL PROJECTS FOR THE ROOT RIVER WATERSHED RESTORATION PLAN[a]

Identification Number (see Maps 74 through 88	Location	Management Action	Focus Areas Addressed	Potential Benefit from Project	Capital Cost (dollars)	Responsible Party	Priority[b]
LRC-03	Nicholson Wildlife Refuge, Village of Caledonia	Remove invasive species	Habitat	Habitat improvement, protection/restoration of NA-2 class natural area	- -[c]	Village of Caledonia	1
RWO-01	Colonial Park, City of Racine	Continue ongoing invasive plant species removal and management activities	Habitat	Habitat improvement, protection/restoration of NA-2 class natural area, removal of large Japanese knotweed infestation	- -[c]	City of Racine, Racine Weed-Out!	2[d]
URR-14	Whitnall Park, City of Franklin, Village of Greendale	Project to remove invasive species that are colonizing this site	Habitat	Habitat improvement, protection/restoration of NA-3 class natural area, removal of infestations of several invasive species	- -[c]	Milwaukee County Parks	2[d]
MPC-03	Grobschmidt Park, City of Franklin	Remove invasive plant species and replant with native species	Habitat	Habitat improvement, protection/restoration of NA-3 class natural area, removal of infestations of several invasive species	17,874[e]	Milwaukee County Parks	4
LRC-30	Tabor Woods, Village of Caledonia	Removal and management of invasive plant species	Habitat	Habitat improvement, protection/restoration of NA-3 class natural area, removal of infestations of several invasive species	- -[c]	Caledonia Conservancy	5
MPC-06	Franklin State Natural Area, City of Franklin	Invasive plant species management and removal on 40 acres of agricultural land	Habitat	Habitat improvement, protection/restoration of NA-3 class natural area, removal of infestations of several invasive species, needed for planned savanna and prairie restoration project	24,640[f]	Milwaukee County Parks	6
MPC-11	Franklin State Natural Area, City of Franklin	Invasive plant species management and removal on 52 acres of degraded oak savanna	Habitat	Habitat improvement, protection/restoration of NA-3 class natural area, removal of infestations of several invasive species, needed for planned savanna restoration project	61,360[f]	Milwaukee County Parks	7

Table 96 (continued)

Identification Number (see Maps 74 through 88	Location	Management Action	Focus Areas Addressed	Potential Benefit from Project	Capital Cost (dollars)	Responsible Party	Priority[b]
MPC-19	Franklin State Natural Area, City of Franklin	Invasive plant species management and removal on 23 acres of degraded oak savanna	Habitat	Habitat improvement, protection/restoration of NA-3 class natural area, removal of infestations of several invasive species, needed for planned savanna restoration project	4,380[f]	Milwaukee County Parks	8
RWO-09	Horlick Park, City of Racine	Invasive plant species removal and management	Habitat	Removal of infestations of several invasive species	- -[c]	Racine County, Racine Weed-Out!	9
MPC-14	Franklin State Natural Area, City of Franklin	Invasive plant species management and removal on 19 acres of agricultural land	Habitat	Habitat improvement, protection/restoration of NA-3 class natural area, removal of infestations of several invasive species, needed for planned prairie restoration project	7,905[e]	Milwaukee County Parks	10

[a]*Table 79 provides more details on the priority projects.*

[b]*Prioritization based on area of site, natural area classification, and severity of infestation based upon SEWISC roadside surveys and WDNR satellite-based survey.*

[c]*Cost estimates are not available for this project. In general, costs of invasive species removal projects are dependent on whether volunteer labor is available for the project and the extent to which it is utilized.*

[d]*These projects had identical rankings in the prioritization.*

[e]*Cost estimate is for invasive species management over the period 2011-2020.*

[e]*Cost estimate is for invasive species management over the period 2013-2022.*

Source: SEWRPC.

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Chapter VII

IMPLEMENTATION

INTRODUCTION

The Root River watershed restoration plan provides a set of specific, targeted recommendations that can be implemented to produce improvements relative to a set of focus issues related to conditions in the watershed. The recommendations given in Chapter VI of this report address four focus areas: water quality, recreational access and use, habitat conditions, and flooding. The improvements that would result from implementing the recommendations represent steps toward achieving the overall goal of restoring and improving the water resources of the Root River watershed.

This watershed restoration plan is a second-level plan for the management and restoration of water resources in the Root River watershed. It was prepared in the context of the Southeastern Wisconsin Regional Planning Commission's (SEWRPC) regional water quality management plan update for the greater Milwaukee watersheds (RWQMPU),[1] which was prepared in coordination with, and largely incorporates, the Milwaukee Metropolitan Sewerage District's (MMSD) 2020 facilities plan.[2] The recommendations of the RWQMPU as they pertain to the Root River watershed and the status of their implementation are summarized in Chapter II of this report. In addition to addressing the recommendations of the RWQMPU, this watershed restoration plan also seeks to incorporate those elements of recent and ongoing watershed management programs and initiatives that are related to the restoration plan's focus areas and are consistent with and complement the goals of the RWQMPU. These programs and initiatives are inventoried and reviewed in Chapter III of this report.

While the recommended plan is designed to attain, to the extent practicable, the targets related to the focus areas presented in Chapter V, the plan is not complete in a practical sense until the steps required to implement the plan—that is, to convert the plan into action policies and programs—are specified. This chapter provides that information and is intended as a guide for use in the implementation of the plan. Basically, it outlines the actions that must be taken by the various levels and agencies of government in concert with private sector organizations if the recommended watershed restoration plan is to be fully carried out. Those units and agencies of government which have plan adoption and plan implementation powers applicable to the plan are identified; necessary or desirable formal plan adoption actions are specified; and specific implementation actions are recommended for

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[1]*SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007 and* Amendment to the Regional Water Quality Management Plan for the Greater Milwaukee Watersheds, *May, 2013.*

[2]*Milwaukee Metropolitan Sewerage District,* MMSD 2020 Facilities Plan, *June 2007.*

each of the units and agencies of government with respect to recommendations addressing the focus areas of the plan. Also, the coordinated roles of the public and private sectors are described, and financial and technical assistance programs available to implement the watershed restoration plan are summarized.

This watershed restoration plan can be implemented in three principal ways: 1) inventory, or the collection, analysis, and dissemination of basic planning data on a uniform, areawide basis; 2) implementation of general recommendations designed to guide management activities in the watershed; and 3) implementation of specific projects designed to meet the targets established for the watershed restoration plan.

A great deal can be achieved in guiding watershed development into a more desirable pattern through the simple task of collecting, analyzing, and disseminating basic planning and engineering data on a continuing, uniform, areawide basis. Experience within the Southeastern Wisconsin Region has shown that, if this important inventory function is properly carried out, the resulting information will be used and acted upon both by local, State, and Federal agencies of government; nongovernmental organizations; and private entities. A wealth of definitive information about the Root River watershed, including natural and manmade features, hydrology and hydraulics, instream conditions, and water quality problems, was assembled under the planning effort. The use of this information base in arriving at development decisions on a day-to-day basis by the public and private interests involved contributes substantially toward implementation of the recommended watershed restoration plan.

The general recommendations provided in this watershed restoration plan are intended to guide management activities in the watershed. Unless otherwise indicated, general recommendations are intended to be broadly applicable over the entire watershed. These recommendations provide guidance for the management of water resources within the watershed with respect to a variety of general and specific factors and issues that contribute to the problems related to each of the four focus areas that this plan addresses.

The specific projects recommended in this plan represent actions that could be taken to partially implement the general recommendations given in this plan. Implementation of these projects will contribute to meeting the targets related to the focus areas established in Chapter V.

This chapter contains a discussion of the nine minimum elements of watershed plans that the U.S. Environmental Protection Agency (USEPA) has identified as being critical for achieving improvements in water quality, and it is demonstrated how this watershed restoration plan fully addresses those elements.

ADOPTION OF THE ROOT RIVER WATERSHED RESTORATION PLAN

Upon completion of the Root River watershed restoration plan the Commission will transmit a copy of the plan to all local legislative bodies within the watershed and to all of the existing Federal, State, areawide, and local units and agencies of government that have potential plan implementation functions.

A copy will be transmitted to the WDNR with a request that the Department approve the plan.

Adoption of the watershed restoration plan by the local legislative bodies and the existing local, areawide, State, and Federal level agencies concerned is highly desirable to assure a common understanding among the several governmental levels and to enable their staffs to program the necessary implementation work. In addition, formal plan adoption may also be required for some State and Federal financial aid eligibility. A model resolution for adoption of the Root River watershed restoration plan is included in Appendix W. Adoption of the recommended watershed restoration plan by any unit or agency of government pertains only to the statutory duties and functions of the adopting agencies. Such adoption does not and cannot in any way preempt or commit action by another unit or agency of government acting within its own area of functional and geographic jurisdiction.

Upon adoption of the plan by a unit or agency of government, it is recommended that the policymaking body of the unit or agency direct its staff to review in detail the elements of the watershed restoration plan. Once such review is completed, the staff can propose to the policymaking body for its consideration and approval the steps necessary to fully integrate the watershed plan elements into the plans and programs of the unit or agency of government.

RELATION OF THE ROOT RIVER WATERSHED RESTORATION PLAN TO THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S NINE ELEMENTS

As part of its approach to watershed planning, the USEPA has identified a set of nine minimum elements that it considers critical for achieving improvements in water quality.[3] These elements are listed in Table 97. USEPA requires that these elements be addressed in watershed-based plans for threatened and impaired waters that are developed or implemented with funding through Section 319 of the Federal Clean Water Act. USEPA also recommends that these elements be included in all other watershed plans intended to address water quality impairments.

The Root River watershed restoration plan was designed to address the nine elements identified by USEPA. It provides a roadmap for addressing the water quality impairments that have been identified in the watershed. As described in Chapter IV of this report, those impairments consist of low concentrations of dissolved oxygen, high concentrations of total phosphorus, and degraded biological communities in several sections of the mainstem of the Root River and three tributary streams (see Map 38 in Chapter IV of this report). As indicated in Table 36 in Chapter IV of this report, the pollutants contributing to these impairments have been identified as total phosphorus, sediment, and total suspended solids. This plan also provides recommendations to address the high concentrations of fecal indicator bacteria found in surface waters of the watershed. While recreational use impairments pursuant to Section 303(d) of the Federal Clean Water Act have not been identified in the Root River watershed, the high concentrations of fecal indicator bacteria documented in Chapter IV suggest that they may be placing limits on the suitability of surface waters in the watershed for recreational uses.

This section describes each of the nine elements identified by USEPA and summarizes how the Root River watershed restoration plan addresses each element.

Element 1: Identify the Causes and Sources of Pollution in the Watershed
Under this element, watershed plans should identify and locate the major causes and sources of water quality impairments in the watershed. The plan should include an estimate of existing and projected future pollutant loadings for the pollutants contributing to the impairments.

Chapter IV of this report contains a thorough inventory of water quality, biological, and habitat conditions in the Root River watershed. This inventory is based upon an extensive database. For instance, the inventory of water quality conditions is based on the analysis of over 10,800 samples collected between 1964 and 2012. This inventory revealed source areas of some pollutants. The findings of this inventory were used in Chapter V to identify the causes of the known impairments, as well as other problems, in the watershed.

To estimate both existing and projected future loads for total phosphorus, total suspended solids, and fecal coliform bacteria, the Root River watershed restoration plan incorporates the findings of the 2007 RWQMPU for the Root River.[4] Under the RWQMPU, a comprehensive, watershed-based, calibrated and validated U.S. Environmental Protection Agency HSPF continuous simulation model was developed to simulate pollutant loads and instream water quality conditions in the streams of the Root River watershed. This HSPF model was applied to

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[3]*U.S. Environmental Protection Agency,* Handbook for Developing Watershed Plans to Restore and Protect Our Waters, *USEPA Publication EPA 841-B-008-002, March 2008.*

[4]*SEWRPC Planning Report No. 50,* op. cit.; Amendment to the Regional Water Quality Management Plan for the Greater Milwaukee Watersheds op. cit.*: SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007.*

Table 97

MINIMUM WATERSHED ELEMENTS TO BE ADDRESSED IN WATERSHED-BASED PLANS

Nine Minimum Elements for a Watershed Plan
1. Identification of the causes and sources of pollution in the watershed
2. Estimate of the load reductions needed to meet water quality standards
3. Description of the management measures to achieve the load reductions
4. Estimates of the amounts of technical and financial assistance and the relevant authorities needed to implement the plan
5. Development of an information and education component
6. Development of an implementation schedule
7. Description of interim, measurable implementation milestone
8. Identification of indicators to measure progress toward meeting water quality standards
9. Development of a monitoring component

Source: U.S. Environmental Protection Agency.

estimate pollutant loads and instream pollutant concentrations over a 10-year simulation period chosen to be representative of long-term precipitation statistics. This model was applied to represent then-existing year 2000 land use conditions and planned 2020 land use conditions. The 2020 conditions were used as a baseline for comparing alternative plans representing different approaches to improving water quality through combinations of point source pollution controls and implementation of agricultural and urban best management practices and green infrastructure. The recommended RWQMPU plan was synthesized from the most effective components of the alternatives. The USEPA HSPF water quality model developed to represent recommended plan conditions explicitly accounted for many of the recommended rural and urban nonpoint source pollution control measures. A more detailed summary of the modeling is given in Chapter VI of this report.

Three of the four pollutants identified for abatement under this watershed restoration plan—total suspended solids, total phosphorus, and fecal coliform bacteria—were modeled under the RWQMPU along with several other pollutants. The fourth pollutant identified for abatement, chloride, was not analyzed under the RWQMPU. The modeled pollutant loads are set forth in Appendix O of this report. It should be noted that these loads are set forth on a subwatershed basis, showing the portions of the watershed that contribute more highly to the loads. This is shown both in the tables and on the maps contained in this appendix.

Element 2: Estimate the Load Reductions Needed to Meet Water Quality Standards

Under this element, the watershed plan should include an estimate of the pollutant load reductions needed to meet water quality standards associated with water quality impairments in the watershed. This estimate can be taken from a TMDL, if one is in place for the watershed. Otherwise it will need to be developed as part of the watershed planning process. The estimate should address both point sources and nonpoint sources in the watershed.

To estimate the required load reductions for total phosphorus, total suspended solids, and fecal coliform bacteria, the Root River watershed restoration plan incorporates the findings of the 2007 RWQMPU for the Root River.[5] Under the RWQMPU, a comprehensive, watershed-based, calibrated and validated U.S. Environmental Protection Agency HSPF continuous simulation model was developed to simulate pollutant loads and instream water quality conditions in the streams of the Root River watershed. This HSPF model was applied to estimate pollutant loads and instream pollutant concentrations over a 10-year simulation period chosen to be representative of long-term precipitation statistics. This model was applied to represent then-existing year 2000 land use conditions and planned 2020 land use conditions. The latter conditions were used as a baseline for comparing alternative plans representing different approaches to improving water quality through combinations of point source pollution controls and implementation of agricultural and urban best management practices and green infrastructure. The recommended RWQMPU plan was synthesized from the most effective components of the alternatives. The

[5]Ibid.

USEPA HSPF water quality model developed to represent recommended plan conditions explicitly accounted for many of the recommended rural and urban nonpoint source pollution control measures. A more detailed summary of the modeling is given in Chapter VI of this report.

Three of the four pollutants identified for abatement under this watershed restoration plan—total suspended solids, total phosphorus, and fecal coliform bacteria—were modeled under the RWQMPU along with several other pollutants. The modeled pollutant loads are set forth in Appendix O of this report. The fourth pollutant identified for abatement, chloride, was not analyzed under the RWQMPU. The reductions required for the modeled pollutants were estimated both on a subwatershed basis and a watershed basis through comparison of the existing (2000) condition pollutant loads with the recommended plan (2020) pollutant loads. These reduction estimates were refined to account for how much of the pollutant load reductions envisioned in the RWQMPU would result from implementation of the stormwater runoff performance standards set forth in Chapter NR 151, "Runoff Management," of the *Wisconsin Administrative Code*. This refinement included an adjustment to account for the changes in the application of NR 151 that have been made since the RWQMPU was completed. A more detailed description of how the required pollutant reductions were estimated is given in Chapter V of this report.

The estimated load reductions required to achieve the levels of water quality envisioned in the RWQMPU are given in Chapter V of this report in: Table 62 for total phosphorus, Table 63 for total suspended solids, and Table 66 for fecal coliform bacteria. Summary statistics describing the modeled water quality conditions associated with these load reductions are also given in Chapter V of this report in: Table 64 for total phosphorus, Table 65 for total suspended solids, and Tables 67 and 68 for fecal coliform bacteria.

Element 3: Describe the Management Measures to be Taken to Achieve the Needed Load Reductions
Under this element, the plan should describe the management measures that need to be implemented to achieve the load reductions estimated under Element 2 described above. This description should be detailed enough to guide implementation and should estimate load reductions to be achieved from each management measure.

Descriptions of recommended management measures are given in Chapter VI of this report. The recommended measures include both general recommendations that apply to the entire watershed and are intended to provide guidance for the management of water resources within the watershed and more than 240 specific projects that represent specific actions to be taken to implement the general recommendations. With one exception, the locations of all of the recommended specific projects are listed in Table 79 and shown on Maps 74 through 88 in Chapter VI of this report. The one exception to this is a recommended project in which the municipal codes and ordinances of all the counties and municipalities in the watershed would be reviewed and audited to identify barriers to the implementation of green infrastructure practices. Because of its nature, this recommendation applies over the entire watershed. In addition, high-priority projects taken from Table 79 are listed in Tables 90 and 94 through 96 In Chapter VI of this report.

Table 79 in Chapter VI of this report also lists estimates of pollutant load reductions for the recommended specific projects. The load reductions that would result from the implementation of the MMSD green infrastructure plan in the portion of the watershed located within the MMSD service area are also given in Chapter VI. The level of implementation of the MMSD green infrastructure plan recommended for 2019, the end of the implementation period of this watershed restoration plan, would result in estimated average annual loading reductions of 130,000 pounds of total suspended solids and 450 pound of total phosphorus. Full implementation of the MMSD plan, which is scheduled to occur in 2035, would result in estimated average annual loading reductions of 1,855,600 pounds of total suspended solids and 6,450 pounds of total phosphorus.

Element 4: Estimate the Amounts of Technical and Financial Assistance and Relevant Authorities Needed to Implement the Plan
Under this element, the plan should estimate the amounts of technical and financial assistance that will be required in order to implement the plan. The plan should also identify those relevant authorities that might play a role in plan implementation. The plan should consider the use of Federal, State, local, and private funds and resources that might be available to assist in implementation.

Table 98

SUMMARY OF ESTIMATED CAPITAL COSTS FOR THE ROOT RIVER WATERSHED RESTORATION PLAN

Plan Element	Cost (dollars)
1. MMSD Green Infrastructure Plan through 2019	10,200,000[a]
2. Specific Projects in Table 79	21,415,472
3. Recreational Use and Access Recommendations	3,828,500
4. Horlick Dam Removal	540,000
5. Information and Education Plan	84,500
Total	36,068,472

[a]*The capital cost of full implementation of the MMSD green infrastructure plan for the portions of the Root River watershed that are contained within the MMSD service area through year 2035 is estimated as $145,000,000.*

Source: SEWRPC.

The capital costs of general recommendations are given in the discussion of these recommendations in Chapter VI of this report. These costs are summarized in Table 98. The estimated capital costs of the Root River watershed restoration plan is $36.1 million. It should be noted that this includes $10.2 million for the implementation of the MMSD green infrastructure plan for the portion of the watershed that is located within MMSD's service area through year 2019. The estimated cost of full implementation of the MMSD green infrastructure plan in the portion of the watershed that is located within MMSD's service area by year 2035 is $145 million. The cost summary in Table 98 also includes capital costs for the specific projects recommended in Table 79 in Chapter VI of this report. The total capital cost of these projects is estimated at about $21.4 million.

The estimated costs of individual recommended specific projects are given in Table 79 in Chapter VI of this report. A summary of the capital costs of these projects is given by project type in Table 99. The total capital cost associated with the 41 high-priority projects is estimated at about $7.2 million. The total capital cost of 129 additional medium and low-priority projects is estimated at about $14.2 million. Table 79 includes 75 projects for which sufficient information was unavailable to develop costs. Costs for these projects will need to be developed through additional planning or preliminary engineering.

The costs given in Tables 79 (in Chapter VI of this report), 98, and 99 are estimated and will need to be refined during preliminary engineering and project development.

The relevant authorities for plan implementation are identified in the section "Plan Implementation Organizations" later in this chapter. This section describes the organizations that have a role in plan implementation and, where appropriate, identifies the source of their legal authority and indicates the types of recommendations that these organizations may implement or help implement. The organizations described include local units of government and local government agencies, regional government agencies, State agencies, Federal agencies, and private organizations. It should be noted that for many recommendations set forth in Chapter VI, the recommendation identifies the implementing organization contemplated under this watershed restoration plan. In addition, the primary authorities responsible for implementation of the recommended specific projects are listed as part of the project descriptions given in Table 79 in Chapter VI of this report.

Sources of funding and technical assistance for implementation of the Root River watershed restoration plan are discussed in the section "Financial and Technical Assistance for Plan Implementation" later in this chapter. This section describes numerous grant and loan programs offered through both public and private sources for many aspects of plan implementation, including grant and assistance programs that are available under the areas of

Table 99

SUMMARY OF ESTIMATED CAPITAL COSTS FOR PROJECTS IN TABLE 79

Project Type	Number of Projects	Cost (dollars)
Urban Stormwater Management		
High-Priority Projects[a]	10	3,984,000
Other Projects with Costs	19	6,770,100
Projects for Which Costs will be Assigned During Project Development	11	- -
Subtotal	40	10,754,100
Streambank Stabilization/Protection		
High-Priority Projects[b]	12	3,004,570
Other Projects with Costs	68	5,244,650
Projects for Which Costs will be Assigned During Project Development	12	- -
Subtotal	92	8,249,220
Riparian Buffer		
High-Priority Projects[c]	9	118,779
Other Projects with Costs	11	500,910
Projects for Which Costs will be Assigned During Project Development	9	- -
Subtotal	29	619,689
Invasive Species Management and Removal		
High-Priority Projects[d]	10	116,159
Other Projects with Costs	3	30,804
Projects for Which Costs will be Assigned During Project Development	7	- -
Subtotal	20	146,963
Agricultural and Other Nonurban Nonpoint Source Pollution Control		
Projects with Costs	7	126,250
Projects for Which Costs will be Assigned During Project Development	6	- -
Subtotal	13	126,250
Repair/Replacement of Degraded Outfalls and Associated Erosion		
Projects with Costs	7	67,500
Projects for Which Costs will be Assigned During Project Development	11	- -
Subtotal	18	67,500
Recreational Access		
Projects with Costs	6	111,750
Projects for Which Costs will be Assigned During Project Development	10	- -
Subtotal	16	111,750
Land Acquisition for Natural Areas		
Projects with Costs	1	1,340,000
Projects for Which Costs will be Assigned During Project Development	0	- -
Subtotal		1,340,000
Instream Habitat		
Projects with Costs	0	- -
Projects for Which Costs will be Assigned During Project Development	6	- -
Subtotal	6	- -
Specific Monitoring Projects		
Projects with Costs	0	- -
Projects for Which Costs will be Assigned During Project Development	3	- -
Subtotal	3	- -

Table 99 (continued)

Project Type	Number of Projects	Cost (dollars)
Total		
High-Priority Projects[b]	41	7,223,508
Other Projects with Costs	129	14,191,964
Projects for Which Costs will be Assigned During Project Development	75	- -
Total	245	21,415,472

[a] *High-priority urban stormwater management projects are described in Table 94 in Chapter VI of this report.*

[b] *High-priority streambank stabilization and protection projects are described in Table 90 in Chapter VI of this report*

[c] *High-priority riparian buffer projects are described in Table 95 in Chapter VI of this report.*

[d] *High-priority riparian buffer projects are described in Table 96 in Chapter VI of this report. It should be noted that there was insufficient information to develop costs for five of the high-priority projects. The costs of invasive species management projects can be highly variable depending upon the extent to which volunteer labor is utilized.*

Source: SEWRPC.

wildlife and fish habitat preservation, water quality protection, land acquisition for park and open spaces, flood mitigation, and other areas such as education and sustainable development. Several aspects of these programs are discussed in the descriptions, including the types and amounts of assistance available, eligibility criteria for assistance, the activities funded or specific technical assistance provided, and, where available, application procedures and deadlines. This section includes a table which provides contact information for the agencies and organizations. In addition, for each recommended specific project, Table 79 in Chapter VI of this report lists programs that could potentially provide funding or technical assistance.

Element 5: Develop Information and Education Components for the Plan
Under this element, watershed plans should include an information and education component designed to enhance public understanding of the watershed plan and encourage early and continued participation by the public in selecting, designing, and implementing the nonpoint source management measures recommended by the plan. This component should identify the education and outreach activities that will be used as part of plan implementation. These information and education activities may support the adoption and long-term operation of management practices and support public involvement efforts.

A detailed information and education plan component is described later in this chapter in the section titled "Information and Education." The material presented in this section includes:

- An identification of the target audiences for information and educational activities;
- A detailed summary of the recommended information and education actions;
- An assignment of responsibilities for organizations taking lead and supporting roles in implementing specific information and education actions;
- A schedule for the implementation of information and education actions;
- A description of the implementation goals and desired outcomes and behavioral changes associated with specific information and education actions; and
- An estimate of the costs associated with information and education activities.

This chapter also includes a section titled "Public Participation" that describes the public participation and stakeholder involvement activities conducted as part of the development of this watershed restoration plan.

Element 6: Develop an Implementation Schedule
Under this element, the watershed plan should include a schedule for implementation of the recommended management measures.

A schedule for the implementation of the Root River watershed restoration plan is presented and discussed in the "Implementation Schedule" section later in this chapter.

Element 7: Describe Interim, Measurable Implementation Milestones
Under this element, the watershed plan should include a description of measurable interim milestones for determining whether management measures and other control actions are being implemented. This element should reflect and be consistent with the implementation schedule developed under Element 6.

Implementation milestones and a procedure for evaluating progress in implementing the plan are presented in the subsection "Evaluating the State of Plan Implementation" in the water quality monitoring section in Chapter VI. The milestones related to plan recommendations are set forth in Table 88 in Chapter VI of this report. In addition, milestones specifically applicable to the information and education element of this watershed restoration plan are set forth as part of the description of this element in Table 100 later in this chapter.

In order to facilitate evaluation of the status of plan implementation, the watershed restoration plan also recommends the continued functioning of the Root River Watershed Plan Advisory Group as an advisory committee. This recommendation calls for annual meetings of the Advisory Group that focus on reviewing the progress of projects called for under the plan and evaluating the state of plan implementation.

Element 8: Identify Indicators to Measure Progress Toward Meeting Water Quality Standards
Under this element, the watershed plan should specify a set of criteria that can be used to determine whether loading reductions are being achieved over time and whether substantial progress is being made toward attaining water quality standards. These indicators can consist of direct measurements or indirect indicators of load reductions.

As described in Chapter IV of this report, watershedwide systematic water quality monitoring began in the Root River watershed during the mid-1960s. While there are gaps in the data, an extensive, long-term data water quality data set is available for the watershed.[6] This data set includes samples in which concentrations of the pollutants contributing to the identified water quality impairments—total phosphorus, total suspended solids, fecal coliform bacteria, and *Escherichia coli*—were assessed. This data set also includes samples in which concentrations of other water quality constituents, such as dissolved oxygen, can be used to assess whether progress is being made toward meeting water quality standards, and constituents that provide a check on other factors that can potentially impact dissolved oxygen concentrations in surface waters, such as five-day biochemical oxygen demand and chlorophyll-*a*. Biological data sets, including surveys of fish, macroinvertebrates, and mussels, are also available for the watershed. The availability of these recent and historical data provides a baseline against which the effects of management measures upon water quality can be assessed.

As described in Chapter VI of this report, the Root River watershed restoration plan explicitly recommends that the available water quality monitoring data for the Root River watershed be periodically collated, analyzed, and placed into context. It also recommends that these data be compared to historical monitoring data and to the

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[6]*As of early August 2012, this data set included 7,930 samples collected from the mainstem of the Root River, 1,370 samples collected from tributary streams in the watershed, and 1,540 samples collected from lakes and ponds in the watershed.*

applicable water quality criteria. The analyses of water quality conditions and biological conditions presented in Chapter IV of this report illustrate one way in which these comparisons could be made. Through the use of direct measurements, these comparisons will provide an assessment of trends and changes in conditions and indicate whether conditions, including those relative to the identified impairments, are improving or worsening. These analyses will indicate whether substantial progress is being made toward meeting water quality standards.

In support of this, Chapter VI also provides guidance to agencies and organizations conducting water quality monitoring regarding the water quality constituents to be monitored. Table 86 in Chapter VI of this report presents a prioritized list of physical and chemical indicators for monitoring programs to consult when those agencies and organizations consider adding constituents to the suite of indicators monitored. The minimum set of additional water quality constituents that would be necessary to monitor to make assessments that are most critical to the water quality focus area of this plan—including the impairments that have been identified in the watershed—are all included in two tiers, with the highest priority for monitoring.

Element 9: Develop a Monitoring Component to the Plan

Under this element, the watershed plan should include a monitoring component to determine whether progress is being made toward attaining the applicable water quality standards. The monitoring program should be integrated with the schedule and milestones defined in Elements 6 and 7, respectively, and should assess water quality conditions against the criteria established in Element 8. The monitoring component should be designed to determine whether loading reductions are being achieved over time and whether substantial progress is being made toward meeting water quality standards.

The Root River watershed restoration plan includes a recommended monitoring program. This monitoring program, which is described in Chapter VI of this report, builds upon the monitoring network that was in place in the watershed during plan development. It includes components designed to address two issues:

1. What are the conditions in the watershed?

2. What is the status of the implementation of the recommendations of this watershed restoration plan?

This monitoring plan element of the watershed restoration plan addresses the first of these questions by recommending the use of a number of water quality indicators, including water chemistry, stream flow, fecal indicator bacteria, and indicators of biological conditions. It addresses the second question through a mechanism to keep track of all the projects that are undertaken in the Root River watershed that implement the recommendations of this plan.

The monitoring plan element of the watershed restoration plan begins with an evaluation of the water quality monitoring network that was in place in the watershed during plan development. This evaluation includes identification of the agencies and organizations conducting water quality monitoring in the watershed and an identification of additional monitoring needs. Components of the water quality monitoring plan element include continued monitoring at the sampling sites utilized for sampling during plan development, as well as an expansion of the monitoring network to fill data gaps identified during the assessment of monitoring needs. This expansion includes monitoring of additional tributary streams, lakes, and ponds in the watershed; the establishment of two to four "real-time" monitoring stations to conduct continuous monitoring of water temperature, specific conductance, dissolved oxygen, turbidity, stage, and streamflow; and periodic sampling of freshwater mussels. The watershed restoration plan contemplates that most of this expansion of monitoring activities could be accomplished through a redirection of effort involving an adjustment in the frequency at which samples are collected at several existing stations.

To determine whether substantial progress is being made toward meeting water quality standards, the Root River watershed restoration plan includes a recommendation that water quality monitoring data for the watershed be periodically collated, analyzed, and placed into context. This recommendation specifically includes comparing those data both to historical data in order to assess trends in conditions within the watershed and to the applicable water quality criteria.

Table 100

ROOT RIVER WATERSHED RESTORATION PLAN INFORMATION & EDUCATION (I&E) PLAN MATRIX

Education Action	Communications Vehicles	Schedule	Lead (Supporting) Organization(s)	Outcomes, Implementation Goals, Behavior Change	Estimated Cost
1. Provide I&E to **elected officials and county and municipal staffs** about the components and recommended management actions in the completed plan, and encourage them to: 1) Adopt the plan; 2) Amend municipal comprehensive plans, codes, and ordinances to recognize recommendations in the plan; and 3) Review their codes to identify barriers to the implementation of green infrastructure practices within their jurisdictions Counties: ● Kenosha ● Milwaukee ● Racine ● Waukesha Cities: ● Franklin ● Greenfield ● Milwaukee ● Muskego ● New Berlin ● Oak Creek ● Racine ● West Allis Villages: ● Caledonia ● Greendale ● Hales Corners ● Mt. Pleasant ● Sturtevant ● Union Grove Towns: ● Dover ● Norway ● Paris ● Raymond ● Yorkville	Distribute copies of the plan, CD, and 12-page color brochure summarizing the plan Schedule meetings, tours, and workshops on the plan and recommendations Include elected officials in presentations on 1) storm-water best management practices, such as porous pavement, green roofs, and bioswale/rain garden streets, and 2) field trips of the Southeast Wisconsin Clean Water Network Present research and recommendations, management practices, and ordinances Provide technical assistance and information about financial assistance	Summer 2014-December 2016 Quarterly meetings of SE WI Clean Water Network (March, June, September, December)	Root-Pike WIN, SWWT, (SEWRPC), (WDNR)	12 meetings, presentation, and workshops between summer 2014 and mid-2016 Knowledge of the components and recommendations in the plan Adoption of the plan by civil divisions by 2016 Recognition of plan recommendations in comprehensive plans, codes, and ordinances by mid-2016 Revision of municipal codes and ordinances to accommodate and promote green infrastructure	I&E to elected officials and municipal staffs: $25,000 (500 hours) Municipal code reviews: $75,000
2. Provide the watershed plan to the **general public and news media**, inform and educate them about water pollution; the hazards and management of yard debris, pet waste, fertilizers, and yard chemicals as they relate to stormwater runoff and groundwater contamination; rain barrels and rain gardens; nonnative and invasive species; and fishing and paddling opportunities. Encourage the public to include appropriate plan recommendations in their activities and to request assistance	Publish and distribute a 12-page color brochure summarizing the plan Leverage the SEWRPC, Root-Pike WIN, SWWT websites, social media, and multimedia, and the *Greener Yards, Cleaner Waters* e-newsletter to announce the plan and activities related to the plan and to inform the public about actions they can take to implement projects. Update the websites on an ongoing basis Issue news releases announcing the plan, recommendations, and activities Provide media interviews, photo opportunities, and tours Leverage Root-Pike WIN e-newsletter, *Greener Yards, Cleaner Waters* (February, March, April, May, June, July, August, September, October), and SWWT *Rivers Report* newsletter to announce the plan and activities related to the plan. Update the newsletters on an ongoing basis Extend/expand the Respect Our Waters multimedia and community outreach campaign Maintain/expand the Keep Our Waters Clean project Provide booths at festivals, fairs, and other events Continue posting links to the plan on SEWRPC, Root-Pike-WIN, and SWWT websites Announce of plan and plan-related activities in the Kenosha and Racine County *Ties to the Land* newsletter	Summer 2014 and at intervals marking implementation progress, major initiatives, photo opportunities, events, and other newsworthy developments Beginning in 2015, and continuing through 2019, one spring and one summer workshop under the Root-Pike WIN *Greener Yards, Cleaner Waters* workshop series Also beginning in 2015, and continuing through 2019, one summer and one fall workshop/tour addressing multiple topics related to combinations of Educa-tion Action Items 2, 4 through 11, and 14 Booths will be staffed at events held from summer 2014 through 2019	Root-Pike WIN, SWWT, Watershed Municipalities, (Southeastern Wisconsin Invasive Species Consortium), (River Bend Nature Center), (Wehr Nature Center) (SEWRPC), (UWEX), (Kenosha County), (Racine County)	Five news releases issued between summer 2014 and 2019 Five news stories published or aired between summer 2014 and 2019 400 brochures distributed between fall 2014 and 2019 20 presentations and workshops from 2015 through 2019 The majority of the public in the watershed has an understanding of watershed water quality conditions. They begin to alter everyday activities, leading to watershed improvement	Cost includes Education Action Items 2, 4 through 11, and 14, which would be accom-plished through a coordinated, multi-purpose program which would include the Communication Vehicles for each of those Action Items, and which share outcomes, except where additional out-comes are noted for an Action Item Brochure: $12,000 Staff Activities: $17,500 (350 hours)

Table 100 (continued)

Education Action	Communications Vehicles	Schedule	Lead (Supporting) Organization(s)	Outcomes, Implementation Goals, Behavior Change	Estimated Cost
3. Provide I&E to **municipal staff** about specific point source pollution recommendations in the plan. Encourage them to adopt the recommended management actions and include them in proposals for funding and assistance	Publish and distribute online and print materials about the plan on an ongoing basis Provide technical assistance and information about financial assistance	Summer 2014 to summer 2015	Root-Pike WIN, SWWT, (SEWRPC), (WDNR), (MMSD)	Up to five presentations 75 pieces of educational materials distributed Knowledge of the components and recommendations in the plan	$4,000 (80 hours)
4. Provide information on technical and funding assistance to **nongovernmental organizations** that have the capabilities to implement expanded water quality monitoring, restoration, and other management actions recommended in the plan. Encourage them to include the recommendations in their activities and in proposals for funding and assistance, and to coordinate their monitoring programs with the existing Milwaukee Metropolitan Sewerage District, City of Racine Health Department, Wisconsin Department of Natural Resources, and U.S. Geological Survey programs	Distribute letters, copies of the plan, CD, and 12-page color brochure summarizing the plan Schedule meetings and tours on the plan and recommendations Publish and distribute online and print materials about the plan on an ongoing basis	Summer 2014 to summer 2019	Root-Pike WIN, SWWT, (SEWRPC), (WDNR), (MMSD), (Water Action Volunteers), (Wisconsin Citizen Lake Monitoring Network), (Southeastern Wisconsin Invasive Species Consortium), (Wisconsin Citizen-Based Monitoring Network)	Shared outcomes listed under Education Action No. 2 above[a] Five monitoring locations added Knowledge of the components and recommendations in the plan	Included under Education Action No. 2 above
5. Provide information on 1) plan recommendations, and 2) technical and funding assistance to **rural landowners and farm operators** owning and/or working lands identified for priority projects. Encourage them to adopt the recommended management actions in their practices Pertinent plan recommendation categories: • Riparian buffers, • Livestock access to streams, • Manure storage, • Dairy wastewater, • Onsite wastewater treatment, and • Streambank erosion	Provide presentations, workshops, and tours of completed projects Publish and distribute online and print materials Description/summary of plan in *Ties to the Land* newsletter	Summer 2014 to summer 2019	County Land Conservation Departments, (USDA NRCS), (land trusts), (Root-Pike WIN), (SWWT), (SEWRPC), (UWEX), (WDNR)	30 presentations and workshops Shared outcomes listed under Education Action No. 2 above[a] 10 projects initiated Knowledge of the plan components and recommendations	Included under Education Action No. 2 above
6. Provide I&E to **private landowners and businesses**, including agricultural supply, lawn maintenance, and golf course managers, about the watershed plan, management of nutrients and chemicals impacts and the watershed, grass buffers and long-rooted native vegetation, and technical and funding assistance. Encourage them to adopt the recommended management actions.	Provide presentations, workshops, and tours Provide demonstration sites Publish and distribute online and print materials related to these topics	Summer 2014 to summer 2019	Root-Pike WIN, SWWT, (SEWRPC), (UWEX), (WDNR)	Shared outcomes listed under Education Action No. 2 above[a] Knowledge of the components and recommendations in the plan 10 projects initiated	Included under Education Action No. 2 above
7. Provide information regarding the plan recommendations to **developers, engineers, and landscapers**. Encourage them to adopt the recommended management actions and include them in their proposals	Provide presentations, workshops, and tours Publish and distribute online and print materials related to these topics	Summer 2014 to summer 2019	Root-Pike WIN, SWWT, (SEWRPC), (UWEX), (WDNR)	Shared outcomes listed under Education Action No. 2 above[a] Knowledge of the components and recommendations in the plan	Included under Education Action No. 2 above

Table 100 (continued)

Education Action	Communications Vehicles	Schedule	Lead (Supporting) Organization(s)	Outcomes, Implementation Goals, Behavior Change	Estimated Cost
8. Provide information on technical and funding assistance for riparian buffers and stream rehabilitation to **county and municipal staffs, riparian property owners, and landscapers**. Provide **homeowner and business associations** with the knowledge needed to maintain naturalized detention basins. Encourage all of these audiences to adopt the recommended management actions	Provide presentations, workshops, and tours Publish and distribute online and print materials related to these topics Provide demonstration sites Distribute SEWRPC "Managing the Water's Edge" riparian buffer brochure	Summer 2014 to summer 2019	County Land Conservation Departments, UWEX, Root-Pike WIN, SWWT, (SEWRPC), (WDNR)	Shared outcomes listed under Education Action No. 2 above[a] Two demonstration sites Knowledge of the components and recommendations in the plan Private landowners along the Root River and its tributaries recognize the benefits of bioengineering to reduce bank erosion and how natural buffers improve water quality and wildlife habitat as part of green infrastructure. Members of homeowners associations will recognize the benefits of vegetating a detention basin and the steps needed to carry it out 10 projects initiated	Included under Education Action No. 2 above
9. Provide information on technical and funding assistance to **public officials and potential grant recipients** regarding the mapping of horse-riding, biking, walking, hiking, skiing, snowshoeing, orienteering, birding, and handicap-accessible trails and canoe/kayak landings for public recreational access	Provide presentations, workshops, and tours	Summer 2014 to summer 2019	Root-Pike WIN, SWWT, (SEWRPC), (UWEX), (WDNR)	Shared outcomes listed under Education Action No. 2 above[a] Knowledge of the components in the plan	Included under Education Action No. 2 above
10. Provide I&E assistance to **municipal staff and potential grant recipients** regarding educational signs, kiosks, and multimedia	Provide presentations, workshops, and tours Provide technical assistance and information about financial assistance	Summer 2014 to summer 2019	Root-Pike WIN, SWWT, (SEWRPC)	Shared outcomes listed under Education Action No. 2 above[a] Knowledge of the components in the plan 23 projects initiated (one for each county, city, village, and town in the watershed)	Included under Education Action No. 2 above
11. Provide I&E to **marina and boatyard owners and operators** regarding water pollution and the maintenance, operation, and storage of recreational vessels	Provide presentations Publish and distribute online and print materials related to these topics Provide technical assistance and information about financial assistance Encourage demonstration sites	Summer 2014 to summer 2019	Root-Pike WIN, SWWT, (SEWRPC), (Wisconsin Marina Association), (UW Sea Grant Institute), (UWEX), (Wisconsin Coastal Management Program), (WDNR), (U.S. Coast Guard)	Shared outcomes listed under Education Action No. 2 above[a] Knowledge of the components and recommendations in the plan Two demonstration sites	Included under Education Action No. 2 above
12. Promote learning strategies for environmental education among **residents and youth**. Encourage educators to include information about ecology and stewardship of the watershed in instruction, curriculum, field trips, and related activities, and in proposals for funding and assistance	Continue supporting and expanding reach of water education programs through Root-Pike WIN's Watershed-based Grant Program and the Respect Our Waters campaign to help integrate basic watershed planning and education into existing elementary, middle, and high school science curriculum. Offer free presentations to teachers and student groups Provide schools with copies of the brochure describing the plan	Summer 2014 to summer 2019	Root-Pike WIN, SWWT, (School Districts), (Wehr Nature Center), (River Bend Nature Center)	10 presentations and workshops	$8,000 (160 hours)
13. Provide I&E to **county and municipal staff** regarding application of chemical deicers to roads and parking lots	Provide presentations	Fall 2014 to Fall 2019	Root-Pike WIN, SWWT, (counties), (municipalities), (UWEX), (WDNR), (WisDOT)	Four presentations (Milwaukee and Waukesha Counties and UWEX have periodically conducted deicing workshops)	$3,200 (64 hours)

Table 100 (continued)

Education Action	Communications Vehicles	Schedule	Lead (Supporting) Organization(s)	Outcomes, Implementation Goals, Behavior Change	Estimated Cost
14. Provide I&E to **private applicators, businesses, and homeowners** regarding application of chemical deicers to roads, driveways, and parking lots	Provide presentations, and publish and distribute online and print materials	Fall 2014 to Fall 2019	Root-Pike WIN, SWWT, (counties), (municipalities), (UWEX), (WDNR), (WisDOT)	10 presentations	$8,000 (160 hours)
15. Provide I&E to **organizations and individuals** that have the ability to encourage and incorporate volunteer activities related to stewardship of the watershed	Provide presentations, workshops, and tours Provide technical assistance and information about financial assistance	Summer 2014 to summer 2019	Root-Pike WIN, SWWT, (SEWRPC)	10 presentations Knowledge of the components in the plan	$8,000 (160 hours)
16. Provide I&E to **organizations and individuals** regarding land trust acquisitions and land selection	Provide presentations, workshops, and tours Provide technical assistance and information about financial assistance	Summer 2014 to summer 2019	Root-Pike WIN, SWWT, (SEWRPC), (Caledonia Conservancy), (Kenosha/Racine Land Trust), (Milwaukee Area Land Conservancy), (Prairie Enthusiasts), (Waukesha County Land Conservancy)	Five presentations Knowledge of the components in the plan Three projects initiated	$4,000 (80 hours)
17. Measure I&E outcomes and activities	A survey of households in the watershed was undertaken in 2010 to collect information on watershed residents' knowledge of watersheds, water quality, yard care impacts, and more. A full report on the survey can be found at *www.rootpikewin.org* on the "Keep Our Waters Clean" page. A follow up survey should be conducted in 2019 to assess the success of the "Keep Our Waters Clean" program and of the information and education efforts undertaken relative to this Root River watershed restoration plan Provide an online form for plan stakeholders to complete information about their activities Send bimonthly requests to plan stakeholders with the link to the form	2019 Summer 2014 to summer 2019	Root-Pike WIN, SWWT, (SEWRPC)	The 2019 household survey will indicate substantial improvements in residents' knowledge of watershed issues since the survey 2010	$15,000
18. Evaluate I&E Plan	Schedule annual meetings to discuss plan progress and updates	Summer 2015 to summer 2019	Root-Pike WIN, SWWT, (SEWRPC), (Root River Advisory Group)	Make necessary adjustments to the I&E Plan to achieve goals and objectives	- -

[a] *The I&E program components described under the "Outcomes" section of Education Action No. 2 above would be designed to reach multiple project stakeholder and plan implementation organizations. Thus, presentations and workshops and educational materials would be designed to meet the interests of the general public, as well as the targeted entities identified under Education Actions Nos. 4 through 11 and 14.*

Source: Root River Watershed Advisory Group; Pike River Watershed-Based Plan-A Guide to Protecting and Restoring Watershed Health*, prepared for Root-Pike Watershed Initiative Network by Applied Ecological Services, August 2013; and SEWRPC.*

In order to monitor implementation of the recommendations of the Root River watershed restoration plan, the plan designates two entities—the Southeastern Wisconsin Watersheds Trust, Inc. (Sweet Water) and the Root-Pike Watershed Initiative Network (Root-Pike WIN)—to act as overseeing entities for tracking implementation. The plan recommends that Sweet Water act as the entity overseeing monitoring of plan implementation for those portions of the watershed that are located within the MMSD planning area, and it is recommended that Root-Pike WIN act as the entity overseeing monitoring of plan implementation for those portions of the watershed in Kenosha and Racine Counties outside of the MMSD planning area. The plan further recommends that all organizations acting to implement this plan report the initiation and completion of projects implementing plan recommendations to the entity overseeing monitoring for the portion of the watershed in which the project is conducted.

PLAN IMPLEMENTATION ORGANIZATIONS

Although the Regional Planning Commission can promote and encourage the implementation of this watershed restoration plan in various ways, the advisory role of the Commission makes actual implementation of the recommended plan dependent upon action by local, areawide, State, and Federal agencies of government and private organizations with an interest in improving conditions related to the plan's four focus areas in the watershed. Examination of the various public agencies that are available to implement elements of the recommended plan reveals an array of departments, commissions, committees, boards, and districts at all levels of government. These agencies range from general-purpose local units of government such as counties, cities, villages, and towns, to special-purpose districts, such as lake districts or drainage districts. These agencies also include State regulatory bodies, such as the Wisconsin Department of Natural Resources (WDNR); and Federal agencies that provide financial and technical assistance for plan implementation, such as the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS).

Because of the many and varied public agencies in existence, it becomes important to identify those agencies having the legal authority and financial capability to most effectively implement the recommended watershed restoration plan elements. Accordingly, those agencies whose actions will have a significant effect, either directly or indirectly, upon the successful implementation of the recommended plan and whose full cooperation in plan implementation will be essential are listed and discussed below. The agencies are, for convenience, listed by level of government; however, interdependence between the various levels, as well as between agencies of government, and the need for close intergovernmental cooperation, is essential to the successful implementation of the plan recommendations.

Numerous private and nonprofit organizations can play an important role in implementing recommendations of this watershed restoration plan. These organizations include local chapters of larger national or regional organizations as well as smaller, community-based groups. The roles that these organizations can play in plan implementation and examples of such groups are also described in this section.

Local-Level Agencies

Several County and municipal agencies have missions and powers that are important to the implementation of this watershed restoration plan. Statutory provisions exist for the creation at the County and municipal level of the following agencies having planning and plan implementation powers, including police powers and acquisition, condemnation (eminent domain), and construction (tax appropriation) powers, important to water quality plan implementation.

County Park and Planning Agencies

County government has considerable latitude available in forming agencies to perform the park and outdoor recreation and zoning and planning functions within the County. Counties may organize park commissions or park and planning commissions pursuant to Section 27.02 and 59.69(2), respectively, of the *Wisconsin Statutes.* Instead of organizing such commissions, counties may elect to utilize committees of the County Board to perform the park and outdoor recreation and zoning and planning functions. The powers are, however, essentially the same no matter how an individual County chooses to organize these functions. If, however, a County elects to establish a county park or county park and planning commission, these commissions have the obligation to prepare a county park system plan and a county street and highway system plan. There is no similar mandate for plan preparation when a County elects to handle these functions with committees of the County Board.

The planning, zoning, plat review, and onsite sewage disposal regulatory functions vary somewhat from county to county within the watershed.

County park departments also conduct land management activities that are important for the implementation of this watershed restoration plan. As shown on Map 62 in Chapter IV of this report, county parks and open space sites comprise a substantial portion of the riparian lands along the mainstem of the Root River and some of its tributary streams. These park and open space sites provide riparian buffers, habitat for wildlife, and corridors for recreational activities, including access to surface waters. The management of these lands gives these departments a major role in plan implementation.

County Land and Water Conservation Committees

County land and water conservation committees are responsible for land conservation programs within the County and are also responsible for implementing the State's soil and water resource management program. These committees report to the County Board. Sections 92.07 and 92.10 of the *Wisconsin Statutes* authorize the land and water conservation committees to have a broad range of powers and duties. These powers and duties include:

- Development and adoption of standards and specifications for management practices to control erosion, sedimentation, and nonpoint sources of water pollution;
- Distribution and allocation of available Federal and State cost-sharing funds relating to soil and water conservation;
- Presentation of research and educational information programs relating to soil and water conservation;
- Conduct of programs designed to prevent flood damage, drainage, irrigation, groundwater, and surface water problems;
- Provision of financial, technical, and other assistance to landowners;
- Acquisition of land and other interests and property, machinery, equipment, and supplies required to carry out various land conservation programs;
- Construction, improvement, operation, and maintenance of structures needed for land conservation, flood prevention, and nonpoint source pollution control; and
- Preparation of a long-range natural resource conservation plan for the County, including an erosion control plan and program.

County land and water conservation committee activities are closely supervised by county boards and are subject to the fiscal resources made available by the board. Pursuant to this law, all four counties that are partially located in the Root River watershed have created land conservation committees to perform these various functions. Day-to-day administration of the programs overseen by the county land conservation committees is performed by the counties' land conservation departments or divisions. These departments act through partnerships with local farmers, landowners, businesses, and State and Federal agencies, to address soil and water conservation issues. The county land conservation committees and departments will have important responsibilities in the implementation of this watershed restoration plan.

Municipal Planning Agencies

Municipal planning agencies include city, village, and town plan commissions and town zoning committees created pursuant to Sections 62.23(1), 61.35, and 60.61(4) of the *Wisconsin Statutes*. Such agencies are important to plan implementation at the local level.

Municipal Utility and Sanitary Districts

Municipal utility districts may be created by cities, villages, and towns pursuant to Section 66.0827 of the *Wisconsin Statutes.* Town sanitary districts may be created pursuant to Section 60.71 and 60.72 of the *Wisconsin Statutes.* Such special districts are authorized to plan, design, construct, operate, and maintain various public utility systems, including sanitary sewerage, water supply, and stormwater drainage systems. At the present time, there exist within the Root River watershed all or portions of the following active sanitary or utility districts: the Caledonia East and West Utility Districts in the Village of Caledonia, the Mount Pleasant Sewer Utility District No. 1 in the Village of Mt. Pleasant, and the Yorkville Sewer Utility District No. 1 in the Town of Yorkville.[7]

Farm Drainage Districts

Chapter 88 of the *Wisconsin Statutes* authorizes landowners to petition the circuit court to establish a drainage district under the control of a county drainage board. Pursuant to Sections 88.11 and 93.07(1) of the *Wisconsin Statutes*, the Department of Agriculture, Trade and Consumer Protection (DATCP) promulgated rules regarding farm drainage districts under Chapter ATCP 48 of the *Wisconsin Administrative Code* on July 1, 1995. Those rules were amended effective September 1, 1999. The rules establish procedures for assessing drainage district costs and benefits, inspecting drainage districts, construction and maintenance projects, landowner actions affecting drainage districts, drainage district records, and enforcement and variances. Section ATCP 48.24 sets forth requirements for the establishment of district corridors with a minimum width of 20 feet from the top of each bank of a district ditch. Those corridors are for the purpose of providing vehicular and equipment access over the entire length of the district ditch and to “provide a buffer against land uses which may adversely affect water quality in the district ditch.” The *Administrative Code* also allows for the establishment of a wider corridor at the discretion of the county drainage board. Drainage districts can play a role in the establishment of riparian buffers. The Root River watershed contains the Yorkville/Raymond Farm Drainage District, which includes portions of the Towns of Raymond and Yorkville, portions of the Union Grove Sanitary District, and portions of the Raymond Storm Water Management District.[8]

Stormwater Drainage Districts

The management of stormwater runoff is an important element in the implementation of this watershed restoration plan. Wisconsin Act 53, which was enacted on December 19, 1997, amended and expanded Section 66.0821 of the *Wisconsin Statutes* to specifically grant municipalities the legal authority to assess service charges to users of a stormwater and surface water sewerage system. This legislation granted municipalities essential authorities for the establishment of stormwater utilities. Several communities in the Root River watershed have established stormwater utilities, a general stormwater fund, or a stormwater fee program. These include the Cities of Franklin,

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[7]*Following incorporation of the Town of Caledonia as the Village of Caledonia, the former Caddy Vista Sanitary District and Caledonia Utility District No. 1 were combined into the Caledonia West Utility District and the former Crestview Sanitary District and the former North Park Sanitary District were combined into the Caledonia East Utility District.*

[8]*Maps from the Wisconsin Department of Agriculture, Trade, and Consumer Protection’s drainage district program indicate that the Hoods Creek Drainage District located in the Villages of Mt. Pleasant and Sturtevant and the Town of Yorkville and the Muskego Drainage District No. 3 located in the northeastern portion of the City of Muskego, may also still be active; however, these maps also indicate that these two districts have levied no recent assessments for any activities.*

Greenfield, Milwaukee, Oak Creek, and West Allis, and the Villages of Greendale and Hales Corners in Milwaukee County; the City of Racine, the Villages of Caledonia, Mt. Pleasant, and Sturtevant, and the Town of Raymond in Racine County; and the City of New Berlin in Waukesha County.

Lake Districts and Associations
Lake districts are special purpose units of government that are established to maintain, protect, and improve the quality of a lake and its watershed for the benefit of the lake, fish and wildlife habitat, and the surrounding community. The boundaries of the district include the riparian property owners and can extend to off-lake properties that affect the watershed or that benefit from the lake. Chapter 33 of the *Wisconsin Statutes* enables lake districts to carry out the following roles and responsibilities:

- Land acquisition for the benefit of the watershed;
- Collection of fees in the form of a tax from affected citizens and the authority to borrow money;
- Development and preparation of surveys or studies, management of aquatic weeds, control of soil erosion, dredging, operating dams, and monitoring water quality; and
- If delegated to do so by a county, city, or village, adopting and regulating boating activities, aircraft, and travel on ice-bound lakes.

There are currently no lake districts in the Root River watershed.

In addition to lake districts, lake associations can also be of help in plan implementation. Lake associations can carry out many of the same roles and functions of a lake district, but some key differences exist. Lake associations are not considered special purpose units of government, and as such do not have taxing authority, and cannot develop and oversee lake use regulations compared to a lake district. However, they are beneficial with regard to implementing water quality improvement projects. Some of the activities they can undertake include the following:

- Operate dams;
- Contract for aquatic plant removal or buy and operate an aquatic plant harvester;
- Apply for and receive certain lake planning and protection grants;
- Collect data on water quality, lake development, and lake use conflicts; and
- Purchase sensitive areas such as wetlands.

There is currently one lake association in the Root River watershed, the Kelly Lakes Association. This organization conducts planning and management activities for Lower and Upper Kelly Lakes.

County and Municipal Health Departments
Because of their expertise in microbiology, county and municipal health departments can provide considerable technical assistance in implementation of some recommendations of this watershed restoration plan. These departments conduct water quality monitoring at swimming beaches and post swim advisories or beach closures when monitoring results indicate that water quality conditions could pose hazards to human health. In addition, some of these departments, most notably the City of Racine Health Department, participate in activities such as surface water quality monitoring and municipal separate storm sewer system illicit discharge detection and elimination.

Areawide Agencies

Statutory provision exist for the creation of the following areawide agencies having both general and specific planning and plan implementation powers potentially applicable to the implementation of this watershed restoration plan.

Milwaukee Metropolitan Sewerage District

The MMSD is a special-purpose unit of government directed by an appointed Commission. In the Root River watershed the MMSD includes all municipalities in Milwaukee County. The District also provides sewage conveyance, storage, and treatment services for the portion of the Caledonia West Utility District serving the Caddy Vista Subdivision in Racine County and the Cities of Muskego and New Berlin in Waukesha County. The District has the authority to levy taxes to fund its capital improvement programs and operation and maintenance of its facilities.

The District has a number of important responsibilities in the area of water resources management, including the collection, transmission, storage, and treatment of domestic, industrial, and other sanitary sewage generated in the District and its contract service areas and the provision of watercourse management programs for most of the major streams within the District. This latter responsibility includes development and implementation of flood mitigation programs for portions of the mainstem of the Root River and several tributary streams. The District also conducts several programs that are relevant to the implementation of this plan, including its water quality monitoring program, its Greenseams program, and its green infrastructure programs.

Southeastern Wisconsin Regional Planning Commission

The Regional Planning Commission has no statutory plan implementation powers. However, in its role as a coordinating agency for planning and development activities within the Southeastern Wisconsin Region, the Commission can influence plan implementation through the community planning assistance services which it renders to its constituent counties and municipalities, and through review and comment of Federal and State grant-in-aid applications, waste discharge permits, and sanitary sewer extensions.

State-Level Agencies

The following State agencies have either general or specific planning authority and hold certain plan implementation powers important to the implementation of this watershed restoration plan.

Wisconsin Department of Natural Resources

The WDNR has broad authority and responsibility in the areas of natural resources protection, water quality control, and water regulation. The WDNR has the obligation to develop long-range, statewide conservation and water resource plans. In addition, it has the authority to designate sites to protect, develop, and regulate the use of State parks, forests, fish, game, lakes, streams, certain plant life, and other outdoor resources; and to acquire conservation and scenic easements.

Designation of State Project Areas

In its role of designating sites to protect the natural resources of the State, the WDNR can play an important part in implementing and funding the stream rehabilitation, prairie and wetland restoration, riparian buffer, and recreational use and access components of the Root River watershed restoration plan. Implementation of these components may be accomplished as a whole, or in part, through creation of a State Project Area within which the WDNR could acquire, develop, and manage properties. Section 23.09(2)(d) of the *Wisconsin Statues* lists purposes for which the State may acquire lands through purchase, lease, or gift. The listed purposes that may be applicable to the recommended plan components include: State forests, State recreation areas, streambank protection, wildlife habitat areas and fisheries, and any other purpose for which gift lands are suitable, as determined by the WDNR.

Chapter NR 1 of the *Wisconsin Administrative Code* establishes priorities for WDNR acquisition of lands. The categories that are applicable to recommended components of this watershed restoration plan, in descending priority, are:

- Land to protect rare and threatened natural resources; to protect genetic and biological diversity; and to protect, manage , or restore critical fish and wildlife habitat.

- Water-based resources that include land important to protect and improve the quality of the State's surface and ground water; and land for recreation and management along streams, rivers, lakes, and flowages.

- Lands to accommodate broad, natural resource-based outdoor recreation and State recreation trails.

- Land within 40 miles of Wisconsin's 12 largest cities.[9]

A proposed State Project Area is evaluated by the WDNR through preparation of a feasibility study, following which the Project Area may be approved or rejected by the Natural Resources Board and the Governor.

Water Pollution Control Function
The responsibility for water pollution control in Wisconsin is centered in the WDNR. The basic authority and accompanying responsibilities relating to the water pollution control function of the WDNR are set forth in Chapter 283 of the *Wisconsin Statutes.* Under that chapter, the WDNR is given broad authority regarding the following:

- Preparing water use objectives and supporting water quality standards;

- Protecting water quality through abatement of nonpoint source pollution from construction site erosion, agricultural runoff, and nonagricultural (urban) runoff;

- Protecting wetlands through enforcement of water quality standards;

- Protecting navigable waters, including authorizing municipal shoreland zoning regulations;

- Regulating groundwater withdrawals from high-capacity wells to ensure that operation of such wells do not adversely affect a public water supply, or regulating withdrawals when high-capacity wells are located in a groundwater protection area, which is defined as an area within 1,200 feet of an outstanding or exceptional resource water or Class I, II, or III trout streams;[10]

- Conserving and managing water resources through regulation of withdrawals from waters of the State;

- Reviewing and approving plans and specifications for components of sanitary sewerage systems;

- Reviewing and approving the creation of joint sewerage systems;

- Regulating the servicing of septic tanks, soil absorption fields, holding tanks, grease interceptors, privies, and other components of private sewage systems;

- Regulating the disposal of septage in municipal sewerage systems;

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[9]*All portions of the Root River watershed are within 40 miles of one or more of the Cities of Kenosha, Milwaukee, Racine, Waukesha, and West Allis—all of which are among the 12 largest cities in the State.*

[10]*Section 281.34(5)(b)1 requires that "an environmental impact report under s. 23.11 (5) must be prepared for a proposed high capacity well located in a groundwater protection area."*

- Performing "activities to clean up or to restore the environment in an area that is in or adjacent to Lake Michigan or Lake Superior or a tributary of Lake Michigan or Lake Superior if the activities are included in a remedial action plan that is approved by the department" (Section 281.83(1)); and

- Administering a financial assistance program for the construction of pollution prevention and abatement facilities.

Each of the above authorities is important to implementation of the recommended watershed restoration plan. The loans and grants available through the financial assistance program are particularly relevant, including those related to:

- Local water quality planning,

- Facilities planning, engineering design, and construction of point source pollution abatement facilities,

- Nonpoint source water pollution abatement "for the implementation of measures to meet nonpoint source water pollution abatement needs identified in areawide water quality management plans," (Section 281.65(1)(a)),

- Lake management planning, and

- River protection.

Under Chapter 243 of the *Statutes*, the WDNR is given broad authority to establish and carry out the Wisconsin Pollutant Discharge Elimination System (WPDES) program in accordance with the policy guidelines set forth by the U.S. Congress under the Federal Water Pollution Control Act Amendments of 1972 and 1987. This legislation establishes a waste discharge permit system and provides that no permit may be issued by the WDNR for any discharge from a point source of pollution which is in conflict with any areawide wastewater treatment and water quality management plan approved by the WDNR. This legislation and accompanying procedures comprise the primary enforcement tool of the WDNR in achieving the established water use objectives and supporting water quality standards.

Other WDNR Authority
The WDNR has the obligation to establish standards for floodplain and shoreland zoning and the authority to adopt, in the absence of satisfactory local action, shoreland and floodplain zoning ordinances. The WDNR also has authority to regulate the following: water diversions, shoreland grading, dredging, encroachments, and deposits related to navigable waters; the construction of neighboring ponds, lagoons, waterways, stream improvements, and pierhead and bulkhead lines; the construction, maintenance, and abandonment of dams; and water levels of navigable lakes and streams and lake and stream improvements, including the removal of certain lakebed materials. The WDNR also makes cost-share monies available for a number of activities, including dam removal, river protection, land and water conservation and stewardship activities, stormwater and runoff management, lake planning and protection, recreational trail development, and aquatic invasive species control. With such broad authority for the protection of the natural resources of the State and Region, the WDNR will be extremely important to the implementation of nearly all of the major elements of the watershed restoration plan.

Wisconsin Department of Administration
The Wisconsin Department of Administration Federally-approved Coastal Zone Management Program for the Great Lakes was established in 1978 under the Federal Coastal Zone Management Act and has been revised over time. The program has identified wetlands protection, habitat restoration, public access, land acquisition, nonpoint source pollution control, land use and community planning, natural hazards, and Great Lakes education projects as current priorities. The program also provides assistance to local governments in the management and protection of shorelands, wetlands, and floodplains through zoning and permitting.

Wisconsin Department of Agriculture, Trade and Consumer Protection

Under the Wisconsin Soil and Water Conservation Law, State-level soil and water conservation responsibilities have been placed under Wisconsin DATCP authority. Within that Department, the law created a seven-member advisory Land and Water Conservation Board. The Land and Water Conservation Board reviews and comments on rules relating to soil and water conservation, administers the State's Farmland Preservation Program, reviews all County erosion control plans and the annual County and long-range County land and water conservation plans, and generally advises the Secretary of DATCP and the University of Wisconsin on matters relating to soil and water conservation. DATCP also makes cost-share monies available for land and water resource management activities such as installation of agricultural best management practices. The DATCP rules require the preparation of county land and water conservation plans and provide for partial funding of the administration and implementation of such county plans. The Department will have important responsibilities relative to implementation of the watershed restoration plan.

Wisconsin Department of Safety and Professional Services

The Wisconsin Department of Safety and Professional Services has responsibility for regulation of construction erosion control and private onsite wastewater treatment systems under Chapters SPS 360, "Erosion Control, Sediment Control and Storm Water Management," and SPS 383, "Private Onsite Wastewater Treatment Systems," of the *Wisconsin Administrative Code*. Department authority for construction site erosion control extends to issuing permits for single- and two-family residential building sites and commercial sites. The Department also has responsibility for the abatement of water pollution through control of the discharge of sewage from boats maintained or operated at any time upon the inland or outlying waters of the state under Chapter SPS 386, "Boat and On-Shore Sewage Facilities," of the *Wisconsin Administrative Code.*

Wisconsin Department of Transportation

The Wisconsin Department of Transportation has important responsibilities regarding 1) nonpoint source pollution abatement related to highway construction and maintenance, 2) constructing stream crossings that permit passage of fish and other aquatic organisms, and 3) minimizing disturbance of existing natural stream channels and restoring disturbed stream channel reaches.

University of Wisconsin-Extension

A University of Wisconsin-Extension (UWEX) office is located within each County. Although the Extension has no statutory plan implementation powers, the Extension can aid communities in solving environmental problems by providing educational and informational programs to the general public, and by offering advice to local decision-makers and community leaders. The Extension carries out these responsibilities by conducting meetings, tours, and consultations, and by providing newsletters, bulletins, and research information. In addition, the UWEX, along with the WDNR, also sponsors the Water Action Volunteers Program (WAV) and the Citizen Lakes Monitoring Program. These sponsorships give the UWEX a role in implementing the recommendations of this plan that are related to water quality monitoring.

Federal-Level Agencies

The following Federal agencies administer aid and assistance programs that may be applicable to implementation of the watershed restoration plan. Funding from such programs may be used for land acquisition, construction of specific facilities, and other management activities.

U.S. Environmental Protection Agency

The USEPA administers water quality management planning grants and sanitary sewerage facility construction grants. The latter can be particularly important to implementation of the water quality management plan. In addition, this agency is responsible for the ultimate achievement and enforcement of water quality standards for all interstate waters, should the States not adequately enforce such standards. In this respect, the USEPA has delegated authority over the National Pollutant Discharge Elimination Systems (NPDES) permit issuance process whereby the WDNR issues discharge permits under both State and Federal authorities. Under guidelines promulgated by the USEPA, areawide water quality management and sanitary sewerage facilities plans must be prepared as prerequisites to the receipt of Federal capital grants in support of sewerage works construction.

The USEPA also administers grant funding for nonpoint source pollution control activities. The 1987 amendments to the Federal Clean Water Act established the Section 319 Nonpoint Source Management Program. Under this program, 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.

U.S. Department of Agriculture, Farm Services Agency
The USDA Farm Services Agency (FSA) administers the programs of the Federal Farm Bill that provide grants to rural landowners in partial support of carrying out approved land and water conservation practices. Grants from this program could be used for implementation of some watershed restoration plan recommendations.

U.S. Department of Agriculture, Natural Resources Conservation Service
This agency administers resource conservation and development projects and watershed projects under Federal Public Law 566 and provides technical and financial assistance to landowners through the county land conservation committees. Such assistance may include the planning and construction of measures for land treatment, agricultural water management, and flood prevention and for public fish, wildlife, and recreational development. This agency also conducts detailed soil surveys and provides interpretations as a guide to utilizing soil survey data in local planning and development. Certain programs administered by this agency, including those providing partial funding for land conservation practices, can contribute to implementation of the land management and treatment measures recommended under this watershed restoration plan.

U.S. Department of the Interior, Geological Survey
The U.S. Geological Survey (USGS) conducts continuing programs on water resource appraisal and monitoring. The programs of the U.S. Geological Survey are essential to the implementation of the watershed restoration plan recommendations to maintain existing stream gaging and water quality monitoring capabilities and to add water quality and streamflow monitoring sites on tributary streams in the watershed.

U.S. Department of the Interior, Fish and Wildlife Service
The U.S. Fish and Wildlife Service has the mission of conserving, protecting, and enhancing fish, wildlife, and plants and their habitats. Thus, the Service would have a role in implementation of the instream and riparian habitat measures recommended under this watershed restoration plan.

U.S. Department of Transportation
The U.S. Department of Transportation, Federal Highway Administration, administers all Federal aid programs working through the Wisconsin Department of Transportation. Thus, this agency has nonpoint source pollution abatement responsibilities with regard to setting standards for highway construction and maintenance.

U.S. Army Corps of Engineers
The Corps of Engineers also administers a regulatory program relating to the discharge of dredge and fill materials into the waters of the United States and adjacent wetlands. This program is administered pursuant to Section 404 of the Federal Water Pollution Control Act as amended in 1972.

Private Organizations
There are several private and nonprofit organizations that are engaged in activities in the Root River watershed that are related to one or more of this plan’s focus areas. Each of these groups addresses a unique set of issues, ranging from groups that have an emphasis on a specific issue, such as invasive species or acquisition and management of natural areas, to groups that broadly focus on the conditions within one or more watersheds. These groups can play an important role in implementing recommendations of this watershed restoration plan. Some of the organizations that have been active in management activities in the Root River watershed are described in the following paragraphs.

Organizations such as the Root-Pike Watershed Initiative Network (Root-Pike WIN) and the Southeastern Wisconsin Watersheds Trust (Sweet Water) have a broad focus on protecting, restoring, and sustaining the ecosystems of several adjacent watersheds. These groups can have direct roles in plan implementation through considering the interrelationship between plan recommendations and their programs to improve water quality of streams and lakes in the study area. In addition, this watershed restoration plan specifically assigns the task of monitoring the implementation of plan recommendations to Root-Pike WIN and Sweet Water (see Chapter VI of this report).

Land trusts and conservancies, such as the Caledonia Conservancy, Kenosha/Racine Land Trust, and the Milwaukee Area Land Conservancy, purchase, or obtain conservation easements for, environmentally valuable lands through member contributions, land or easement donations, and grants obtained from other sources. These organizations can play a significant part in plan implementation through coordination of their land acquisition and easement programs with the recommendations of the plan.

Several groups have been active in controlling litter and debris along urban streams in the watershed. These organizations include the Badger Trails hiking organization, S.C. Johnson Corporation, the Racine Marriott, the Sierra Club, Racine Lutheran High School Environmental Club, the YWCA of Racine Kids Nature Kamp, and the West Allis Central High School Conservation Club. In addition, the City of Racine Department of Parks, Recreation and Cultural Services, in conjunction with Leadership Racine, conducts Adopt-A-River and Adopt-A-Beach programs through which participating community organizations, associations, and agencies assume responsibility for litter control in riparian and beach areas of City of Racine parks. There is potential for park friends groups associated with county and municipal parks located in the watershed to conduct similar activities. Through these activities, these groups can help to implement some of this plan’s habitat-related recommendations.

Several organizations also conduct activities to remove invasive plant species from riparian and upland areas in the Root River watershed. The Southeastern Wisconsin Invasive Species Consortium provides technical support for invasive species management. Other groups that have conducted invasive species management activities in the watershed include the Adopt-A-Park program, friends groups associated with county and municipal parks, Weed Out! Racine, the Hoy Audubon Society, the Sierra Club Southeast Gateway Group, the Kenosha/Racine Land Trust, the Greendale Environmental Group, and groups from the University of Wisconsin-Parkside. Through the continuation of activities to manage invasive species, these groups can help to implement some of this plan’s habitat-related recommendations.

Through its lake management planning activities, aquatic plant management activities, and other management activities, the Kelly Lakes Association will have a role in implementing recommendations of this plan as they relate to Lower and Upper Kelly Lakes.

Nature centers such as River Bend Nature Center, Wehr Nature Center, and the Root River Environmental Community Center, can support plan implementation through their educational programs. In addition, citizen-based monitoring programs, such as the WAV Program, generally require local coordinators and sponsors in order to operate in an area. This need creates a potential for these centers, or other groups, to support implementation of this watershed restoration plan through involvement in water quality monitoring.

PUBLIC PARTICIPATION

Public and stakeholder involvement in the development and implementation of the Root River Watershed Restoration Plan is essential to the success of the plan. In order to ensure that the plan addresses all necessary issues, conditions, and recommended improvements, public participation was encouraged from the inception of the planning process in June 2010 and throughout the development of the plan. In addition, the Root River Watershed Restoration Plan (RRWRP) Advisory Group has created an Information & Education Plan to enhance implementation of the watershed plan.

Goals of public participation during the planning process were to obtain input from public stakeholders and to generate awareness of the plan and its focus on water quality, habitat, recreational use and access, flooding in Racine County, and the status of the Horlick dam. Public participation included a two-part survey of interested parties in December 2010 that served to identify and prioritize issues for development of the plan (see Chapter I, "Survey of Interested Parties").

Planning meetings and stakeholders meetings were another primary component of public participation during the planning process. Six public planning meetings were held between June 2010 and January 2012. In March 2012, the planning group was formally established with 21 members and was named the Root River Watershed Restoration Plan Advisory Group. This Group met 10 times between November 2012 and May 2014 to review chapters of the draft plan report. At the same time, meetings specifically designed to report on the plan to the public and obtain public input became known as Public Stakeholders Meetings.

All meetings were announced to the public. News releases were issued for 2011-2012 planning meetings and 2013-2014 Public Stakeholders meetings. Stakeholders meeting announcements were sent by electronic mail to more than 850 recipients.

Eleven Public Stakeholders meetings were held between March 2012 and July 2014. The primary purpose of the meetings was to report on the plan. Eight of these meetings also included:

- A Southeastern Wisconsin Regional Planning Commission (SEWRPC) staff presentation on agricultural and parkland restoration in the Root River watershed;
- A Root-Pike Watershed Initiative Network (WIN) presentation on river corridor redevelopment;
- A City of Racine Health Department and Milwaukee Metropolitan Sewerage District (MMSD) presentation on water quality monitoring;
- A Milwaukee County Department of Engineering presentation on a porous pavement parking lot, including a tour of the project;
- A Wisconsin Department of Natural Resources (WDNR) presentation on Root River Teleost and Aquatic Macroinvertebrate Survey Results;
- A SEWRPC staff presentation on the Horlick dam, including a trip to the dam;
- A Milwaukee Riverkeeper and 16th Street Community Health Center report on lessons learned from implementing the Kinnickinnic and Menomonee River watershed plans; and
- Five public participation stations at which attendees provided recommendations for specific projects related to the four focus issues.

A total of 412 people attended the Public Stakeholders meetings between March 2012 and February 2014. The meetings were held in eight different locations within the Root River watershed.

In addition to the six June 2010 through January 2012 planning meetings, 10 Advisory Group meetings were held from May 2012 through May 2014.

The Root River plan was also featured in presentations at the Eighth Annual Clean Rivers, Clean Lake Conference in Milwaukee in April 2012 and the 10th Annual Clean Rivers, Clean Lake Conference in Milwaukee in May 2014.

In order to provide the public with access to materials related to development of the watershed restoration plan, SEWRPC hosted a Root River Watershed Restoration Plan page on its website. Several different types of materials were available in downloadable form on this webpage. As draft chapters of the plan report were completed, links to the text were placed on the page. In addition, copies of presentations made at meetings of the Public Stakeholders group and summary notes from meetings of the Plan Advisory Group could be accessed through this webpage. The webpage also contained a comments screen through which members of the public could ask questions and submit comments on the draft plan. Links leading to this page were placed on the SEWRPC homepage, as well as the Root-Pike WIN and Sweet Water websites. Some materials related to plan development were also available on the Root-Pike WIN website.

INFORMATION AND EDUCATION

The Root River Watershed Restoration Plan includes an Information and Education (I&E) Plan to enhance understanding of the watershed plan's recommendations and the measures to achieve its goals and objectives. The I&E Plan is designed to encourage the public's early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented. The education and outreach activities and actions in the I&E Plan will be used to implement the watershed plan; support the adoption and long-term operation and maintenance of management practices represented in the plan; and support stakeholder involvement in the plan.

The primary goals of the I&E Plan are to:

1. Assist local units of government, State and Federal agencies, businesses, nongovernmental organizations, and private landowners in identifying and implementing specific actions that will restore and benefit the natural assets of the Root River watershed;

2. Provide educational resources for the management of water resources within the Root River watershed;

3. Provide educational resources for the management of land surfaces that drain directly and indirectly to the Root River; and

4. Track, measure, and report on implementation of the I&E Plan.

Copies of the watershed plan are being provided to public officials in the civil divisions within the watershed, as shown on Map 2 in Chapter I of this report. Individual meetings and presentations about the plan will be scheduled with public decision-making bodies at the request of Counties and municipalities, and adoption of the plan will be requested from each civil division in the watershed.

Additional targeted audiences include private landowners and agricultural producers/operators; commercial stakeholders including businesses, developers, engineers, and landscapers; professionals involved in nutrient and chemical management; nature centers, service clubs, and potential grant recipients; the general public; and the media.

Governing bodies are encouraged to:

- Adopt the Root River Watershed Restoration Plan;

- Recognize plan recommendations to reduce point source pollution, monitor water quality, and address flooding from the overflow of streams and stormwater flooding in geographically relevant comprehensive plans, codes, and ordinances;

- Revise municipal codes and ordinances to accommodate and promote green infrastructure;

- Encourage and support business and agricultural communities and other stakeholder efforts to implement recommended point source and nonpoint source pollution abatement actions in the watershed plan;

- Increase awareness of the issues related to water quality, habitat, recreational use and access, and flooding in the watershed among residents, landowners, businesses, commercial stakeholders, and other targeted audiences.

Table 100 serves as an I&E Plan summary of recommended actions. Supplemental information in this report related to information and education includes the following:

- Descriptions of 2001-2012 I&E-related watershed projects funded by the Root-Pike WIN grant program and grant recipients are provided in Table 8 in Chapter III of this report in the "Education Programs" subsection of Chapter III of this report.

- Potential topics for I&E activities, as identified in the 2010 survey of interested parties, are listed in Table 1 in Chapter I of this report.

- Targeted audiences for I&E can be further identified in Table 79 in Chapter VI of this report under the "Municipality" and "Owner" columns.

- Marinas and yacht clubs are identified in Table 56 in Chapter IV of this report.

IMPLEMENTATION SCHEDULE

An implementation schedule is an important plan element which 1) provides coordination of implementation by indicating when particular management measures should be implemented relative to other management measures, and 2) organizes the implementation of projects by allowing a reasonable amount of time for the development of the leadership, partnerships, capacity, and funding sources required for project implementation.

Table 101 presents a schedule for the implementation of general recommendations of the Root River watershed restoration plan.

Several comments should be made on the timeline set forth in Table 101. First, some of the dates set forth for completion of implementation of particular plan elements reflect regulatory requirements that impact upon those elements. For example, the dates given for implementation of the changes to municipal separate storm sewer system (MS4) illicit discharge detection and elimination (IDDE) procedures recommended in Chapter VI are the anticipated dates of reissuance of the communities' MS4 discharge permits under the Wisconsin Pollutant Discharge Elimination System program. This reflects the fact that the recommended changes in IDDE procedures will require changes in these permits. Similarly, the date given to complete the recommended removal of Horlick dam reflects the deadline set forth in the WDNR's letter indicating that the spillway capacity of the dam must be modified to pass the 100-year flood without overtopping. Second, some of the dates set forth for the completion of other plan elements reflect implementation schedules given in other plans that recommended these elements. Examples of these include 1) the schedule for implementation of green infrastructure practices in the portion of the watershed that is in the MMSD service area, which is based on the MMSD green infrastructure plan schedule, and 2) the schedule for implementation of several rural nonpoint source measures which reflect the schedule set forth in the RWQMPU.

With respect to the specific projects recommended in Table 79 in Chapter VI of this report, each project is given a priority rating of "high," "medium," or "low." The Root River watershed restoration plan envisions that the majority of the high-priority projects will be completed within the five-year implementation period for this plan ending in 2014, with the balance of the high-priority projects being completed by the end of year 2024. It is

Table 101

IMPLEMENTATION SCHEDULE FOR GENERAL RECOMMENDATIONS OF THE ROOT RIVER WATERSHED RESTORATION PLAN

Recommendation	Level of Implementation	Date to Complete Implementation	Comments
Water Quality			
Point Source Measures			
General Recommendations	- -	Ongoing	
Abandonment of Yorkville WWTP	- -	At end of useful life[a]	
Urban Nonpoint Source Measures			
General Recommendations	- -	Ongoing	Note that there are also specific recommended projects
MS4 IDDE Program Modifications[b]			Because implementation of this recommendation will require changes to the communities' MS4 discharge permits, it is anticipated that implementation will occur as part the regular reissuance of the permits
Root River Group[c]	Full	September 2018	
City of Oak Creek	Full	June 2018	
Communities Covered Under the State MS4 General Permit[d]	Full	2019	
Green Infrastructure Installation			
MMSD Service Area	7 percent	2019	Implementation schedule for MMSD green infrastructure plan given in Table 82 in Chapter VI of this report
	42 percent	2025	
	100 percent	2035	
Outside of MMSD Service Area	35-50 rain gardens	2019	
	70-100 rain gardens	2024	
	175-250 rain gardens	2039	
Reducing Impacts of Nuisance Wildlife	- -	As needed	Address as water quality problems are documented
Reducing Impacts of Pet Waste	- -	As needed	Address as water quality problems are documented
Rural Nonpoint Source Measures			Note that there are also specific recommended projects
Install Practices to Reduce Soil Loss from Crop Land to Attain Erosion Rates Less than "T"	Full	2020	
Provision of Manure Storage	Full	2020	
Nutrient Management Plans	Full	2020	
Provision of Barnyard Runoff Control	Full	2020	
Live Stock Exclusion	Full	2020	
Conversion of Marginal Cropland to Wetland and Prairie	Full	After 2039	
Milking Center Waste Treatment	- -	Ongoing	
Private Onsite Wastewater Treatment System Programs			
Completion of Inventories	Full	October 2017	Schedule is based upon the deadlines set forth in Section SPS 383.255 of the *Wisconsin Administrative Code*
Other Program Elements	Full	October 2019	
Agricultural Pilot Projects	1 project	2019	
	3 projects	2024	
Water Quality Monitoring			
Continuation of Existing Monitoring Network	- -	Ongoing	
Expansion of Monitoring Network	Full	2019	
Mussel Survey	- -	2022	It is recommended that mussel surveys be conducted at 10-year intervals. The previous survey was conducted in 2012
Collation and Analysis of Monitoring Data	- -	2024	It is recommended that this be done at 10-year intervals

Table 101 (continued)

Recommendation	Level of Implementation	Date to Complete Implementation	Comments
Recreational Use and Access			
Trails			Note that there are also specific recommended projects
Additions to Oak Leaf Trail	Full	2035	
Development of Root River Corridor	Full	After 2035	
Surface Water Access			
Recommended Canoe/Kayak Landing	1 access site	2024-2039	
Addition of Parking at Upper Kelly Lake Access Site	Full	2024	
Debris Jam Removal Feasibility Study	Full	2024	
Root River Water Trail	Full	2039	
Stocking/Management of Urban Fishing Waters	- -	Ongoing	
Nature Center Operations	- -	Ongoing	
Habitat			
Invasive Species Management	- -	Ongoing	Note that there are also specific recommended projects
Riparian Buffer Installation and Management	- -	Ongoing as Development Occurs	Note that there are also specific recommended projects
Groundwater Recharge Protection	- -	Ongoing as Development Occurs	
Maintenance of Surface Water Hydrology	- -	Ongoing as Development Occurs	
Preserving and Expanding Wildlife Populations	- -	Ongoing	
Instream Habitat			
Fish Passage Assessments	Tier 1 sites	2019	
	Tier 2 sites	2024	
	Tier 3 sites	2039	
Large Woody Debris			
Assessments	Full	2019	
Management	- -	2024	
Culvert and Bridge Examination	- -	Ongoing	
Diseased Tree Thinning	- -	Ongoing	
Streambank and Streambed Erosion			Note that there are also specific recommended projects
Streambank Stability Surveys	Full	2024	
Horlick Dam			
Dam Removal	Full	April 22, 2024	
Flooding (Racine County)			
General Recommendations	- -	Ongoing	
Information and Education Plan	- -	Ongoing	Schedule given in Table 100
Specific Project Recommendations			
High-Priority Projects	Full	2019-2024	
Medium-Priority Projects	Full	2024-2039	
Low-Priority Projects	Full	After 2039	

Footnotes to Table 101

[a]*Based on population and sewage flow information available at the time, the RWQMPU concluded that this would be likely to happen sometime after year 2020.*

[b]*This recommendation has been implemented for the MS4 communities in the watershed that are permitted under the Menomonee River Watershed-Based Permit. These communities include the Cities of Greenfield, Milwaukee, and West Allis.*

[c]*The Root River Group includes the Cities of Franklin, New Berlin, and Racine and the Villages of Caledonia, Greendale, Hales Corners, and Mt. Pleasant.*

[d]*Communities covered under the State's MS4 general permit include the City of Muskego, the Village of Sturtevant, and the Town of Norway.*

Source: SEWRPC.

envisioned that medium-priority projects will be completed over the period 2024-2039 and that low-priority projects will be completed after 2039.

In addition to the schedules given in Tables 79 (in Chapter VI of this report) and 101, a schedule for implementation of education actions recommended as part of the information and education element of this watershed restoration plan was previously presented in Table 100.

The purpose of this implementation schedule is to provide guidance for the implementation of the Root River watershed restoration plan. As the plan is implemented, it will be important to take a flexible approach to the application of this schedule. One reason for this is that implementation of many of the recommendations provided in this plan require opportunities which may or may not present themselves within the time frames envisioned in the schedule. For example, recommendations that require the acquisition of land or easements for implementation require the opportunity to purchase lands from landowners who are willing to sell. Similarly, the ability to install best management practices on private land is dependent upon the cooperation and participation of landowners. There may also be opportunities to achieve cost savings in implementing recommended projects in concert with, or as part of other, unrelated projects. Finally, it is important to note that the availability of funding is constantly changing. Opportunities to fund particular types of projects may be short-lived. Since these opportunities may not always be available, it is important to capitalize on them whenever possible. Because of this, it will be important to take a flexible rather than a rigid approach to the application of the implementation schedule.

FINANCIAL AND TECHNICAL ASSISTANCE FOR PLAN IMPLEMENTATION[11]

It is important for the units of government, agencies, and private organizations working within the Root River watershed to effectively utilize all available sources of financial and technical assistance for the timely implementation of the recommended plan. In addition to utilizing current tax revenue sources, such as property

[11]*The financial assistance programs described in this section and the accompanying appendices were active as of the date of publication of this report. Such programs are subject to modification or elimination based on budget considerations, and additional programs may be enacted over time to address emerging issues. As this plan is implemented, information on grant program changes should be collated as necessary. The Catalog of Federal Domestic Assistance Programs can be accessed at* http://www.cfda.gov. *Additional information on grants can be accessed through the University of Wisconsin-Madison Libraries Grants Information collection at:* http://grants.library.wisc.edu.

taxes, fees, and State-shared taxes, the local units of government in the watershed can also make use of revenue sources, such as borrowing, special taxes and assessments, special assessments, areawide assessments, contributions in aid of construction, impact fees, establishment of stormwater utilities, State and Federal grants, grants from foundations, and gifts. In addition to their regular resources, private organizations working in the watershed can also make use of State and Federal grants, grants from foundations, and gifts.

Various types of technical and financial assistance useful in plan implementation are also available from county, State, and Federal agencies. Examples of the type of assistance available includes possible State and Federal cost-share funding for nonpoint source pollution control and habitat projects; technical advice on land and water management practices provided by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) staff and county land conservation staffs; and educational, advisory, and review services offered by the University of Wisconsin-Extension Service and the Regional Planning Commission.

Borrowing

Local units of government are normally authorized to borrow so as to effectuate their powers and discharge their duties. Chapter 67 of the *Wisconsin Statutes* generally empowers counties, cities, villages, and towns to borrow money and to issue municipal obligations not to exceed 5 percent of the equalized assessed valuation of their taxable property, with certain exceptions, including school bonds and revenue bonds. The general obligation bonds issued are secured by the full faith and credit of the municipality due to its ability to levy property taxes to support the principal and interest payments of the bonds. Such borrowing powers which are directly related to the implementation of this watershed restoration plan include the ability of counties, cities, and villages to issue bonds and borrow for park and open space acquisition and development.

Special Taxes and Assessments

Municipalities have special assessment powers for constructing public works or improvements under Section 66.0701 of the *Wisconsin Statutes.* In addition, counties and cities have special assessment powers for park and parkway acquisition and improvements under Sections 27.065 and 27.10(4), respectively, of the *Wisconsin Statutes.* Counties are empowered under Section 27.06 of the *Wisconsin Statutes* to levy a mill tax to be collected and placed into a separate fund and to be paid out only upon order of the county park commission for the purchase of land and other expenses. Farm drainage boards, town sanitary districts, metropolitan sewerage districts, cities, and villages also have taxing and special assessment powers under Sections 33.32(5), 200.13(1), 66.0827(2), and 62.18(16) of the *Wisconsin Statutes.*

Grant and Loan Programs

The identification of potential funding sources, including sources other than solely local-level sources, is an integral part of the implementation of a successful plan. The following description of funding sources includes those that appear to be applicable as of the year 2014. Funding programs and opportunities are constantly changing. Accordingly, the involved local staffs need to continue to track the availability and status of potential funding sources and programs. It is intended that this list facilitate the implementation of the activities set forth in the recommended plan. Some of the programs described herein may not be available under all envisioned conditions for a variety of reasons, including local eligibility requirements or lack of funds in Federal and/or State budgets at a given time. Nonetheless, the list of sources and programs should provide a starting point for identifying possible funding opportunities for implementing the watershed restoration plan recommendations.

Numerous grant and loan programs are offered through both public and private sources for many aspects of plan implementation. Table 102 summarizes many of the major grant and assistance programs available to municipalities under the areas of wildlife and fish habitat preservation, water quality protection, land acquisition for park and open spaces, flood mitigation, and other areas such as education and sustainable development that have the potential to indirectly affect the quantity and quality of the water resources of the Region. Table 103 also lists contact information for details about the grant programs. In recognition of the multi-objective nature of many

Table 102

POTENTIAL FUNDING PROGRAMS TO IMPLEMENT RECOMMENDATIONS OF THE ROOT RIVER WATERSHED RESTORATION PLAN[a,b]

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
1	Captain Planet Foundation	Captain Planet Foundation Small Grant Program	U.S.-based schools and nonprofit organizations with an annual operating budget of less than $3 million	1. Projects that provide hands-on environmental opportunities for youth, 2. Projects that serve as a catalyst to getting environmental-based education in schools 3. Projects that have real environmental outcomes 4. Projects that inspire youth and communities to participate in environmental stewardship activities	Grants ranging between $500 and $2,500. Priority given to requests that have secured at least 50 percent matching or in-kind funding for their projects	January 31 September 31
2	Charles Stewart Mott Foundation	Charles Stewart Mott Foundation	Nonprofit organizations	1. Strengthening the environmental community 2. Public policies that advance conservation of freshwater ecosystems 3. Site-based conservation of freshwater ecosystems	Grants ranging between $15,000 and $250,000	Continuous
3	Corporation for National and Community Service	AmeriCorps	Nonprofit organizations, educational institutions, local units of government, labor organizations	1. Improvements related to energy and water performance in economically disadvantaged communities 2. Sustained recycling and waste treatment activities 3. Improvement of at-risk public lands and waterways	Funds and member slots	Varies
4	Freshwater Future	Healing Our Waters	Nonprofit organizations with 501(c)(3) status	1. Development and implementation of GLRI proposals 2. Capacity building	Up to $15,000 to aid in development or implementation of GLRI proposals. Up to $5,000 for capacity building	None
5	Fund for Lake Michigan	Fund for Lake Michigan	Local communities and nonprofit organizations	Projects in southeastern Wisconsin that enhance the ecological health of nearshore and coastal areas and rivers and improve the quality of water flowing into the Lake	Grants, no maximum given	In 2014, January 24

Table 102 (continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
6	Graham-Martin Foundation	Graham-Martin Foundation	Schools, homeowners, homeowner associations, nonprofit organizations, lake and watershed associations, neighborhood associations, faith centers, State and local governments	Small-scale restoration and rain gardens	Funding to provide rain garden plants at a discount	Apply through the Foundation's website
7	Great Lakes Fishery Trust	Great Lakes Fishery Trust	Nonprofit organizations, educational institutions, and governmental agencies	1. Access to the Great Lakes Fishery 2. Ecosystem health and sustainable fish populations 3. Great Lakes stewardship	No cost or time limitations on grant requests	Announced by program on website
8	Great Lakes Protection Fund	Great Lakes Protection Fund	State and local units of government, nonprofit organizations, for-profit businesses, and individuals	1. Improve the health of the Great Lakes 2. Promote the interdependence of healthy ecological and economic systems 3. Support innovative, creative, and venturesome ideas	Finance the total cost of accepted projects	Continuous application process
9	James E. Dutton Foundation	James E. Dutton Foundation	Conservation organizations	1. Wetland restorations 2. Stream restorations 3. Educational programs	Project grants	Continuous
10	Joyce Foundation	Joyce Foundation Grant Program	Nonprofit organizations	1. Projects that address the introduction and spread of aquatic invasive species in and around the Great Lakes Basin 2. Projects that address polluted, nonpoint source runoff from agricultural lands and cities 3. Use of green infrastructure to manage stormwater 4. Support of Great Lakes restoration and protection policies	Finance the total cost of accepted projects	Continuous acceptance of letters of inquiry Grant proposals are considered at meetings of the Foundation's Board of Directors in April, July, and December
11	Milwaukee Metropolitan Sewerage District	Green Infrastructure Partnership Program	Government agencies, nongovernmental organizations, private property owners	Installation of green infrastructure practices	Reimbursement for eligible costs to a maximum of 50 percent of project costs	March 31
12	Milwaukee Metropolitan Sewerage District	Green Streets Partnership Program	Owners of roadways	1. Addition of green infrastructure to roadway projects 2. Retrofitting streets with green infrastructure	Up to $125,000 per award Requires a match of staff time. While a funding match is not required, it will increase project scoring	October 1

Table 102 (continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
13	Milwaukee Metropolitan Sewerage District	MMSD Rain Gardens Project	Homeowners, nonprofit groups, business owners	Rain gardens	Provides rain garden plants at reduces prices	March 17
14	National Fish and Wildlife Foundation	Acres for America	State, local, and tribal governments, nonprofit organizations	1. Providing access to the outdoors 2. Conserving critical habitat 3. Connecting existed protected lands 4. Ensuring the future of rural economies	$2.5 million available annually Requires at least one-to-one match	Pre-proposals June 3 Full proposals August 1
15	National Fish and Wildlife Foundation	Bring Back the Natives/More Fish	Federal, state, local, and tribal governments and agencies, nonprofit organizations, universities and schools	Conservation projects that restore, protect, and enhance sensitive, endangered, or threatened populations of native fish	Grants of $25,000 to $100,000 Requires 2 to 1 nonfederal match	Request for proposals typically released in the spring
16	National Fish and Wildlife Foundation	Environmental Solutions for Communities	State, local, and tribal governments, nonprofit organizations, educational institutions	1. Stewardship on agricultural lands 2. Community-based conservation projects 3. Green infrastructure	Grants of $25,000 to $100,000. Match of 100 percent or greater is more competitive.	Mid-December
17	National Fish and Wildlife Foundation	Five Star and Urban Waters Restoration Grant Program	Any entity eligible to receive grants. Requires at least five partnering organizations	Eligible projects depend on funding source	Grants of $20,000 to $50,000. Requires match of 100 percent or more	Early February
18	National Fish and Wildlife Foundation	Sustain Our Great Lakes	State, local, and tribal governments, nonprofit organizations, educational institutions	1. Improve the health of the Great Lakes 2. Promote the interdependence of healthy ecological and economic systems	Provides grants of $25,000 to $1,500,000. Match of 100 percent or greater is more competitive	Mid-February
19	PeopleForBikes	PeopleForBikes Community Grant Program	Local governments, State and Federal agencies, nonprofit organizations	1. Bike paths, lanes, and bridges, 2. Bike parks 3. Bike racks, parking, and storage	Provides grants of up to $10,000 for a project. Grant must represent less than 50 percent of project budget	January August
20	Root-Pike Watershed Initiative Network	Root-Pike WIN Watershed-Based Grant Program	Nonprofit organizations, units of government and other government agencies	1. Projects to reduce and prevent water, air, and soil pollution 2. Education about watershed issues 3. Protection and restoration of natural areas 4. Projects that improve public access to public waterways	Provides grants of $500-$10,000. Root-Pike WIN prefers not to be sole funder of a project	October 1

Table 102 (continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
21	Southeastern Wisconsin Invasive Species Coalition	SEWISC Assistance Program	Eligible recipients depend upon funding source and may include individuals, nonprofit organizations, community and civic groups, private businesses, and units of government	Projects to lessen the impacts of invasive species in southeastern Wisconsin	Provides up to $2,000. Match of at least 25 percent is required	As announced on SEWISC website. Deadline for 2014 is February 28.
22	Southeastern Wisconsin Watersheds Trust	Sweet Water Mini-Grant Program	Nonprofit organizations, civic groups, community groups	Projects that improve water quality, restore habitat, promote conservation and advance public education concerning water issues	Provides grants of $1,000-$5,000	November 15
23	Surdna Foundation	Surdna Foundation	Nonprofit organizations with 501(c)(3) status	Innovative stormwater management projects, green infrastructure	Recent grants have ranged between $50,000 and $1,000,000	Continuous
24	U.S. Army Corps of Engineers	Ecosystem Restoration Program	State and local units of government, nonprofit organizations	Projects to restore aquatic ecosystems for fish and wildlife	65 percent Federal cost-share of construction costs and cannot exceed $5,000,000	None
25	U.S. Army Corps of Engineers	Emergency Streambank and Shore Protection Program	Local communities	Bank protection of highways, bridges, essential public works, churches, hospitals, schools, and other public services from flood-induced erosion	Federal share cannot exceed $1,500,000 for a given project. Cost-share program with local match of 35 percent for design and construction required	None
26	U.S. Army Corps of Engineers	Great Lakes Fishery and Ecosystem Restoration Program	State and local units of government, public agencies, private interests, nonprofit organizations	Projects to restore degraded ecosystem structure, function, and process to a more natural condition	Federal cost-share of 65 percent of planning, design, and construction costs up to $10,000,000	None
27	U.S. Army Corps of Engineers	Small Flood Damage Reduction Program	State and local units of government	1. Projects designed to reduce the impact of flood events 2. Projects must be designed and constructed by the Corps	50 to 65 percent Federal cost-share assistance above $100,000 and cannot exceed $7,000,000: 35 to 50 percent local match is required	None
28	U.S. Army Corps of Engineers	Snagging and Clearing for Flood Control Program	State and Local units of government	1. Removal of obstructions that restrict flood flows in navigable waters 2. Projects must be designed and constructed by the Corps	Project studies are in most cases at Federal expense. 65 percent Federal cost-share is provided for project implementation and cannot exceed $500,000	None
29	U.S. Department of Agriculture Farm Services Agency	Conservation Reserve Program	Individual landowners in a 10- or 15-year contract	1. Grass waterways 2. Riparian buffers 3. Shallow water areas for wildlife 4. Wetland restoration 5. Windbreaks	50 percent Federal cost-share assistance. 50 percent local match from individual; an annual rental payment for the length of the contract is also provided	Annually or ongoing[c]

Table 102 (continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
30	U.S. Department of Agriculture Farm Services Agency	Emergency Conservation Program	Individual landowners	Repair damage to farmland caused by natural disasters	Up to 75 percent cost share to implement emergency conservation practices	Announced by FSA
31	U.S. Department of Agriculture, Farm Services Agency	Emergency Forest Restoration Program	Private landowners with nonindustrial forests	Repair damage to forests caused by natural disasters	Up to 75 percent cost-share to implement emergency conservation practices	Announced by FSA
32	U.S. Department of Agriculture Farm Services Agency	Grasslands Reserve Program	Private landowners and operators to protect grazing uses with permanent easements or rental contracts of 10-, 15-, or 20-year duration	Participants voluntarily limit future development and cropping of the land while retaining the right to conduct common grazing practices and production of forage and seed	For permanent easements, compensation up to the fair market value of the land minus grazing value For rental contracts, up to 75 percent of grazing value of land	Continuous
33	U.S. Department of Agriculture Natural Resources Conservation Service	Conservation Stewardship Program	Individual landowners in a five-year contract	1. Filter strips 2. Riparian buffers 3. Wildlife corridors 4. Stream habitat improvement	Payments for maintaining and/or enhancing natural resources not to exceed $40,000 per year or $200,000 over a five year period	Annually
34	U.S. Department of Agriculture Natural Resources Conservation Service	Emergency Watershed Protection Program	Individual landowners	1. Debris removal 2. Streambank stabilization 3. Levee, dike, and dam repair 4. Erosion control 5. Floodplain easements	Up to 75 percent Federal cost-share assistance. 25 percent local match is required	Continuous
35	U.S. Department of Agriculture Natural Resources Conservation Service	Environmental Quality Incentives Program	Individual landowners in a contract ranging from one to 10 years	1. Animal waste management practices 2. Soil erosion and sediment control practices 3. Nutrient management 4. Groundwater protections 5. Habitat improvement	Up to 75 percent Federal cost-share assistance. 25 percent local match is required	Annually
36	U.S. Department of Agriculture Natural Resources Conservation Service	Wildlife Habitat Incentive Program	Individual landowners in a contract ranging from one to 10 years	1. Instream fish habitat structures 2. Invasive species control 3. Prairie restoration 4. Habitat restoration	Up to 75 percent Federal cost-share assistance. 25 percent local match is required	Continuous

Table 102 (continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
37	U.S. Department of Agriculture Natural Resources Conservation Service	Wetlands Reserve Program	Individual landowners in 10-year contracts or 30-year or permanent easements	1. Easements 2. Wetland restoration	For permanent easements, 100 percent Federal cost share of restoration costs plus easement payment For 30-year easements 75 percent Federal cost share of restoration costs plus 75 percent of easement payment for permanent easement	Continuous
38	U.S. Environmental Protection Agency	Environmental Justice Small Grant Program	Incorporated nonprofit organizations and Federally recognized Indian tribes	1. Increase awareness of stormwater 2. Lessen impacts from stormwater 3. Watershed education	Federal grants of $20,000 to $50,000	January
39	U.S. Environmental Protection Agency	Targeted Watershed Grant Program	Watershed organizations nominated by State Governors or Tribal leaders	1. Watershed projects to protect water resources 2. Training and technical assistance to local partnerships	Maximum 75 percent Federal cost-share assistance. Minimum 25 percent nonfederal match	November
40	U.S. Environmental Protection Agency	Urban Waters Small Grants	States, local governments, universities and colleges, nonprofit institutions	Research, investigations, training, studies and demonstrations that will advance the restoration of urban waters.	Federal grant of $40,000 to $60,000. Minimum local match of $2,500	January
41	U.S. Federal Emergency Management Agency	Flood Mitigation Assistance Program	State agencies and participating National Flood Insurance Program communities	1. Elevation, relocation, or demolition of insured structures 2. Acquisition 3. Dry floodproofing 4. Minor structural projects 5. Flood mitigation planning	75 percent Federal cost-share assistance. 25 percent local match required	Announced on FEMA website
42	U.S. Federal Emergency Management Agency	Hazard Mitigation Grant Program	State agencies and participating National Flood Insurance Program communities	1. Floodproofing 2. Relocation 3. Elevation of structures 4. Property acquisition	75 percent Federal cost-share assistance. 12.5 percent State match and 12.5 percent local match required	Within 60 days of a Presidential disaster declaration
43	U.S. Federal Emergency Management Agency	Hazard Mitigation Grant Program	State agencies and participating National Flood Insurance Program communities	1. Acquisition and relocation of structures in flood hazard areas 2. Floodproofing 3. Minor structural projects 4. Flood control projects for critical facilities	75 percent Federal cost-share assistance. 25 percent local match required	Announced on FEMA website Applicants must have a FEMA-approved Mitigation plan in order to qualify for project grants

Table 102 (continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
44	U.S. Fish and Wildlife Service	Fish and Wildlife Management Assistance Program	Federal agencies, state agencies, local governments, other public institutions, and private nonprofit organizations	1. Habitat restoration 2. Monitoring and assessment 3. Removal of passage barriers 4. Aquatic plant establishment 5. Programs to manage aquatic invasive species	Federal grants of $1,000 to $750,000 with an average grant of $75,000 No local match required, but matches of at least 50 percent encouraged	Contact FWS regional office for deadline
45	U.S. Fish and Wildlife Service	Great Lakes Fish and Wildlife Restoration Act Grant Program	States, Tribal Governments, Native American Treaty Organizations. Local governments, universities, nongovernmental organizations, and conservation organizations can receive funding if sponsored by an eligible entity.	Restoration of fish and wildlife resources and their habitat in the Great Lakes basin	Federal cost-share assistance for up to 75 percent of project costs. Nonfederal match of at least 25 percent required	December 16
46	U.S. Fish and Wildlife Service	North American Wetlands Conservation Fund	Public and private organizations	1. Land acquisition 2. Wetland restoration	Standard grant program: $75,000 to $1,000,000 Federal cost-share assistance Small grant program: up to $75,000 Federal cost-share assistance Both require at least 50 percent local match	February 28, July 87 November 7
47	U.S. Fish and Wildlife Service	Partners for Fish and Wildlife Program	Private landowners for a contract of at least 10 years	Restoration of degraded wetlands, native grasslands, stream and riparian corridors, and other habitat areas	Full cost-share and technical assistance; individual projects cannot exceed $25,000	Continuous
48	U.S. Forest Service	Community Forest and Open Space Preservation Program	Local units of government, tribes, qualified nonprofit agencies	Acquisition of land for community forests	50 percent Federal cost-share assistance up to $400,000. 50 percent local match required	January 15
49	Wisconsin Board of Commissioners of Public Lands	State Trust Fund Loan Program	Counties, cities, villages, towns, metropolitan sewerage districts, sanitary districts, lake districts, drainage districts	Any public purpose	Loans at competitive rates	Continuous
50	Wisconsin Citizen-Based Monitoring Network	Wisconsin Citizen-Based Monitoring Partnership Program	Local units of government, lake districts and associations, school districts, river management organizations, colleges, universities, tech schools, nonprofit conservation organizations	Citizen-based monitoring of natural populations and communities and environmental components such as soil, water, and air.	$75,000-100,000 available Statewide annually	Spring

Table 102 (continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
51	Wisconsin Coastal Management Program	Wisconsin Coastal Management Grant Program	Local units of government, State agencies, colleges and universities, school districts, regional planning commission serving coastal areas, tribal governments, nonprofit organizations	1. Coastal wetland protection and habitat protection 2. Nonpoint source pollution control 3. Coastal resource and community planning' 4. Great Lakes education 5. Public access and historic preservation projects	50 percent State match for projects with budgets of $60,000 or less with 50 percent local match required 40 percent State match for projects with budgets greater than $60,000 with 60 percent local match required	November
52	Wisconsin Department of Natural Resources	Aquatic Invasive Species Prevention and Control Grant Program	Local units of government, lake districts and associations, school districts, river management organizations, colleges, universities, tech schools, nonprofit conservation organizations	1. Education, prevention, and planning 2. Established population control 3. Early detection and response 4. Maintenance and containment 5. Research and Demonstration	Up to 75 percent State cost share Maximum award depends on type of project	February 1 August 1
53	Wisconsin Department of Natural Resources	County Conservation Aids	County and tribal governments	1. Aquatic habitat development 2. Aquatic vegetation management 3. Lake and stream rehabilitation and improvement	50 percent State cost-share of eligible costs	Contact WDNR regional grant specialist
54	Wisconsin Department of Natural Resources	Dam Removal Grant Program	Counties, cities, villages, towns, lake districts, and private dam owners	1. Dam removal planning 2. Dam removal 3. Restoration of impoundment	100 percent of eligible project costs up to $50,000	Continuous
55	Wisconsin Department of Natural Resources	Environmental Improvement Fund Loan Program	Cities, villages, towns, counties, sanitary districts lake districts, metropolitan sewerage districts, Federally-recognized Indian tribes	1. Construction and modification of WWTPs 2. Nonpoint source pollution abatement projects	Low interest loans	Notice of intent to apply due December 31
56	Wisconsin Department of Natural Resources	Knowles-Nelson Stewardship Program	Local units of government, qualified nonprofit conservation organizations	1. Land acquisition 2. Streambank protection 3. Fish and wildlife habitat	50 percent State cost-share assistance. 50 percent local match is required	May 1
57	Wisconsin Department of Natural Resources	Lake Management Planning Grants	Local units of government, lake districts and associations, school districts, river management organizations, colleges, universities, tech schools, nonprofit conservation organizations	1. Monitoring 2. Education 3. Organizational development 4. Studies 5. Plan development	75 percent State cost-share assistance. 25 percent local match is required Small scale grant maximum of $3,000. Large-scale grant maximum of $25,000	February 1 August 1

Table 102 (continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
58	Wisconsin Department of Natural Resources	Lake Protection Grants	Local units of government, lake districts and associations, school districts, river management organizations, colleges, universities, tech schools, nonprofit conservation organizations	1. Purchase of land or easements 2. Restoration of wetlands or shorelands 3. Development of local regulations or ordinances 4. Lake management plan implementation	75 percent State cost-share assistance. 25 percent local match is required. Maximum award of $200,000	May 1
59	Wisconsin Department of Natural Resources	Land and Water Conservation Fund Grant Program	State agencies and local units of government	1. Planning for acquisition of parks 2. Land acquisition for parks and open space 3. Supporting facilities that enhance recreational opportunities	50 percent cost-share assistance	May 1
60	Wisconsin Department of Natural Resources	Landowner Incentive Program	Any land that is not publicly owned	Projects to create and manage habitat for rare and declining species	Technical assistance 75 percent State cost-share, when funds are available	Continuous
61	Wisconsin Department of Natural Resources	Municipal Dam Grant Program	Counties, cities, villages, towns, lake districts	1. Dam maintenance, repair, and modification 2. Dam abandonment and removal	Repair, reconstruction, and modification awards cover 50 percent of the first $400,000 and 25 percent of the next $800,000 of eligible project costs Dam abandonment and removal awards cover 100 percent of first $400,000 of eligible project costs	January 22
62	Wisconsin Department of Natural Resources	Municipal Flood Control Grant Program	Cities, villages, towns, tribes, metropolitan sewerage districts	1. Structure and land acquisition 2. Structure floodproofing 3. Riparian restoration 4. Flood storage 5. Stormwater storage/detention 6. Flood mapping	State grant covers up to 70 percent of eligible costs. Requires minimum 30 percent local cost share	March 17
63	Wisconsin Department of Natural Resources	Recreational Trails Aid Program	Municipal governments and incorporated organizations	1. Maintenance and restoration of existing trails 2. Development or rehabilitation of trailside and trailhead facilities 3. Construction of new trails 4. Land acquisition for trails	State grant convers up to 50 percent of eligible project costs. Requires 50 percent match. Match may include other State funding	May 1

Table 102 (continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
64	Wisconsin Department of Natural Resources	River Protection Grant Program	Counties, cities, villages, towns, lake districts and associations, river management organizations, and nonprofit organizations	1. Management plan development 2. Education projects 3. Land acquisition 4. Installation of nonpoint source pollution abatement projects 5. River restoration projects	State provides 75 percent cost-share up to $10,000 for planning projects or $50,000 for management projects. 25 percent local match required	December 10 for planning projects February 1 for management projects
65	Wisconsin Department of Natural Resources	Targeted Runoff Management Grant Program	Cities, villages, towns, counties, regional planning commissions, tribal governments, special purpose lake, sewerage, and sanitary districts	1. Construction of structural BMPs 2. Implementation of nonstructural cropping practices 3. Implementation of State agricultural performance standards	State covers up to 70 percent of eligible costs. Grants of $500,000 - $1,000,000 for large-scale projects and up to $150,000 for small-scale projects	April 15
66	Wisconsin Department of Natural Resources	Urban Forestry Grant Program	Counties, cities, villages, towns, and nonprofit organizations	1. Tree inventories 2. Urban forestry management plans 3. Tree ordinance development 4. Tree planting, pruning, maintenance, and removal	State covers 50 percent of eligible costs. Regular grants of $1,000 to $25,000. Startup grants of $1,000 to $4,000	October 1
67	Wisconsin Department of Natural Resources	Urban Nonpoint Source and Storm Water Management Grant Program	Local units of government	1. Planning 2. Education and Information Activities 3. Ordinance development and enforcement 4. Training 5. Structural stormwater BMPs 6. Streambank stabilization	70 percent State cost-share assistance for projects not involving construction, requiring a 30 percent local match. 50 percent State cost-share assistance for projects not involving construction, requiring a 50 percent local match	April 15
68	Wisconsin Department of Natural Resources	Weed Management Area Private Forest Grant Program	Eligible weed management groups	1. Information, education, and outreach 2. Inventories of invasive plant species 3. Control of invasive plant species 4. Invasive plant management planning	State reimburses 75 percent of eligible costs to a maximum of $15,000 to any weed management group. Requires a 25 percent match	April 1
69	Wisconsin Department of Safety and Professional Services	Wisconsin Fund–Private Onsite Wastewater Treatment System Replacement or Rehabilitation Financial Assistance Program	Owners of principal residences and small businesses who meet income limits	Replacement or rehabilitation of failing onsite wastewater treatment systems that were built before July 1, 1978	Maximum grant award of $7,000. Loans are also available	January 31

Table 102 (continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
70	Wisconsin Department of Transportation	Congestion Mitigation and Air Quality Improvement Program	Counties, local governments, transit operators, State agencies	Pedestrian and bicycle facilities	State reimburses up to 80 percent costs. Requires a minimum 20 percent match	January of odd-numbered years
71	Wisconsin Department of Transportation	Transportation Alternatives Program	State agencies, local governments with taxing authority, Indian tribes	1. Provision of facilities for pedestrians and bicycles 2. Mitigation of water pollution due to highway runoff 3. Conversion and use of abandoned railroad right of ways as trails	Federal match reimbursing up to 80 percent of project costs. Sponsor must provide at least 20 percent of funding	October of odd-numbered years
72	Wisconsin Environmental Education Board	Wisconsin Environmental Education Board Grant Program	State agencies, local units of government, schools, colleges, universities, nonprofit corporations	Development, dissemination, and implementation of environmental education programs	Project grants of up to $10,000. Requires minimum 25 percent match	February 15

[a]*The Catalog of Federal Domestic Assistance Programs can be accessed at:* https://www.cfda.gov/?s=main&mode=list&tab=list*. Additional information on grants can be accessed through the U.S. Environmental Protection Agency at:* http://water.epa.gov/grants_funding/ *and through the University of Wisconsin-Madison Libraries Grants Information Collection at* http://grants.library.wisc.edu*.*

[b]*Some of the programs described in this table may not be available under all envisioned conditions for a variety of reasons, including local eligibility requirements or lack of funds in Federal and/or State budgets at a given time.*

[c]*Two types of sign-up are available for the Conservation Reserve Program (CRP): continuous CRP, which has no time line and is used for small sensitive tracts of land and regular CRP, which has an annual application period and is used for large tracts of land.*

Source: SEWRPC.

Table 103

CONTACT INFORMATION FOR POTENTIAL FUNDING SOURCES[a,b]

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
Captain Planet Foundation	Captain Planet Foundation Small Grant Program	Captain Planet Foundation 133 Luckie Street, 2nd Floor Atlanta, GA 30303	(404) 522-4270	captainplanetfoundation.org
Charles Stewart Mott Foundation	Charles Stewart Mott Foundation	Charles Stewart Mott Foundation Mott Foundation Building 503 S. Saginaw Street, Suite 1200 Flint, MI 48502-1851	(800) 238-5651	www.mott.org
Corporation for National and Community Service	AmeriCorps	Wisconsin National and Community Service Board 1 West Wilson Street Room 456 Madison, WI 53703	(800) 620-8307	www.nationalservice.gov/programs/americorps
Freshwater Future	Healing Our Waters	Freshwater Future P.O. Box 2479 Petoskey, MI 49770	(231) 571-5001	www.freshwaterfuture.org
Fund for Lake Michigan	Fund for Lake Michigan	Fund for Lake Michigan Global Water Center 247 Freshwater Way, Suite 537 Milwaukee, WI 53204	(414) 418-5008	www.fundforlakemichigan.org
Graham-Martin Foundation	Graham-Martin Foundation	Graham-Martin Foundation 10101 N. Casey Road Evansville, WI 53536	(608) 226-2553	www.grahammartin.org
Great Lakes Fishery Trust	Great Lakes Fishery Trust	Great Lakes Fishery Trust 230 N. Washington Square, Suite 300 Lansing, MI 48933	(417) 371-7468	www.glft.org
Great Lakes Protection Fund	Great Lakes Protection Fund	Great Lakes Protection Fund 1560 Sherman Avenue, Suite 880 Evanston, IL 60201	(847) 425-8250	glpf.org
James E. Dutton Foundation	James E. Dutton Foundation	James E. Dutton Foundation, Inc. 6655 Rainbow Drive Merrill, WI 54452	(414) 640-0523	www.jameseduttonfoundation.org
Joyce Foundation	Joyce Foundation Grant Program	The Joyce Foundation 321 North Clark Street, Suite 1500 Chicago, IL 60654	(312) 782-2464	www.joycefdn.org

Table 103 (continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
Milwaukee Metropolitan Sewerage District	Green Infrastructure Partnership Program	Milwaukee Metropolitan Sewerage District 260 W. Seeboth Street Milwaukee, WI 53204-1446	(414) 225-2132	www.h20capture.com/learn/finding-programs/GI-Partnership-Program
Milwaukee Metropolitan Sewerage District	Green Streets Partnership Program	Milwaukee Metropolitan Sewerage District 260 W. Seeboth Street Milwaukee, WI 53204-1446	(414) 225-2151	www.h20capture.com/learn/finding-programs/green-streets-program
Milwaukee Metropolitan Sewerage District	MMSD Rain Gardens Project	Milwaukee Metropolitan Sewerage District 260 W. Seeboth Street Milwaukee, WI 53204-1446	(414) 225-2151	www.h20capture.com/learn/finding-programs/Rain-Gardens-Project
National Fish and Wildlife Foundation	Acres for America	National Fish and Wildlife Foundation 1133 Fifteenth Street, N.W., Suite 1100 Washington, DC 20005	(612) 564-7253	www.nfwf.org/acresforamerica/
National Fish and Wildlife Foundation	Bring Back the Natives/More Fish	National Fish and Wildlife Foundation Western Partnership Office 421 SW 6th.Avenue, Suite 950 Portland, OR 97200	(503) 417-8700	www.nfwf.org/bbnmorefish
National Fish and Wildlife Foundation	Environmental Solutions for Communities	National Fish and Wildlife Foundation 1133 Fifteenth Street, N.W., Suite 1100 Washington, DC 20005	(202) 595-2471	www.nfwf.org/environmentalsolutions/
National Fish and Wildlife Foundation	Five Star and Urban Waters Restoration Grant Program	National Fish and Wildlife Foundation 1133 Fifteenth Street, N.W., Suite 1100 Washington, DC 20005	(415) 243-3104	www.nfwf.org/fivestar/
National Fish and Wildlife Foundation	Sustain Our Great Lakes	National Fish and Wildlife Foundation 1133 Fifteenth Street, N.W., Suite 1100 Washington, DC 20005	(612) 564-7253	www.sustainourgreatlakes.org www.nfwf.org
PeopleForBikes	PeopleForBikes Community Grant Program	PeopleForBikes P.O. Box 2359 Boulder, CO 80306	(303) 449-4893	www.peopleforbikes.org/pages/community-grants
Root-Pike Watershed Initiative Network	Root-Pike WIN Watershed-Based Grant Program	Root-Pike Watershed Initiative Network P.O. Box 044164 Racine, WI 53404	(262) 898-2055	www.rootpikewin.org
Southeastern Wisconsin Invasive Species Coalition	SEWISC Assistance Program	Southeastern Wisconsin Invasive Species Coalition P.O. Box 24182 Milwaukee, WI 53244	- -	sewisc.org

Table 103 (continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
Southeastern Wisconsin Watersheds Trust (Sweet Water)	Sweet Water Mini-Grant Program	Sweet Water 600 E. Greenfield Avenue Milwaukee, WI 53204-2944	(414)-382-1766	swwtwater.com
Surdna Foundation	Surdna Foundation	Surdna Foundation 330 Madison Avenue, 30th Floor New York, NY 10017	(212) 557-0010	www.surdna.org
U.S. Army Corps of Engineers	Ecosystem Restoration Program	U.S. Army Corps of Engineers-Detroit District Chief of Planning Office, 7th Floor 477 Michigan Avenue Detroit, MI 48226-2550	(313) 226-6758	www.lre.usace.army.mil
U.S. Army Corps of Engineers	Emergency Streambank and Shore Protection Program	U.S. Army Corps of Engineers-Detroit District Chief of Planning Office, 7th Floor 477 Michigan Avenue Detroit, MI 48226-2550	(313) 226-6758	www.lre.usace.army.mil
U.S. Army Corps of Engineers	Great Lakes Fishery and Ecosystem Restoration Program	U.S. Army Corps of Engineers-Detroit District Chief of Planning Office, 7th Floor 477 Michigan Avenue Detroit, MI 48226-2550	(313) 226-6758	www.lre.usace.army.mil
U.S. Army Corps of Engineers	Small Flood Damage Reduction Program	U.S. Army Corps of Engineers-Detroit District Chief of Planning Office, 7th Floor 477 Michigan Avenue Detroit, MI 48226-2550	(313) 226-6760	www.lre.usace.army.mil
U.S. Army Corps of Engineers	Snagging and Clearing for Flood Control Program	U.S. Army Corps of Engineers-Detroit District Chief of Planning Office, 7th Floor 477 Michigan Avenue Detroit, MI 48226-2550	(313) 226-6758	www.lre.usace.army.mil
U.S. Department of Agriculture Farm Services Agency	Conservation Reserve Program	U.S. Department of Agriculture Farm Services Agency 1012 Vine Street Union Grove, WI 53182	(262) 878-3353	www.fsa.usda.gov
U.S. Department of Agriculture Farm Services Agency	Emergency Conservation Program	U.S. Department of Agriculture Farm Services Agency 1012 Vine Street Union Grove, WI 53182	(262) 878-3353	www.fsa.usda.gov
U.S. Department of Agriculture Farm Services Agency	Emergency Forest Restoration Program	U.S. Department of Agriculture Farm Services Agency 1012 Vine Street Union Grove, WI 53182	(262) 878-3353	www.fsa.usda.gov

Table 103 (continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
U.S. Department of Agriculture Farm Services Agency	Grasslands Reserve Program	U.S. Department of Agriculture Farm Services Agency 1012 Vine Street Union Grove, WI 53182	(262) 878-3353	www.fsa.usda.gov
U.S. Department of Agriculture Natural Resources Conservation Service	Conservation Stewardship Program	U.S. Department of Agriculture Natural Resources Conservation Service 1012 Vine Street Union Grove, WI 53182	(262) 878-1243	www.nrcs.usda.gov
U.S. Department of Agriculture Natural Resources Conservation Service	Emergency Watershed Protection Program	U.S. Department of Agriculture Natural Resources Conservation Service 8030 Excelsior Drive Madison, WI 53717	(608) 662-4422 ext. 234	www.nrcs.usda.gov
U.S. Department of Agriculture Natural Resources Conservation Service	Emergency Watershed Protection Program—Floodplain Easements	U.S. Department of Agriculture Natural Resources Conservation Service 8030 Excelsior Drive Madison, WI 53717	(608) 662-4422 ext. .252	www.nrcs.usda.gov
U.S. Department of Agriculture Natural Resources Conservation Service	Environmental Quality Incentives Program	U.S. Department of Agriculture Natural Resources Conservation Service 1012 Vine Street Union Grove, WI 53182	(262) 878-1243	www.nrcs.usda.gov
U.S. Department of Agriculture Natural Resources Conservation Service	Wildlife Habitat Incentive Program	U.S. Department of Agriculture Natural Resources Conservation Service 1012 Vine Street Union Grove, WI 53182	(262) 878-1243	www.nrcs.usda.gov
U.S. Department of Agriculture Natural Resources Conservation Service	Wetlands Reserve Program	U.S. Department of Agriculture Natural Resources Conservation Service 8030 Excelsior Drive Madison, WI 53717	(608) 662-4422 ext. .252	www.nrcs.usda.gov
U.S. Environmental Protection Agency	Environmental Justice Small Grant Program	U.S. Environmental Protection Agency Office of Environmental Justice 1200 Pennsylvania Avenue NW Washington, DC 20460	(202) 564-2515	www.epa.gov/compliance/environmentaljustice/grants/ej-dmgrants.html
U.S. Environmental Protection Agency	Targeted Watershed Grant Program	U.S. Environmental Protection Agency Office of Wetlands, Oceans, & Watersheds 1200 Pennsylvania Avenue NW Washington, DC 20460	(312) 886-7742	water.epa.gov/grants_funding/twg/initiative_index.cfm
U.S. Environmental Protection Agency	Urban Waters Small Grant Program	U.S. Environmental Protection Agency 1200 Pennsylvania Avenue NW Washington, DC 20460	(202) 566-0730	www2.epa.gov/urbanwaters/urban-water-small-grants

Table 103 (continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
U.S. Federal Emergency Management Agency	Flood Mitigation Assistance Program	Federal Emergency Management Agency Region V 6th Floor 536 S. Clark Street Chicago, Il 60605	(312) 408-5500	www.fema.gov/hazard-mitigation-grant-program
U.S. Federal Emergency Management Agency	Hazard Mitigation Grant Program	Federal Emergency Management Agency Region V 6th Floor 536 S. Clark Street Chicago, Il 60605	(312) 408-5500	www.fema.gov/hazard-mitigation-grant-program
U.S. Federal Emergency Management Agency	Pre-Disaster Mitigation Program	Federal Emergency Management Agency Region V 6th Floor 536 S. Clark Street Chicago, Il 60605	(312) 408-5500	www.fema.gov/hazard-mitigation-grant-program
U.S. Fish and Wildlife Service	Fish and Wildlife Management Assistance Program	U.S. Fish and Wildlife Service 5600 American Boulevard West Suite 990 Bloomington, MN 55437-1458	(612) 713-5960	www.fws.gov/fisheries/
U.S. Fish and Wildlife Service	Great Lakes Fish and Wildlife Restoration Act Grant Program	U.S. Fish and Wildlife Service Green Bay Fish and Wildlife Conservation Office 6644 Turner Road Elmira, MI 49730	(231) 584-3553	www.fws.gov/midwest/fisheries/glfwra-grants.html#
U.S. Fish and Wildlife Service	North American Wetlands Conservation Fund	U.S. Fish and Wildlife Service 5600 American Boulevard West Suite 990 Bloomington, MN 55437-1458	(612) 713-5960	www.fws.gov/birdhabitat/Grants?NAWCA
U.S. Fish and Wildlife Service	Partners for Wildlife Program	U.S. Fish and Wildlife Service 4511 Helgesen Drive Madison, WI 53718-6747	(608) 221-1206	www.fws.gov.midwest.partners/index.html
U.S. Forest Service	Community Forest and Open Space Conservation Program	U.S. Forest Service 271 Mast Road Durham, NH 03824-4600	(630) 868-7719	www.fs.fed.us/spf/coop/programs/loa/cfp.shtml
Wisconsin Citizen-Based Monitoring Network	Wisconsin Citizen-Based Monitoring Partnership Program	Wisconsin Department of Natural Resources P.O. Box 7921 – ER/6 Madison, WI 53707-7921	(608) 261-4669	wiatri.net/cbm/Partnership/
Wisconsin Board of Commissioners of Public Lands	Wisconsin State Trust Fund Loan Program	Wisconsin Board of Commissioners of Public Lands P.O. Box 8943 Madison, WI 53708-8943	(608) 266-1370	bcpl.wisconsin.gov/section.asp?linkid=1438&locid=145

Table 103 (continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
Wisconsin Coastal Management Program	Wisconsin Coastal Management Grant Program	Wisconsin Coastal Management Program 101 E. Wilson Street, 9th Floor P.O. Box 8944 Madison, WI 53708-8944	(608) 267-7982	www.doa.state.wi.us/section.asp?linkid=65&locid=9
Wisconsin Department of Natural Resources	Aquatic Invasive Species Prevention and Control Grant Program	Wisconsin Department of Natural Resources 141 NW Barstow Street Room 180 Waukesha, WI 53188 Wisconsin Department of Natural Resources 2300 N. Martin Luther King, Jr. Drive Milwaukee, WI 53212	(262) 574-2130 (414) 263-8569	dnr.wi.gov/Aid/AIS.html
Wisconsin Department of Natural Resources	County Conservation Aids	Wisconsin Department of Natural Resources 2300 N. Martin Luther King, Jr. Drive Milwaukee, WI 53212	(414) 263-8569	dnr.wi.gov/aid/countyconservation.html
Wisconsin Department of Natural Resources	Dam Removal Grant Program	Wisconsin Department of Natural Resources P.O. Box 7921 Madison, WI 53707-7921	(608) 266-8033	dnr.wi.gov/Aid/DamRemoval.html
Wisconsin Department of Natural Resources	Environmental Improvement Fund Loan Program	Wisconsin Department of Natural Resources P.O. Box 7921 Madison, WI 53707-7921	(608) 264-8986	dnr.wi.gov/Aid/EIF.html
Wisconsin Department of Natural Resources	Knowles-Nelson Stewardship	Wisconsin Department of Natural Resources P.O. Box 7921 Madison, WI 53707-7921	(608) 267-0497 (608) 267-0868	dnr.wi.gov/topic/Stewardship
Wisconsin Department of Natural Resources	Lake Management Planning Grant Program	Wisconsin Department of Natural Resources 141 NW Barstow Street Room 180 Waukesha, WI 53188	(262) 574-2130	dnr.wi.gov/Aid/LakeMgtPlanning.html
Wisconsin Department of Natural Resources	Lake Protection Grant Program	Wisconsin Department of Natural Resources 141 NW Barstow Street Room 180 Waukesha, WI 53188	(262) 574-2130	dnr.wi.gov/Aid/LakeClassificationProtection.html
Wisconsin Department of Natural Resources	Land and Water Conservation Fund Grant Program	Wisconsin Department of Natural Resources 2300 N. Martin Luther King, Jr. Drive Milwaukee, WI 53212	(414) 263-8610	dnr.wi.gov/aid/LWCF.html
Wisconsin Department of Natural Resources	Landowner Incentive Program	Wisconsin Department of Natural Resources P.O. Box 7921 Madison, WI 53707-7921	(608) 266-5243	dnr.wi.gov/topic/endangered resources/lip.html

Table 103 (continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
Wisconsin Department of Natural Resources	Municipal Dam Grant Program	Wisconsin Department of Natural Resources P.O. Box 7921 Madison, WI 53707-7921	(608) 266-8033	dnr.wi.gov/Aid/DamMunicipal.html
Wisconsin Department of Natural Resources	Municipal Flood Control Grant Program	Jeffrey Soellner WDNR Grant Program Manager Wisconsin Department of Natural Resources P.O. Box 7921 Madison, WI 53707-7921	(608) 267-7152	dnr.wi.gov/Aid/MunFloodControl.html
Wisconsin Department of Natural Resources	Recreational Trails Aid Program	Wisconsin Department of Natural Resources P.O. Box 7921 Madison, WI 53707-7921	(608) 267-9385	dnr.wi.gov/Aid/RTA.html
Wisconsin Department of Natural Resources	River Protection Grant Program	Wisconsin Department of Natural Resources Sturtevant Service Center 9531 Rayne Road Suite 4 Sturtevant, WI 53177	(262) 844-2357	dnr.wi.gov/Aid/Rivers.html
Wisconsin Department of Natural Resources	Targeted Runoff Management Grant Program	Wisconsin Department of Natural Resources 2300 N. Martin Luther King, Jr. Drive Milwaukee, WI 53212	(262) 884-2360	dnr.wi.gov/Aid/TargetedRunoff.html
Wisconsin Department of Natural Resources	Urban Forestry Grants	Wisconsin Department of Natural Resources 2300 N. Martin Luther King, Jr. Drive Milwaukee, WI 53212	(414) 263-8602	dnr.wi.gov/topic/UrbanForests/grants/index.html
Wisconsin Department of Natural Resources	Urban Nonpoint Source and Storm Water Management Grant Program	Wisconsin Department of Natural Resources 2300 N. Martin Luther King, Jr. Drive Milwaukee, WI 53212	(262) 884-2360	dnr.wi.gov/Aid/UrbanNonpoint.html
Wisconsin Department of Natural Resources	Weed Management Area Private Forest Grant Program	Wisconsin Department of Natural Resources P.O. Box 7921 Madison, WI 53707-7921	(608) 266-9276	dnr.wi.gov/Aid/WMA.html
Wisconsin Department of Safety and Professional Services	Wisconsin Fund—Private Onsite Wastewater Treatment System Replacement or Rehabilitation Financial Assistance Program	Wisconsin Department of Safety and Professional Services P.O. Box 2658 Madison, WI 53701-2658	(608) 266-6769	www.dsps.wi.gov/Documents/Industry%20Services/Forms
Wisconsin Department of Transportation	Congestion Mitigation and Air Quality Improvement Program	Wisconsin Department of Transportation 141 NW Barstow Street P.O. Box 798 Waukesha, WI 53187-0798	(262) 548-8789	www.dot.wisconsin.gov/localgov.aid/cmaq.html

Table 103 (continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
Wisconsin Department of Transportation	Transportation Alternatives Program	Wisconsin Department of Transportation 141 NW Barstow Street P.O. Box 798 Waukesha, WI 53187-0798	(262) 548-8789	www.dot.wisconsin.gov/localgov.aid/tap.html
Wisconsin Environmental Education Board	Wisconsin Environmental Education Board Grant Program	Wisconsin Environmental Education Board 110H Trainer Natural Resources Building UW-Stevens Point 800 Reserve Street Stevens Point, WI 54481	(715) 346-3805	www.uwsp.edu/cnr-ap/weeb/Grant-Program/Pages/default.aspx

[a]*The Catalog of Federal Domestic Assistance Programs can be accessed at:* https://www.cfda.gov/?s=main&mode=list&tab=list*. Additional information on grants can be accessed through the U.S. Environmental Protection Agency at:* http://water.epa.gov/grants_funding/ *and through the University of Wisconsin-Madison Libraries Grants Information Collection at* http://grants.library.wisc.edu.

[b]*Some of the programs described in this table may not be available under all envisioned conditions for a variety of reasons, including local eligibility requirements or lack of funds in Federal and/or State budgets at a given time.*

Source: SEWRPC.

of the grant programs, the programs described in the following subsections are organized according to the following general categories, which are based on the four focus areas for the Root River watershed restoration planning effort (plus education):

- Water Quality, Habitat, and Education
- Water Quality, Habitat, and Recreation
- Habitat
- Recreation
- Flooding (Racine County) and Horlick Dam

Water Quality, Habitat, and Education

AmeriCorps

AmeriCorps State and National supports a wide range of local service programs that engage thousands of Americans in intensive community service each year. It provides grants to a network of local and national organizations and agencies committed to using national service to address critical community needs in education, public safety, health, and the environment. Each of these organizations and agencies, in turn, uses its AmeriCorps funding to recruit, place, and supervise AmeriCorps members nationwide.

AmeriCorps grants are awarded to eligible organizations proposing to engage AmeriCorps members in evidence-based or evidence-informed interventions to strengthen communities. Eligible organizations include public or private nonprofit organizations, including faith-based and other community organizations; institutions of higher education; local units of government; labor organizations; partnerships and consortia; and Indian Tribes.

Support is provided for projects in six focus areas: disaster services, economic opportunity, education, environmental stewardship, healthy futures, and veterans and military families. Grants for environmental stewardship provide support for direct services that contribute to increased energy and water efficiency, renewable energy use, or improving at-risk ecosystems. In addition, grants support educational activities leading to increased efficiency, renewable energy use, and ecosystem improvements—particularly for economically disadvantaged households and communities. Grant activities decrease energy and water consumption; improve at-risk ecosystems; provide educational activities that lead directly to decreased energy and water consumption or improved at-risk ecosystems; and increase green training opportunities that may lead to decreased energy and water consumption or improved at-risk ecosystems.

Specific priorities include construction or physical improvements related to energy and water performance in economically disadvantaged communities; direct, sustained recycling and waste treatment activities; improvements of at-risk public lands or waterways; creating awareness among economically disadvantaged communities of personal actions to benefit energy and water conservation/efficiency and solid waste recycling; and formal and informal green job training for economically disadvantaged people.

Awards are for funds and AmeriCorps member slots. Award amounts vary. There is no specific match requirement for fixed amount grants, but awards do not provide all the funds necessary to operate the program. Organizations must raise the additional revenue required.

Organizations that are proposing a project that operates in only one state must apply to this competition through the Governor-appointed State or Territory Commissions. Each state and territory administers its own selection process. Organizations should contact the Wisconsin National and Community Service Board to learn about their state or territory processes and deadlines.

Captain Planet Foundation Small Grants Program
The Captain Planet Foundation provides funding to support hands-on environmental projects designed to encourage innovative initiatives that inspire and empower children and youth to work at creating environmental solutions in their homes, schools, and communities. Grants from the Captain Planet Foundation are intended to:

- Provide hands-on environmental stewardship opportunities for youth;
- Serve as a catalyst to getting environment-based education in schools;
- Have real environmental outcomes; and
- Inspire youth and communities to participate in community service through environmental stewardship activities.

The Foundation primarily makes grants to U.S.-based schools and organizations with an annual operating budget of less than $3 million. Applicant organizations or sponsoring agencies that are exempt from federal taxation under the Internal Revenue Code Section 501 are eligible for funding. This includes most schools and nonprofit organizations. Captain Planet Foundation will accept small grant requests for amounts between $500 and $2,500. Preferential consideration is given to requests that have secured at least 50 percent matching or in-kind funding for their projects. Applications are due September 30 for spring and summer projects and January 31 for fall and winter projects.

Charles Stewart Mott Foundation
The Charles Stewart Mott Foundation provides funds to advance conservation of freshwater ecosystems in North America, with an emphasis on the Great Lakes. Funding objectives include strengthening the environmental community to produce a strong, effective, and sustainable nongovernmental organizational community dedicated to the long-term conservation of freshwater ecosystems; well designed and effectively implemented water quality and water quantity policies that advance the conservation of freshwater ecosystems; and site-base conservation efforts in which selected ecosystems are protected and restored through place-based conservation activities.

The Foundations provides two types of grants: general purpose grants and project support grants. General purpose grants provide financial assistance for the full range of the grantee's activities. These are designed to help grantees meet operating costs. Under general purpose grants, grantees determine how the funds will be used. In contrast, project support grants provide financial assistance for specific activities or programs of grantees. Occasionally grantees will be awarded a mix of general purpose and project support to help them meet core costs and pilot new programs. The majority of grants range between $15,000 and $250,000 annually, with a median grant size of $100,000.

An application for support is made through a letter of inquiry to the Foundation. The letter should describe the purpose and objectives of the project, general methodology, and total cost of the project. A letter of inquiry enables the Foundation program staff to determine the relevance of the proposed project to the Foundation's programs and to provide advice on whether to submit a full proposal.

Fund for Lake Michigan
The Fund for Lake Michigan was established in conjunction with the resolution of disputes concerning the We Energies Oak Creek Power Plant and Elm Road Generating Station. The agreement establishing the Fund provides for payments of $4 million each year from 2011 through 2035 to fund projects to improve the health of Lake Michigan. The Fund provides grants to nonprofit organizations and local government agencies for projects that will enhance the ecological health of the nearshore and coastal areas and rivers of southeastern Wisconsin through habitat preservation and restoration and for projects that improve the quality of the water flowing into Lake Michigan through reductions of pollutants, including toxins and nutrients. This program does not fund advocacy efforts, general research projects, or education projects. In 2011 and 2012 the Fund awarded grants

ranging from about $14,000 to $500,000. Examples of projects funded include habitat restoration projects, including restoration of woodlands, wetlands, instream sites, and brownfields; installation of riparian buffers, green infrastructure, and best management practices; removal of dams; development of watershed restoration plans; collection of water quality data in support of planning efforts; and small grant programs run by local watershed groups.

Applications for funding are made through a letter of inquiry to the Fund via its online grants management system. Based upon the letters received, full proposals are invited from prospective grantees that the Fund considers best suited to help achieve the goals of the Fund. Prospective applicants are encouraged to discuss proposals with representatives of the Fund prior to applying. In 2014, the deadline for letters of inquiry was in late January.

Graham-Martin Foundation

The Graham-Martin Foundation partners with local governments, conservation groups, nonprofit organizations, schools, faith centers, and lake and watershed associations to help fund the installation of rain gardens. Funding from the Foundation enables local partners to provide rain garden plants to persons installing rain gardens at discounted prices.

Great Lakes Protection Fund

The Great Lakes Protection Fund is a private, nonprofit corporation founded in 1989 by the Governors of the Great Lakes states. It is a permanent environmental endowment that supports collaborative actions to improve the health of the Great Lakes ecosystem. The Fund finances projects that advance the goals of the Great Lakes Toxic Substances Control Agreement and the Great Lakes Water Quality Agreement, notably restoring and maintaining the chemical, physical, and biological integrity of the Great Lakes basin ecosystem.

The Fund provides support to projects that create, test and deploy new ways of improving the physical, chemical, and biological health of the basin ecosystem. Its investments reflect the nine priority areas the Great Lake's Governors have identified to guide government efforts to protect and restore the Great Lakes. These shared priorities are to:

- Ensure the sustainable use of water resources while confirming that the States retain authority over water use and diversions of Great Lakes waters;
- Promote programs to protect human health against adverse effects of pollution in the Great Lakes ecosystem;
- Control pollution from diffuse sources into water, land, and air;
- Continue to reduce the introduction of persistent bioaccumulative toxics into the Great Lakes ecosystem;
- Stop the introduction and spread of nonnative aquatic invasive species;
- Enhance fish and wildlife by restoring and protecting coastal wetlands, fish, and wildlife habitats;
- Restore to environmental health the areas of concern identified by the International Joint Commission as needing remediation;
- Standardize and enhance the methods by which information is collected, recorded, and shared within the region; and
- Adopt sustainable use practices that protect environmental resources and may enhance the recreational and commercial value of the Great Lakes.

The Fund can support specific projects through grants, loans, program-related investments, or other financial mechanisms. Nonprofit organizations, for-profit businesses, government agencies, and individuals are eligible to apply for project support. Applications for support are made by first discussing the potential project with Fund staff, followed by submission of a pre-proposal. Based upon the pre-proposal an applicant may be invited to submit a full proposal.

Healing Our Waters Coalition
The Healing Our Waters Coalition, which is administered by Freshwater Future,[12] seeks to clean up sewage and toxic sediments, restore damaged habitat, protect high-quality habitat, and control and prevent the introduction of invasive species in the Great Lakes. It offers grants under two programs.

The Federal Project Support Grants Program provides award of up to $15,000 to aid in the development and implementation of proposals and projects under the Great Lakes Restoration Initiative (GLRI) and other Federal programs. The Community Engagement Grants Program provides awards of up to $5,000 to give groups the capacity to engage in Federally funded, government-led restoration activities occurring or being planned in their communities.

Environmental, conservation, and community organizations with 501(c)(3) status are eligible to apply for funding under these programs. Examples of the types of projects funded include:

- Small aspect of a larger GLRI restoration project;
- Assistance with the development of a GLRI proposal, such as grant writing or project development assistance;
- Research needed as part of a GLRI restoration proposal or project, such as water or soil testing;
- Specialist services needed as part of a GLRI restoration proposal or project;
- Facilitating the development of a collaborative GLRI proposal between multiple organizations working in the same geographic areas; and
- Assistance with implementing a secured GLRI proposal through activities such as project management training, collaboration building, match development, or development of specific technical capabilities.

There is no deadline for applications. Grants are given on a first come, first served basis.

James E. Dutton Foundation
The James E. Dutton Foundation makes grants to organizations for programs that benefit wildlife, animal causes, the environment, and natural resources. The Foundation provides support for endeavors that provide care for wildlife and animals; provide animal rescue and/or shelter; enhance wildlife populations through habitat conservation, improvement, and/or restoration; promote sound land management; increase public awareness; and educate the public. The Foundation also provides assistance to organizations or programs that support individuals with their goals of caring for or enjoying wildlife, animals, and the outdoors; educating the public; preserving natural resources; and giving people the opportunity to experience animals, wildlife, and the outdoors. Projects funded in the past include wetland restorations, stream restorations, provision of trail markers at parks, and

[12] http://freshwaterfuture.org/

educational programs. Grant requests should be submitted to the Foundation in writing and should include a description of the requesting organization and its mission. The request should also include a detailed description of the project or program for which the grant is being requested, along with the grant budget and schedule.

Joyce Foundation
The Joyce Foundation provides funding to nonprofit organizations for policy-related projects to protect and restore the Great Lakes. Granting priorities include projects that address the introduction and spread of aquatic invasive species in and around the Great Lakes Basin; polluted, nonpoint source runoff from agricultural lands and cities, including the use of green infrastructure as a way to better manage stormwater and reduce combined sewer overflows in urban areas; and funding of and support for Great Lakes restoration and protection policies. The application process begins with a letter of inquiry to the Foundation outlining the proposed project. Based upon this letter, the Foundation may ask the applicant to submit a full proposal.

Milwaukee Metropolitan Sewerage District
The MMSD has several programs to fund the installation of green infrastructure within its service area.

GREEN INFRASTRUCTURE PARTNERSHIP PROGRAM
MMSD's Green Infrastructure Partnership Program[13] provides funding to increase the application of more natural stormwater management practices that capture, store, or filter rainwater. This program reimburses costs for eligible green infrastructure expenses including materials, construction costs, and signage costs. Partners receive incentive funding for the installation of practices such as constructed wetlands, native landscaping, porous pavement, rain barrels, cisterns, green alleys, green streets, stormwater trees, bioswales, greenways, rain gardens, and green roofs. Some applicants may wish to apply for Signature Project Status to receive up to 50 percent in matching funds for eligible costs. Funding can be awarded to public or government agencies, nongovernmental organizations, and private property owners for projects located in the MMSD service area. Applications must be submitted by the property owner. Applications are due March 31 of each year.

GREEN STREETS PARTNERSHIP PROGRAM
Through its Green Streets Program, MMSD is providing funding to add green infrastructure to currently planned roadway projects or to retrofit streets with green infrastructure. Eligible applicants need to own the road asset or have the authority to act as an agent on behalf of the owner of the roadway. The District does not require a funding match for this project, but does require a staff-time match. This should include a designated amount of staff time for the creation of educational materials on the project, associated educational activities, and facilities management time for maintenance. Although it is not required, a funding match is welcomed and will increase project scoring. Funding through this Partnership Program can be used to add green infrastructure provisions in currently planned roadway projects, or retrofitting of streets. Individual awards will not exceed $125,000.

MMSD RAIN GARDEN PROJECT
The MMSD Rain Garden Project provides rain garden plants at reduced prices. Any homeowner, business owner, or local nonprofit organization can purchase plants, which are not to be resold.

National Fish and Wildlife Foundation
The National Fish and Wildlife Foundation (NFWF) is a nonprofit organization created by the U.S. Congress to protect and restore the Nation's fish, wildlife, plants, and habitat. The Foundation works with Federal agencies and corporate and foundation partners to offer several conservation initiatives. Through these initiatives, the Foundation provides funding on a competitive basis to support projects for wildlife and habitat conservation. Several NFWF programs are described below.

[13]*MMSD's Green Infrastructure Partnership Program incorporates the District's earlier Green Roof Initiative.*

Acres for America

Walmart has worked with the NFWF to establish Acres for America, a commitment to purchase and preserve one acre of wildlife habitat for every acre of land developed by the company. The program protects critical habitat for birds, fish, plants, and wildlife, and includes providing funding for urban conservation efforts. Funding priorities include:

- Providing access for people to enjoy the outdoors;
- Conserving critical habitats for birds, fish, plants, and wildlife;
- Connecting existing protected lands to unify wild places and protect migration routes; and
- Ensuring the future of rural economies that depend on forestry, ranching, and recreation.

About $2.5 million is available annually for grants. All grants require a minimum one-to-one match of cash or contributed goods and services. Higher ratios of matching funds may aid in making applications more competitive. Applications for grants are made through a two-stage process. Pre-proposals are submitted online through the NFWF's Easygrants System. These are due by June 3 of each year. Based upon the pre-proposal an applicant may be invited to submit a full proposal.

Bring Back the Natives/More Fish

The Bring Back the Natives/More Fish program is a partnership among the NFWF, the U.S. Fish and Wildlife Service, the U.S. Bureau of Land Management, the U.S. Forest Service, the National Oceanic and Atmospheric Administration, the Jackson Hole One Fly Foundations, Orvis, Bass Pro Shops, and the Brunswick Foundation. This program invests in conservation activities that restore, protect, and enhance native populations of sensitive, threatened, or endangered fish species, especially in areas on or adjacent to Federal agency lands. It also provides grants to help implement the goals of the National Fish Habitat Action Plan.[14] Projects that address declines of fish species due to habitat alteration, lack of adequate stream flow, and invasive or nonnative species are of particular interest.

Eligible applicants for grants include local, state, federal, and tribal governments and agencies, special districts, nonprofit organizations, schools, and universities. Grant awards generally range between $25,000 and $100,000. Applicants must provide a nonfederal match of at least two dollars for every dollar of grant funds requested. Eligible matches include cash, in-kind donations, and volunteer labor. This grant program is offered annually with a request for proposals typically being released in the spring.

Environmental Solutions for Communities

The Environmental Solutions for Communities Program is a partnership between Wells Fargo and the NFWF dedicated to helping communities create a more sustainable future through responsible environmental stewardship. This program promotes sustainable communities by supporting projects that support sustainable agricultural practices and private land stewardship; conserve critical land and water resources and improve local water quality; restore and manage natural habitat, species, and ecosystems that are important to community livelihoods; facilitate investments in green infrastructure, renewable energy, and energy efficiency; and encourage broad-based citizen and targeted youth participation in project implementation. Priority for grants is given to projects that address one or more of the following:

- Support innovative, cost-effective programs that enhance stewardship on private agricultural lands to enhance water quality and quantity and/or improve wildlife habitat for species of concern, while maintaining or increasing agricultural productivity.

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[14] *This plan can be found at* www.fishhabitat.org.

- Support community-based conservation projects that protect and restore local habitats and natural areas, enhance water quality, promote urban forestry, educate and train community leaders on sustainable practices, promote related job creation and training, and engage diverse partners and volunteers.

- Support visible and accessible demonstration projects that showcase innovative, cost-effective, and environmentally friendly approaches to improve environmental conditions within urban communities by "greening" traditional infrastructure and public projects such as stormwater management and flood control, public park enhancements, and renovations to public facilities.

- Support projects that increase the resiliency of the Nation's coastal communities and ecosystems—including the Great Lakes—by restoring coastal habitats, living resources, and water quality to enhance livelihoods and quality of life in these communities.

Eligible applicants include nonprofit organizations, educational institutions, and state, tribal, and local governments working in states where Wells Fargo operates. Grant awards typically range between $25,000 and $100,000, with an average grant amount of $40,000. The ratio of nonfederal matching funds to grant funds is considered during the review process, with projects that meet or exceed a one-to-one match ratio being more competitive. Application materials are submitted through the NFWF Easygrants system. Applications are generally due in mid-December of each year.

FIVE STAR/URBAN WATERS RESTORATION GRANT PROGRAM

The Five Star/Urban Waters Restoration Grant program is a partnership among the National Association of Counties, the NFWF, and the Wildlife Habitat Council in cooperation with the U.S. Environmental Protection Agency (USEPA), the U.S. Forest Service, the U.S. Fish and Wildlife Service, Southern Company, FedEx, and PG&E. The program seeks to develop community capacity to sustain local natural resources for future generations by providing modest financial assistance to diverse local partnerships for wetland, forest, riparian, and coastal habitat restoration; stormwater management; outreach; and stewardship with a particular focus on water quality, watersheds, and the habitats they support.

The Five Star/Urban Waters Restoration Program is open to any entity that can receive grants. Grants range from $20,000 to $50,000, with average grant awards of $25,000 to $35,000. A minimum one-to-one match of funds is expected. All applications must include at least five organizations contributing to the project through funding, technical support, workforce support, land, or other in-kind services. Partnerships should include a variety of public and private entities, such as youth groups, colleges and universities, resource conservation and development councils, soil and water conservation districts, conservation organizations, watershed organizations, businesses, community groups, government agencies, and foundations. Applications are made through the NFWF Easygrants system. While this program includes several subprograms, there is only one application.

The Five Star/Urban Waters Restoration Program has separate programs related to different funders. Each funder has specific requirements for projects supported by their program. NFWF matches applications to all funding sources applicable to that project's activities, location, and project type. Programs potentially applicable to the Root River watershed are described below.

USEPA Five Star Program

Funds from the USEPA Five Star Program are available nationwide to any size community. Competitive criteria for this funding include:

- On-the-ground restoration: Projects must include on-the-ground wetland, riparian, instream and/or coastal habitat restoration.

- Environmental outreach, education, and training: Projects should integrate meaningful education and training into the restoration either through community outreach or participation or integrations, with K-12 environmental curriculum.

- Measurable results: Projects must result in measurable ecological, educational, and community benefits.

USEPA and U.S. Forest Service Urban Waters Program

Funds from this program are available nationwide for urban areas to improve urban water quality, increase public access, and restore riparian habitat and urban forests in developed watersheds. Projects with an environmental justice focus or that benefit underserved and economically distressed communities in urban areas have funding priority. Projects funded by this program should address one or more of the following project elements:

- Urban Forest Restoration: Implement projects that are focused on improving water quality of urban watersheds through forest restoration, riparian restorations, and community canopy enhancements to benefit urban waterways and/or improve stormwater infiltration.

- Education and Training: Develop educational programs to provide training to schools, businesses, community groups, and homeowners on how to implement tree planting with purposeful design, rain gardens, designed riparian restorations, or other programs to reduce water pollution and stormwater flow or to promote low-impact design and/or green infrastructure practices.

- Stormwater Management: Design projects intended to control rain water through green infrastructure tools such as tree canopy, permeable pavement, green street designs, bioswales, planter boxes, and green roofs to reduce stormwater flow, control flooding, and slow runoff into surface water.

- Communities and Water Quality Data: Establish or advance a water quality monitoring program that serves to involve community members and/or address community issues and priorities.

- Promote Access to Urban Waterways: Design community-based projects that promote access to urban waterways and enhance outdoor recreational opportunities.

The FedEx Earthsmart Outreach Program

This program funds projects that support environmental conservation, restoration, and stewardship and incorporate community involvement and education. All proposals in these areas must propose a volunteer event for up to 50 local FedEx employees. FedEx funds will support high-quality projects in municipalities where the company has facilities. Within the Root River watershed, this would include the City of New Berlin.

SUSTAIN OUR GREAT LAKES

Sustain Our Great Lakes is a public-private partnership among ArcelorMittal, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the U.S. Forest Service, the NFWF, the National Oceanic and Atmospheric Administration, and the U.S. Department of Agriculture Natural Resources Conservation Service. Its mission is to sustain, restore and protect fish, wildlife and habitat in the Great Lakes basin by leveraging funding, building conservation capacity, and focusing partners and resources on key ecological issues.

The program achieves this mission, in part, by awarding competitive grants for on-the-ground habitat restoration and enhancement. Grants awards can range from $25,000 to $1,500,000. Funding priority is given to projects that improve the quality and connectivity of tributary, wetland, and coastal habitats. Eligible grant recipients include nonprofit organizations; State, provincial, tribal, and local governments; and educational institutions. The ratio of matching contributions to grant funds is a factor considered during review of applications. Projects that meet or exceed a one-to-one ratio of matching funds to grant funds are more competitive for funding.

In 2014, grant funding for work in the Great Lakes basin will be awarded for projects related to habitat restoration and delisting of habitat-related beneficial use impairments. Applications are submitted online through the NFWF's Easygrants system. Pre-proposals are usually due in mid-February.

Southeastern Wisconsin Watersheds Trust, Inc. (Sweet Water) Mini-Grant Program
The Sweet Water Mini-Grant program supports local, grassroots effort to improve water quality, restore habitat, promote conservation, and advance public education concerning water issues in the Greater Milwaukee watersheds, including the Root River watershed. A special focus of this program is the use of green infrastructure practices. The program provides grants ranging from $1,000 to $5,000 to established nonprofit organizations, community groups, and civic groups for projects and activities that advance the objectives of achieving healthy and sustainable water resources. Projects should also advance the following goals:

- Making measurable progress in improving regional water resources;
- Supporting land use practices that improve water quality;
- Forging relationships to find and leverage funding; and
- Implementing cost-effective projects resulting in measurable water quality improvements.

Applications for this program are due November 15.

Surdna Foundation
The Surdna Foundation seeks to foster sustainable communities in the United States—communities guided by principles of social justice and distinguished by healthy environments, strong local economies and thriving cultures. As part of this mission, it seeks to fund projects in these three areas. Funding priorities include creating pilot projects or expanding promising projects in cities and metropolitan areas that demonstrate innovative stormwater management practices. Funding projects in cities that are responding to Federal regulatory action regarding stormwater management is a particular priority, as is funding green infrastructure solutions that create quality jobs, businesses, and other equitable economic benefits. Other funding priorities include informing and building capacity of community organizers, public leaders, practitioners, private investors, and others in the water field; developing new stormwater fee structures and public private partnerships; and the development of small-scale, distributed (neighborhood level) water retrofit projects.

Nonprofit organizations that have a valid tax exemption status under Section 501(c)(3) of the Internal Revenue Code and are classified as public charities and not as "private foundation" under Section 509(a) are eligible to apply. The application process begins with a letter of inquiry to the Foundation outlining the proposed project. Based upon this letter, the Foundation may ask the applicant to submit a full proposal.

U.S. Army Corps of Engineers Emergency Streambank and Shore Protection Program
Section 14 of the 1946 Flood Control Act authorizes the Corps to study, design, and construct emergency streambank and shoreline works to protect public infrastructure such as streets, bridges, schools, water and sewer lines, National Register sites, and churches from damage or loss by natural erosion. The Federal cost limit on Section 14 projects is $1.5 million at any one site, including all study, design, and construction expenditures.

Projects are undertaken on a cost-shared basis. The feasibility study is 100 percent Federally funded up to $100,000. Costs of the feasibility study that exceed $100,000 must be shared equally by the Federal government and the local sponsor. The local sponsor is also required to provide 35 percent of the implementation costs of developing plans and specifications and construction. The nonfederal share of project implementation costs may include credit for lands, easements, rights-of-way, relocations, and disposal areas necessary for the project, plus a cash contribution of at least 5 percent of the total project implementation costs.

The Corps conducts an initial appraisal early in the feasibility study that determines whether the project meets program criteria and provides a basis for determining scope and cost of an entire feasibility study. The solution must be economically feasible and environmentally acceptable. If an acceptable alternative is identified in the feasibility study, the Corps prepares plans and specifications and manages construction of the project.

U.S. Department of Agriculture Farm Services Agency

The U.S. Department of Agriculture Farm Services Agency (FSA) oversees a number of voluntary conservation programs. These programs work to address a large number of agriculture-related conservation issues including: protecting drinking water, reducing soil erosion, preserving wildlife habitat, and aiding farmers whose farms are damaged by natural disasters. Several FSA programs that may provide funds or assistance for efforts in the Root River watershed are described below.

CONSERVATION RESERVE PROGRAM

The Conservation Reserve Program (CRP) is a voluntary program for agricultural landowners that provides annual rental payments and cost-share assistance to establish long-term, resource-conserving covers on eligible farmland. The CRP goals are to reduce soil erosion, protect the nation's ability to produce food and fiber, reduce sedimentation in streams and lakes, improve water quality, establish wildlife habitat, and enhance forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive areas to vegetative cover. Examples of this type of cover include a prairie-compatible, noninvasive forage mix; wildlife plantings; and trees, which may be incorporated into filter strips or riparian buffers, as appropriate. Farmers receive an annual rental payment for the term of the multi-year contract based on the agriculture rental value of the land, and up to 50 percent Federal cost sharing is provided to establish vegetative cover. These contracts typically have a term of 10 to 15 years. Technical assistance and support of this program is provided by the USDA's NRCS and county conservation departments. NRCS works with landowners to develop their applications, and to plan, design, and install the conservation practices on the land.

Enrollment in the CRP occurs both on a continuous and annual basis. Continuous CRP is focused on environmentally sensitive land and offers are not ranked against each other. Environmentally sensitive land may include, but is not limited to, agricultural land prone to erosion, pasture or agricultural land that borders river or stream banks, or field margins. Continuous CRP sign-up land eligibility requirements also take into consideration the type of conservation practice the owner wishes to install. Accepted conservation practices include buffers for wildlife habitat, contour grass strips, filter strips, grass waterways, riparian buffers, shallow water areas for wildlife, shelter belts, wetland buffers, and wetland restorations. Continuous CRP sign-up can occur at any time. All enrollment offers are processed through the local FSA office.

General CRP sign-up only occurs when the Secretary of Agriculture announces USDA will accept bids for enrollment. General CRP sign-up is competitive and offers are ranked against each other on a national level. Offers made during general CRP sign-up are ranked primarily on the environmental benefits that will result from the proposed conservation practices to be put in place. FSA assigns each offer an Environmental Benefits Index (EBI) depending on the environmental sensitivity of the land and the type(s) of conservation practices proposed for it. It is this EBI that is used to rank offers against each other and selections for enrollment are made from that ranking. Factors contributing to the Environmental Benefits Index include benefits to wildlife habitat, benefits to water quality, benefits to the farm itself from reduced erosion, benefits to air quality, benefits that will last beyond the contract period, and cost of both the annual rental payments and the cost-share to establish conservation practices.

EMERGENCY CONSERVATION PROGRAM

The Emergency Conservation Program (ECP) helps farmers and ranchers to repair damage to farmlands caused by natural disasters and to help put in place methods for water conservation during severe drought. The ECP does this by giving ranchers and farmers funding and assistance to repair damaged farmland or to install methods for water conservation. Upon application, the FSA County Committee inspects the damage to determine if land is eligible for ECP. For land to qualify for ECP funds, the damage from the natural disaster or severe drought must create new conservation problems that if not dealt with would further damage the land, significantly affect the land's productive capacity, represent damage from a natural disaster unusual for the area, and/or would be too costly to repair and to return the land to agricultural production without Federal assistance. Technical assistance to fix the conservation problem may also be provided by the United States NRCS. Conservation problems that existed before the disaster or severe drought are ineligible for ECP assistance. Funding for the ECP is determined by Congress. Up to 75 percent of the cost to implement emergency conservation practices can be provided; however, the final amount is determined by the committee reviewing the application. Qualified limited resource producers may earn up to 90 percent cost-share.

Emergency Forest Restoration Program

The Emergency Forest Restoration Program (EFRP) helps the owners of nonindustrial private forests restore forest health damaged by natural disasters. The EFRP does this by authorizing payments to owners of private forests to restore disaster-damaged forests. The local FSA County Committee implements EFRP for all disasters with the exceptions of drought and insect infestations. In the case of drought or an insect infestation, the national FSA office authorizes EFRP implementation. The FSA County Committee inspects the damage to determine if forest land is eligible for EFRP. For land to qualify for EFRP funds, the damage from the natural disaster must create new conservation problems that if not dealt with would harm the natural resources on the land and/or significantly affect future land use. Only owners of nonindustrial private forests with tree cover existing before the natural disaster occurred are eligible to apply. The land must be owned by a private individual, group, association, corporation, or other private legal entity that has decision making authority on the land and does not use the land for business purposes. Funding for EFRP is determined by Congress. Up to 75 percent of the cost to implement emergency conservation practices can be provided; the final amount is determined by the committee reviewing the application.

Grasslands Reserve Program

The Grassland Reserve Program (GRP) is a voluntary FSA program for landowners and operators to protect grazing uses and related conservation values by conserving grassland, including rangeland, pastureland, shrubland, and certain other lands. Participants voluntarily limit future development and cropping uses of the land while retaining the right to conduct common grazing practices and operations related to the production of forage and seed. The program offers eligible landowners and operators two options: permanent easements and rental contracts of 10-year, 15-year, or 20-year duration. For permanent easements, the GRP offers compensation up to the fair market value of the land concerned minus the grazing value of the land. For rental contracts, the GRP provides annual payments of 75 percent of the grazing value established by the Federal Farm Service Agency, up to $50,000, to a single person or legal entity. Certain grassland easements or rental contracts may also be eligible for cost-share assistance of up to 50 percent of the cost to reestablish grassland functions and values where land has been degraded or converted to other uses. Payments of this cost-share assistance may not exceed $50,000 per year to a single person or legal entity. A grazing management plan is required for participants.

U.S. Department of Agriculture Natural Resources Conservation Service

The USDA's NRCS oversees a number of voluntary conservation programs. These programs work to address a large number of agriculture-related conservation issues including: protecting drinking water, reducing soil erosion, preserving wildlife habitat, and aiding farmers whose farms are damaged by natural disasters. Several NRCS programs that may provide funds or assistance for efforts in the Root River watershed are described below.

Conservation Stewardship Program

The Conservation Stewardship Program (CSP) is a voluntary program that encourages agricultural and forestry producers to address natural resource concerns by undertaking additional conservation activities and by improving and maintaining existing conservation systems. CSP provides financial and technical assistance to help producers conserve and enhance soil, water, air, and related natural resources on their land. Eligible lands include cropland, grassland, improved pastureland, range land, nonindustrial private forest land, and agricultural land under the jurisdiction of an Indian tribe. CSP pays participants for conservation performance, with higher performance resulting in higher payment levels. Average payments in Wisconsin in 2013 were $19 per acre for cropland, $13 per acre for pastureland, and $4 per acre for woodland. Nationally, CSP addresses natural resource concerns related to soil quality, soil erosion, water quality, water quantity, air quality, plant resources, animal resources, and energy. In each state, the program focuses on three to five of these priority concerns. For agricultural land in Wisconsin, the Federal fiscal year 2014 priority resource concerns are soil erosion, water quality, plants, and energy. The program is administered by the NRCS and requires participating producers to enter into renewable five-year contracts.

Emergency Watershed Protection Program

The purpose of the Emergency Watershed Protection (EWP) program is to undertake emergency measures, including the purchase of floodplain easements, for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood, or any other natural occurrence is causing, or has caused, a sudden impairment of the watershed. It is not necessary for a national emergency to be declared for an area to be eligible for assistance. The program objective is to assist sponsors and individuals in implementing emergency measures to relieve imminent hazards to life and property created by a natural disaster. Activities include providing financial and technical assistance to remove debris from streams, protecting destabilized streambanks, establishing cover on critically eroding lands, repairing conservation practices, and purchasing floodplain easements. The program is designed for installation of recovery measures. Typical EWP program practices in Wisconsin include sediment or debris removal; streambank stabilization; levee, dike, and dam repair; grade stabilization; erosion control; floodplain easements; and repairs to large flood control structures. NRCS provides financial assistance up to 75 percent of the construction costs for installing eligible emergency measures to protect lives and property. Sponsors are responsible for providing their 25 percent cost-share. Work must not begin before the execution of an agreement with NRCS.

Since 1996, NRCS has been authorized to purchase floodplain easements on lands that qualify for EWP assistance. Floodplain easements restore, protect, maintain, and enhance the functions of the floodplain; conserve natural values including fish and wildlife habitat, water quality, flood water retention, ground water recharge, and open space; reduce long-term Federal disaster assistance; and safeguard lives and property from floods, drought, and the products of erosion. Floodplain easements are permanent conservation easements that provide the NRCS with the full authority to restore and enhance the floodplain’s functions and values. In exchange, a landowner receives the least of one of the three following values as an easement payment:

- A geographic rate established by the NRCS state conservationist;
- A value based on a market appraisal analysis for agricultural uses or assessment for agricultural land; or
- The landowner offer.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program that supports agriculture and environmental quality as compatible goals. Through EQIP, farmers may receive financial and technical help with structural and management conservation practices on agricultural land. EQIP offers contracts through the NRCS for conservation practice implementation for periods ranging from one to 10 years, and it pays up to 75 percent of the costs of eligible conservation practices. Incentive payments and cost-share payments may also be made to encourage a farmer to adopt land management practices such as nutrient management, manure management, integrated pest management, or wildlife habitat management. EQIP requires that farmers have or develop a conservation plan for the acreage affected by the EQIP practices. Conservation practices must meet NRCS technical standards.

Wetlands Reserve Program

The Wetlands Reserve Program (WRP) is a voluntary program through the NRCS that offers landowners the opportunity to protect, restore, and enhance wetlands on their property. The program’s goal is to achieve the greatest wetland functions and values with optimum wildlife habitat on those lands that are enrolled. It provides landowners with technical assistance and financial incentives and assistance to restore and enhance wetlands in exchange for retiring marginal agricultural land. Lands eligible for WRP are wetlands farmed under natural conditions; farmed wetlands; prior converted cropland; farmed wetland pasture; certain lands that have the potential to become wetlands as a result of flooding; rangeland, pasture, or forest production lands where the hydrology has been significantly degraded and can be restored; riparian areas that link protected wetlands; lands adjacent to protected wetlands that contribute significantly to wetland functions and values; and wetlands previously restored under a local, State, or Federal Program that need long-term protection.

The program offers landowners three options: permanent conservation easements, 30-year conservation easements, and restoration cost-share agreements of a minimum 10-year duration. For permanent easements, the WRP provides an easement payment up to the fair market value of the land concerned, and pays 100 percent of the costs of restoration. For 30-year easements, the WRP pays an easement payment of 75 percent of what would be paid for a permanent easement. In addition, the program pays 75 percent of restoration costs. For restoration cost-share agreements, the WRP pays up to 75 percent of restoration costs. Under the easement options, the USDA will pay all costs associated with recording the easement in the local land records office, including recording fees, charges for abstracts, survey and appraisal fees, and title insurance. Under the voluntary easement the landowner retains the rights to control of access, title and right to convey title, quiet enjoyment, undeveloped recreational uses, subsurface resources, and water rights.

WILDLIFE HABITAT INCENTIVE PROGRAM

The Wildlife Habitat Incentive Program (WHIP) is a voluntary program for developing or improving high-quality habitat that supports fish and wildlife populations of National, State, tribal, and local significance. Through WHIP, the NRCS provides technical and financial assistance to private and tribal landowners for the development of upland, wetland, aquatic, and other types of wildlife habitat. Land eligible for WHIP includes private agricultural land including cropland, grassland, rangeland, pasture, and other land determined by NRCS to be suitable for fish and wildlife habitat development; nonindustrial private forest land, including rural land that has existing tree cover or is suitable for growing trees; and tribal land.

A WHIP plan of operations, which is required for the area covered in the application, becomes the basis for developing the WHIP cost-share agreement. Standard cost-share agreements between NRCS and the participant are for a minimum of one year after completion of the last conservation practice and they can extend up to 10 years. NRCS will reimburse up to 75 percent of the cost to install conservation practices for permanent priority fish and wildlife habitat. Participants are expected to maintain the cost-shared practices for their anticipated life spans. Up to 25 percent of WHIP funds will be available for long-term cost-share agreements with periods of 15 years or longer to protect and restore essential plant and animal habitat. NRCS can pay up to 90 percent of the cost to install conservation practices under these long-term agreements.

U. S. Environmental Protection Agency

ENVIRONMENTAL JUSTICE SMALL GRANT PROGRAM

The USEPA’s Environmental Justice Small Grant Program provides financial assistance to community-based organizations that work on local solutions that address local environmental or public health issues. The primary purpose of proposed projects should be to develop a comprehensive understanding of environmental and public health issues, identify ways to address these issues at the local level, and educate and empower the community. The long-term goals of the program are to help build the capacity of the affected community and create self-sustaining, community-based partnerships that will continue to improve local environments in the future. Funds from this program can be used to support nonprofit organizations with activities that address environmental justice concerns, including but not limited to: increasing awareness of and lessening impacts from stormwater; actively addressing harmful air particles that affect the health and well being of residents; building capacity of community leaders, adults, and youth through health data collection activities and watershed education; promoting the connection of health issues to environmental quality through comprehensive outreach and education; reducing pesticide exposure and improving health of farm workers by training health care providers about pesticide exposure; monitoring farm workers' working conditions; and encouraging healthy, environmentally friendly alternatives to industrially produced agriculture.

Incorporated nonprofit organizations and Federally recognized Native American tribal governments are eligible to apply. Applicants must be located within the same state(s), territory, commonwealth, or tribe that the proposed project will be located. In addition, an eligible applicant must be able to demonstrate that it has worked directly with the affected community. An "affected community" for the purposes of this assistance program is a community that is disproportionately impacted by environmental harms and risks and has a local environmental and public health issue that is identified in the proposal.

Project grants are awarded for a one-year project period. Grants range from $20,000 to $50,000, with an average grant of $30,000. The program has no matching fund requirements.

TARGETED WATERSHED GRANT PROGRAM

The Targeted Watersheds Grant Program provides resources in the form of grants or cooperative agreements to support watershed organizations in their efforts to expand and improve existing water protection measures. In separate competitive announcements, funds are awarded to assist watershed partnerships comprised of state, tribal, local, and interstate agencies, and public or nonprofit organizations in developing, implementing, and demonstrating:

- On-the-ground projects to improve or maintain water quality; and

- Organizational and technical capacity building projects that place organizations in a position to implement on-the-ground watershed projects.

Funds are used to support both on-the-ground and educational activities relating to the prevention, reduction, and elimination of water pollution. Funds are awarded to eligible entities that best meet the selection criteria described in the request for proposals.

Applications are made in response to a request for proposals. Eligible applicants include states, local governments, public and private nonprofit organizations, Federally recognized Indian tribal governments, U.S. territories or possessions, and interstate agencies. Applicants are required to demonstrate a minimum nonfederal match of 25 percent of the total cost of the project or projects. The match may be cash or in-kind consistent with the regulation governing match requirements

URBAN WATERS SMALL GRANT PROGRAM

The goal of the Urban Waters Small Grants program is to fund research, investigations, experiments, training, surveys, studies, and demonstrations that will advance the restoration of urban waters by improving water quality through activities that also support community revitalization and other local priorities. Through this program, USEPA awards grants of $40,000 to $60,000 each to support such projects. In general, projects should promote a comprehensive understanding of local water quality issues; identify and support activities that address these issues at the local level; engage, educate and empower communities surrounding the urban waterbody; and benefit surrounding communities, including those that have been adversely impacted by the water pollution issues affecting the urban waterbody. Examples of projects that are eligible for funding under this program include, but are not limited to, those that:

- Foster collaboration and/or coordinate a partnership among diverse stakeholders, including industry, environmental groups, upstream and downstream interests (actors), etc., to develop a plan or study;

- Develop educational programs to provide training and recognition to schools, business, and homeowners on how to implement practices that reduce the amount of water pollution and/or stormwater entering the waterbody, or promote low-impact design and/or green infrastructure practices;

- Map trails and other walkways along waterbodies to identify gaps or areas where additional connectivity is needed;

- Establish a baseline monitoring program for routine water quality monitoring and support and/or establish monitoring to identify areas of concern and possible places where restoration efforts can be effectively targeted; and

- Provide education and training related to preparing community members for anticipated jobs in green infrastructure, water quality restoration, or other water quality improvement projects (i.e., green jobs).

Wisconsin Citizen-Based Monitoring Partnership Program

Since 2004, the Wisconsin Department of Natural Resources and the Wisconsin Citizen-Based Monitoring Network have sought to expand citizen and volunteer participation in natural resource monitoring by providing funding and assistance with high-priority projects. Qualifying topics include monitoring of aquatic and terrestrial species; natural communities; and environmental components such as water, weather, and soil. Eligible projects include those that:

- Have direct, substantial citizen involvement or are relevant to the conduct of citizen-based projects;

- Are specifically intended for Wisconsin and, in most cases, carried out in Wisconsin;

- Address priority Wisconsin natural resource monitoring needs or issues; and

- Are current with all deliverables for past Partnership Program projects.

Requests for proposals are issued in the spring of each year. In recent years, a total of between $75,000 and $100,000 has been available annually for projects throughout the State.

Wisconsin Coastal Management Grant Program

The Wisconsin Coastal Management Program is administered by the Wisconsin Department of Administration's Bureau of Intergovernmental Relations. This program is dedicated to preserving and making accessible the natural and historic resources of Wisconsin's Great Lakes coasts. The program works cooperatively with State, local, and tribal government agencies and nonprofits in managing the ecological, economic, and aesthetic assets of the Great Lakes and their coastal areas. Grants are available for coastal wetland protection and habitat restoration, nonpoint source pollution control, coastal resources and community planning, Great Lakes education, public access, and historic preservation. Approximately $1.5 million is available through the program annually. Eligible applicants include local units of government, State agencies, colleges and universities, school districts, regional planning commissions serving coastal areas, tribal units of government, and private nonprofit organizations. Projects with budgets totaling $60,000 or less require a 50 percent local match. Projects with budgets larger than $60,000 require a 60 percent local match.

Wisconsin Department of Safety and Professional Services

WISCONSIN FUND PRIVATE ONSITE WASTEWATER TREATMENT SYSTEM
REPLACEMENT OR REHABILITATION FINANCIAL ASSISTANCE PROGRAM

The Wisconsin Fund Private Onsite Wastewater Treatment System Replacement or Rehabilitation Financial Assistance Program provides financial assistance for the replacement or rehabilitation of failing private onsite wastewater treatment system serving a principal residence or small commercial business. Applicants must meet specified income limits. In addition, the failing system serving the residence or business must have been constructed prior to July 1, 1978. Septic systems that fail by discharging to surface water, groundwater, or zones of seasonally saturated soils receive funding priority. The maximum grant award is $7,000.

Wisconsin Environmental Education Board Grant Program

The Wisconsin Environmental Education Board (WEEB) awards grants for the development, dissemination, and implementation of environmental education programs. Grants are awarded in three areas: general environmental education, forestry education, and water education. Eligible applicants include State agencies, local units of government, public school districts, private schools, public and private colleges and universities, and nonprofit corporations. WEEB awards three types of grants: mini-grants ranging between $1 and $1,000, small grants ranging between $1,001 and $5,000, and large grants ranging between $5,001 and $10,000. These grants require minimum matching funds of 25 percent of the requested amount. This match may consist of funding, supplies, or in-kind labor.

All grant funded projects must provide learning opportunities tied to one of the goals identified within *Wisconsin's Plan for Environmentally Literate and Sustainable Communities*.[15] These goals are:

1. Build awareness of environmental literacy and sustainable communities;

2. Promote access to information and educational experiences needed to support environmental literacy and sustainable communities at home, work, school, and play;

3. Build the capacity of individuals, organizations, businesses, and governments to advance environmental literacy and sustainable communities;

4. Promote research and/or assessment to identify strategies that advance environmental literacy and sustainable communities. Assess progress toward environmental literacy and sustainable communities; and

5. Identify, develop, share, or secure funding strategies and resources to advance environmental literacy and sustainable communities.

Water Quality, Habitat, and Recreation

Great Lakes Fishery Trust

The Great Lakes Fishery Trust provides funding to nonprofit organizations, educational institutions, and governmental agencies to enhance, protect, and rehabilitate Great Lakes fishery resources. The Trust provides funding in three broad areas: access to the Great Lakes fishery, ecosystem health and sustainable fish populations, and Great Lakes stewardship. Funding priorities related to access to the Great Lakes fishery include construction of new access sites, upgrading and renovating existing access sites, engineering and feasibility studies for proposed access sites, land acquisition to support access site development, and communication and outreach efforts regarding existing shore-based angling opportunities. Funding priorities related to ecosystem health and sustainable fish populations include targeted acquisition of land or easements to protect essential habitat, restoration of Great Lakes wetlands, removal of dams or barriers to restore fish passage, and targeted evaluations of new or experimental approaches in habitat restoration and fish passage. Funding priorities related to Great Lakes stewardship include projects that build understanding at the ecosystem or watershed level and promote taking related action on Great Lakes issues including protecting biological diversity, sustaining commercial and recreational fisheries, controlling nonnative nuisance species, and reducing pollution, as well as those that promote environmental stewardship through direct experiences with natural resources or promote awareness of, and access to, existing Great Lakes stewardship education programs and resources.

There are no cost or time limitations on grant requests; however, potential projects are evaluated on the costs versus the expected benefits as well as upon the reasonableness of the time requested to complete the project. The fund accepts proposals for different funding categories at different times throughout the year.

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[15]*Wisconsin Environmental Education Board, Wisconsin Environmental Education Foundation, and Wisconsin Environmental Education Association,* Wisconsin's Plan for Environmentally Literate and Sustainable Communities, *no date.*

Root-Pike Watershed Initiative Network Watershed-Based Grant Program

The Root-Pike WIN Watershed-Based Grant Program awards grants to fund a variety of community-based projects in the Root River, Pike River, and Oak Creek watersheds and in the associated Lake Michigan direct drainage area. The types of projects funded include environmental restoration efforts, planning studies and projects, research studies on topics related to restoration and management of the watersheds, construction and installation of recreational access facilities, workshops, and educational efforts. The focus areas for grants include projects to reduce and prevent water, soil, and air pollution from urban and rural sources; projects to establish or improve education and communication about watershed issues; projects that protect or restore natural areas; and projects that improve public access to rivers, streams, lakes, and other public waterways. Potential projects are evaluated based on the degree to which they meet Root-Pike WIN's mission and vision; follow the recommendations of or best management practices suggested by agencies such as SEWRPC and the WDNR; protect unique environmental, archaeological, or cultural areas; can be duplicated throughout the watershed; encourage partnerships and leverage resources; balance a long-term focus with short-term results; and promote excellence by fostering a sense of pride and identification in the watershed. Grants are awarded annually and awards generally range between $500 and $10,000, subject to the availability of funds. Eligible applicants include nonprofit organizations, units of government, or other public agencies. Applications for grants are due October 1.

Wisconsin Department of Natural Resources

The WDNR administers several grant and loan programs that support efforts by local governments, private organizations, and private landowners to protect public health, the environment, and outdoor recreation. Several WDNR programs that may provide funds or assistance for efforts in the Root River watershed are described below.

AQUATIC INVASIVE SPECIES PREVENTION AND CONTROL GRANT PROGRAM

The Aquatic Invasive Species Prevention and Control Grant Program was established to help prevent and control the spread of aquatic invasive species in the waters of the State. It provides a State cost-share of up to 75 percent of the cost of projects in a variety of categories to local units of government, lake districts, qualified school districts, colleges, universities, vocational and technical schools, qualified nonprofit organizations, river management organizations, qualified lake associations, and State and Federal natural resource or land management agencies. Eligible projects include education, prevention, and planning projects; projects to control established populations; early detection and response projects; maintenance and containment projects; and research and demonstration projects. The maximum grant awards vary with the type of project. A simplified application process is available for grants to fund Clean Boats Clean Water landing inspection programs. Annual deadlines for applications are February 1 and August 1.

COUNTY CONSERVATION AIDS

Funds are available to enhance county fish and wildlife programs per Section 23.09(12) of the *Wisconsin Statutes* and NR 50 of the *Wisconsin Administrative Code*. County and tribal governing bodies participating in the county fish and wildlife programs are eligible to apply. The State may pay a maximum of 50 percent of the eligible actual project costs. The current statewide annual allocation of funds is about $150,000.

ENVIRONMENTAL IMPROVEMENT FUND LOANS PROGRAM

The Wisconsin Environmental Improvement Fund (EIF) is the means through which the State makes use of the USEPA Clean Water State Revolving Fund. The EIF encompasses two environmental financing programs for local governments: the Clean Water Fund Program (CWF) and the Safe Drinking Water Fund Program. The CWF provides low-interest loans for nonpoint source pollution abatement projects, estuary protection projects, and the construction and modification of municipal wastewater treatment facilities. The Wisconsin Departments of Administration and Natural Resources jointly administer the CWF loan program. Cities, towns, villages, counties, town sanitary districts, public inland lake protection and rehabilitation districts, metropolitan sewerage districts, and Federally recognized tribal governments are eligible to apply. In addition to the regular loans under the CWF, small loans are available for projects with total project costs of less than $1,000,000, a pilot projects program is available to fund nontraditional activities intended to allow a wastewater treatment plant to meet its permit limits,[16] and hardship financial assistance is available for municipalities with low income and high user costs.

Knowles-Nelson Stewardship Program

The Knowles-Nelson Stewardship Program was established to preserve the State's most significant land and water resources for future generations and to provide the land base and recreational facilities needed for quality outdoor experiences. The program achieves these goals by funding the acquisition of land and easements for conservation and recreation purposes, developing and improving recreational facilities, and restoring wildlife habitat. The program provides grants for a variety of purposes including natural areas, habitat areas, streambank protection, State trails, acquisition and development of local parks, county forests, urban green space, and urban rivers. The program provides 50 percent matching grants to local units of government and qualified nonprofit conservation organizations for the acquisition of land and easements.

Lake Management Planning Grant Program

The purpose of the lake management grants is to collect and analyze information needed to protect and restore lakes and their watersheds. Counties, towns, cities, villages, tribes, qualified nonprofit conservation organizations, qualified lake associations, qualified school districts, public inland lake protection and rehabilitation districts, town sanitary districts, and other local governmental units that are established for the purpose of lake management, are eligible to apply for funding to collect and analyze information needed to protect and restore lakes and their watersheds.

Two types of grants are available: grants for small-scale planning projects and grants for large-scale planning projects. Small-scale planning primary objectives include: public education and awareness, obtaining basic information on lake use and conditions, and enhancing organizational capacity. These will be protection-oriented, often volunteer-led efforts that can be used to develop a foundation for lake management efforts or updating existing plans. Examples of projects eligible for small-scale grants include lake monitoring projects; lake education projects; organizational development projects; and studies, assessments, and other activities needed to develop management goals. Large-scale projects are intended to address the needs of larger lakes and lakes with complex and technical planning challenges. The intent of these projects is to create a land management plan. This plan may require more than one grant to complete. Examples of projects eligible for large-scale grants include gathering and analysis of physical, chemical, and biological information on lakes; describing present and potential land uses within lake watersheds and on shorelines; reviewing jurisdictional boundaries and evaluating ordinances that relate to zoning, sanitation, pollution control, or surface use; assessments of fish, aquatic life, wildlife, and their habitats; and developing, evaluating, publishing, and distributing alternative courses of action and recommendations in a lake management plan.

Applications must be received in WDNR regional offices and postmarked no later than February 1 for the spring grant cycle and August 1 for the fall grant cycle.

Land and Water Conservation Fund Grant Program

The WDNR administers the Land and Water Conservation Fund Grant Program utilizing funds from the U.S. Department of Interior. Under this program, counties, cities, villages, towns, tribal governments, school districts and other State political subdivisions are eligible to apply for grants for acquisition and/or development of public outdoor recreation areas and facilities. Eligible projects under this program include:

- Land acquisition or development projects that will provide opportunities for public outdoor recreation;

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[16] *Practices implemented under an adaptive management plan or a water quality trading plan could be considered eligible as pilot projects.*

- Acquisition of property with frontage on rivers, streams, lakes, estuaries and reservoirs that will provide water-based outdoor recreation;

- Natural areas and outstanding scenic areas, where the objective is to preserve the scenic or natural values, including wildlife areas and areas of physical or biological importance; and

- Acquisition of land for or development of nature-based outdoor recreation trails.

Projects are eligible to receive up to 50 percent cost-share funding.

LAKE PROTECTION GRANT PROGRAM

The Lake Protection Grant program was designed to assist local governments, lake districts and associations, and other nonprofit organizations in improving and protecting water quality in lakes. A 75 percent State cost-share is available, with a 25 percent local match. The maximum grant awarded is $200,000. Projects that are eligible for cost-share assistance include land acquisition for easement establishment, wetland restoration, and various lake improvement projects such as those involving pollution prevention and control, diagnostic feasibility studies, and lake restoration. The annual deadline for application is May 1.

LANDOWNER INCENTIVE PROGRAM

The Landowner Incentive Program helps private landowners create and manage habitat for species that are rare or declining. This program provides management advice, assistance with management plans, and cost-share funding to individuals and organizations on private lands throughout the state. Technical assistance is available to Wisconsin landowners free of charge, and is not contingent on applying for or receiving a cost-share grant. This technical assistance can include identifying what habitats or species may be present on a parcel or land, suggesting approaches to management, providing help in determining priorities and timelines, providing guidance in developing management plans, providing referrals for cost or technical assistance through a variety of programs, and providing information on land protection options. This program can also reimburse landowners for up to 75 percent of the cost for the on-the-ground practices that are involved in the management of the project. The landowner is required to contribute the matching percentage. Funds are not currently available for new projects.

RECREATIONAL TRAILS AIDS PROGRAM

Municipal governments and incorporated organizations are eligible to receive reimbursement for development and maintenance of recreational trails and trail-related facilities for both motorized and nonmotorized recreational trail uses. Eligible sponsors may be reimbursed for up to 50 percent of eligible project costs. Funds from this program may be used in conjunction with funds from the state snowmobile or ATV grant programs and Knowles-Nelson Stewardship development projects. Eligible projects include maintenance or restoration of existing trails, development or rehabilitation of trailside and trailhead facilities and trail linkages, construction of new trails, and property acquisition for trails.

RIVER PROTECTION GRANT PROGRAM

The River Protection Grant Program as set forth in Chapter NR 195 of the *Wisconsin Administrative Code* is designed to assist local governments, lake districts, qualified lake associations, qualified river management organizations, and other qualified nonprofit organizations in improving and protecting water quality in rivers. This program provides a 75 percent State cost-share and requires a 25 percent local match. Cost-share funding cannot exceed $10,000 for any single planning project or $50,000 for a management projects. Projects that are eligible for cost-share include planning activities such as organizational projects related to forming or sustaining river management organizations, education projects, and management plan development and management activities such as land acquisition, easement establishment, ordinance development, installation of nonpoint source abatement projects, river restoration projects, and river plan implementation projects.

TARGETED RUNOFF MANAGEMENT GRANT PROGRAM

The Targeted Runoff Management (TRM) Grant Program offers competitive grants for local governments for controlling nonpoint source pollution. Grants reimburse costs for agriculture or urban runoff management practices in targeted, critical geographic areas with surface water or groundwater quality concerns. Cities; villages; towns; counties; regional planning commissions; tribal governments; and special purpose lake, sewerage, and sanitary districts are eligible to apply for funding under this program. Grant monies may fund the construction of best management practices (BMPs) to control nonpoint source pollution. They can also fund BMP design as part of a construction project. The cost-share rate for TRM projects is up to 70 percent of eligible costs. Grant recipients must comply with program conditions, provide the local portion of the project costs, install all BMPs constructed under these programs, and maintain BMPs for 10 years. If applicants are providing these grant funds to private landowners, a similar contractual agreement is required between the applicant and the landowner.

Several types of grants are available. For large-scale, nonTMDL projects, only agricultural projects implementing State agricultural performance standards and prohibitions are eligible. These projects may be located in any area to protect or restore surface water or groundwater; however, the project area may not be smaller than eight square miles or larger than 39 square miles. Eligible costs include those related to the construction of structural BMPs, implementation of nonstructural cropping practices, and some staffing costs to plan and install management practices. These projects have durations of three to four years. Typical grants awarded range between about $500,000 and $1,000,000.

For small-scale, nonTMDL projects, only agricultural projects implementing State agricultural performance standards and prohibitions are eligible. These projects may be located in any area to protect or restore surface water or groundwater. These projects have durations of two to three years. Grants awards are limited to $150,000.

Funding is also available for large- and small-scale projects designed to meet TMDL goals approved by the USEPA.

Urban Forestry Grant Program

The WDNR offers urban forestry grants to counties, cities, villages, towns, tribes, and 501(c)(3) nonprofit organizations conducting projects in Wisconsin. These grants fall into three categories: regular grants, startup grants, and catastrophic storm grants.

Regular urban forestry grants support projects that improve a community's capacity to manage its trees. Current emphases are on projects that create emerald ash borer preparedness, projects that improve the entire urban forest canopy, and innovative projects that act as a model for other projects. Grants provide 50 percent of project costs and range between $1,000 and $25,000. They require the project sponsor to provide a local share of 50 percent of project costs. Eligible projects include tree inventories, canopy assessments, urban forestry management plans, tree ordinance development, public outreach, staff or volunteer training, tree planting, tree maintenance, and tree removal. Applications for regular urban forestry grants are due October 1.

Urban forestry startup grants support small projects focused on initial steps in community tree care and management. A long-term goal for applicants should be the development of a sustained community tree management program. Grants provide 50 percent of project costs and range between $1,000 and $5,000. They require the project sponsor to provide local share of 50 percent of project costs. Eligible projects include no more than two of the following: tree planting, tree pruning and/or removal, tree inventory and/or management plan, or public outreach. Applications for regular urban forestry grants are due October 1.

Urban forestry catastrophic storm grants provide funds for tree repair, removal, or replacement within urban areas following a catastrophic storm event for which the Governor has declared a State of Emergency under Section 166.03 of the *Wisconsin Statutes*. A catastrophic storm means damage to urban forests caused by snow, ice, hail, wind, or tornado. Grants range between $4,000 and $50,000. No local share is required.

Urban Nonpoint Source and Storm Water Management Grant Program

The Urban Nonpoint Source and Storm Water Management Grant Program offers competitive grants to local governments to reimburse the costs of planning or construction projects to control urban stormwater runoff pollution. Cities; villages; towns; counties; regional planning commissions; tribal governments; and special-purpose lake, sewage, or sanitary districts may apply. The local government must have either jurisdiction over the project area or be required to control stormwater discharges with an inter-governmental agreement between the municipality and the WDNR. Eligible areas are urban lands with population density of at least 1,000 people per square mile or nonpermitted commercial or municipally owned industrial uses.

Two types of grants are available under this program: planning grants and construction grants. Eligible projects for planning grants include stormwater management planning for urban areas, preparation of local ordinances affecting stormwater discharge, evaluation of local financing options for stormwater utilities, administrative costs for initial establishment of local stormwater management funding programs, illicit discharge detection and elimination, and public information and education activities. Eligible projects for construction grants include construction of structural urban best management practices, engineering design and construction services for best management practice installation, land acquisition and easement purchase, storm sewer rerouting and removal of structures, and streambank and shoreline stabilization. The maximum possible grant is $200,000, with $150,000 for construction activities and $50,000 for land acquisition and easements.

WEED MANAGEMENT AREA PRIVATE FOREST GRANT PROGRAM

The Weed Management Area Private Forest Grant Program assists eligible weed management groups in addressing invasive plants, both by dealing directly with the invasive plants and by providing information, education, and outreach to others. This program provides reimbursement of 75 percent of eligible costs and requires a 25 percent match. Grants under this program may not exceed $15,000 to any weed management group. Eligible costs include education, information, and outreach; coordinating a weed management group; inventories of invasive plant species occurrences; control of invasive plant species that impact nonindustrial private forest land; monitoring; long-term invasive plant management plan development; and miscellaneous practices pertaining to management of invasive plants that impact forests including reforestations, forest improvement, soil and water protection and improvement, wetland and riparian area protection and improvement, and terrestrial wildlife and habitat enhancement. Applications are due April 1.

Habitat

Southeastern Wisconsin Invasive Species Consortium, Inc.

The Southeastern Wisconsin Invasive Species Consortium, Inc. (SEWISC) periodically has funds available to support worthwhile projects designed to lessen the impacts of invasive species in southeastern Wisconsin. SEWISC assistance funds are most often designated for on-the-ground invasive species control work, and must be used in the eight-county SEWISC region. Grant funds may be used to accomplish a specific project or to support an ongoing program; however, preference is given to projects that demonstrate a long-term commitment to invasive species control, especially continued control of the particular invasive species populations targeted by the project. In some instances funding is earmarked for specific types of projects, such as on-the-ground invasive species control. Depending on the source of the funding, individuals, established nonprofit organizations, community and civic groups, private businesses, or units of government may be eligible to receive funds. Funded projects require a match that equals at least 25 percent of the total project budget. In-kind services such as volunteer labor can be used for this match. When funds become available, SEWISC posts notice on their website (*sewisc.org*) and makes announcements via their newsletter and electronic mail lists.

U.S. Army Corps of Engineers Aquatic Ecosystem Restoration Program

Under the authority provided by Section 206 of the Water Resources Development Act of 1996, the Corps may plan, design, and build projects to restore aquatic ecosystems for fish and wildlife. Projects must improve the quality of the environment, be in the public interest, demonstrate cost effectiveness and have a Federal cost-share of no more than $5.0 million in total cost. Recreation projects, if justified, may be included in the total project, but they may not increase the Federal share of the total project by more than 10 percent, and any recreational component should not detract from ecosystem benefits.

The process for Section 206 projects begins after a nonfederal sponsor requests Corps of Engineers assistance under the program. When funding is available, the Corps prepares a feasibility study, beginning with an estimate of the overall scope and cost of the study and a determination of whether the project is in the Federal interest. The feasibility study formulates alternatives to achieve the restoration, evaluates the environmental effects of the alternatives, documents the project requirements, and provides a scope and cost estimate for project implementation. If the feasibility report recommends a plan for implementation, the Corps of Engineers prepares project plans and specifications and obtains any required Federal permits. The Corps of Engineers then manages construction of the project by a private contractor.

Nonfederal sponsors must be public agencies or national nonprofit organizations capable of undertaking future requirements for operation, maintenance, repair, replacement, and rehabilitation, or may be any nonprofit organization if there are no future requirements for operation, maintenance, repair, replacement, and rehabilitation. All potential sponsors must be able to provide any required lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas. The affected local government must consent to the nonprofit entity being a sponsor.

The Corps of Engineers provides the first $100,000 of feasibility study costs. A nonfederal sponsor must contribute 50 percent of the cost of the feasibility study after the first $100,000 of expenditures, 35 percent of the cost of design and construction, 50 percent of the cost of recreational features, and 100 percent of the cost of operation and maintenance. The sponsor receives a credit for the value of real estate necessary to implement the project. The entire nonfederal share of the project cost may be credited as work in kind, but, to receive credit, the services must be provided after a formal Feasibility Study Cost Sharing Agreement or Project Cooperation Agreement is signed.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service oversees several programs that provide funding and technical support for the conservation, protection, and enhancement of fish and wildlife and their habitat.

FISH AND WILDLIFE MANAGEMENT ASSISTANCE PROGRAM

The Fish and Wildlife Management Assistance Program provides technical and financial assistance for the conservation and management of fish and wildlife resources, including minimizing the establishment, spread, and impact of aquatic invasive species. Eligible applicants include other Federal agencies, state agencies, local governments, Native American organizations, other public institutions and organizations, and private nonprofit organizations. Grant awards range between $1,000 and $750,000, with an average grant of $75,000. This program has no matching requirements; however, partner contributions of at least 50 percent of project costs are encouraged. The extent of partner contributions may be a factor in selection of projects to be funded.

Funds may be used to conduct fish and wildlife management activities that align with the conservation, restoration, and management goals and priorities of the Fish and Wildlife Conservation Offices, including goals and priorities identified by the National Fish Passage Program and individual partnerships under the National Fish Habitat Partnership. Restoration work can consist of habitat construction activities such as culvert replacements, dam removals, fishway construction, installation of fish habitat structures and vegetation plantings. Examples of funded activities include habitat restoration, monitoring and assessment, removal of barriers to passage, fish propagation, and aquatic plant establishment. This also includes efforts to minimize the establishment, spread, and impact of aquatic invasive species. Technical assistance—in the form of advice on biological, chemical, and/or physical aspects of a project—is also available to awardees. Awardees are expected to include a public outreach component in their project.

GREAT LAKES FISH AND WILDLIFE RESTORATION ACT GRANT PROGRAM

The Great Lakes Fish and Wildlife Restoration Act Grant Program provides Federal grants on a competitive basis to states, tribes, and other interested entities to encourage cooperative conservation, restoration and management of fish and wildlife resources and their habitat in the Great Lakes basin. The projects are funded under authority of the Great Lakes Fish and Wildlife Restoration Act of 2006. The purpose of the Act is to provide assistance to States, Indian tribes, and other interested entities to encourage cooperative conservation, restoration, and management of the fish and wildlife resources and their habitats in the Great Lakes Basin. States, Federally recognized tribal governments, and Native American treaty organizations within the Great Lakes Basin are eligible to receive funding. Local governments, nongovernmental organizations, universities, and conservation organizations may receive funding if sponsored by a State, tribal government, or treaty organization.

All proposals should focus on the restoration of fish and/or wildlife resources and their habitats in the Great Lakes Basin and should be consistent with the goals of the Great Lakes Fish and Wildlife Restoration Act of 2006 and the recommendations of the Great Lakes Regional Collaboration's *Strategy to Restore and Protect the Great Lakes*.[17] Examples of recently funded projects include dam removals, wetland restorations, riparian restorations, and invasive species removal.

Project costs for successful projects have ranged between $2,500 and $2,000,000, with the cost of the average project being about $113,000. A nonfederal match of a least 25 percent of the total project cost is required. This match can consist of cash and/or in-kind support. The value of land in easement or fee title is not eligible as a match. In addition, Grant funds cannot be used to purchase land or easements; however, the costs associated with preparing for the purchase of land or easements directly tied to the project are eligible.

North American Wetlands Conservation Fund

The North American Wetlands Conservation Fund provides grant funds for wetlands conservation projects in the United States, Canada, and Mexico. This program has both a standard grant program and a small grant program. Eligible applicants include public and private organizations and individuals who have developed partnerships to carry out wetlands conservation.

The Standard Grants Program supports projects in Canada, the United States, and Mexico that involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats. Awards range between $75,000 and $1,000,000, with an average award of $710,000.

The Small Grants Program operates only in the United States. It supports the same type of projects and adheres to the same selection criteria and administrative guidelines as the U.S. Standard Grants Program; however, project activities are usually smaller in scope and involve fewer project dollars. Grant requests may not exceed $75,000. Funding priority is given to grantees or partners new to the grant programs administered under the North American Wetlands Conservation Act.

Grant funds from this program may be used to acquire real property interest in lands or waters, or to restore, manage, and/or enhance wetland ecosystems and other habitat for migratory birds and other fish and wildlife. Projects must provide long-term conservation for wetlands-associated migratory birds and other wetlands-associated wildlife. The required matching share varies on a grant-by-grant basis and is set forth in the grant award, but must be at least 50 percent of the project costs, with the exception that any project activities located on Federal lands and waters can be funded with 100 percent Federal funding.

The application deadlines for the Standard Grant Program are February 28 and July 8. The deadline for the Small Grants Program is November 7.

Partners for Fish and Wildlife Program

The Partners for Fish and Wildlife (PFW) Program is a voluntary, incentive-based program that provides direct technical assistance and financial assistance in the form of cooperative agreements to private landowners to restore and conserve fish and wildlife habitat for the benefit of resources under the trusteeship of a Federal department. Locally based field biologists work one-on-one with private landowners and other partners to plan, implement, and monitor their projects. Any privately owned land is potentially eligible for restoration, including working farms and recreation lands. Most participants are individual private landowners. Major priorities in the Midwest include the restoration of wetlands, grasslands, forests, and stream corridors. Prior to implementation of habitat projects, the program requires that the landowner and project biologist sign an agreement that specifies the work to be done and financial contributions. The minimum length of the agreement is 10 years, although longer

[17] *Great Lakes Regional Collaboration*, Strategy to Restore and Protect the Great Lakes, *December 2005.*

time commitments are encouraged. There is no minimum cost-share requirement, although projects with a higher cost-share, especially from the landowner, are more competitive. Cost-share may be provided as in-kind services or cash. The landowner must agree to maintain the restoration project throughout the agreement period. Funds for individual projects are limited to $25,000.

U.S. Forest Service

COMMUNITY FOREST AND OPEN SPACE PRESERVATION PROGRAM

The Community Forest and Open Space Preservation Program provides funding for the acquisition of community forests by local governments, tribal governments, and qualified nonprofit entities. The program pays up to 50 percent of project costs and requires a 50 percent nonfederal match. Individual grant applications may not exceed $400,000. The lands acquired must be at least five acres in size, at least 75 percent forested, and suitable to sustain natural vegetation. Priority is given to projects that contribute to a landscape conservation initiative. The program requires that the forests provide continuing community benefits and that public access is provided to the forests.

Recreation

PeopleForBikes Community Grant Program

The PeopleForBikes Community Grant Program provides funding for important and influential projects that leverage Federal funding and build momentum for bicycling in communities across the U.S. This program supports bicycle infrastructure projects and targeted advocacy initiatives that make it easier and safer for people of all ages and abilities to ride. Eligible applicants include nonprofit organizations with a focus on bicycling, active transportation, or community development; from city or county agencies or departments; and State or Federal agencies. Grants are given to support a specific project or program. In most cases the funds are provided for projects that focus on bicycle infrastructure projects such as:

- Bike paths, lanes, and bridges;
- Bike parks and pump tracks; and
- End of trip facilities, such as bike racks, bike parking, and bike storage.

Eligible costs include engineering and design work, construction costs including materials, labor, equipment rental, and reasonable volunteer support costs. The maximum grant is $10,000. While the program does not require a specific percentage match, leverage and funding partnerships are carefully considered during application review. This program does not consider grant requests in which the grant would amount to 50 percent or more of the project budget.

Applications are made with a letter of interest submitted through PeopleForBikes website. Based upon the letter of interest, organizations will be invited to submit a full application. PeopleForBikes generally holds one to two open grant cycles every year, with letters of interest due in January and August.

Wisconsin Department of Transportation

CONGESTION MITIGATION AND AIR QUALITY IMPROVEMENT PROGRAM

The Congestion Mitigation and Air Quality Improvement Program provides funding for transportation projects that improve air quality and reduce traffic congestion in counties classified as air quality nonattainment or maintenance areas for the Federal criteria pollutants ozone and particulate matter. Funds are available to counties, local units of government, transit operators, and state agencies. Private entities interested in applying for funds must find a public sponsor with taxing authority to sponsor a project application. Applicants must provide at least a 20 percent match of the project's total cost. Project sponsors must pay project costs and then seek reimbursement through the Wisconsin Department of Transportation. Construction projects costing $200,000 or more are eligible for funding, as are nonconstruction projects costing $50,000 or more. Projects must comply with applicable Federal and State requirements. Examples of eligible projects include pedestrian and bicycle facilities.

The funds are made available through a competitive application process that generally takes place in odd-numbered calendar years. Applications are typically available in late January and due in April.

TRANSPORTATION ALTERNATIVES PROGRAM

The Transportation Alternatives Program is available to State and local units of government to assist with projects designed to enhance the transportation system and mitigate some of the effects of the transportation network. With some exceptions, projects that were eligible for funding under the former Bicycle and Pedestrian Facilities Program, Safe Routes to School Program, and/or Transportation Enhancements Program are eligible under the Transportation Alternatives Program. Local governments with taxing authority, State agencies, and Indian tribes are eligible for funding. Construction projects costing $200,000 or more are eligible for funding, as are nonconstruction projects costing $50,000 or more. Under this program, project sponsors pay for a project and seek reimbursement from the Wisconsin Department of Transportation. This program will provide up to 80 percent of project costs. The sponsor must provide at least 20 percent of project costs. Projects must relate to surface transportation. In addition, projects must fall into one of 12 categories specified in the Federal Moving Ahead for Progress in the 21st Century Act (MAP-21). Categories most relevant to the Root River Watershed Restoration Plan include:

- Provision of facilities for pedestrians and bicycles;
- Preservation of abandoned railway corridors; and
- Mitigation of water pollution due to highway runoff or reduction of vehicle-caused wildlife mortality.

Completed projects must be usable and not staged so that additional money is needed to create a useful project.

Flooding (Racine County) and Horlick Dam

Federal Emergency Management Agency Programs

Several Federal Emergency Management Agency (FEMA) programs provide funding for flood mitigation activities. In the State of Wisconsin these programs are administered through the Wisconsin Department of Military Affairs, Division of Emergency Management. These programs are described below.

FLOOD MITIGATION ASSISTANCE PROGRAM

The Flood Mitigation Assistance (FMA) program can provide up to 75 percent of the costs attendant to the acquisition, relocation, elevation, and floodproofing of structures in compliance with NFIP standards. In addition to participating in the NFIP, eligible program applicants must meet cost-benefit criteria established by FEMA. Mitigation of repetitive-loss properties is given a high priority under this program. The program also provides planning grants for the preparation of flood mitigation plans.

HAZARD MITIGATION GRANT PROGRAM

The Hazard Mitigation Grant Program (HMGP) can provide up to 75 percent of the costs attendant to certain natural hazard mitigation programs. In the case of flood mitigation, projects can include the floodproofing or acquisition and relocation of floodprone properties, the elevation of structures in compliance with National Flood Insurance Program (NFIP) standards, and other flood control measures, including structural projects, where identified as cost-effective. To be eligible for mitigation activities with FEMA funding, structures must be insured under the NFIP. Under the HMGP, the balance of the costs is shared by the State of Wisconsin (12.5 percent) and the grantee (12.5 percent). Communities in Wisconsin can apply through the State for HMGP funds only after a Presidential disaster declaration is issued. HMGP funds must be applied for within 60 days of the declaration. The State, as HMGP grantee, is responsible for identifying and prioritizing projects. Eligible projects must be included as part of the grantee’s all-hazard mitigation plan and must meet cost-benefit criteria established by FEMA. Although State and local units of government are eligible applicants, HMGP funds can be used on private property for eligible projects. The HMGP gives priority to properties identified by FEMA as repetitive-loss properties.

PRE-DISASTER MITIGATION PROGRAM

FEMA's Pre-Disaster Mitigation Program (PDM) can potentially provide up to 75 percent of the costs attendant to pre-disaster mitigation planning and the implementation of cost-effective mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. Examples of eligible projects include property acquisition, structure acquisition and demolition or relocation, structure elevation, safe room construction, dry floodproofing of nonresidential structures and historic residential structures, and minor localized flood reduction projects.

U.S. Army Corps of Engineers Great Lakes Fishery and Ecosystem Restoration Program

Section 506 of the Water Resources Development Act of 1996 authorizes the USCOE to participate in planning, engineering, design and construction of projects to restore degraded ecosystem structure, function, and dynamic processes to a more natural condition. Such projects include the removal of lowhead dams as a way to improve water quality and fish and wildlife habitat. Projects require partnering with a nonfederal sponsor that may be a public agency, state or local government, private interest, or nonprofit environmental organization.

Following a request from a potential nonfederal sponsor, a preliminary restoration plan is prepared to document Federal interest. Next, a Federally funded feasibility study is conducted to determine if there is a Federal interest in the project. If the cost of the cost of the feasibility study is less than $1.0 million, this phase includes preparation of plans and specifications. If not, a detailed project report is required before initiating plans and specifications. Finally, a project cooperation agreement is executed between the Corps and the nonfederal sponsor and construction begins.

The preliminary restoration plan is Federally funded and limited to $25,000. The feasibility study is also Federally funded. Costs for planning, design, and construction are subject to a 35 percent nonfederal contribution, up to 50 percent of which may be in the form of lands, easements, rights-of-ways, relocations, and dredge material disposal areas need for construction. Costs of operations and maintenance are funded 100 percent by the nonfederal sponsor.

U.S. Army Corps of Engineers Small Flood Damage Reduction Program

Section 205 of the 1948 Flood Control Act authorizes the Corps of Engineers to plan, design, and construct structural and nonstructural flood control projects in partnership with nonfederal government agencies, such as cities, counties, special authorities, or units of state government. Projects are planned and designed under this authority to provide the same complete flood risk management project that would be provided under specific congressional authorizations. The maximum federal cost for planning, design, and construction of any one project is $7.0 million. Each project must be economically justified, environmentally sound, and technically feasible. Flood risk management projects are not limited to any particular type of improvement. Levee and channel modifications are examples of flood risk management projects constructed utilizing the Section 205 authority.

The feasibility study is 100 percent Federally funded up to $100,000. Costs over $100,000 are shared equally with the nonfederal sponsor. Up to one-half of the nonfederal share can be in the form of in-kind services. Costs for preparation of plans and specifications are shared at 65 percent Federal/35 percent nonfederal. Construction cost-share varies between 50 percent and 65 percent Federal, based on whether a structural or nonstructural solution is implemented. The nonfederal share of construction consists of provision of any necessary lands, easements, rights-of-way, relocations and disposal areas, plus a cash contribution of 5 percent of the total project costs.

In response to a written request from a potential nonfederal sponsor, the Corps conducts an initial appraisal early in the Feasibility Study to determine whether the project meets program criteria and provides a basis for determining scope and cost of an entire feasibility study. The solution must be economically feasible and environmentally acceptable. If an acceptable solution is identified in the feasibility study, the Corps prepares plans and specifications and manages construction of the project.

U.S. Army Corps of Engineers Snagging and Clearing for Flood Risk Management Program
Section 208 of the 1954 Flood Control Act provides authority for the Corps of Engineers for channel clearing and excavation, with limited embankment construction by the use of materials from the clearing operation to reduce nuisance flood risk caused by debris and minor shoaling of rivers. The maximum Federal cost for the project development and construction is $500,000 and each project must be economically justified, environmentally sound, and feasible.

The feasibility study is 100 percent Federally funded up to $100,000. Costs over $100,000 are shared equally with the nonfederal sponsor. Up to one-half of the nonfederal share can be in the form of in-kind services. Costs for preparation of plans and specifications are shared at 65 percent Federal/35 percent nonfederal. The construction cost varies between 30 percent and 65 percent Federal. The nonfederal share of construction consists of provision of any necessary lands, easements, rights-of-way, relocations and disposal areas, plus a cash contribution of 5 percent of the total project costs.

The Corps conducts an initial appraisal early in the feasibility study to determine whether the project meets program criteria and provides a basis for determining scope and cost of an entire feasibility study. The solution must be economically feasible and environmentally acceptable. If an acceptable alternative is identified in the feasibility study, the Corps prepares plans and specifications and manages construction of the project.

Wisconsin Department of Natural Resources
The WDNR administers several grant programs related to dams and flood control as described below.

DAM REMOVAL GRANT PROGRAM
The Dam Removal Grant Program, as described in Chapter NR 336 of the *Wisconsin Administrative Code*, provides reimbursement for 100 percent of eligible project costs up to a maximum of $50,000 to remove a dam. Eligible project costs include labor, materials and equipment directly related to planning the actual removal, the dam removal itself, and the restoration of the impoundment. The project sponsor is responsible for ineligible costs and project costs in excess of the maximum grant award. Counties, cities, villages, towns, tribes, public inland lake protection and rehabilitation districts, and private dam owners are eligible to apply for grant funds to remove a dam they own. Any person can apply to receive funds to remove an abandoned dam if they have obtained legal access to the property on which the dam is located. Applications are accepted on a continual basis. Awards are made on a first come, first served basis until all of the funding is obligated. For the 2013-2015 biennium, about $500,000 has been committed to this program. It should be noted that an applicant may not receive a grant from both the Municipal Dam Grant Program and the Dam Removal Grant Program (see below) for removal of the same dam.

MUNICIPAL DAM GRANT PROGRAM
The Municipal Dam grant program, as described in Chapter NR 335 of the *Wisconsin Administrative Code*, provides a cost-sharing opportunity for eligible engineering and construction costs for dam maintenance, repair, modification or abandonment and removal up to a maximum of $400,000. Funding sources outside the applicant's own resources can be used toward the local match for this grant. Cities, towns, villages, counties, tribes, and public inland lake protection and rehabilitation districts (lake districts) may apply for grants to conduct eligible activities on dams that they own. Private dam owners are not eligible to apply. Dams that are inspected, approved and licensed by a Federal agency under 18 CFR Part 12 are not eligible to receive funding. (NR 335.02(2)(b)). An applicant must own the entire dam or have permanent legal access for operation and maintenance to the specific piece of land on which the dam is located.

Eligible projects include dam repair, reconstruction, modification, or abandonment and removal to improve the safety of the dam. The owner must have received inspection directives or an administrative order from WDNR that requires the dam safety project. Dam repair/reconstruction/modification project grant awards will cover:

- 50 percent of the first $400,000 of eligible project costs;
- 25 percent of the next $800,000 of eligible project costs; and
- Zero project costs above $1.2 million.

Dam abandonment and removal project grant awards will cover 100 percent of the first $400,000 of eligible project costs.

MUNICIPAL FLOOD CONTROL GRANT PROGRAM

The Municipal Flood Control Grant Program provides funds to help local governments minimize flooding and flood-related damages by acquiring property, floodproofing structures, creating open-space flood storage areas, constructing flood control structures and restoring the flood-carrying capacity and natural and beneficial functions of watercourses. Projects eligible under this program include acquisition and removal of flood-damaged structures and structures in the 1-percent-annual-probability floodplain; floodproofing and elevation of structures; riparian restoration projects; acquisition of vacant land or conservation or flowage easements to provide flood storage; construction of structures for the collection, detention, retention, storage, and transmission of stormwater for flood control and riparian restoration projects; and flood mapping projects, including flood insurance studies. Eligible applicants include cities, villages, towns, tribal governments, and metropolitan sewerage districts. The State share of the project cost of a funded project may not be greater than 70 percent of the eligible project costs.

General

Wisconsin State Trust Fund Loan Program

The State Trust Fund Loan Program administered by the Wisconsin Board of Commissioners of Public Lands provides loans to municipalities for any public purpose. Eligible borrowers include counties, cities, villages, towns, metropolitan sewerage districts, town sanitary districts, public inland lake protection and rehabilitation districts, and drainage districts. Loans are available with terms of up to 20 years. The interest rates and maximum amount that may be borrowed per calendar year are based upon the availability of funds. Applicants must provide a general obligation bond.