COMMUNITY ASSISTANCE
PLANNING REPORT NO. 316

A RESTORATION PLAN FOR THE ROOT RIVER WATERSHED

Part Two

Appendices

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SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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Roger Chernik .... President, River Bend Nature Center

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Thomas Friedel .... Administrator, City of Racine

Susan Greenfield .... Former Executive Director, Root-Pike Watershed Initiative Network

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Alan Jasperson .... Secretary-Treasurer, Racine County Drainage Board

Stevan Keith .... Sustainability and Environmental Engineer, Milwaukee County Architecture, Engineering and Environmental Services Division

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Andrew Yencha .... Natural Resources Educator, Southeast Wisconsin UW Cooperative Extension

COMMUNITY ASSISTANCE PLANNING REPORT
NUMBER 316

A RESTORATION PLAN FOR THE ROOT RIVER WATERSHED

Part Two of Two
Appendices

Prepared by the

Southeastern Wisconsin Regional Planning Commission
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for

with funding from

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July 2014

$20.00

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Appendix A

ADVISORY GROUP
MEMBERSHIP AND MEETING DATES

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ROOT RIVER WATERSHED RESTORATION PLAN
ADVISORY GROUP

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ROOT RIVER WATERSHED RESTORATION PLAN
ADVISORY GROUP MEETINGS

May 2, 2012
September 5, 2012
November 7, 2012
February 6, 2013
May 1, 2013
August 7, 2013
October 2, 2013
November 13, 2014
February 12, 2014
May 14, 2014

ROOT RIVER WATERSHED RESTORATION
PLANNING GROUP MEETINGS

May 4, 2010
June 8, 2010
January 27, 2011
April 21, 2011
June 23, 2011
September 15, 2011
November 16, 2011
January 18, 2012
March 14, 2012
May 16, 2012
September 26, 2012
November 28, 2012
February 17, 2013
May 29, 2013
August 28, 2013
October 30, 2013
December 4. 2013
February 26, 2014

FINAL MEETING TO PRESENT FULL PLAN

July 31, 2014

Appendix B

SEWRPC RIPARIAN BUFFER GUIDE NO. 1 “MANAGING THE WATER’S EDGE”

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Managing the Water's Edge

Making Natural Connections

Problem Statement:

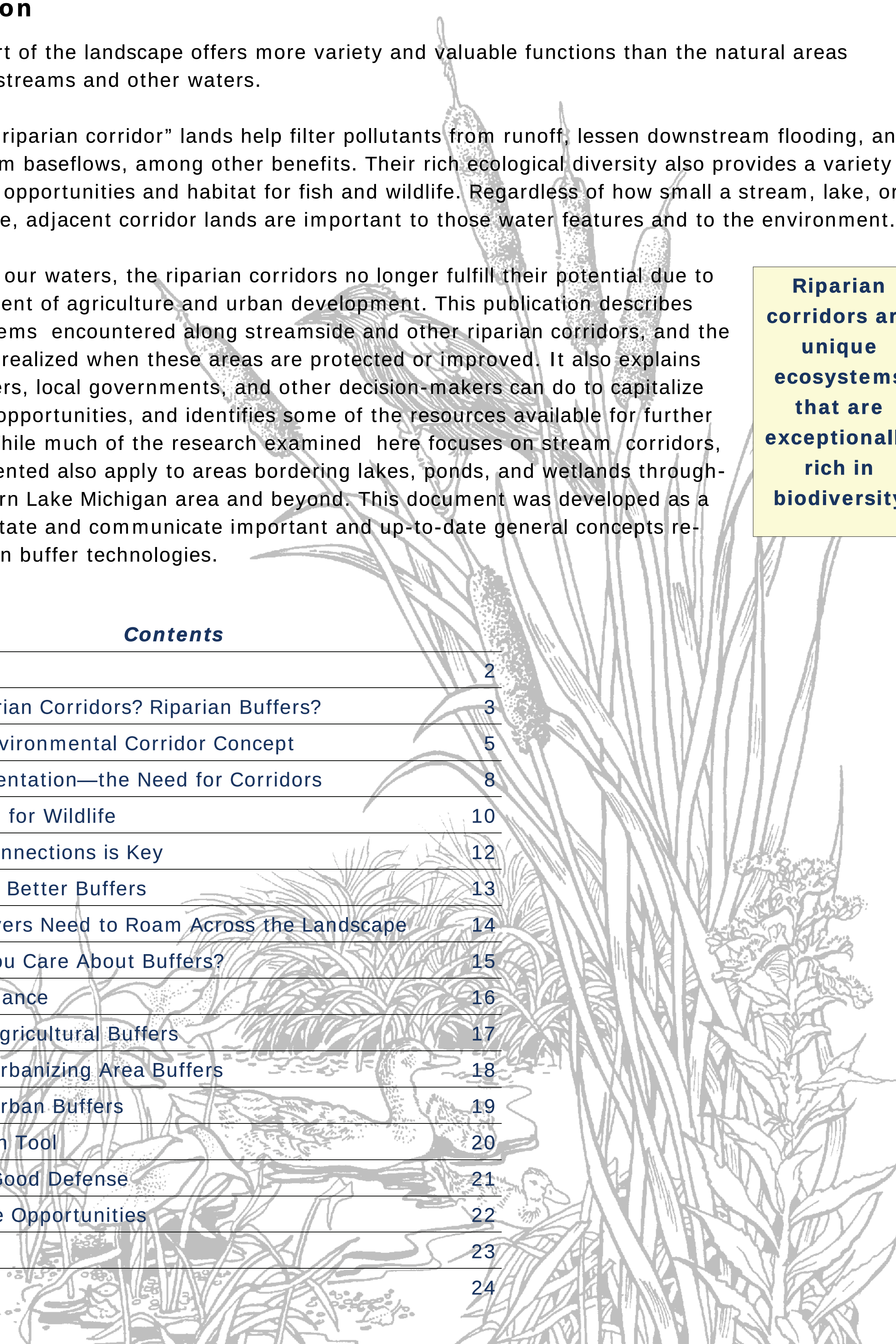
Despite significant research related to buffers, there remains no consensus as to what constitutes optimal riparian buffer design or proper buffer width for effective pollutant removal, water quality protection, prevention of channel erosion, provision of fish and wildlife habitat, enhancement of environmental corridors, augmentation of stream baseflow, and water temperature moderation.

Southeastern Wisconsin Regional Planning Commission

Our purpose in this document is to help protect and restore water quality, wildlife, recreational opportunities, and scenic beauty.

This material was prepared in part with funding from the U.S. Environmental Protection Agency Great Lakes National Program Office provided through CMAP, the Chicago Metropolitan Agency for Planning.

Introduction



Perhaps no part of the landscape offers more variety and valuable functions than the natural areas bordering our streams and other waters.

These unique "riparian corridor" lands help filter pollutants from runoff, lessen downstream flooding, and maintain stream baseflows, among other benefits. Their rich ecological diversity also provides a variety of recreational opportunities and habitat for fish and wildlife. Regardless of how small a stream, lake, or wetland may be, adjacent corridor lands are important to those water features and to the environment.

Along many of our waters, the riparian corridors no longer fulfill their potential due to the encroachment of agriculture and urban development. This publication describes common problems encountered along streamside and other riparian corridors, and the many benefits realized when these areas are protected or improved. It also explains what landowners, local governments, and other decision-makers can do to capitalize on waterfront opportunities, and identifies some of the resources available for further information. While much of the research examined here focuses on stream corridors, the ideas presented also apply to areas bordering lakes, ponds, and wetlands throughout the southern Lake Michigan area and beyond. This document was developed as a means to facilitate and communicate important and up-to-date general concepts related to riparian buffer technologies.

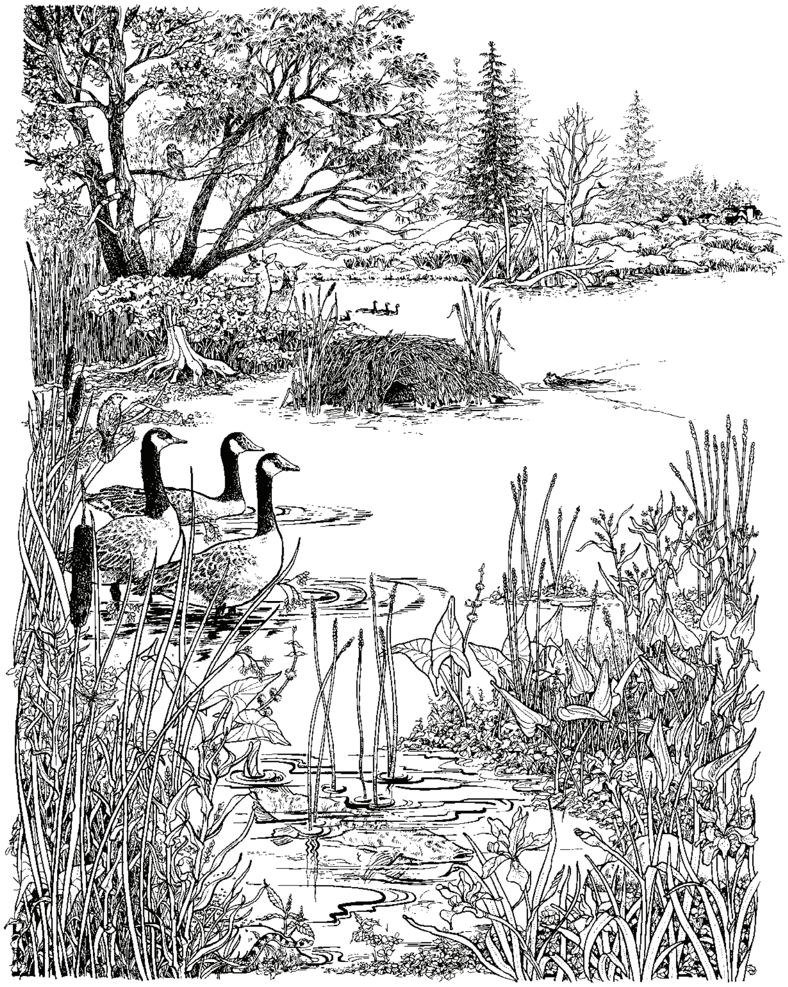
Riparian corridors are unique ecosystems that are exceptionally rich in biodiversity

Contents

Introduction	2
What are Riparian Corridors? Riparian Buffers?	3
Beyond the Environmental Corridor Concept	5
Habitat Fragmentation—the Need for Corridors	8
Wider is Better for Wildlife	10
Maintaining Connections is Key	12
Basic Rules for Better Buffers	13
Creeks and Rivers Need to Roam Across the Landscape	14
Why Should You Care About Buffers?	15
A Matter of Balance	16
Case Study—Agricultural Buffers	17
Case Study—Urbanizing Area Buffers	18
Case Study—Urban Buffers	19
A Buffer Design Tool	20
Buffers are a Good Defense	21
Buffers Provide Opportunities	22
Summary	23
More to Come	24

What Are Riparian Corridors? Riparian Buffer Zones?

The word riparian comes from the Latin word *ripa*, which means bank. However, in this document we use riparian in a much broader sense and refer to land adjoining any water body including ponds, lakes, streams, and wetlands. This term has two additional distinct meanings that refer to 1) the "natural or relatively undisturbed" corridor lands adjacent to a water body inclusive of both wetland and upland flora and fauna and 2) a buffer zone or corridor lands in need of protection to "buffer" the effects of human impacts such as agriculture and residential development.



University of Wisconsin—Extension

The word buffer literally means something that cushions against the shock of something else (noun), or to lessen or cushion that shock (verb). Other useful definitions reveal that a buffer can be something that serves to separate features, or that is capable of neutralizing something, like filtering pollutants from stormwater runoff. Essentially, buffers and buffering help protect against adverse effects.

Riparian buffer zones function as core habitat as well as travel corridors for many wildlife species.

Riparian buffers are zones adjacent to waterbodies such as lakes, rivers, and wetlands that simultaneously protect water quality and wildlife, including both aquatic and terrestrial habitat. These zones minimize the impacts of human activities on the landscape and contribute to recreation, aesthetics, and quality of life. **This document summarizes how to maximize both water quality protection and conservation of aquatic and terrestrial wildlife populations using buffers.**

What Are Riparian Corridors? Riparian Buffer Zones?

Buffers **can** include a range of complex vegetation structure, soils, food sources, cover, and water features that offer a variety of habitats contributing to diversity and abundance of wildlife such as mammals, frogs, amphibians, insects, and birds. Buffers can consist of a variety of canopy layers and cover types including ephemeral (temporary-wet for only part of year) wetlands/seasonal ponds/spring pools, shallow marshes, deep marshes, wetland meadows, wetland mixed forests, grasslands, shrubs, forests, and/or prairies. Riparian zones are areas of transition between aquatic and terrestrial ecosystems, and they can potentially offer numerous benefits to wildlife and people such as pollution reduction and recreation.

In the water resources literature, riparian buffers are referred to in a number of different ways. Depending on the focus and the intended function of a buffer, or a buffer-related feature, buffers may be referred to as stream corridors, critical transition zones, riparian management areas, riparian management zones, floodplains, or green infrastructure.

It is important to note that within an agricultural context, the term buffer is used more generally to describe filtering best management practices most often at the water's edge. Other practices which can be interrelated may also sometimes be called buffers. These include grassed waterways, contour buffer strips, wind breaks, field border, shelterbelts, windbreaks, living snow fence, or filter strips. These practices may or may not be adjacent to a waterway as illustrated in the photo to the right. For example, a grassed waterway is designed to filter sediment and reduce erosion and may connect to a riparian buffer. These more limited-purpose practices may link to multipurpose buffers, but by themselves, they are not adequate to provide the multiple functions of a riparian buffer as defined here.

U.S. Department of Agriculture, Natural Resource Conservation Service, Ohio Office.

Beyond the Environmental Corridor Concept

The term "environmental corridors" (also known as "green infrastructure") refers to an interconnected green space network of natural areas and features, public lands, and other open spaces that provide natural resource value. Environmental corridor planning is a process that promotes a systematic and strategic approach to land conservation and encourages land use planning and practices that are good for both nature and people. It provides a framework to guide future growth, land development, and land conservation decisions in appropriate areas to protect both community and natural resource assets.

Environmental corridors are an essential planning tool for protecting the most important remaining natural resource features in Southeastern Wisconsin and elsewhere. Since development of the environmental corridor concept, there have been significant advancements in landscape ecology that have furthered understanding of the spatial and habitat needs of multiple groups of organisms. In addition, advancements in pollutant removal practices, stormwater control, and agriculture have increased our understanding of the effectiveness and limitations of environmental corridors. In protecting water quality and providing aquatic and terrestrial habitat, there is a need to better integrate new technologies through their application within riparian buffers.

SEWRPC has embraced and applied the environmental corridor concept developed by Philip Lewis (Professor Emeritus of Landscape Architecture at the University of Wisconsin-Madison) since 1966 with the publication of its first regional land use plan. Since then, SEWRPC has refined and detailed the mapping of environmental corridors, enabling the corridors to be incorporated directly into regional, county, and community plans and to be reflected in regulatory measures. The preservation of environmental corridors remains one of the most important recommendations of the regional plan. Corridor preservation has now been embraced by numerous county and local units of government as well as by State and Federal agencies. The environmental corridor concept conceived by Lewis has become an important part of the planning and development culture in Southeastern Wisconsin.

Beyond the Environmental Corridor Concept

Environmental corridors are divided into the following three categories.

- **Primary environmental corridors** contain concentrations of our most significant natural resources. They are at least 400 acres in size, at least two miles long, and at least 200 feet wide.

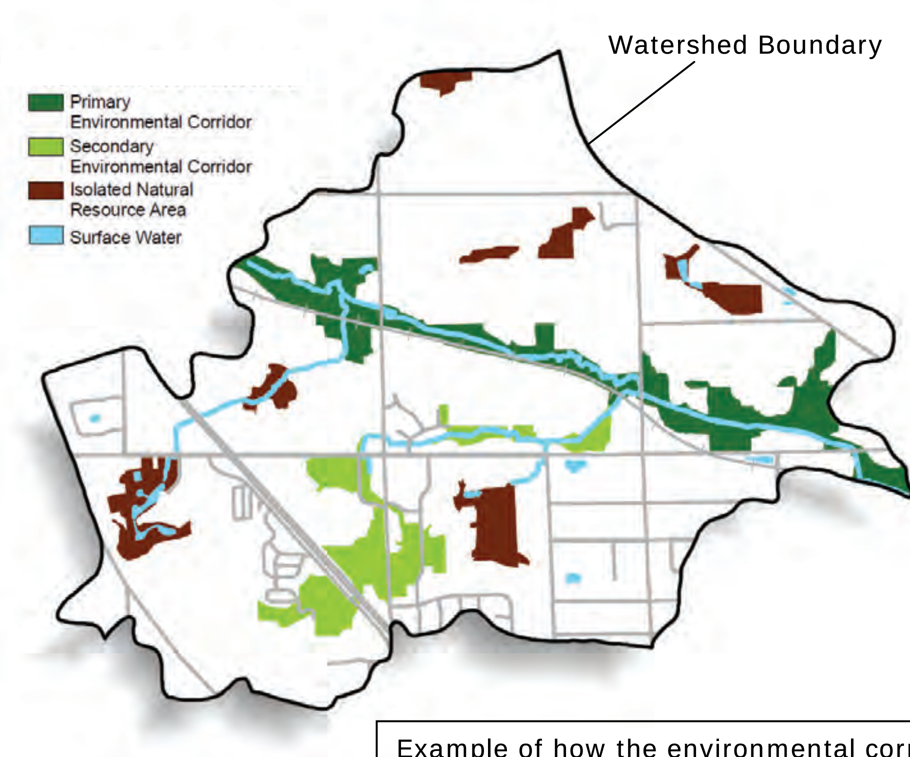
- **Secondary environmental corridors** contain significant but smaller concentrations of natural resources. They are at least 100 acres in size and at least one mile long, unless serving to link primary corridors.

- **Isolated natural resource areas** contain significant remaining resources that are not connected to environmental corridors. They are at least five acres in size and at least 200 feet wide.

Key Features of Environmental Corridors

- Lakes, rivers, and streams
- Undeveloped shorelands and floodlands
- Wetlands
- Woodlands
- Prairie remnants
- Wildlife habitat
- Rugged terrain and steep slopes
- Unique landforms or geological formations
- Unfarmed poorly drained and organic soils
- Existing outdoor recreation sites
- Potential outdoor recreation sites
- Significant open spaces
- Historical sites and structures
- Outstanding scenic areas and vistas

Beyond the Environmental Corridor Concept

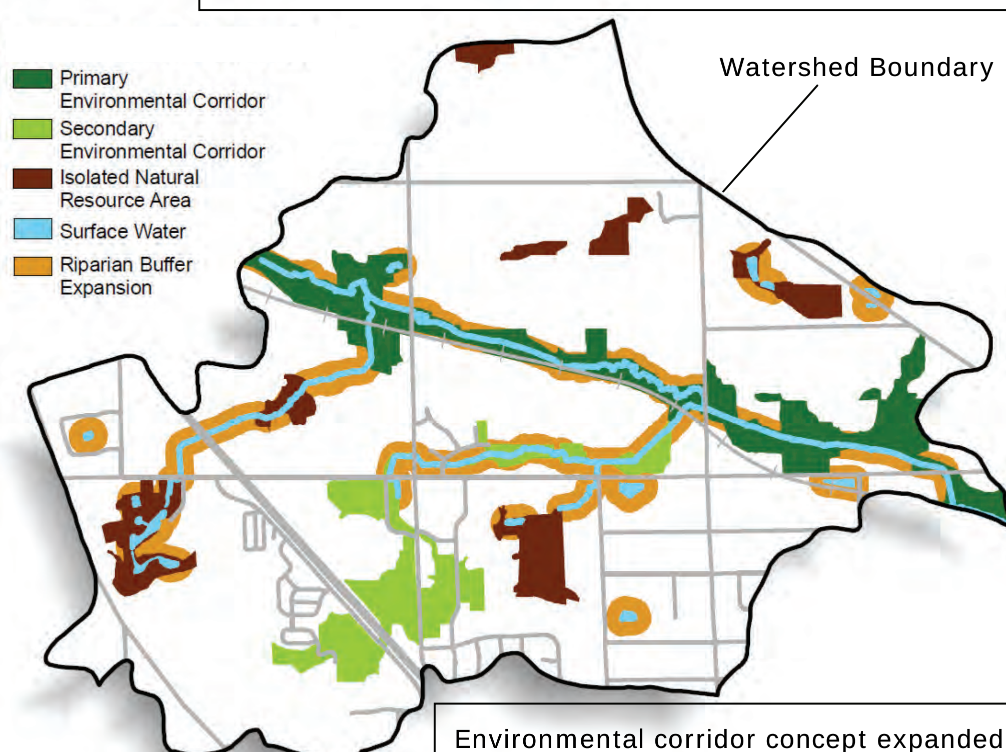


The Minimum Goals of **75** within a Watershed

75% minimum of total stream length should be naturally vegetated to protect the functional integrity of the water resources. (Environment Canada, How Much Habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great lakes Areas of Concern, Second Edition, 2004)

75 foot wide minimum riparian buffers from the top edge of each stream bank should be naturally vegetated to protect water quality and wildlife. (SEWRPC Planning Report No 50, A Regional Water Quality Management Plan for the Greater Milwaukee Watersheds, December 2007)

Example of how the environmental corridor concept is applied on the landscape. For more information see "Plan on It!" series **Environmental Corridors: Lifelines of the Natural Resource Base** at http://www.sewrpc.org/SEWRPC/LandUse/EnvironmentalCorridors.htm



Environmental corridor concept expanded to achieve the Goals of 75. Note the expanded protection in addition to the connection of other previously isolated areas.

Habitat Fragmentation—The Need for Corridors

Southeastern Wisconsin is a complex mosaic of agricultural and urban development. Agricultural lands originally dominated the landscape and remain a major land use. However, such lands continue to be converted to urban uses. Both of these dominant land uses fragment the landscape by creating islands or isolated pockets of wetland, woodland, and other natural lands available for wildlife preservation and recreation. By recognizing this fragmentation of the landscape, we can begin to mitigate these impacts.

New developments should incorporate water quality and wildlife enhancement or improvement objectives as design criteria by looking at the potential for creating linkages with adjoining lands and water features.

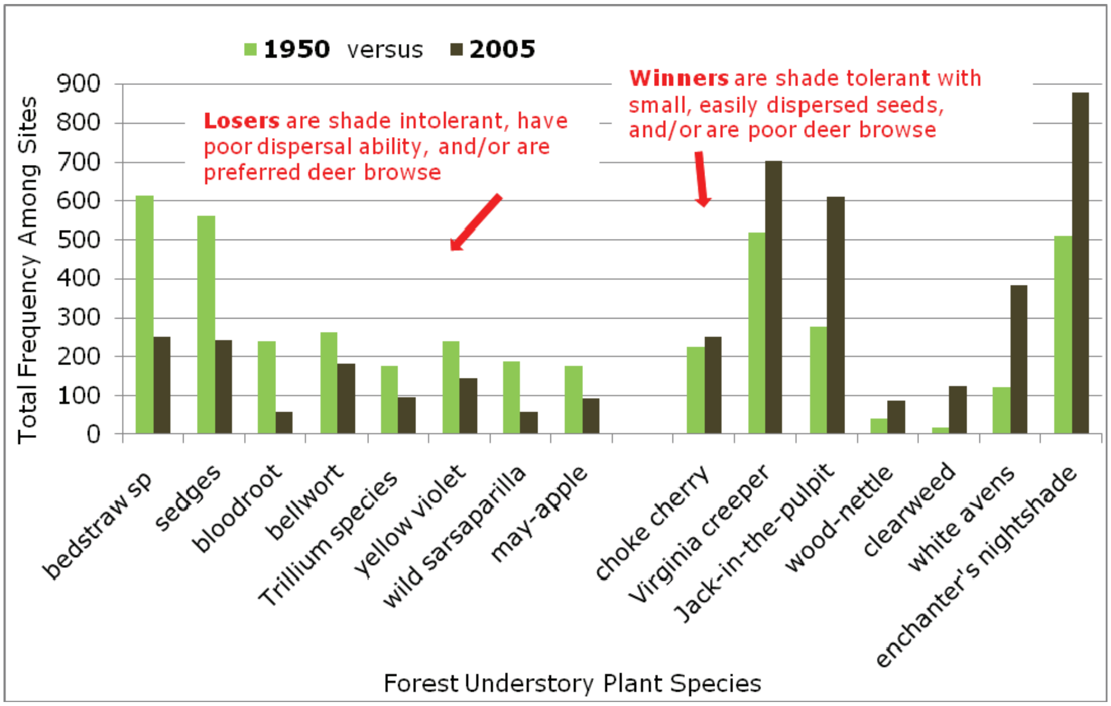
At the time of conversion of agricultural lands to urban uses, there are opportunities to re-create and expand riparian buffers and environmental corridors reconnecting uplands and waterways and restoring ecological integrity and scenic beauty locally and regionally. For example, placement of roads and other infrastructure across stream systems could be limited so as to maximize continuity of the riparian buffers. This can translate into significant cost savings in terms of reduced road maintenance, reduced salt application, and limited bridge or culvert maintenance and replacements. This simple practice not only saves the community significant amounts of money, but also improves and protects quality of life. Where necessary road crossings do occur, they can be designed to provide for safe fish and wildlife passage.

Overland travel routes for wildlife are often unavailable, discontinuous, or life endangering within the highly fragmented landscapes of Southeastern Wisconsin and elsewhere.

State Threatened Species: Blanding's turtle

Habitat Fragmentation—The Need for Corridors

Forest understory plant species abundance among stands throughout Southern Wisconsin



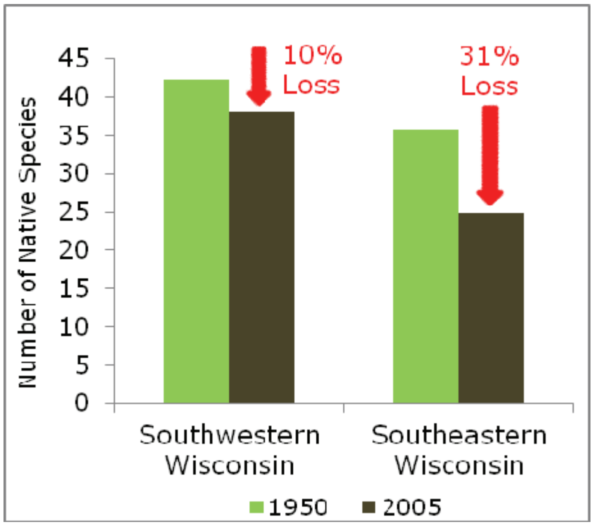
Forest fragmentation has led to significant plant species loss within Southern Wisconsin

(Adapted from David Rogers and others, 2008, Shifts in Southern Wisconsin Forest Canopy and Understory Richness, Composition, and Heterogeneity, Ecology, 89 (9): 2482-2492)

"...these results confirm the idea that large intact habitat patches and landscapes better sustain native species diversity. It also shows that people are a really important part of the system and their actions play an increasingly important role in shaping patterns of native species diversity and community composition. Put together, it is clear that one of the best and most cost effective actions we can take toward safeguarding native diversity of all types is to protect, enhance and create corridors that link patches of natural habitat."
Dr. David Rogers, Professor of Biology at the University of Wisconsin-Parkside

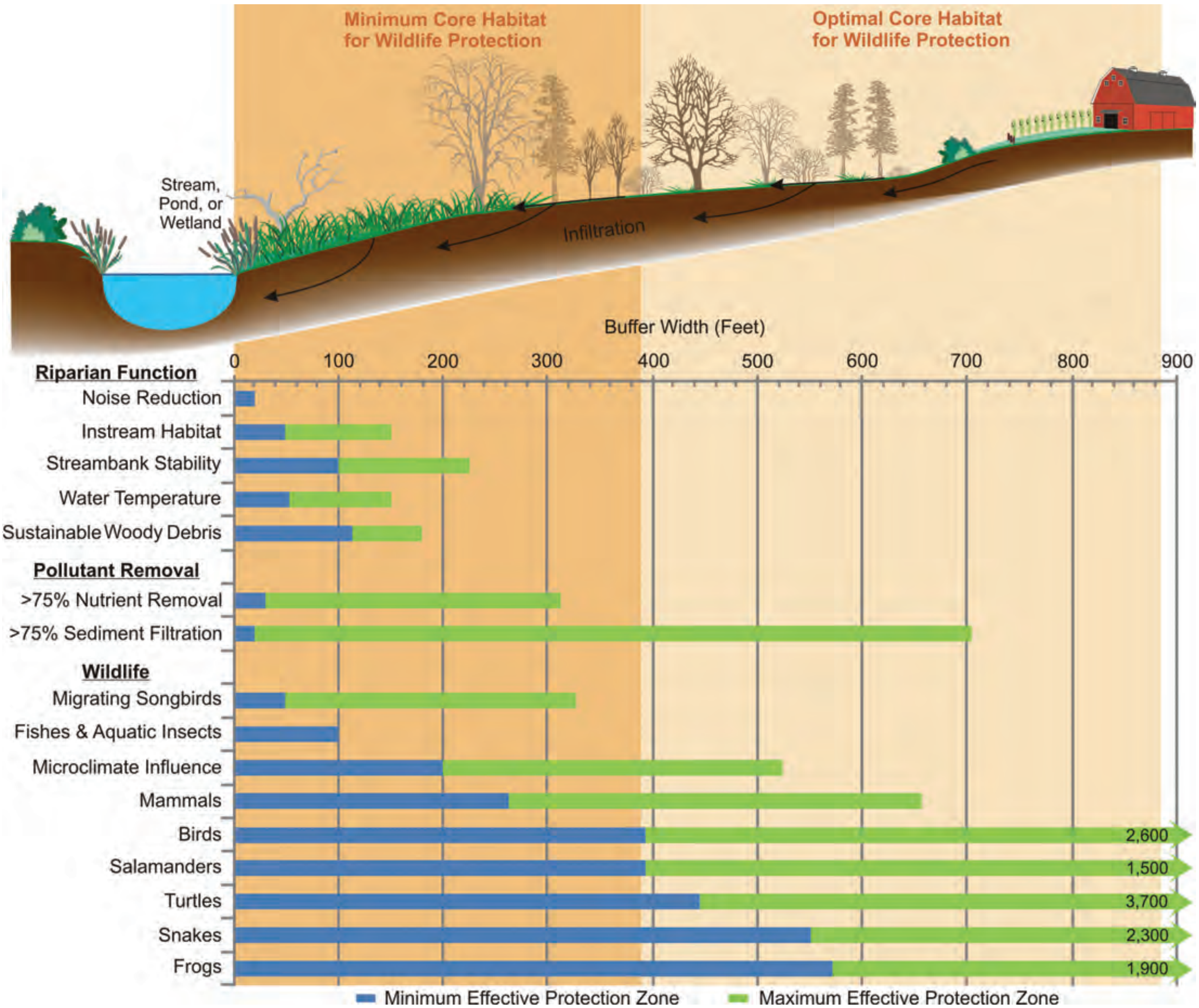
Since the 1950s, forests have increasingly become more fragmented by land development, both agricultural and urban, and associated roads and infrastructure, which have caused these forests to become isolated "islands of green" on the landscape. In particular, there has been significant loss of forest understory plant species over time (shrubs, grasses, and herbs covering the forest floor.) It is important to note that **these forests lost species diversity even when they were protected as parks or natural areas**.

One major factor responsible for this decline in forest plant diversity is that routes for native plants to re-colonize isolated forest islands are largely cut-off within fragmented landscapes. For example, the less fragmented landscapes in Southwestern Wisconsin lost fewer species than the more fragmented stands in Southeastern Wisconsin. In addition, the larger-sized forests and forests with greater connections to surrounding forest lands lost fewer species than smaller forests in fragmented landscapes.



Wider is Better for Wildlife

Why? Because buffer size is the engine that drives important natural functions like food availability and quality, access to water, habitat variety, protection from predators, reproductive or resting areas, corridors to safely move when necessary, and help in maintaining the health of species' gene pools to prevent isolation and perhaps extinction.



One riparian buffer size does not fit all conditions or needs. There are many riparian buffer functions and the ability to effectively fulfill those functions is largely dependent on width. Determining what buffer widths are needed should be based on what functions are desired as well as site conditions. For example, as shown above, 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. Hence, the value of large undisturbed parcels along waterways which are part of, and linked to, an environmental corridor system. The minimum effective buffer width distances are based on data reported in the scientific literature and the quality of available habitats within the context of those studies.

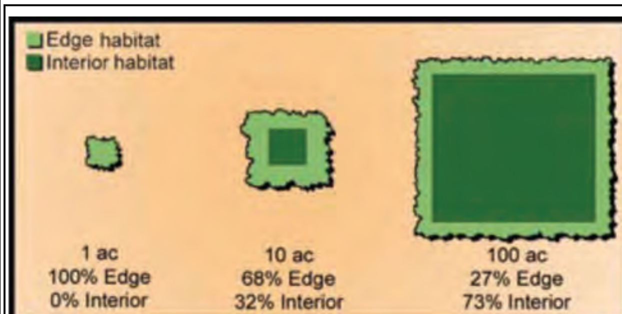
Wider is Better for Wildlife

Wildlife habitat needs change within and among species. **Minimum Core Habitat and Optimum Core Habitat distances were developed from numerous studies to help provide guidance for biologically meaningful buffers to conserve wildlife biodiversity.** These studies documented distances needed for a variety of biological (life history) needs to sustain healthy populations such as breeding, nesting, rearing young, foraging/feeding, perching (for birds), basking (for turtles), and overwintering/dormancy/hibernating. These life history needs require different types of habitat and distances from water, for example, one study found that Blanding's turtles needed approximately 60-foot-wide buffers for basking, 375 feet for overwintering, and up to 1,200 feet for nesting to bury their clutches of eggs. Some species of birds like the Blacked-capped chickadee or white breasted nuthatch only need about 50 feet of buffer, while others like the wood duck or great blue heron require 700-800 feet for nesting. Therefore, **understanding habitat needs for wildlife species is an important consideration in designing riparian buffers.**

Although *Ambystoma* salamanders require standing water for egg laying and juvenile development, most other times of the year they can be found more than 400 feet from water foraging for food.

Wisconsin Species	Mimimum Core Habitat (feet)	Optimum Core Habitat (feet)	Number of Studies
Frogs	571	1,043	9
Salamanders	394	705	14
Snakes	551	997	5
Turtles	446	889	27
Birds	394	787	45
Mammals	263	No data	11
Fishes and Aquatic Insects	100	No data	11
Mean	388	885	

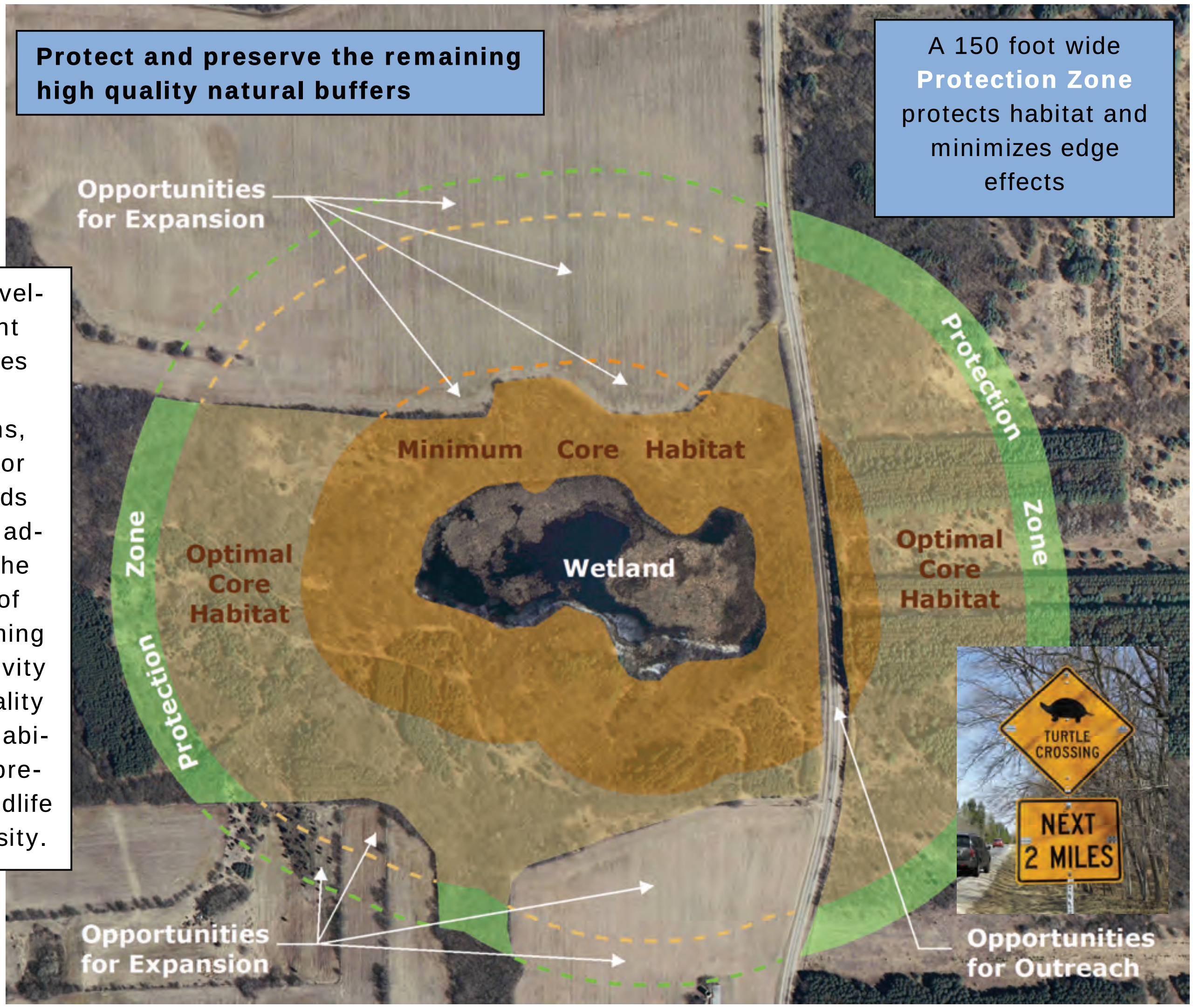
This approach was adapted from *R.D. Semlitsch and J.R. Bodie, 2003, Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibian and Reptiles, Conservation Biology, 17(5):1219-1228.* These values are based upon studies examining species found in Wisconsin and represent mean linear distances extending outward from the edge of an aquatic habitat. The Minimum Core Habitat and Optimum Core Habitat reported values are based upon the mean minimum and mean maximum distances recorded, respectively. Due to a low number of studies for snake species, the recommended distances for snakes are based upon values reported by *Semlitsch and Bodie.*



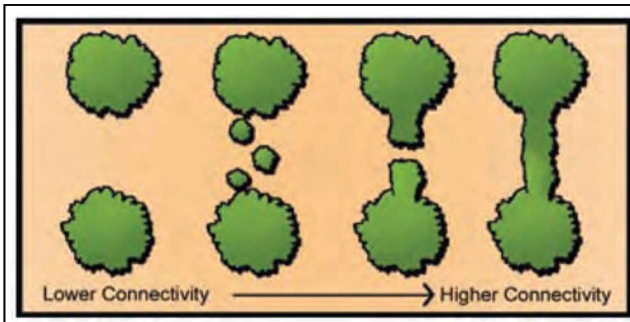
"***Large patches typically conserve a greater variety and quality of habitats, resulting in higher species diversity and abundance."*** *Larger patches contain greater amounts of interior habitat and less edge effects, which benefits interior species, by providing safety from parasitism, disease, and invasive species.*
(Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station)

Maintaining Connections is Key

Like humans, all forms of wildlife require access to clean water. Emerging research has increasingly shown that, in addition to water, more and more species such as amphibians and reptiles cannot persist without landscape connectivity between quality wetland and upland habitats. Good connectivity to upland terrestrial habitats is essential for the persistence of healthy sustainable populations, because these areas provide vital feeding, overwintering, and nesting habitats found nowhere else. Therefore, both aquatic and terrestrial habitats are essential for the preservation of biodiversity and they should ideally be managed together as a unit.



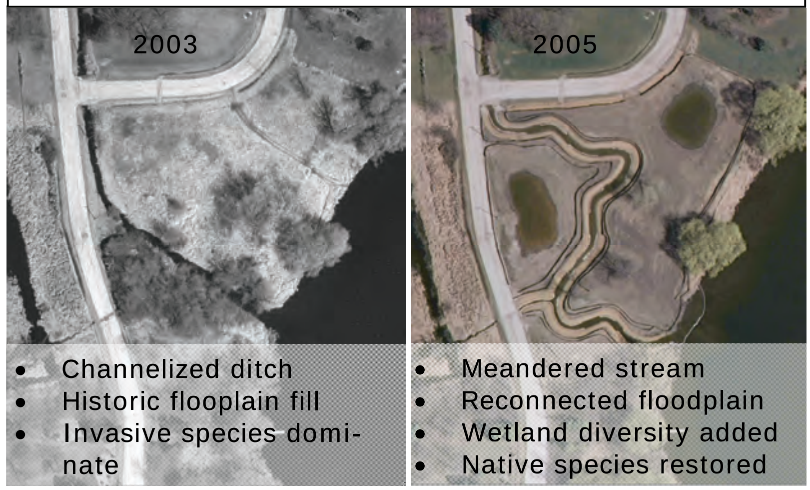
Land development practices near streams, lakes, or wetlands need to address the issue of maintaining connectivity with quality upland habitats to preserve wildlife biodiversity.



Increasing connectivity among quality natural landscapes (wetlands, woodlands, prairies) can benefit biodiversity by providing access to other areas of habitat, increasing gene flow and population viability, enabling recolonization of patches, and providing habitat (Bentrup 2008).

Basic Rules to Better Buffers

There are opportunities to improve buffer functions to improve water quality and wildlife habitat, even in urban situations



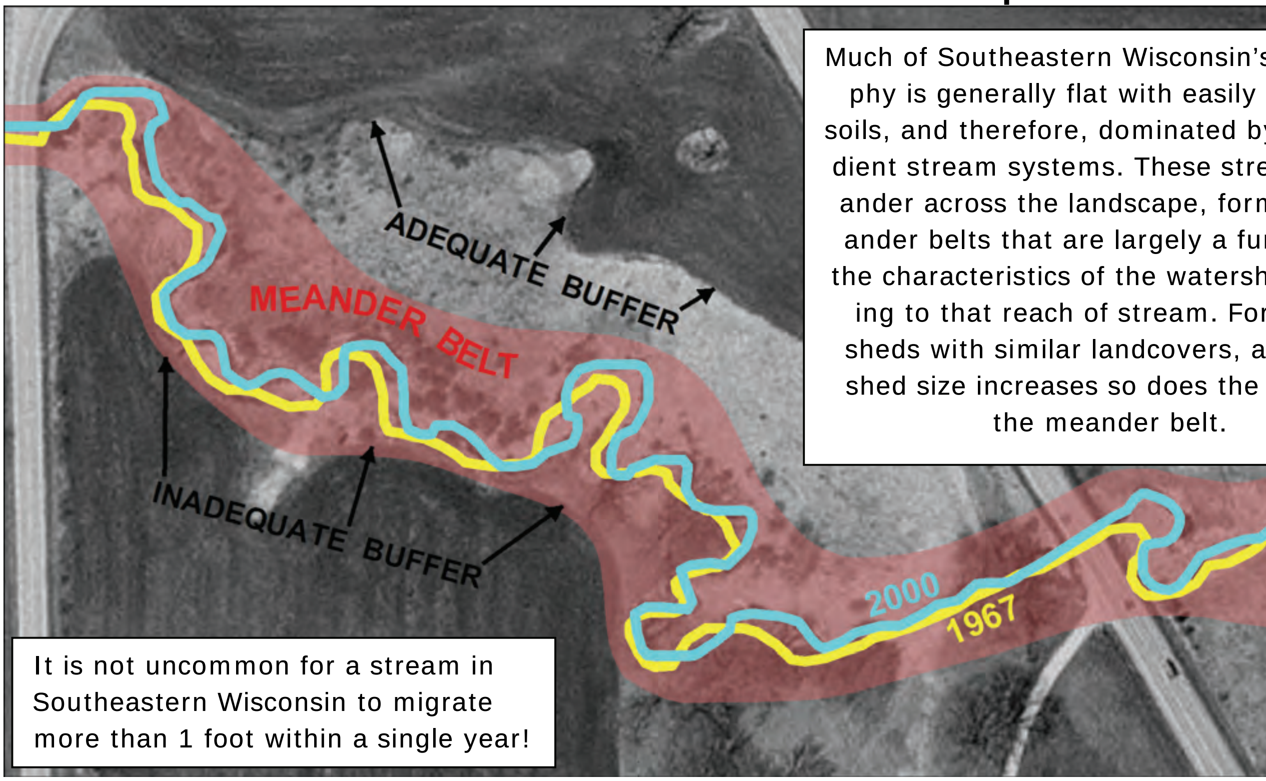
Protecting the integrity of native species in the region is an objective shared by many communities. The natural environment is an essential component of our existence and contributes to defining our communities and neighborhoods. Conservation design and open space development patterns in urbanizing areas and farm conservation programs in rural areas have begun to address the importance of maintaining and restoring riparian buffers and connectivity among corridors.

How wide should the buffer be? Unfortunately, there is no one-size-fits all buffer width adequate to protect water quality, wildlife habitat, and human needs. Therefore, the answer to this question depends upon the predetermined needs of the landowner and community objectives or goals. As riparian corridors become very wide, their pollutant removal (buffering) effectiveness may reach a point of diminishing returns compared to the investment involved. However, the prospects for species diversity in the corridor keep increasing with buffer width. For a number of reasons, 400- to 800-foot-wide buffers are not practical along all lakes, streams, and wetlands within Southeastern Wisconsin. Therefore, communities should develop guidelines that remain flexible to site-specific needs to achieve the most benefits for water resources and wildlife as is practical.

Key considerations to better buffers/corridors:

- Wider buffers are better than narrow buffers for water quality and wildlife functions
- Continuous corridors are better than fragmented corridors for wildlife
- Natural linkages should be maintained or restored
- Linkages should not stop at political boundaries
- Two or more corridor linkages are better than one
- Structurally diverse corridors (e.g., diverse plant structure or community types, upland and wetland complexes, soil types, topography, and surficial geology) are better than corridors with simple structures
- Both local and regional spatial and temporal scales should be considered in establishing buffers
- Corridors should be located along dispersal and migration routes
- Corridors should be located and expanded around rare, threatened, or endangered species
- Quality habitat should be provided in a buffer whenever possible
- Disturbance (e.g. excavation or clear cutting vegetation) of corridors should be minimized during adjacent land use development
- Native species diversity should be promoted through plantings and active management
- Non-native species invasions should be actively managed by applying practices to preserve native species
- Fragmentation of corridors should be reduced by limiting the number of crossings of a creek or river where appropriate
- Restoration or rehabilitation of hydrological function, streambank stability, instream habitat, and/or floodplain connectivity should be considered within corridors.
- Restoration or retrofitting of road and railway crossings promotes passage of aquatic organisms

Creeks and Rivers Need to Roam Across the Landscape



Much of Southeastern Wisconsin's topography is generally flat with easily erodible soils, and therefore, dominated by low gradient stream systems. These streams meander across the landscape, forming meander belts that are largely a function of the characteristics of the watershed draining to that reach of stream. For watersheds with similar landcovers, as watershed size increases so does the width of the meander belt.

It is not uncommon for a stream in Southeastern Wisconsin to migrate more than 1 foot within a single year!

Healthy streams naturally meander or migrate across a landscape over time. Streams are transport systems for water and sediment and are 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."** In other words the stream retains its physical dimensions (equilibrium), but those physical features are shifted, or migrate, over time (dynamic).

Room to Roam

Riparian buffer widths should take into account the amount of area that a stream needs to be able to self-adjust and maintain itself in a state of dynamic equilibrium. ... These are generally greater than any minimum width needed to protect for pollutant removal alone.


744

Streams are highly sensitive, and they respond to changes in the amounts of water and sediment draining to them, which are affected by changing land use conditions. For example, streams can respond to increased discharges of water by increased scour (erosion) of bed and banks that leads to an increase in stream width and depth—or "degradation." Conversely, streams can respond to increased sedimentation (deposition) that leads to a decrease in channel width and depth—or "aggradation."

Why Should You Care About Buffers?

Economic Benefits:

- Increased value of riparian property
- Reduced lawn mowing time and expense
- Increased shade to reduce building cooling costs
- Natural flood mitigation protection for structures or crops
- Pollution mitigation (reduced nutrient and contaminant loading)
- Increased infiltration and groundwater recharge
- Prevented loss of property (land or structures) through erosion
- Greater human and ecological health through biodiversity

Recreational Benefits:

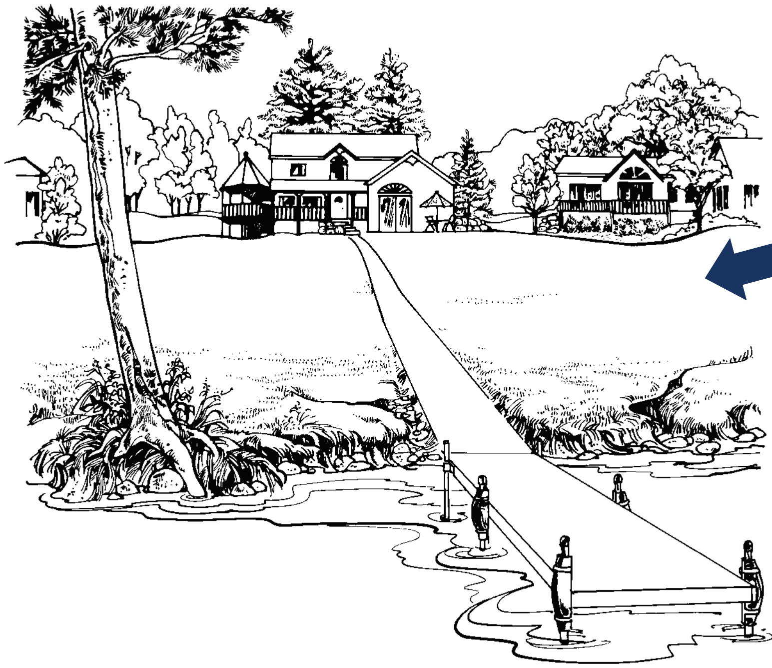
- Increased quality of the canoeing/kayaking experience
- Improved fishing and hunting quality by improving habitat
- Improved bird watching/wildlife viewing quality and opportunities
- Increased potential for expansion of trails for hiking and bicycling
- Opportunities made available for youth and others to locally reconnect with nature

Riparian buffers make sense and are profitable monetarily, recreationally, and aesthetically!

Social Benefits:

- Increased privacy
- Educational opportunities for outdoor awareness
- Improved quality of life at home and work
- Preserved open space/balanced character of a community
- Focal point for community pride and group activities
- Visual diversity
- Noise reduction

A Matter of Balance



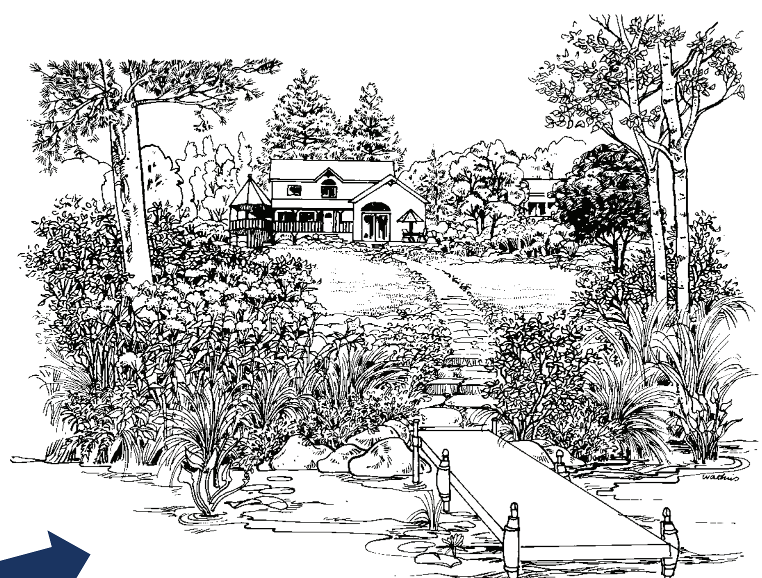
University of Wisconsin—Extension

Although neatly trimmed grass lawns are popular, these offer limited benefits for water quality or wildlife habitat. A single house near a waterbody may not seem like a "big deal," but the cumulative effects of many houses can negatively impact streams, lakes, and wetlands.

All the lands within Southeastern Wisconsin ultimately flow into either the Mississippi River or the Great Lakes systems. The cumulative effects of agriculture and urban development in the absence of mitigative measures, ultimately affects water quality in those systems. Much of this development causes increases in water runoff from the land into wetlands, ponds, and streams. This runoff transports water, sediments, nutrients, and other pollutants into our waterways that can lead to a number of problems, including flooding that can cause crop loss or building damage; unsightly and/or toxic algae blooms; increased turbidity; damage to aquatic organisms from reduced dissolved oxygen, lethal temperatures, and/or concentrations of pollutants; and loss of habitat.

Riparian buffers are one of the most effective tools available for defending our waterways. Riparian buffers can be best thought of as forming a living, self-sustainable protective shield. This shield protects investments in the land and all things on it as well as our quality of life locally, regionally, and, ultimately, nationally. Combined with stormwater management, environmentally friendly yard care, effective wastewater treatment, conservation farming methods, and appropriate use of fertilizers and other agrichemicals, **riparian buffers complete the set of actions that we can take to minimize impacts to our shared water resources.**

Lakeshore buffers can take many forms, which require a balancing act between lake viewing, access, and scenic beauty. Lakeshore buffers can be integrated into a landscaping design that complements both the structural development and a lakeside lifestyle. Judicious placement of access ways and shoreline protection structures, and preservation or reestablishment of native vegetation, can enhance and sustain our use of the environment.



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Case Study—Agricultural Buffers

Agricultural nonpoint source pollution runoff continues to pose a threat to water quality and aquatic ecosystems within Wisconsin and elsewhere. In an effort to address this problem, the Wisconsin Buffer Initiative was formed with the goal of designing a buffer implementation program to achieve science-based, cost-effective, water quality improvements (report available online at http://www.soils.wisc.edu/extension/nonpoint/wbi.php).

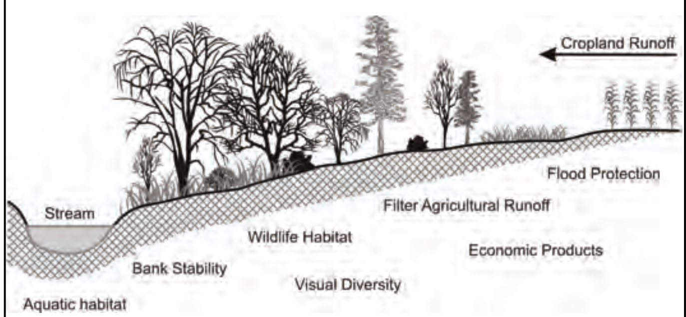
While it is true that riparian buffers alone may not always be able to reduce nutrient and sediment loading from agricultural lands, WBI researchers found that "…***riparian buffers are capable of reducing large percentages of the phosphorus and sediment that are currently being carried by Wisconsin streams. Even in watersheds with extremely high loads (top 10%), an average of about 70% of the sediment and phosphorus can be reduced through buffer implementation***." (*Diebel, M.J. and others, 2009, Landscape planning for agricultural nonpoint source pollution reduction III: Assessing Phosphorus and sediment reduction potential, Environmental Management, 43:69-83.*).

Challenge:
Buffers may take land out of cultivated crop production and require additional cost to install and maintain. Cost sharing, paid easements, and purchase of easements or development rights may sometimes be available to offset costs.

Benefits:
Buffers may offset costs by producing perennial crops such as hay, lumber, fiber, nuts, fruits, and berries. In addition, they provide visual diversity on the landscape, help maintain long-term crop productivity, and help support healthier fish populations for local enjoyment.

Federal and state natural resource agencies have long recognized the need to apply a wide range of Best Management Practices on agricultural lands to improve stream water quality. Although there are many tools available in the toolbox to reduce pollutant runoff from agricultural lands, such as crop rotations, nutrient and manure management, conservation tillage, and contour plowing, riparian buffers are one of the most effective tools to accomplish this task. Their multiple benefits and inter-connectedness from upstream to downstream make riparian buffers a choice with watershed-wide benefits.

Determine what benefits are needed.



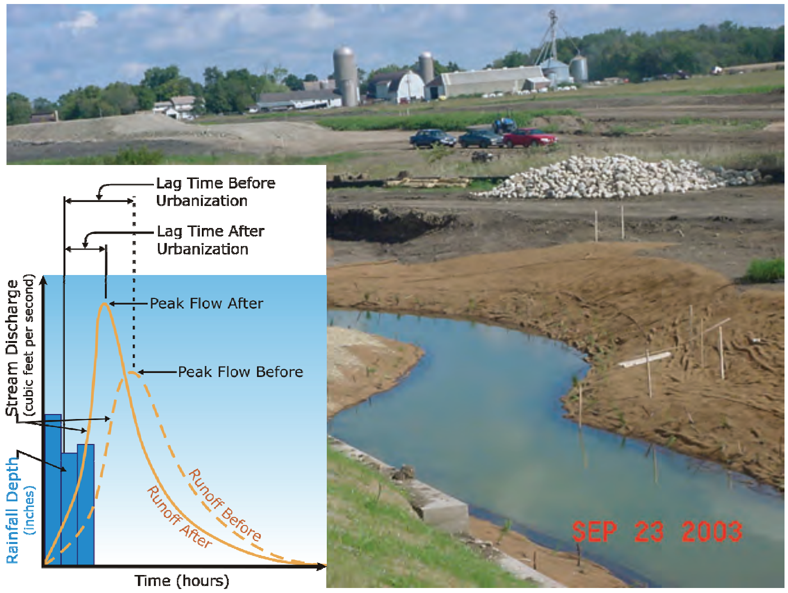
The USDA in *Agroforestry Notes* (AF Note-4, January 1997) outlines a four step process for designing riparian buffers for Agricultural lands:

1-Determine what buffers functions are needed
2-Identify the best types of vegetation to provide the needed benefits
3-Determine the minimum acceptable buffer width to achieve desired benefits
4-Develop an installation and maintenance plan

Drain tiles can bypass infiltration and filtration of pollutants by providing a direct pathway to the water and "around" a buffer. This is important to consider in design of a buffer system which integrates with other agricultural practices.

Case Study—Urbanizing Area Buffers

When development occurs near a waterbody, the area in driveways, rooftops, sidewalks, and lawns increases, while native plants and undisturbed soils decrease. As a result, 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, one the consequences of urban development is an increase in the amount of stormwater, which runs off the land instead of infiltrating into the ground. Therefore, **urbanization impacts the watershed, not only by reducing groundwater recharge, but also by changing stream hydrology** through increased stormwater runoff volumes and peak flows. This means less water is available to sustain the baseflow regime. The urban environment also contains increased numbers of pollutants and generates greater pollutant concentrations and loads than any other land use. This reflects the higher density of the human population and associated activities, which demand measures to protect the urban water system.



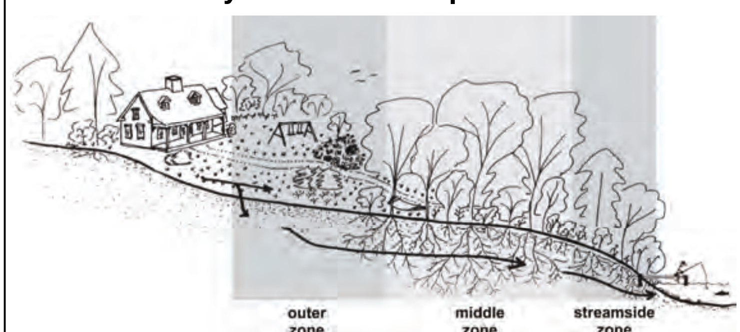
Comparison of hydrographs before and after urbanization. Note the rapid runoff and greater peak streamflow tied to watershed development. (Adapted from Federal Interagency Stream Restoration Working Group (FISRWG), Stream Corridor Restoration: Principles, Processes, and Practices, October 1998)

Mitigation of urban impacts may be as simple as not mowing along a stream corridor or changing land management and yard care practices, or as complex as changing zoning ordinances or widening riparian corridors through buyouts.

Challenge:
Urban development requires balancing flood protection, water quality protection, and the economic viability of the development.

Opportunities:
Buffers may offset costs by providing adequate space for providing long-term water quantity and water quality protection. In addition, they provide visual diversity on the landscape, wildlife habitat and connectedness, and help maintain property values.

Anatomy of an urban riparian buffer



The most effective urban buffers have three zones:

Outer Zone-Transition area between the intact buffer and nearest permanent structure to capture sediment and absorb runoff.

Middle Zone-Area from top of bank to edge of lawn that is composed of natural vegetation that provides wildlife habitat as well as improved filtration and infiltration of pollutants.

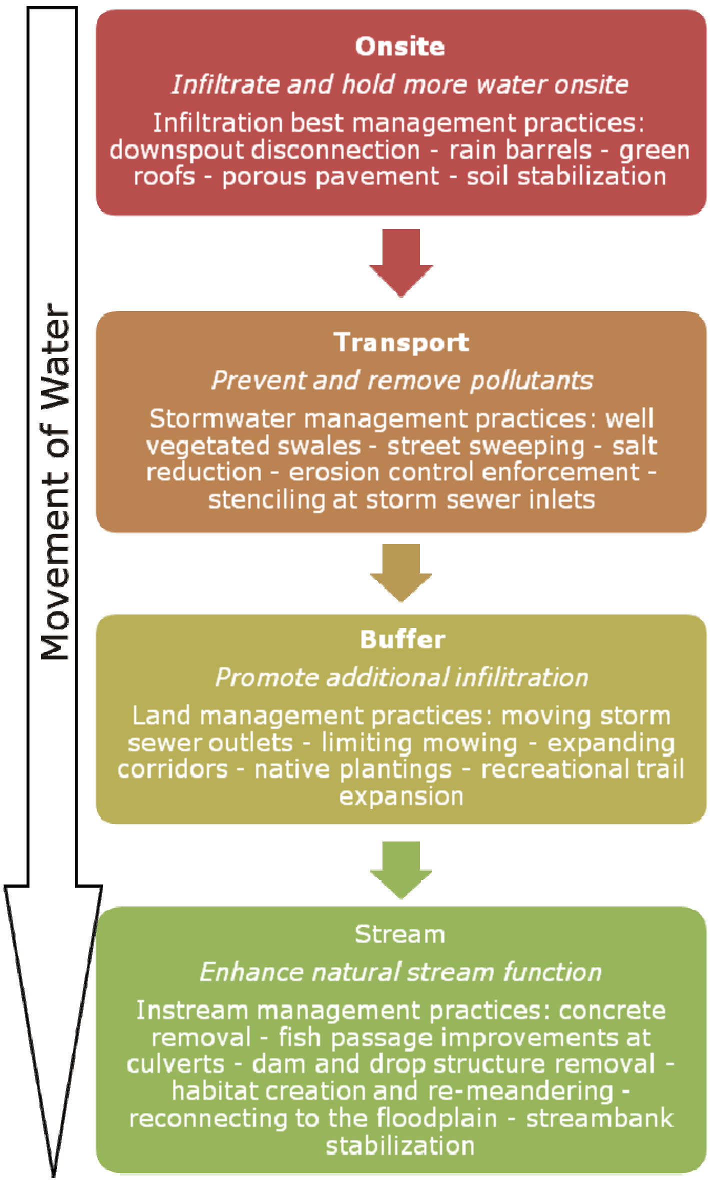
Streamside Zone-Area from the water's edge to the top of the bank or uplands that provides critical connection between water, wetland, and upland habitats for wildlife as well as protect streams from bank erosion

(Fact sheet No. 6 Urban Buffer in the series Riparian Buffers for Northern New Jersey)

Case Study—Urban Buffers

Placement of riparian buffers in established urban areas is a challenge that requires new and innovative approaches. In these areas, historical development along water courses limits options and requires balancing flood management protection versus water quality and environmental protection needs. Consequently, some municipalities have begun to recognize the connections between these objectives and are introducing programs to remove flood-prone structures and culverts from the stream corridors and allow recreation of the stream, restoring floodplains, and improving both the quality of life and the environment.

In urban settings it may be necessary to limit pollution and water runoff before it reaches the buffer.



Challenge:
There are many potential constraints to establishing, expanding, and/or managing riparian buffers within an urban landscape. Two major constraints to establishment of urban buffers include:

1) **Limited or confined space to establish buffers** due to encroachment by structures such as buildings, roadways, and/or sewer infrastructure;
2) **Fragmentation of the landscape** by road and railway crossings of creeks and rivers that disrupt the linear connectedness of buffers, limiting their ability to provide quality wildlife habitat.

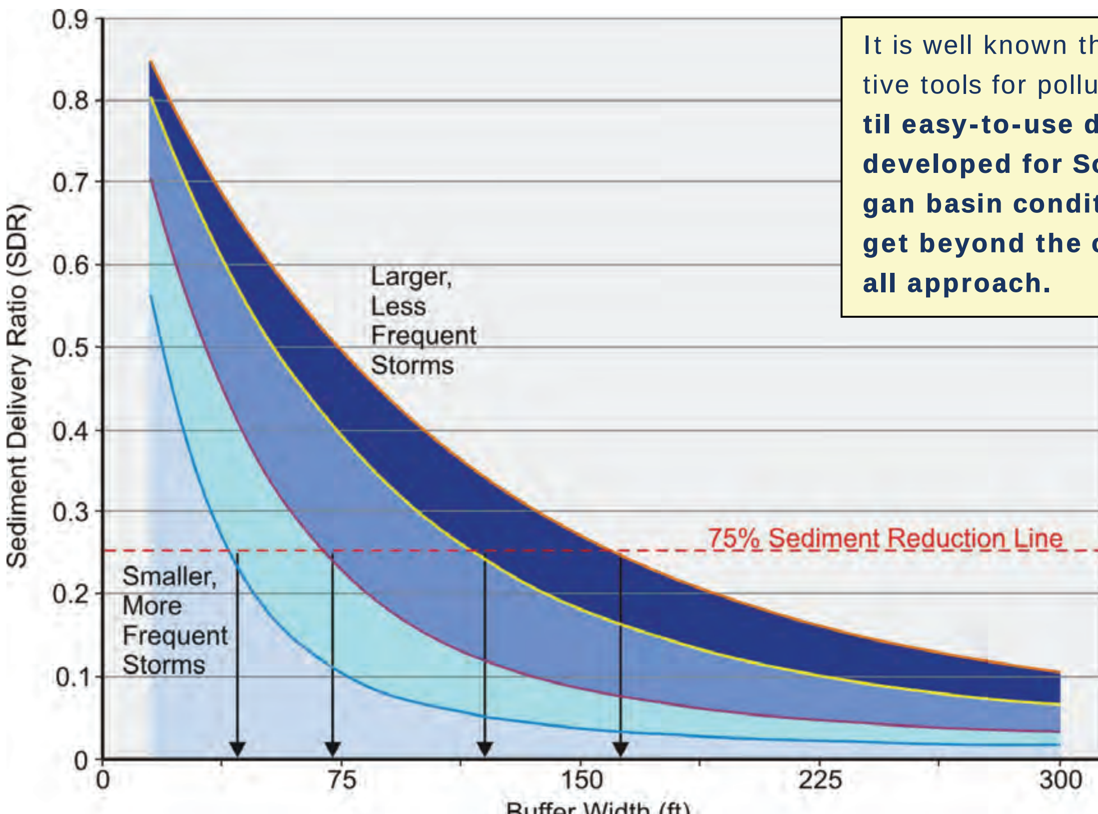
Much traditional stormwater infrastructure intercepts runoff and diverts it directly into creeks and rivers, bypassing any benefits of buffers to infiltrate or filter pollutants. This is important to consider in design of a buffer system for urban waterways, which begin in yards, curbsides, and construction sites, that are figuratively as close to streams as the nearest storm sewer inlet.

A Buffer Design Tool

Design aids are needed to help municipalities, property owners, and others take the "guesswork" out of determining adequate buffer widths for the purpose of water resource quality protection. While there are various complex mathematical models that can be used to estimate sediment and nutrient removal efficiencies, they are not easily applied by the people who need them including homeowners, farmers, businesses and developers.

To fill this gap, design aid tools are being developed using factors such as slope, soils, field length, incoming pollutant concentrations, and vegetation to allow the user to identify and test realistic buffer widths with respect to the desired percent pollutant load reduction and storm characteristics. By developing a set of relationships among factors that determine buffer effectiveness, the width of buffer needed to meet specific goals can be identified.

In the example below, 50-foot-wide buffers are necessary to achieve 75 % sediment removal during small, low intensity storms, while buffers more than 150 feet wide are necessary to achieve the same sediment reduction during more severe storms. Based on this information, decision-makers have the option of fitting a desired level of sediment removal into the context of their specific conditions. Under most conditions, a 75-foot width will provide a minimum level of protection for a variety of needs (SEWRPC PR No. 50, Appendix O.)



It is well known that buffers are effective tools for pollutant removal, but **until easy-to-use design aid tools are developed for Southern Lake Michigan basin conditions, we can never get beyond the current one size fits all approach.**

This generalized graph depicts an example of model output for an optimal buffer width to achieve a 75% sediment reduction for a range of soil and slope, vegetation, and storm conditions characteristic of North Carolina. *(Adapted from Muñoz-Carpena R., Parsons J.E.. 2005. VFSMOD-W: Vegetative Filter Strips Hydrology and Sediment Transport Modeling System v.2.x. Homestead, FL: University of Florida. http://carpena.ifas.ufl.edu/vfsmod/citations.shtml)*

Buffers Are A Good Defense

Today's natural resources are under threat. These threats are immediate as in the case of chemical accidents or manure spills, and chronic as in the case of stormwater pollution carrying everything from eroded soil, to fertilizer nutrients, to millions of drips from automobiles and other sources across the landscape. Non-native species have invaded, and continue to invade, key ecosystems and have caused the loss of native species and degradation of their habitats to the detriment of our use of important resources.

> ***"Riparian ecosystems are naturally resilient,*** *provide linear habitat connectivity, link aquatic and terrestrial ecosystems, and create thermal refugia for wildlife: all characteristics that can contribute to ecological adaptation to climate change."*
>
> *(N. E. Seavy and others, Why Climate Change Makes Riparian Restoration More Important Than Ever: Recommendations for Practice and Research, 2009, Ecological Restoration 27(3):330-338)*

A more subtle, but growing, concern is the case of stresses on the environment resulting from climate change. Buffers present an opportunity for natural systems to adapt to such changes by providing the space to implement protective measures while also serving human needs. **Because riparian buffers maintain an important part of the landscape in a natural condition, they offer opportunities for communities to adjust to our changing world.**

Well-managed riparian buffers are a good defense against these threats. In combination with environmental corridors, buffers maintain a sustainable reserve and diversity of habitats, plant and animal populations, and genetic diversity of organisms, all of which contribute to the long-term preservation of the landscape. Where they are of sufficient size and connectivity, riparian buffers act as reservoirs of resources that resist the changes that could lead to loss of species.

Refuge or protection from increased water temperatures as provided by natural buffers is important for the preservation of native cold-water, cool-water, and warm-water fishes and their associated communities.

Buffers Provide Opportunities

River, lake, and wetland systems and their associated riparian lands form an important element of the natural resource base, create opportunities for recreation, and contribute to attractive and well-balanced communities. These resources can provide an essential avenue for relief of stress among the population and improve quality of life in both urban and rural areas. Such uses also sustain industries associated with outfitting and supporting recreational and other uses of the natural environment, providing economic opportunities. Increasing access and assuring safe use of these areas enhances public awareness and commitment to natural resources. Research has shown that property values are higher adjoining riparian corridors, and that such natural features are among the most appreciated and well-supported parts of the landscape for protection.

We demand a lot from our riparian buffers!

Sustaining this range of uses requires our commitment to protect and maintain them.

Summary

The following guidance suggestions highlight key points to improve riparian corridor management and create a more sustainable environment.

Riparian corridors or buffers along our waters may contain varied features, but all are best preserved or designed to perform multiple important functions.

Care about buffers because of their many benefits. Riparian buffers make sense and are profitable monetarily, recreationally, aesthetically, as well as environmentally.

Enhance the environmental corridor concept. Environmental corridors are special resources which deserve protection. They serve many key riparian corridor functions, but in some cases, could also benefit from additional buffering.

Avoid habitat fragmentation of riparian corridors. It is important to preserve and link key resource areas, making natural connections and avoiding habitat gaps.

Employ the adage "wider is better" for buffer protection. While relatively narrow riparian buffers may be effective as filters for certain pollutants, that water quality function along with infiltration of precipitation and runoff and the provision of habitat for a host of species will be improved by expanding buffer width where feasible.

Allow creeks and rivers room to roam across the landscape. Streams are dynamic and should be buffered adequately to allow for natural movement over time while avoiding problems associated with such movement.

Consider and evaluate buffers as a matter of balance. Riparian buffers are a living, self-sustainable shield that can help balance active use of water and adjoining resources with environmental protection.

Agricultural buffers can provide many benefits. Riparian buffers in agricultural settings generally work well, are cost-effective, and can provide multiple benefits, including possibly serving as areas to raise certain crops.

Urban buffers should be preserved and properly managed. Though often space-constrained and fragmented, urban buffers are important remnants of the natural system. Opportunities to establish or expand buffers should be considered, where feasible, complemented by good stormwater management, landscaping, and local ordinances, including erosion controls.

A buffer design tool is needed and should be developed. Southeastern Wisconsin and the Southern Lake Michigan Basin would benefit from development of a specific design tool to address the water quality function of buffers. Such a tool would improve on the currently available general guidance on dimensions and species composition.

Buffers are a good defense. Combined with environmental corridors, riparian buffers offer a good line of defense against changes which can negatively impact natural resources and the landscape.

Managing the Water's Edge

MORE TO COME

Future editions in a riparian buffer planning series are being explored with the intent of focusing on key elements of this critical land and water interface. Topics may include:

- Information sharing and development of ordinances to integrate riparian buffers into existing land management plans and programs
- Integration of stormwater management practices and riparian buffer best management practices
- Application of buffers within highly constrained urban corridors with and without brownfield development
- Installation of buffers within rural or agricultural lands being converted to urban uses
- Utilization of buffers in agricultural areas and associated drainage systems
- Integration of riparian buffers into environmental corridors to support resources preservation, recreation and aesthetic uses
- Preservation of stream courses and drainageways to minimize maintenance and promote protection of infrastructure
- Guidance for retrofitting, replacement, or removal of infrastructure such as dams and road crossings, to balance transportation, recreation, aesthetic, property value, and environmental considerations.
- Protection of groundwater recharge and discharge areas
- Protection of high quality, sensitive coastal areas, including preservation of recreational potential

MORE INFORMATION

This booklet can be found at http://www.sewrpc.org/RBMG-no1 . Please visit the website for more information, periodic updates, and a list of complementary publications.

* * *

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Jeff Thornton, PhD, Principal Planner

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May 7, 2010

Appendix C

MAP TOOLS TO DETERMINE EXISTING AND POTENTIAL RIPARIAN BUFFER LANDS THAT ARE CONSIDERED "VULNERABLE" TO DEVELOPMENT

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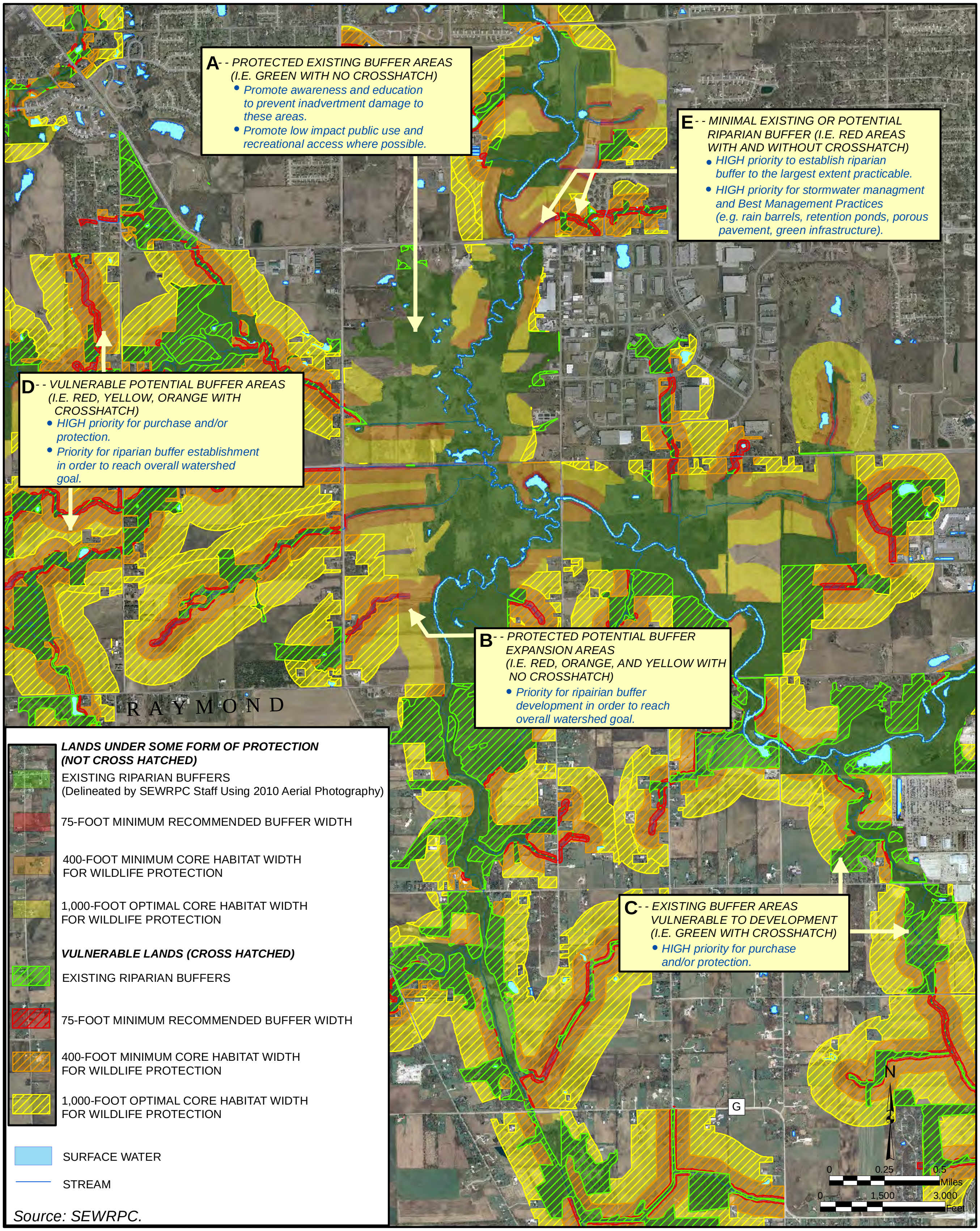
Figure C-1

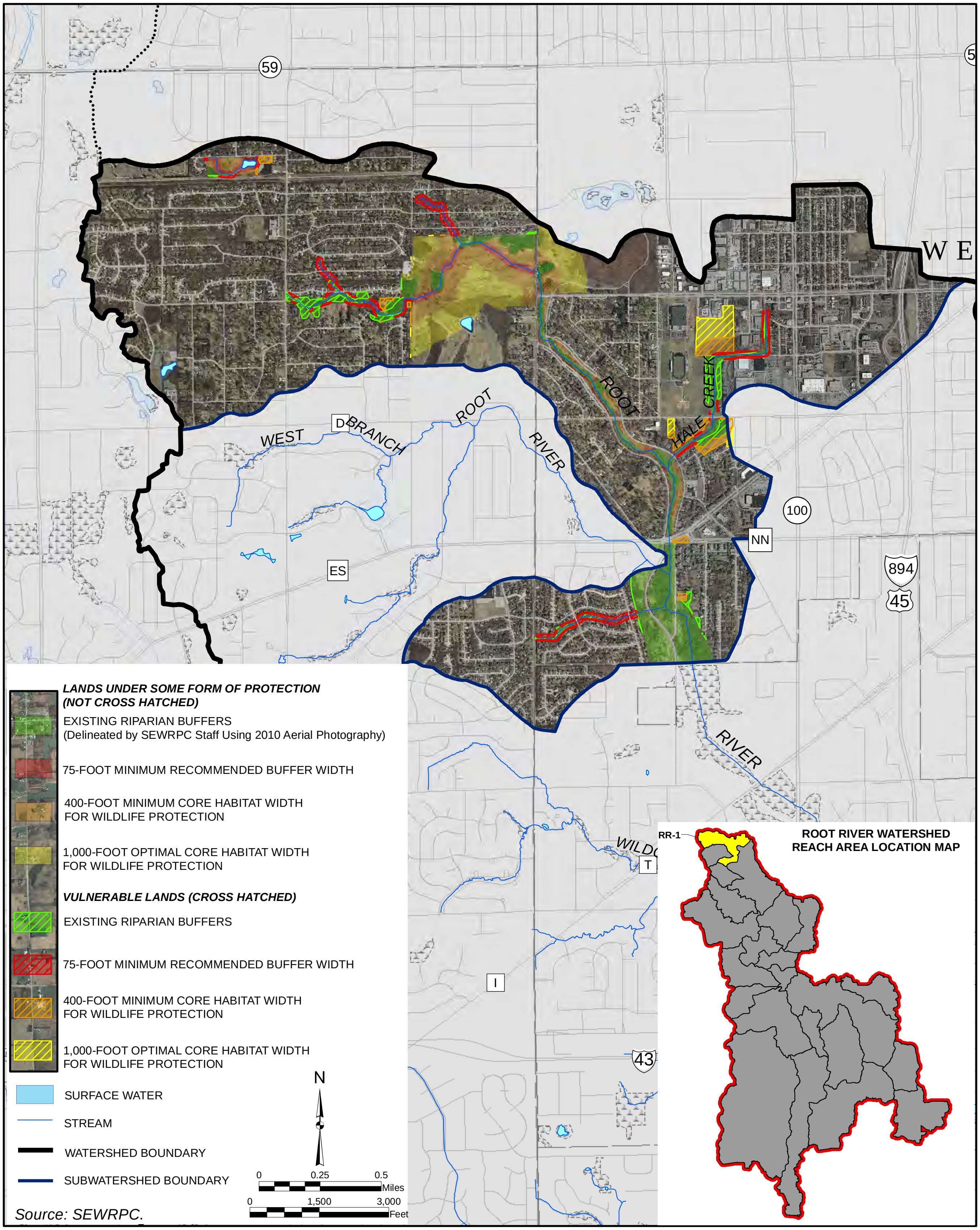
EXAMPLES OF AREAS THAT SHOULD BE IDENTIFIED IN MAPS C-1 THROUGH C-23 TO IMPLEMENT RECOMMENDATIONS



Source: SEWRPC.

Map C-1

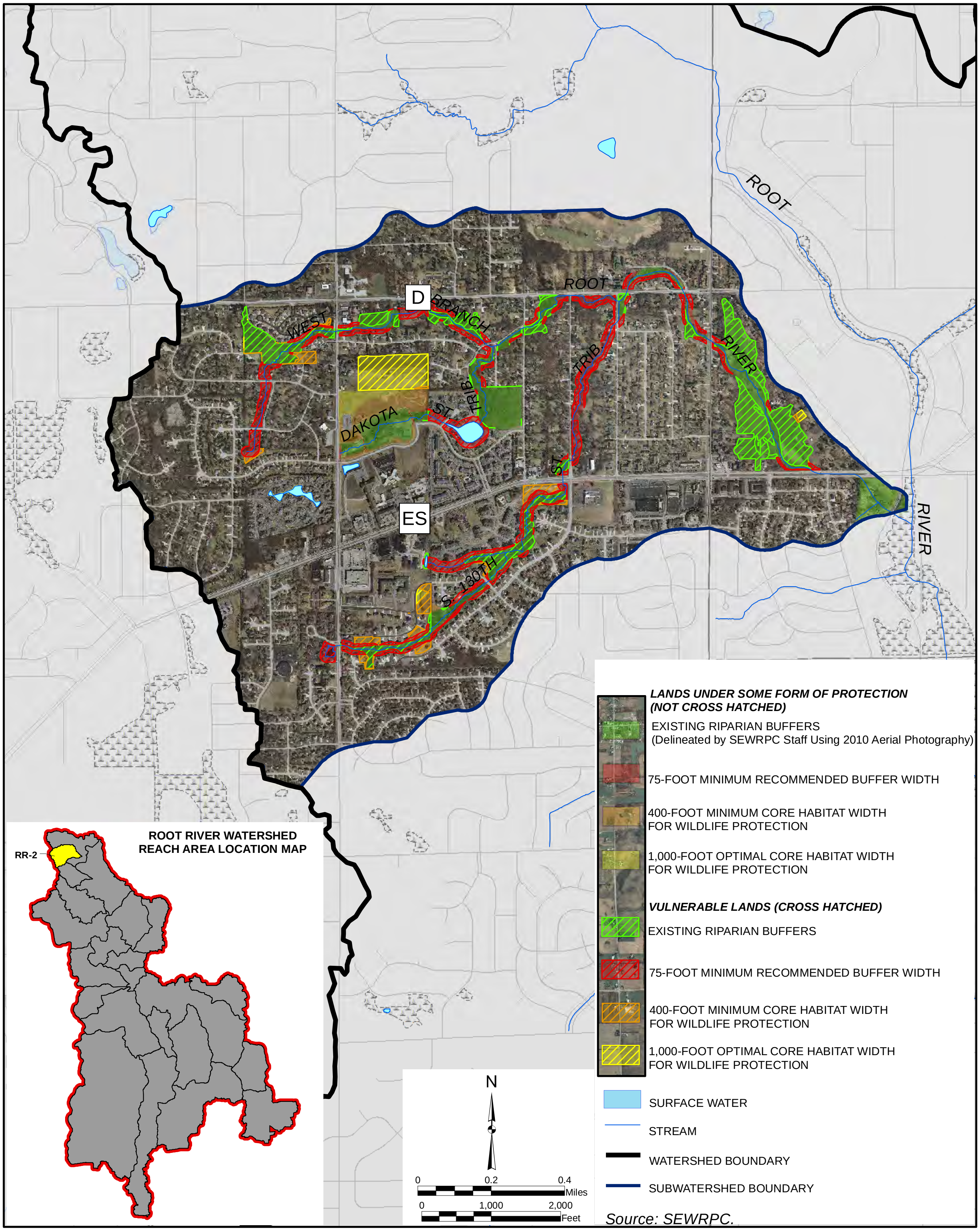
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 1 (INCLUDES PORTIONS OF THE CITIES OF GREENFIELD, NEW BERLIN, AND WEST ALLIS)



Source: SEWRPC.

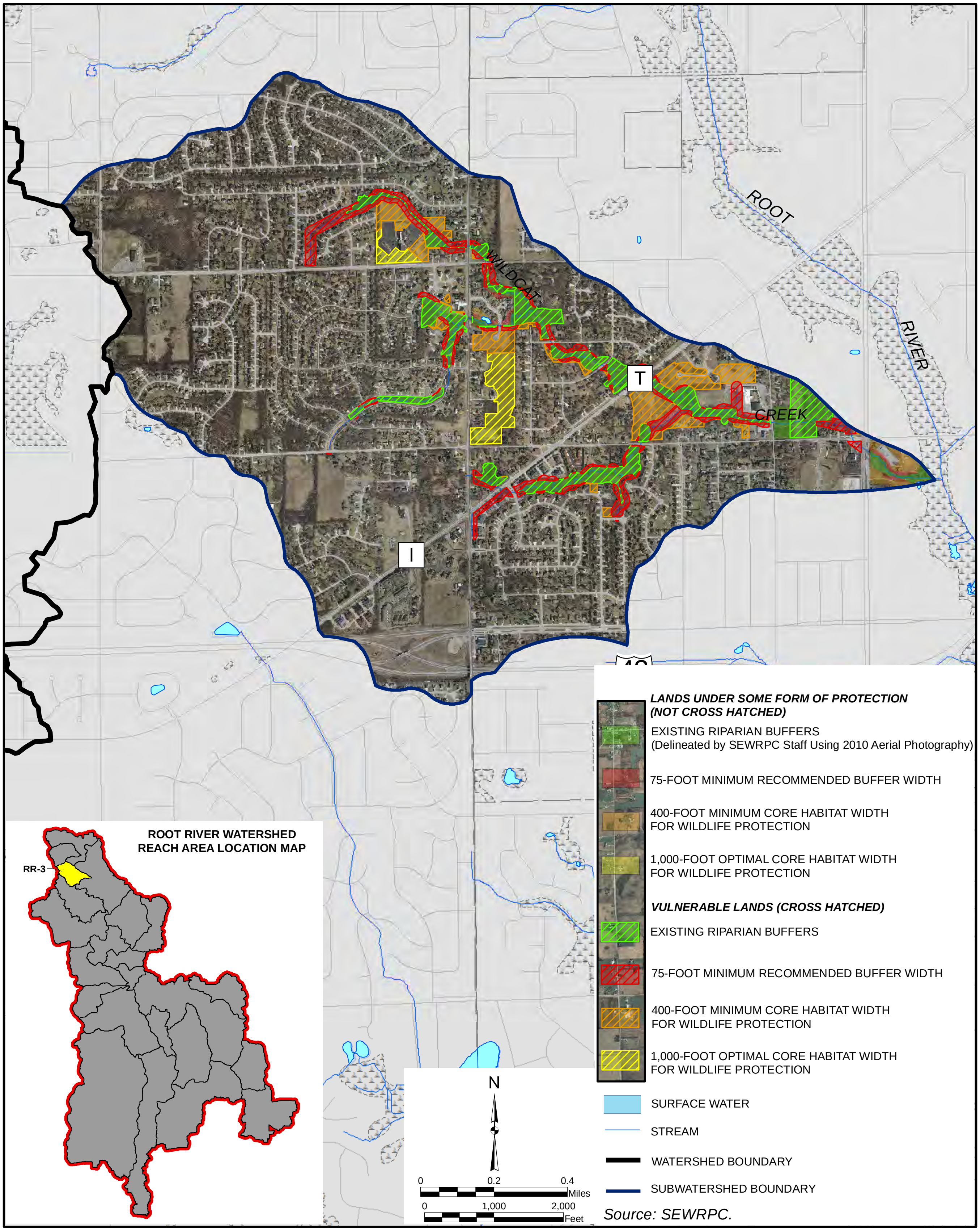
Map C-2

PROPOSED RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 2 (INCLUDES PORTIONS OF THE CITIES OF NEW BERLIN AND WEST ALLIS)



Map C-3

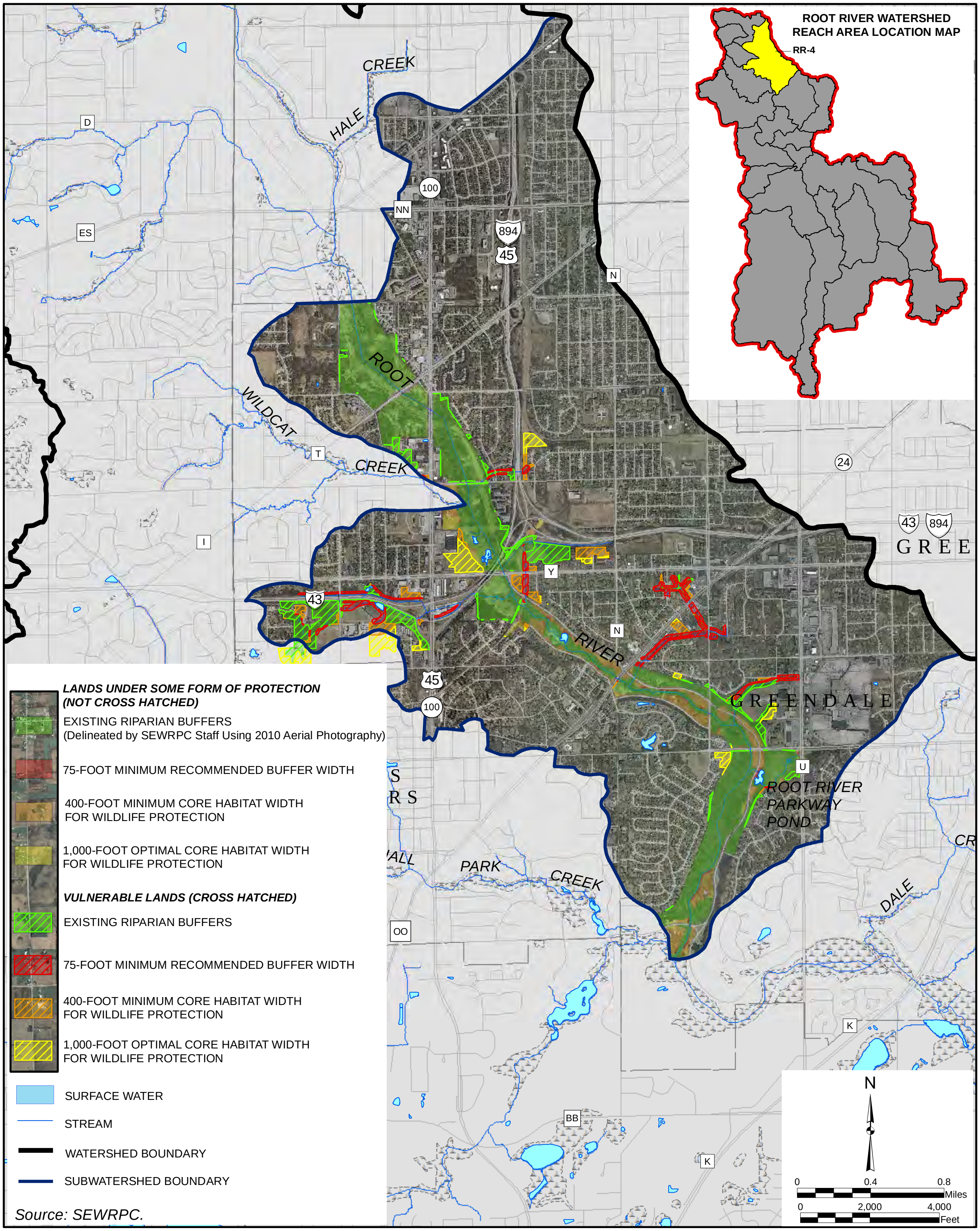
PROPOSED POTENTIAL RIPARIAN BUFFER PROTECTION AREAS
IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 3
(INCLUDES PORTIONS OF THE CITIES OF GREENFIELD AND NEW BERLIN)



Source: SEWRPC.

Map C-4

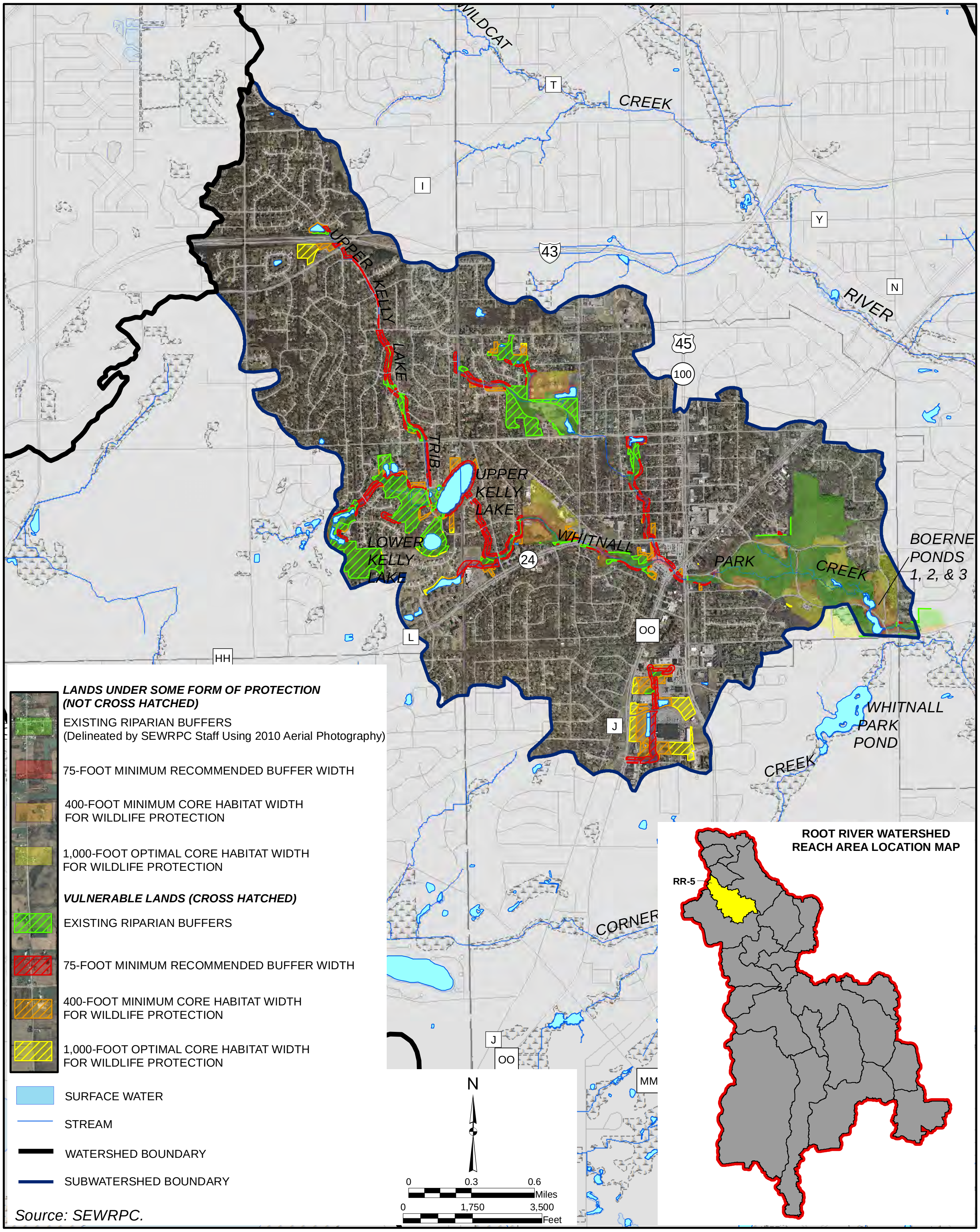
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 4 (INCLUDES PORTIONS OF THE CITIES OF GREENFIELD, MILWAUKEE, AND WEST ALLIS AND THE VILLAGES OF GREENDALE AND HALES CORNERS)



Source: SEWRPC.

Map C-5

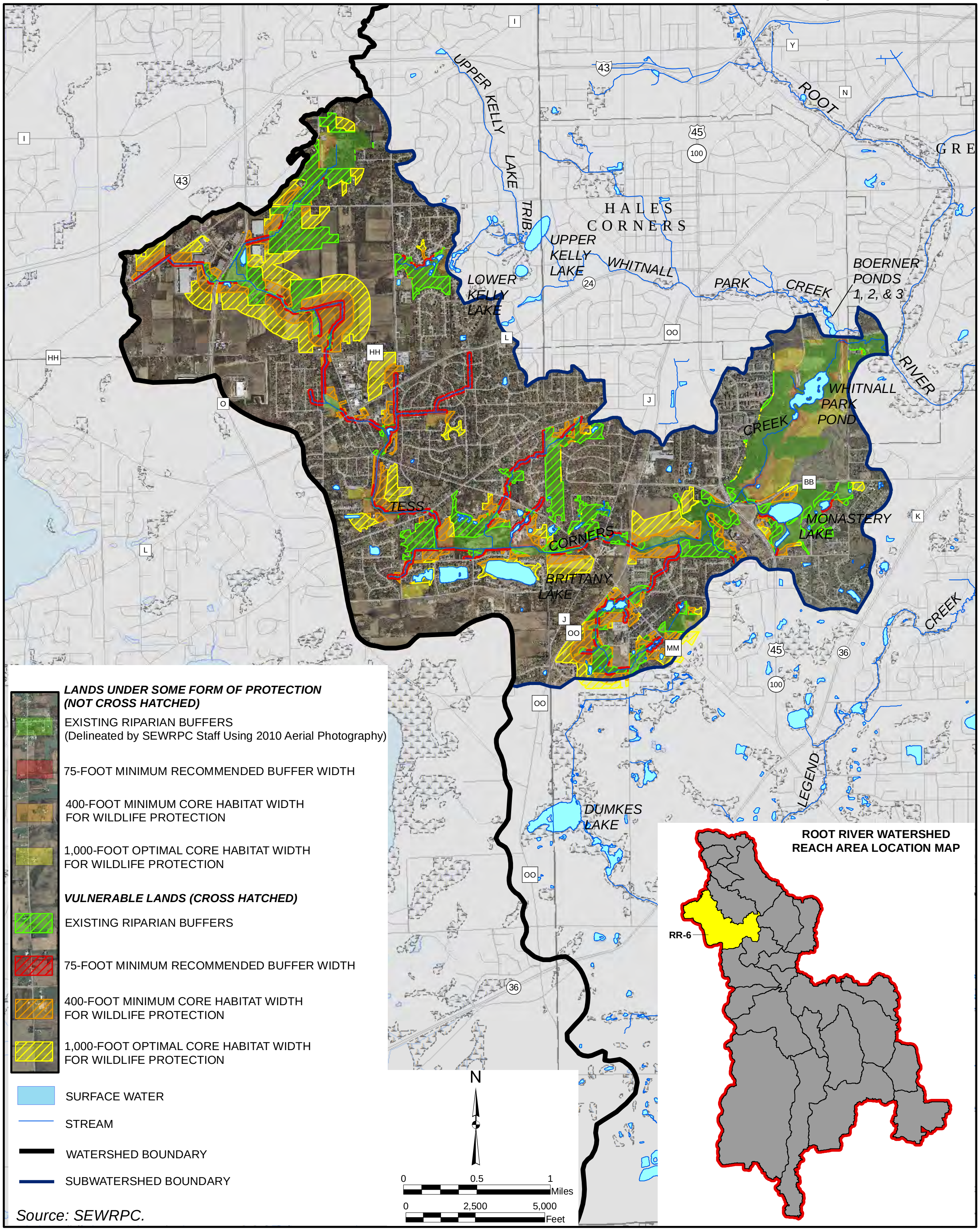
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 5 (INCLUDES PORTIONS OF THE CITIES OF FRANKLIN, GREENFIELD, MUSKEGO, AND NEW BERLIN, AND THE VILLAGE OF HALES CORNERS)



Source: SEWRPC.

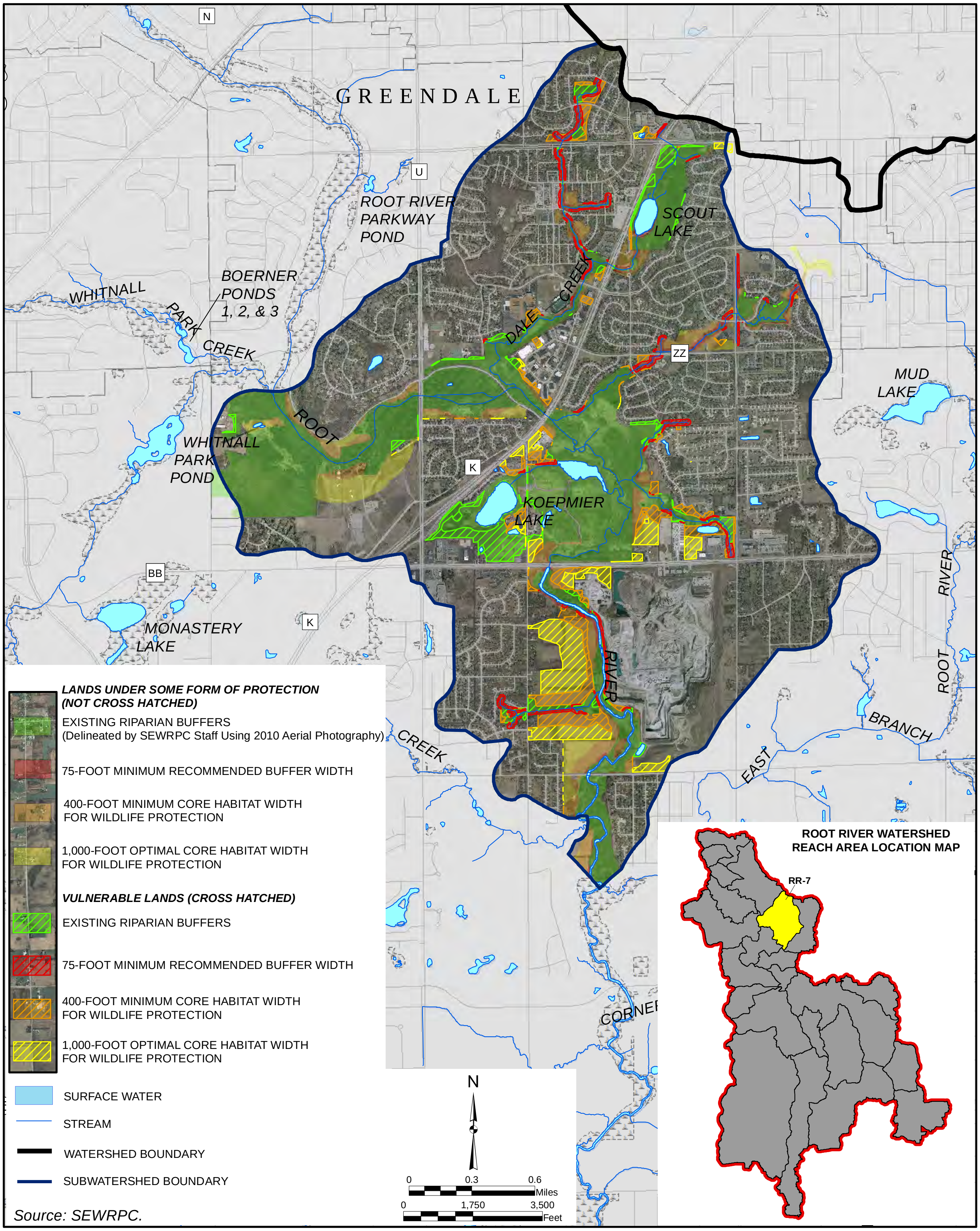
Map C-6

PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 6 (INCLUDES PORTIONS OF THE CITIES OF FRANKLIN, MUSKEGO, AND NEW BERLIN, AND THE VILLAGES OF GREENDALE AND HALES CORNERS)



Map C-7

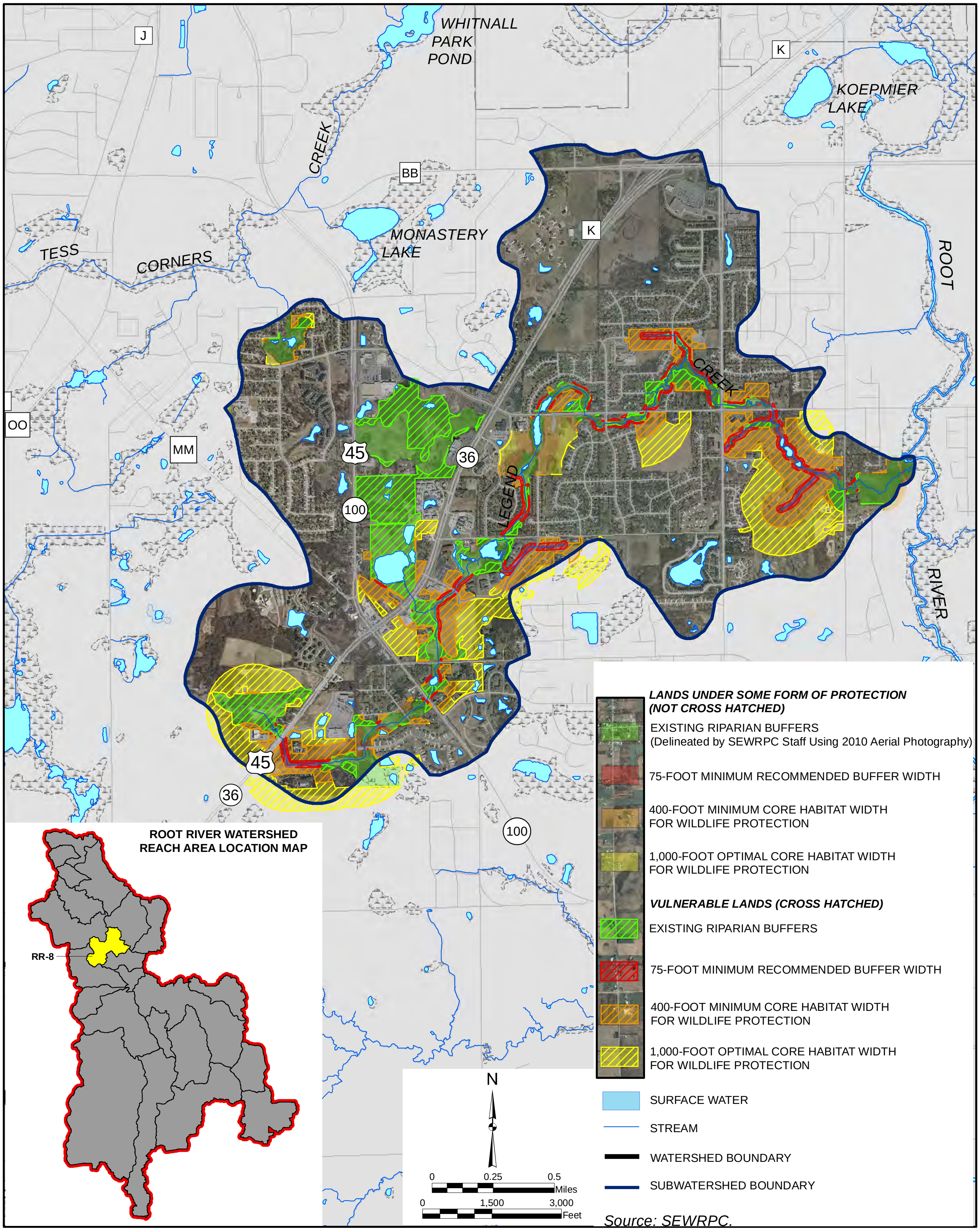
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 7 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN AND THE VILLAGE OF GREENDALE)



Source: SEWRPC.

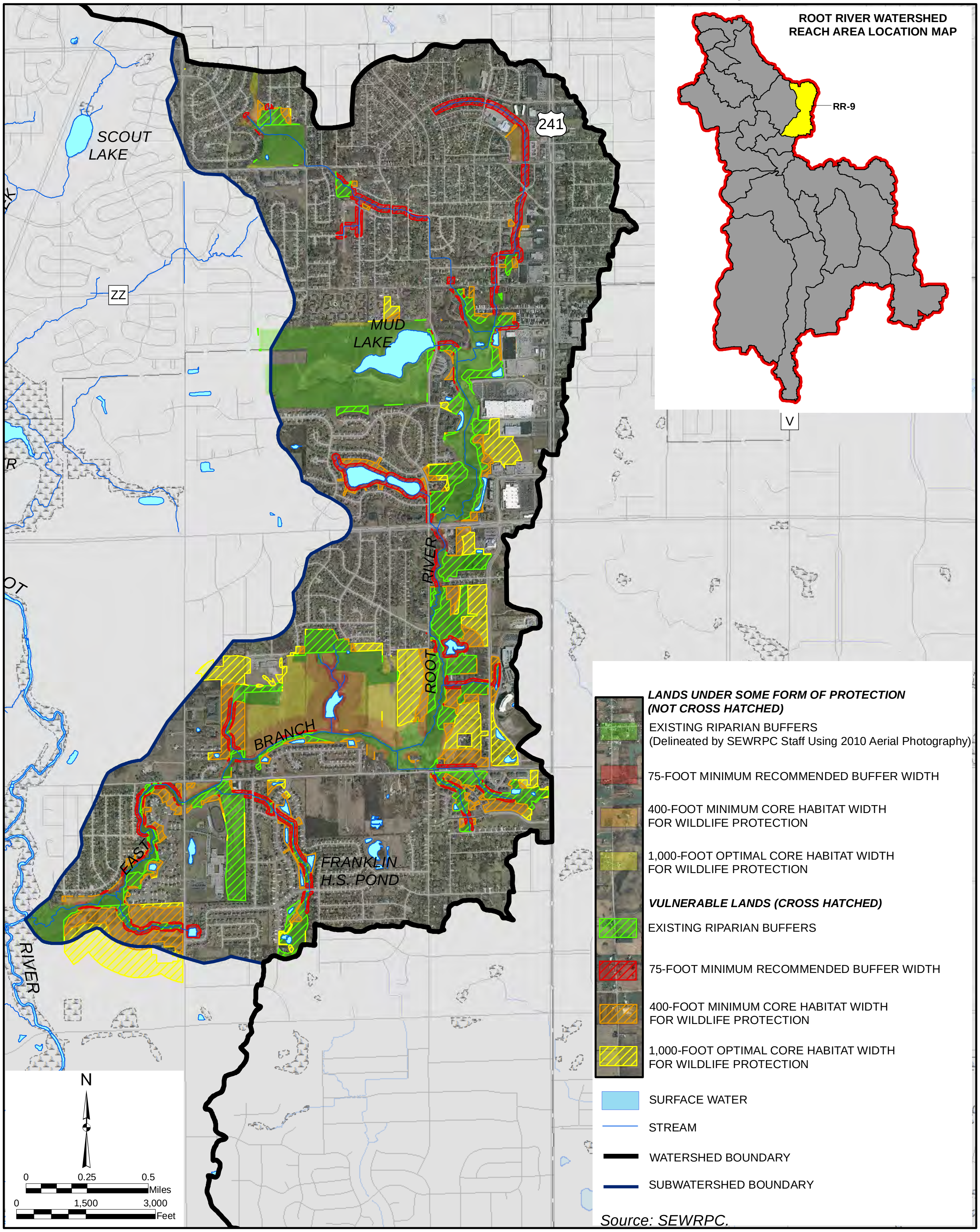
Map C-8

PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 8 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN)



Map C-9

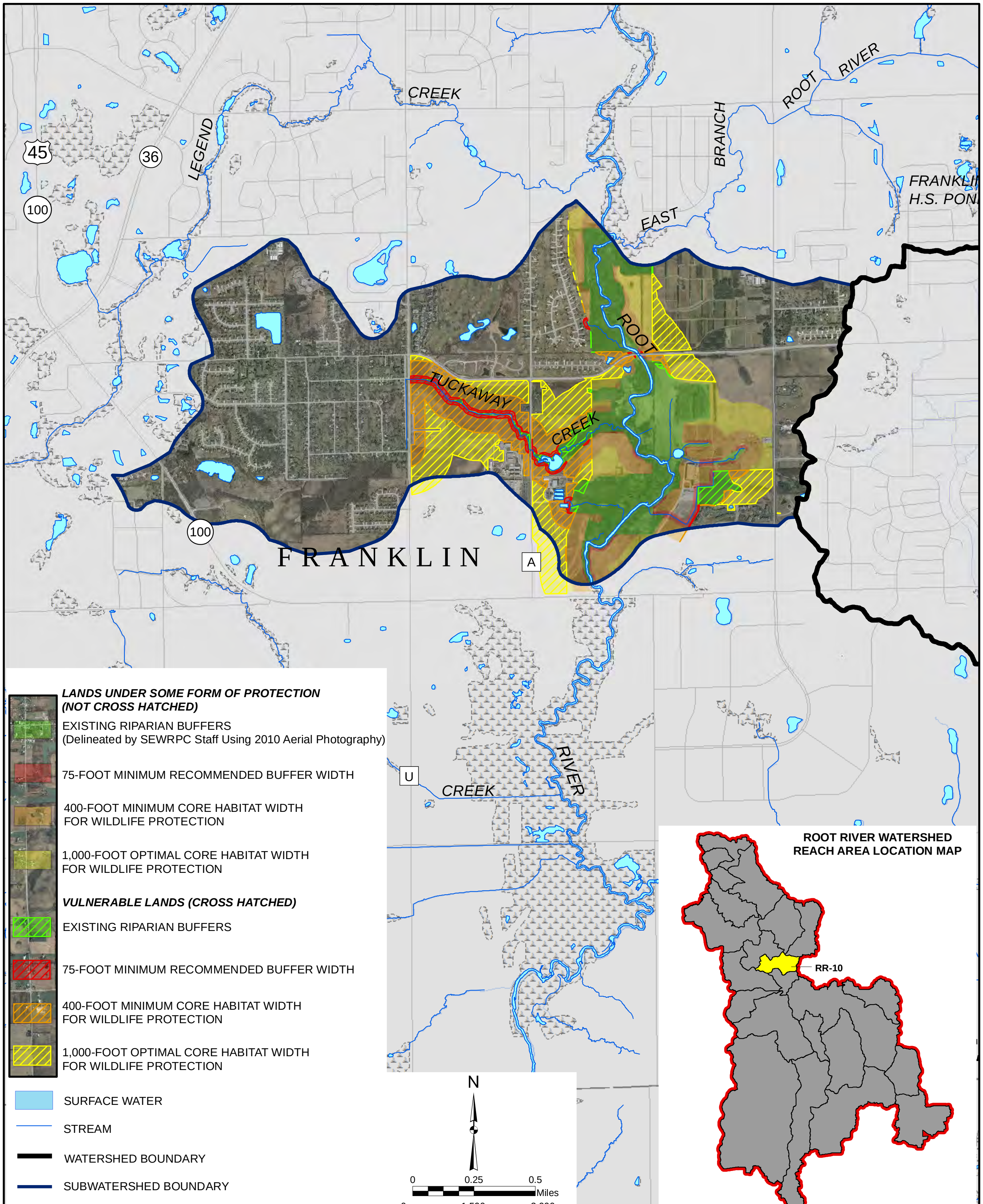
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS
IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 9
(INCLUDES PORTIONS OF THE CITIES OF FRANKLIN, GREENFIELD, MILWAUKEE,
AND OAK CREEK, AND THE VILLAGE OF GREENDALE)



Source: SEWRPC.

Map C-10

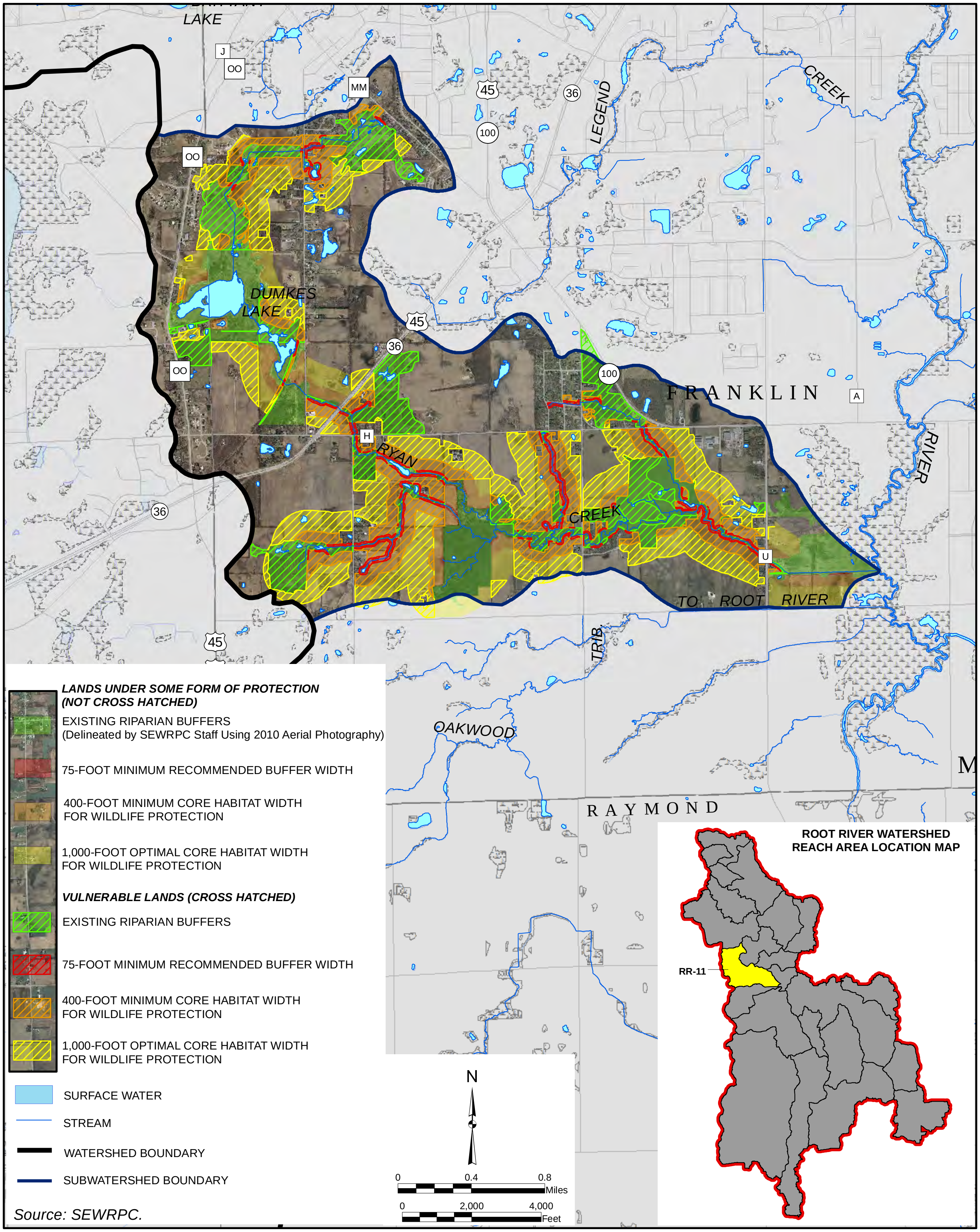
**PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS
IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 10
(INCLUDES PORTIONS OF THE CITY OF FRANKLIN)**



Source: SEWRPC.

Map C-11

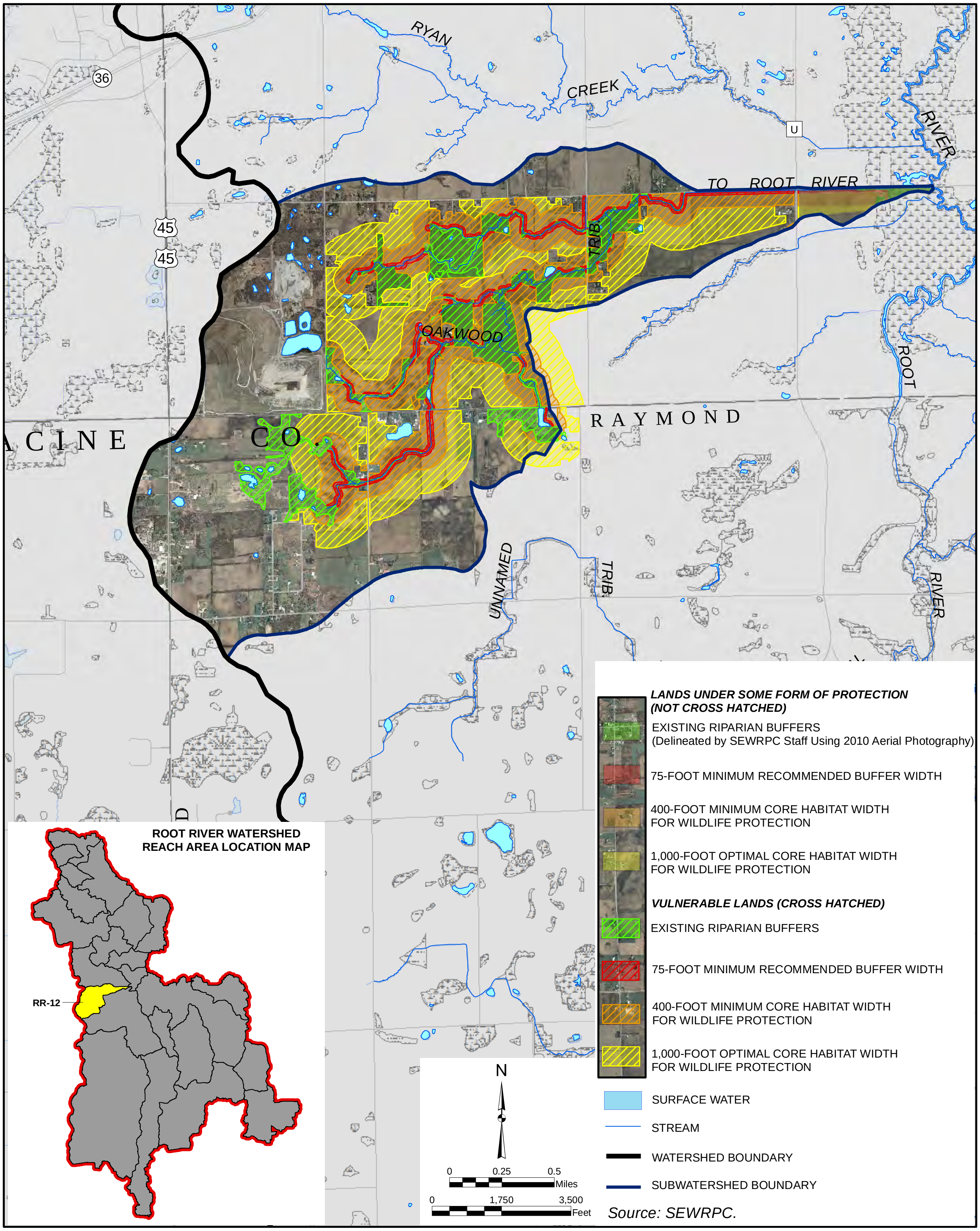
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 11 (INCLUDES PORTIONS OF THE CITES OF FRANKLIN AND MUSKEGO)



Source: SEWRPC.

Map C-12

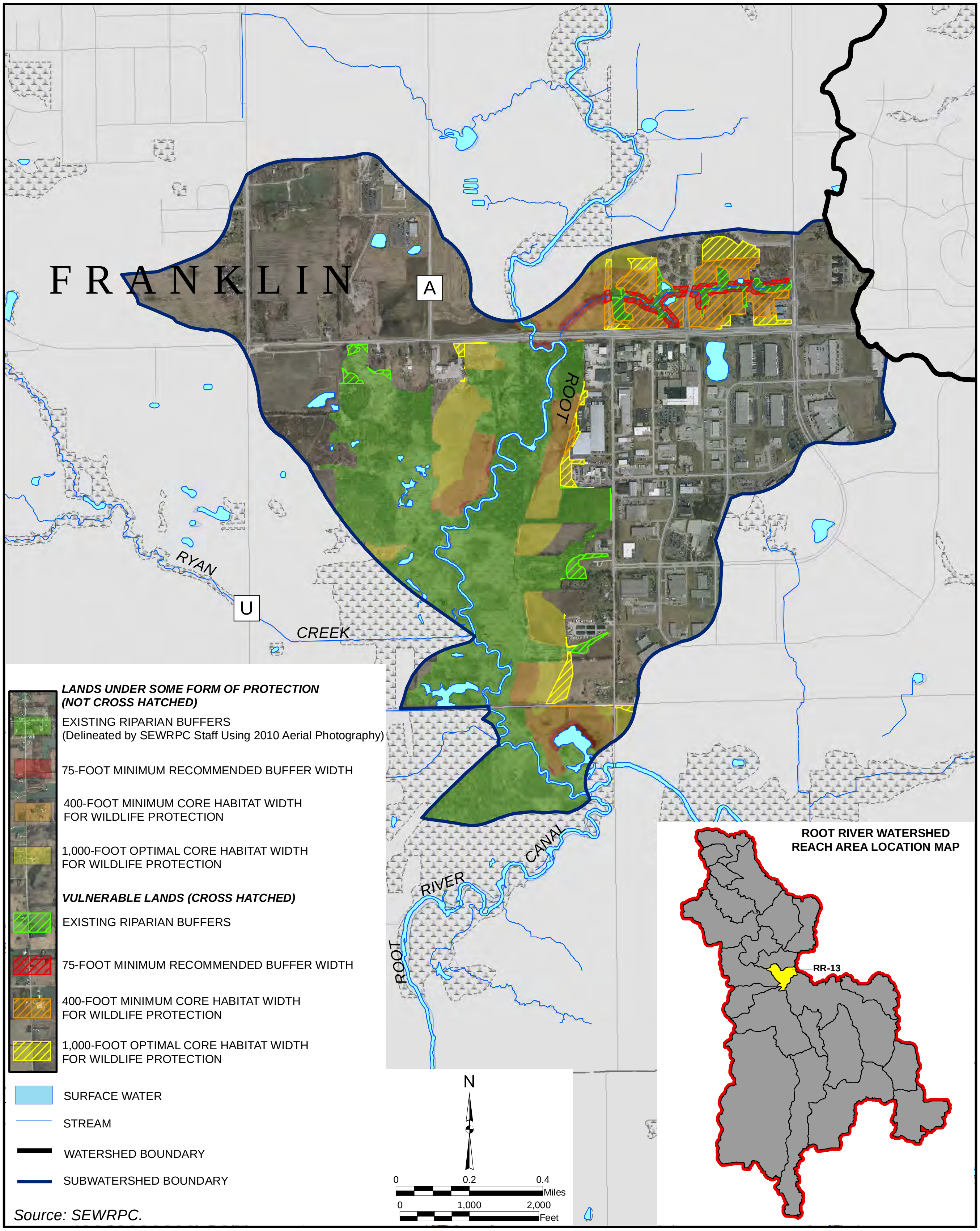
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS
IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 12
(INCLUDES PORTIONS OF THE CITY OF FRANKLIN, AND THE TOWNS OF NORWAY AND RAYMOND)



Source: SEWRPC.

Map C-13

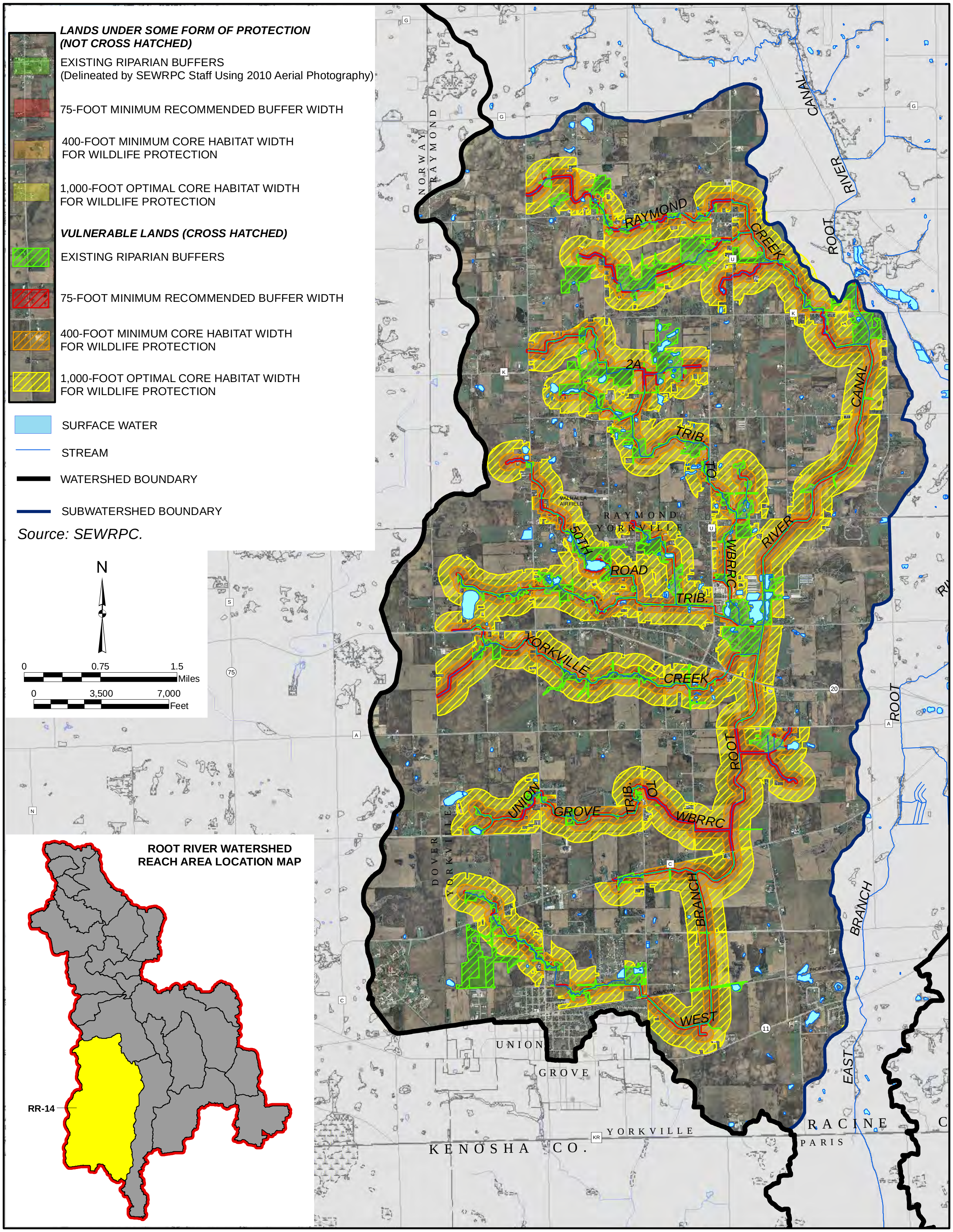
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 13 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN)



Source: SEWRPC.

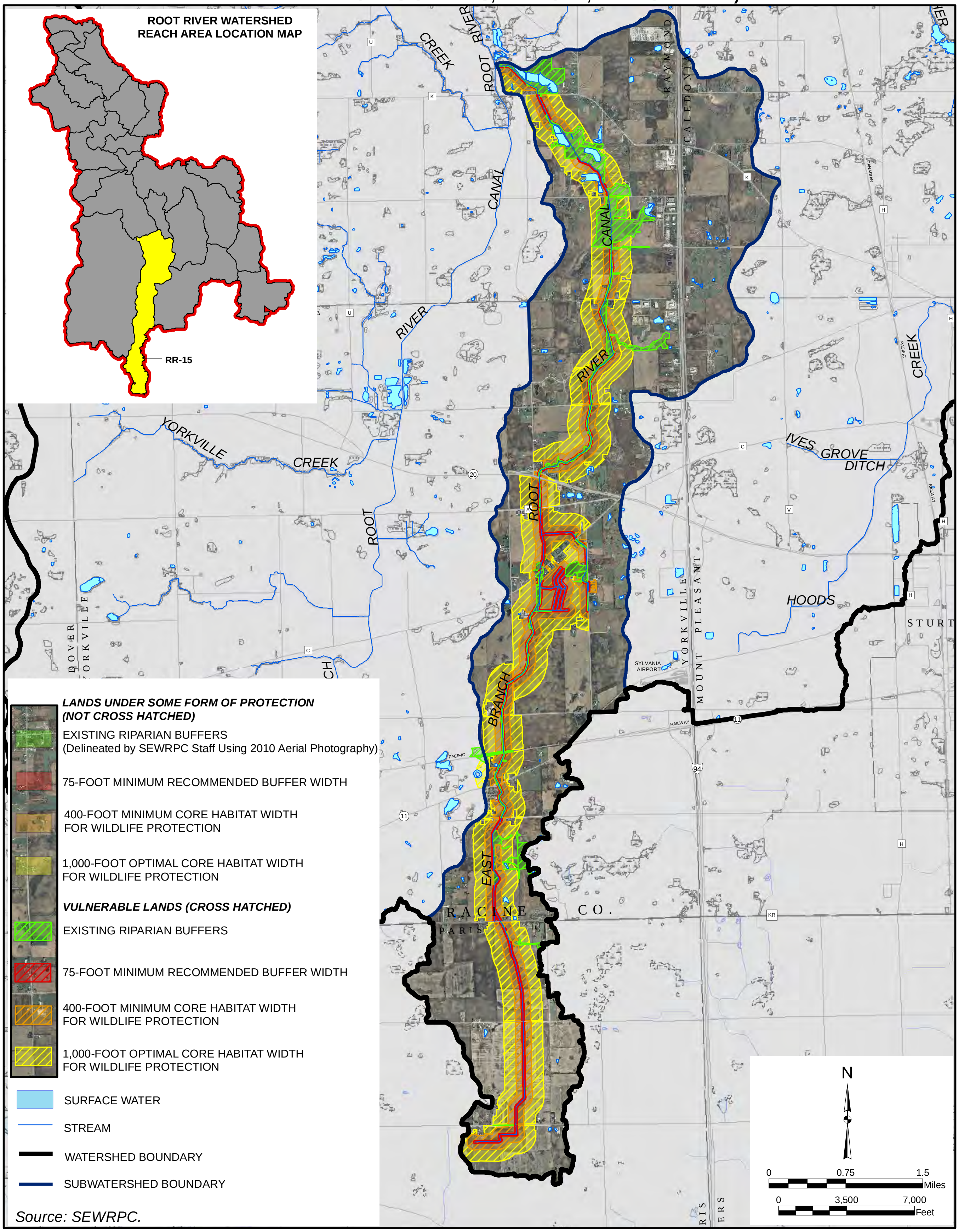
Map C-14

PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 14 (INCLUDES PORTIONS OF THE VILLAGE OF UNION GROVE, AND THE TOWNS OF DOVER, YORKVILLE, AND RAYMOND)



Map C-15

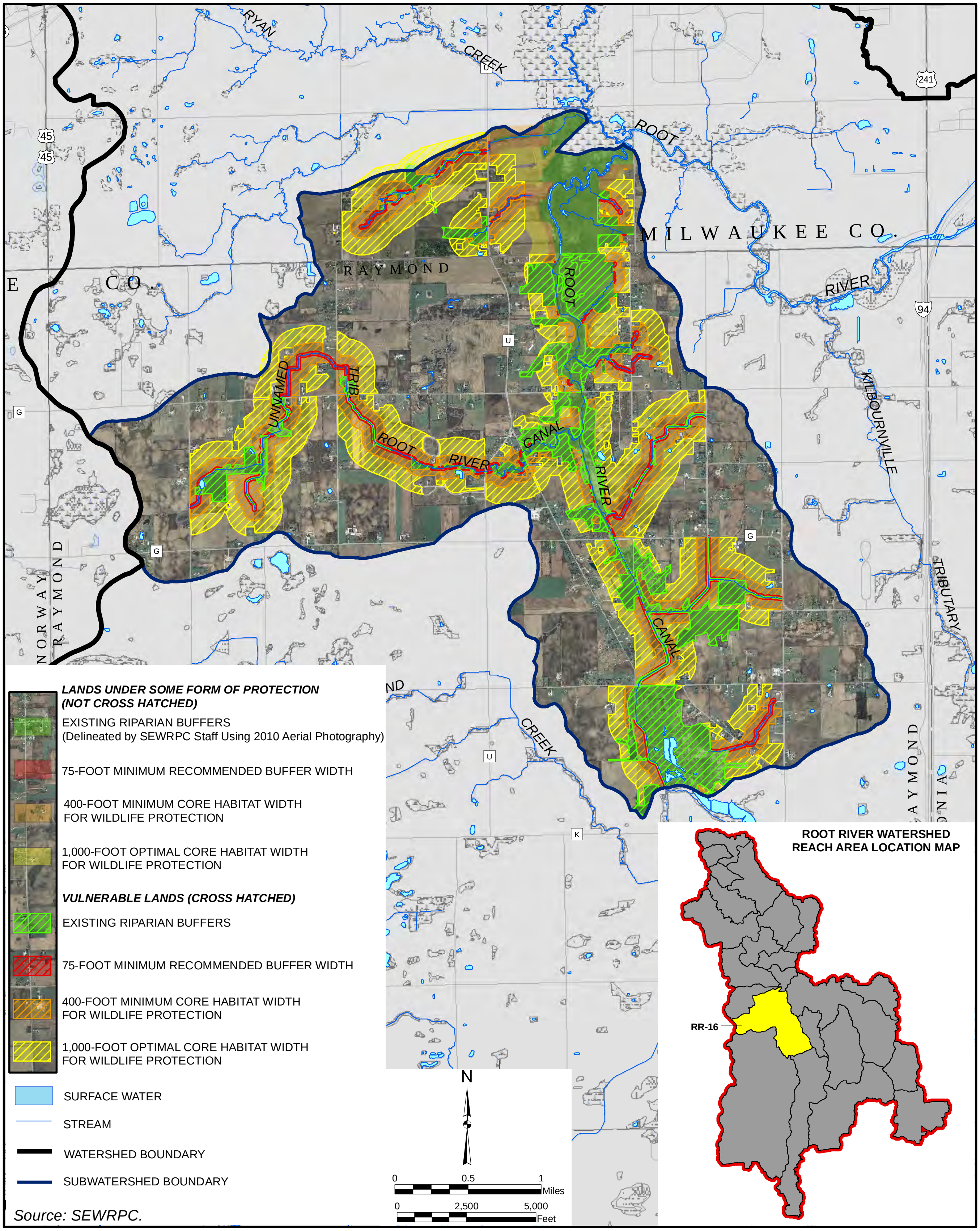
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 15 (INCLUDES PORTIONS OF THE VILLAGES OF CALEDONIA AND MOUNT PLEASANT, AND THE TOWNS OF PARIS, RAYMOND, AND YORKVILLE)



Source: SEWRPC.

Map C-16

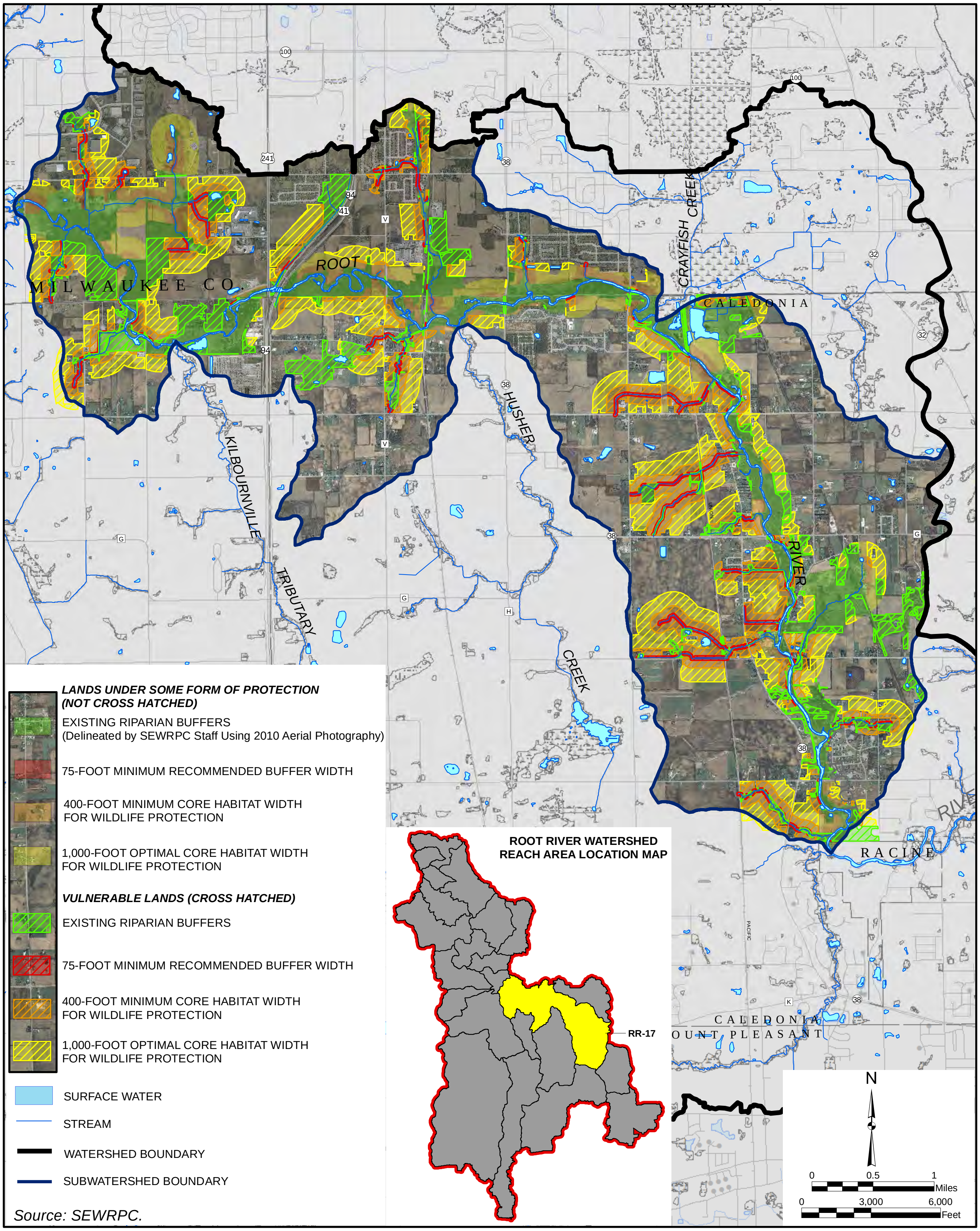
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS
IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 16
(INCLUDES PORTIONS OF THE CITY OF FRANKLIN AND TOWN OF RAYMOND)



Source: SEWRPC.

Map C-17

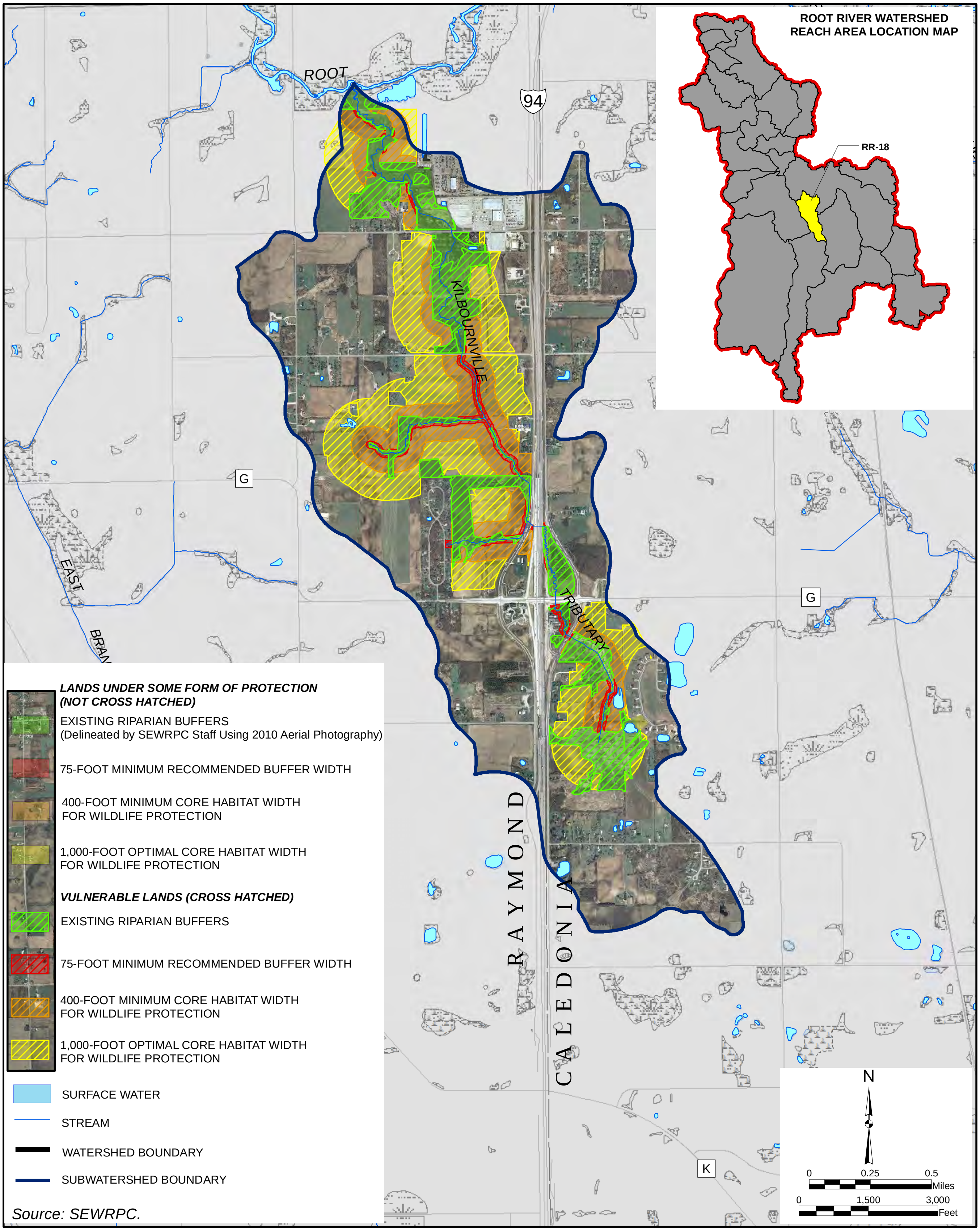
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 17 (INCLUDES PORTIONS OF THE CITES OF FRANKLIN, OAK CREEK AND RACINE, THE VILLAGE OF CALEDONIA, AND THE TOWN OF RAYMOND)



Source: SEWRPC.

Map C-18

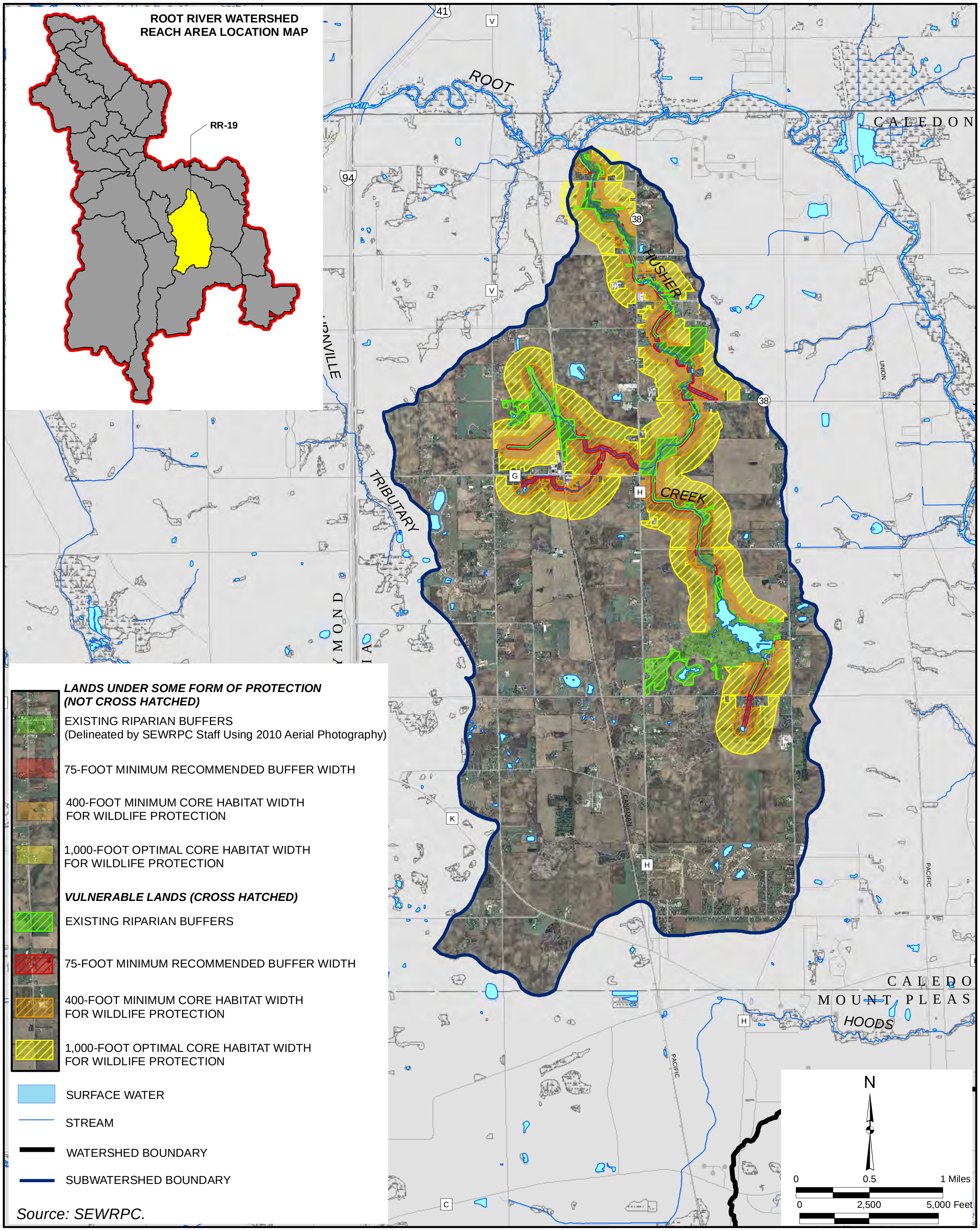
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 18 (INCLUDES PORTIONS OF THE VILLAGE OF CALEDONIA, AND THE TOWN OF RAYMOND)



Source: SEWRPC.

Map C-19

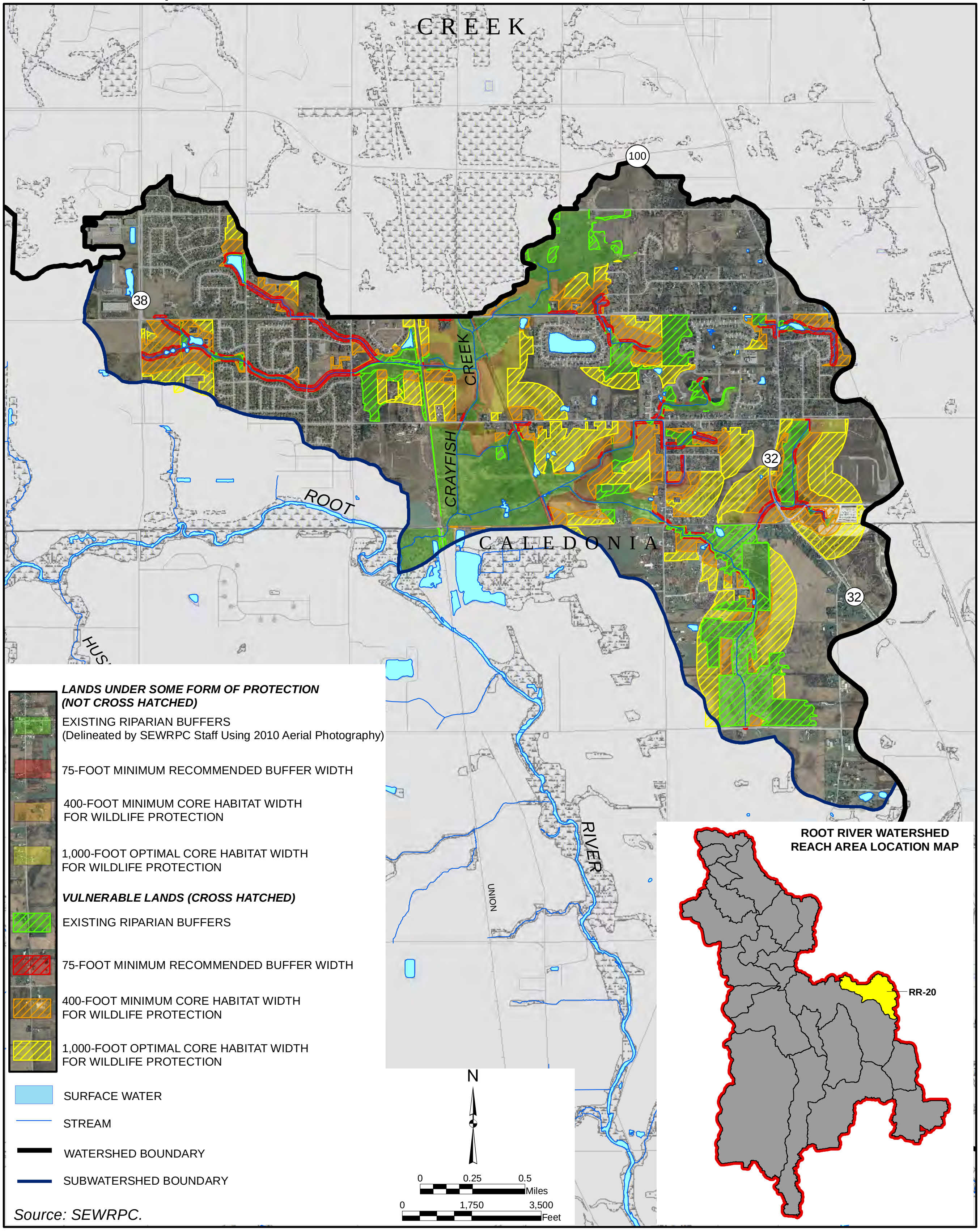
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 19 (INCLUDES PORTIONS OF THE VILLAGE OF CALEDONIA)



Source: SEWRPC.

Map C-20

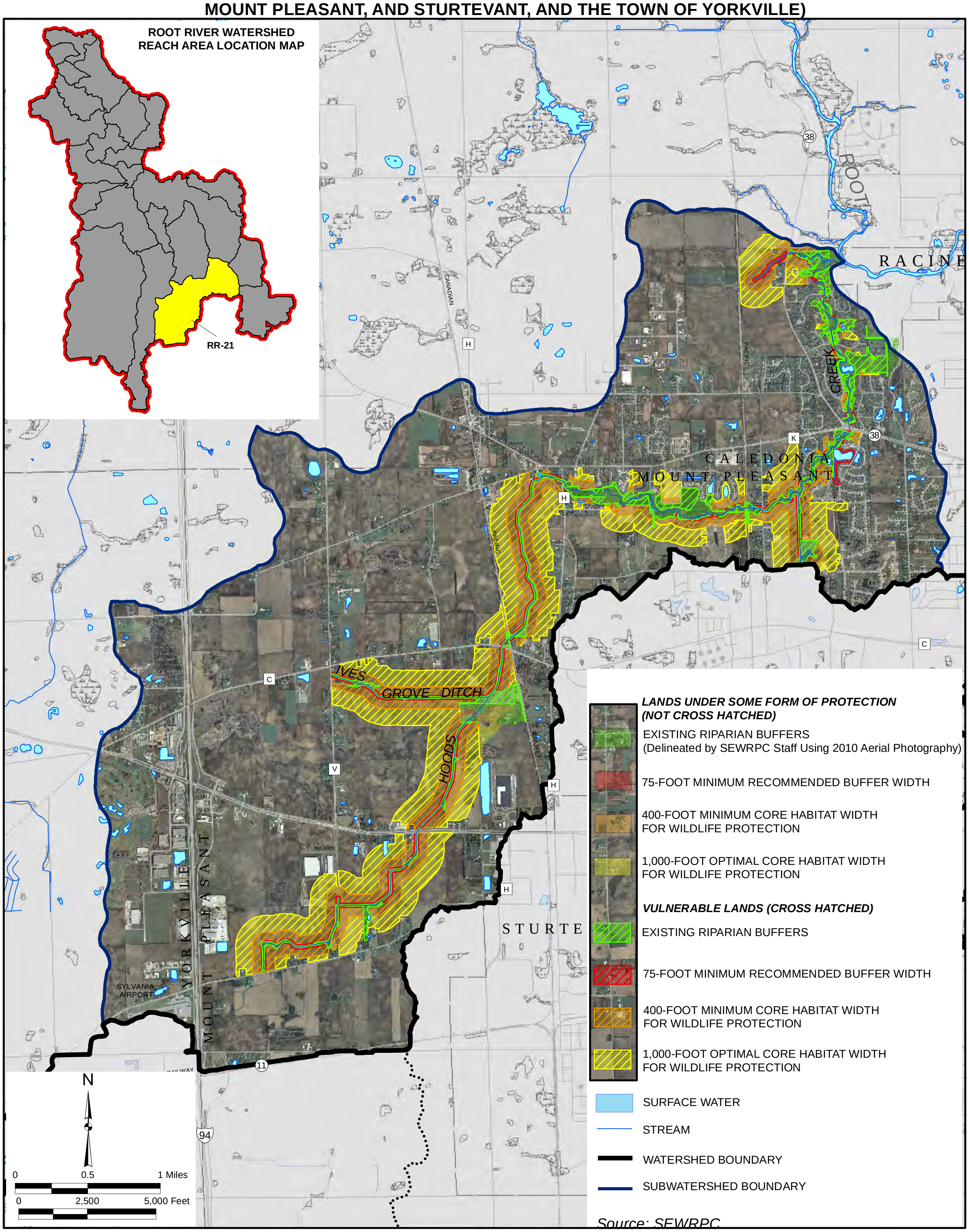
**PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS
IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 20
(INCLUDES PORTIONS OF THE CITY OF OAK CREEK AND VILLAGE OF CALEDONIA)**



Source: SEWRPC.

Map C-21

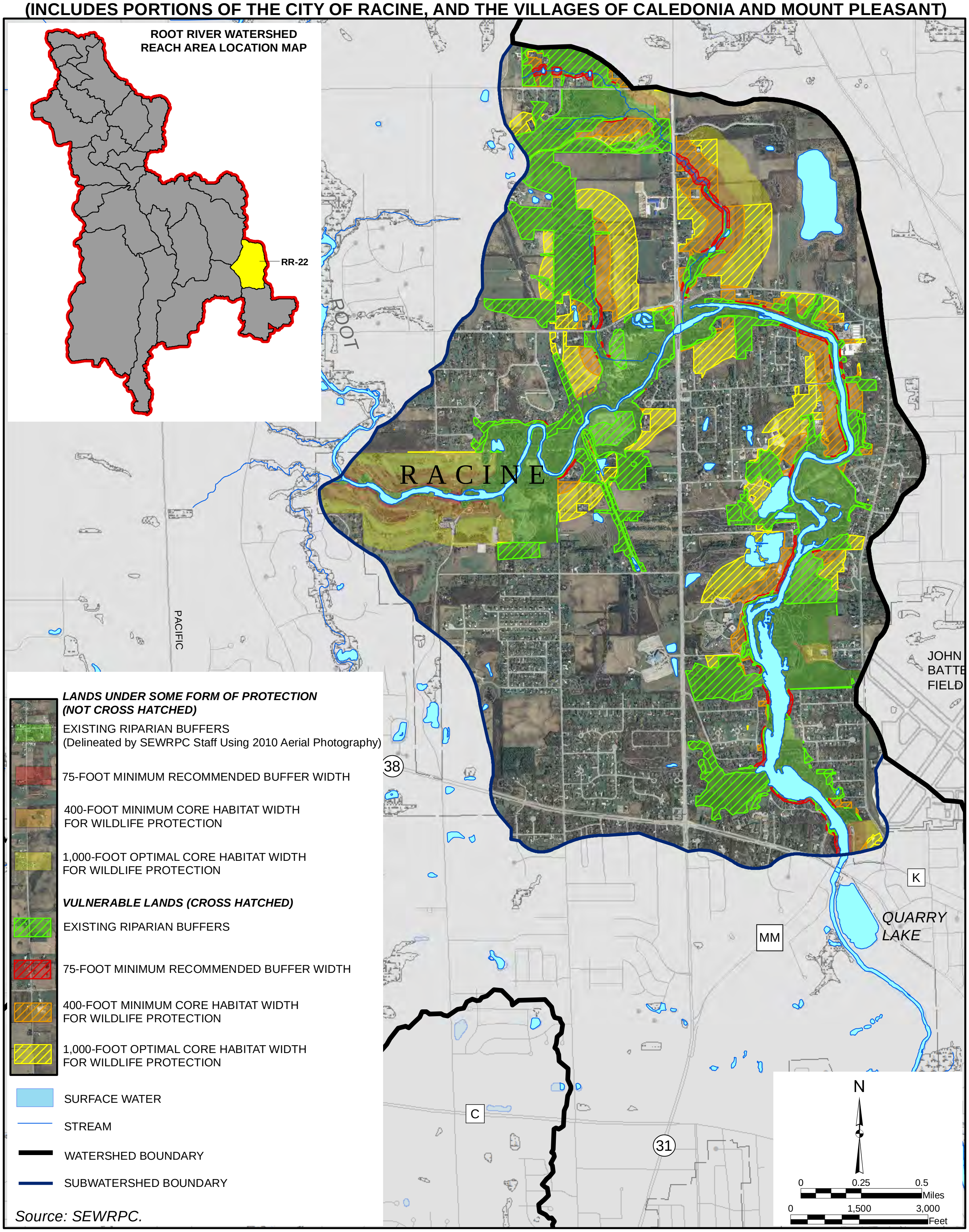
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 21 (INCLUDES PORTIONS OF THE CITY OF RACINE, THE VILLAGES OF CALEDONIA, MOUNT PLEASANT, AND STURTEVANT, AND THE TOWN OF YORKVILLE)



Source: SEWRPC

Map C-22

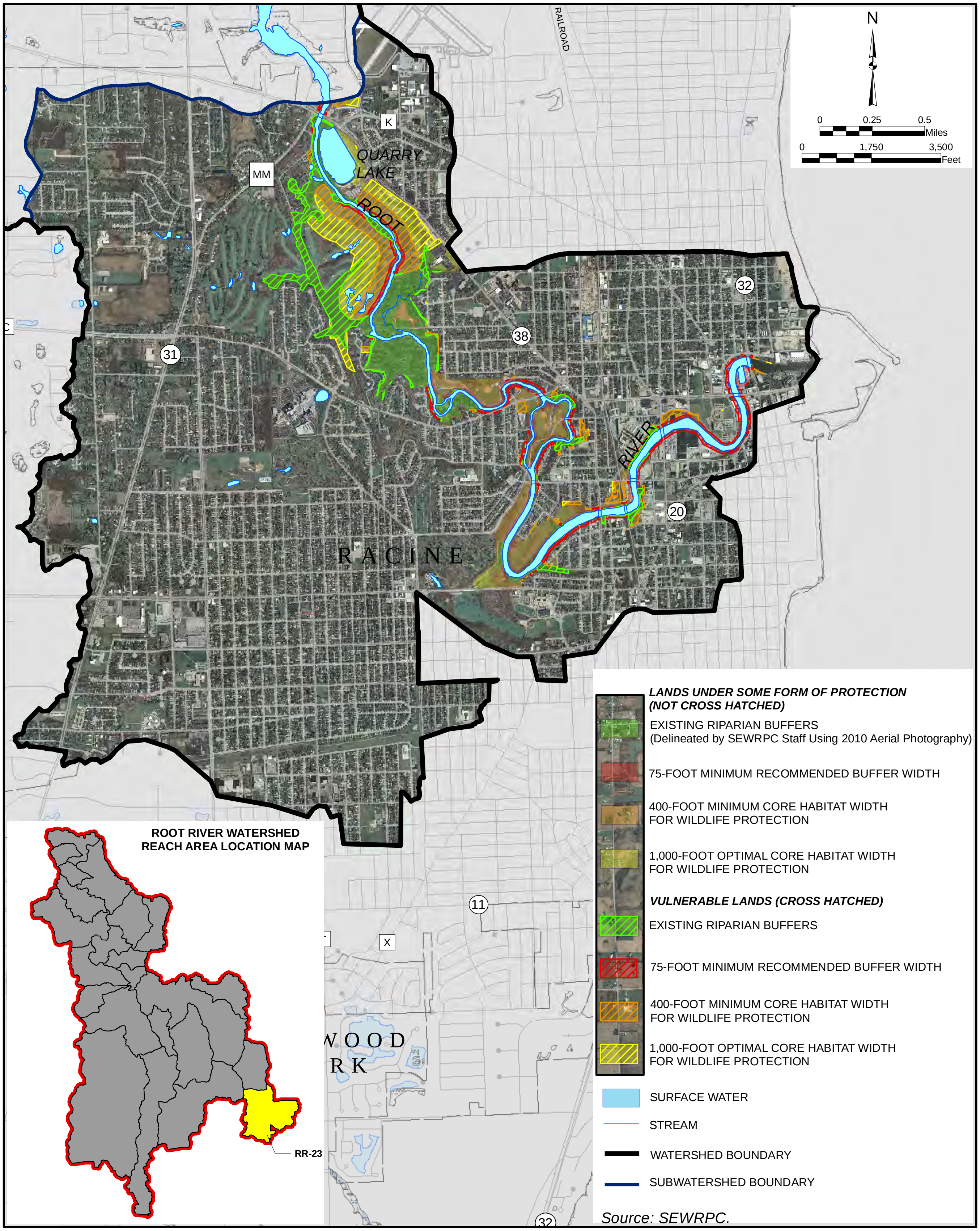
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 22 (INCLUDES PORTIONS OF THE CITY OF RACINE, AND THE VILLAGES OF CALEDONIA AND MOUNT PLEASANT)



Source: SEWRPC.

Map C-23

PROPOSED PRIORITY AND POTENTIAL RIPARIAN BUFFER PROTECTION AREAS
IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 23
(INCLUDES PORTIONS OF THE CITY OF RACINE, AND THE VILLAGE OF MOUNT PLEASANT)



Source: SEWRPC.

Appendix D

MAP TOOLS TO DETERMINE "VULNERABLE" EXISTING AND POTENTIAL RIPARIAN BUFFER LANDS THAT ARE WITHIN AREAS OF HIGH GROUNDWATER RECHARGE

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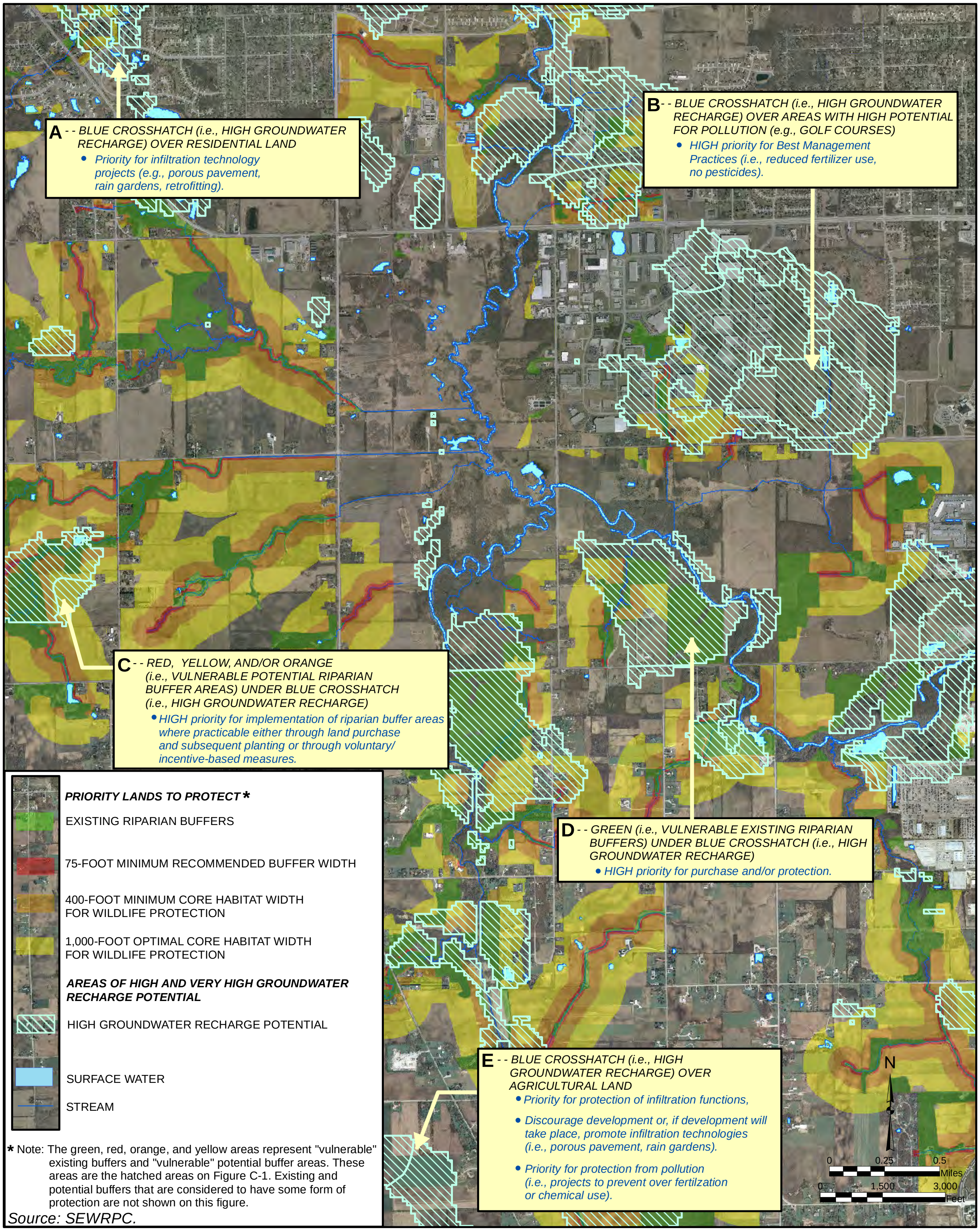
Figure D-1

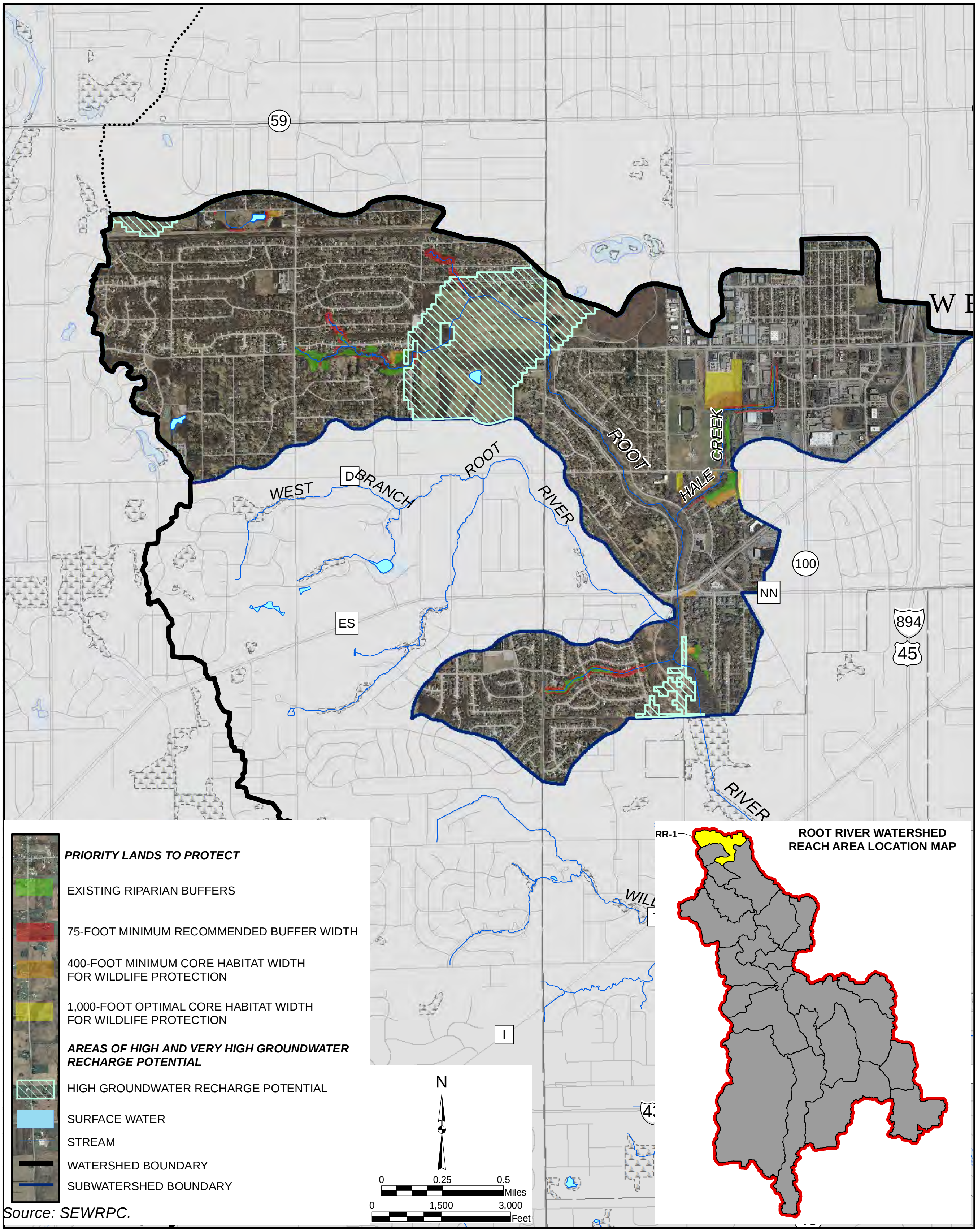
EXAMPLES OF AREAS THAT SHOULD BE IDENTIFIED IN APPENDIX MAPS D-1 THROUGH D-23 TO IMPLEMENT RECOMMENDATIONS



Source: SEWRPC.

Map D-1

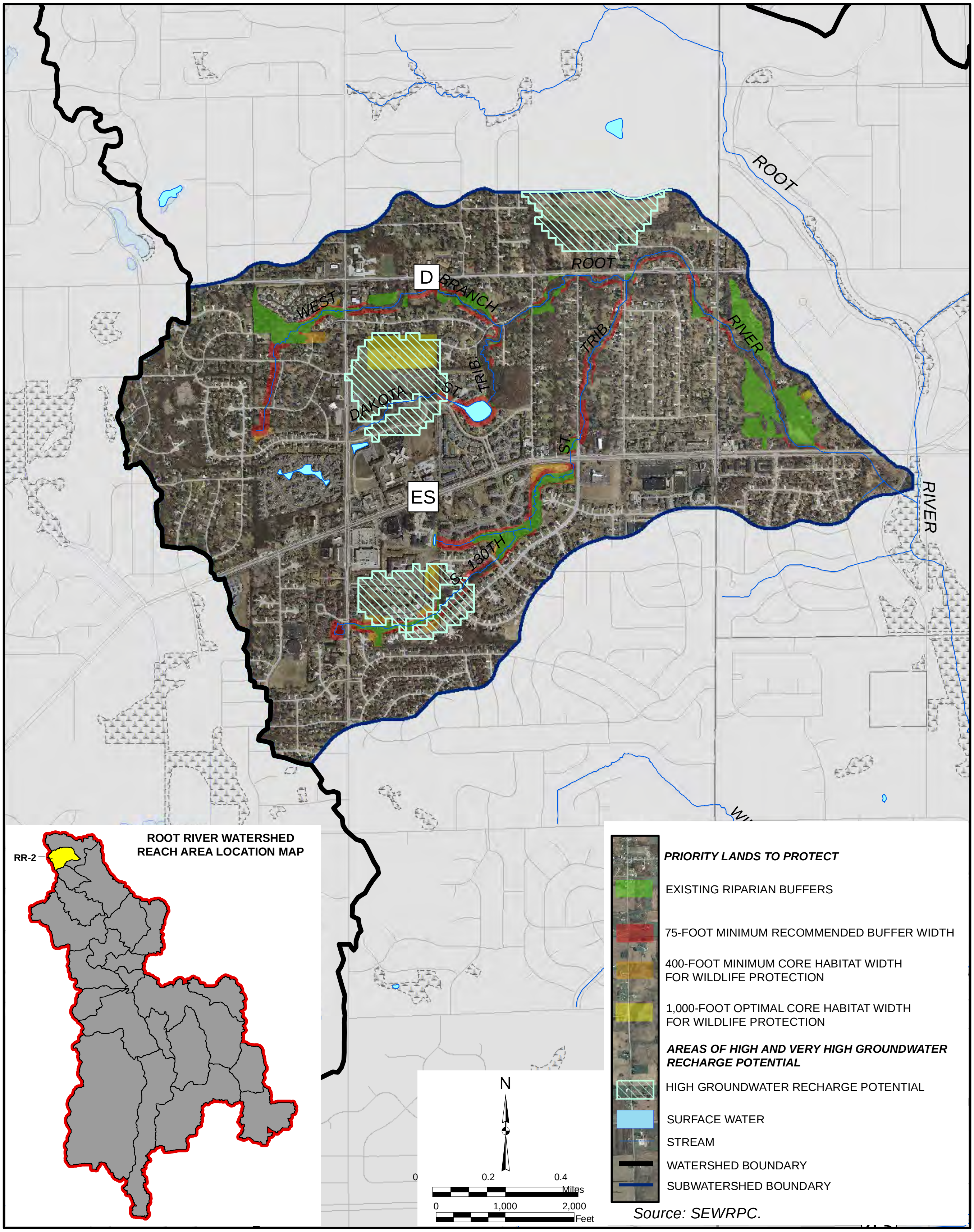
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 1 (INCLUDES PORTIONS OF THE CITIES OF GREENFIELD, NEW BERLIN, AND WEST ALLIS)



Source: SEWRPC.

Map D-2

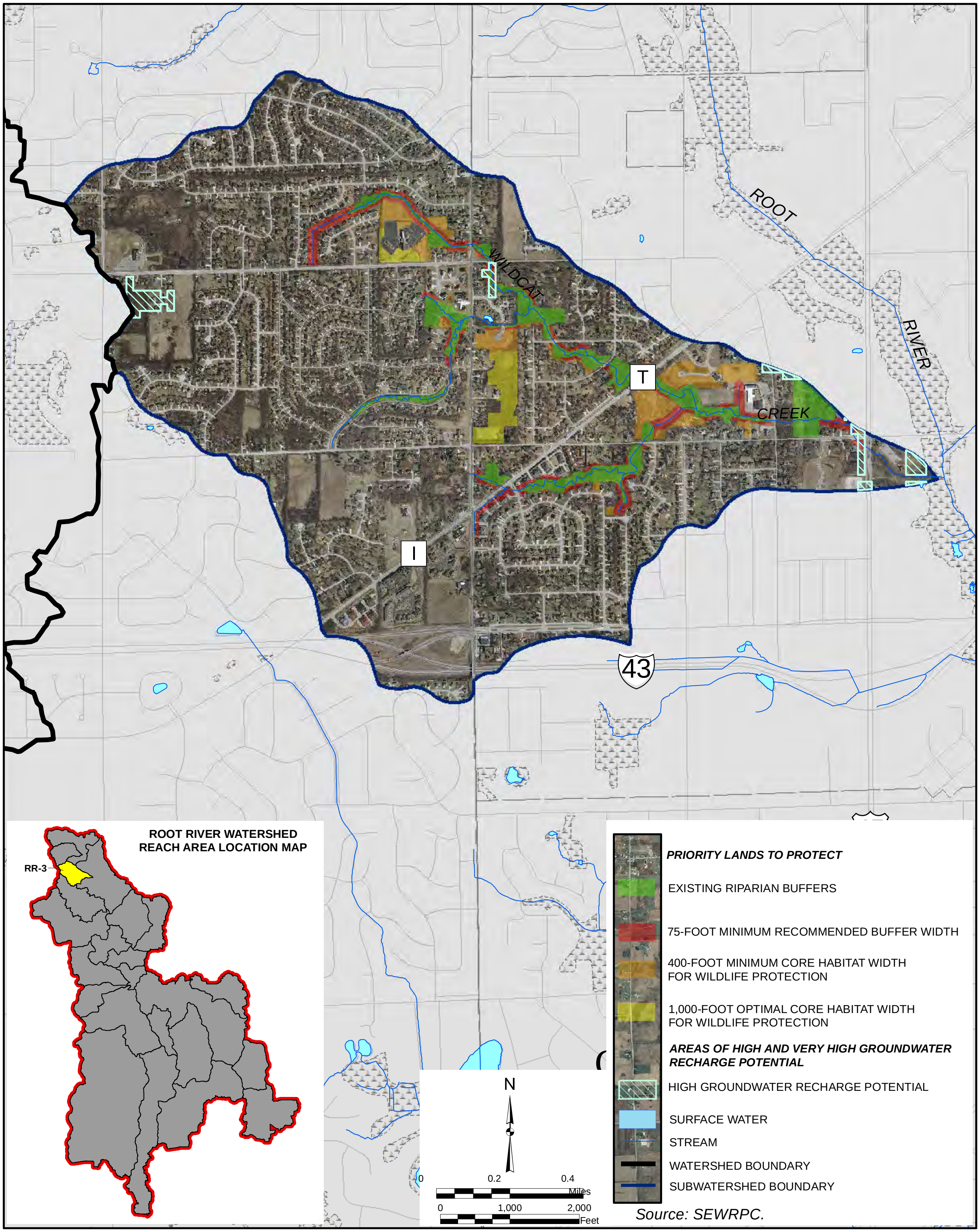
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 2 (INCLUDES PORTIONS OF THE CITIES OF NEW BERLIN AND WEST ALLIS)



Source: SEWRPC.

Map D-3

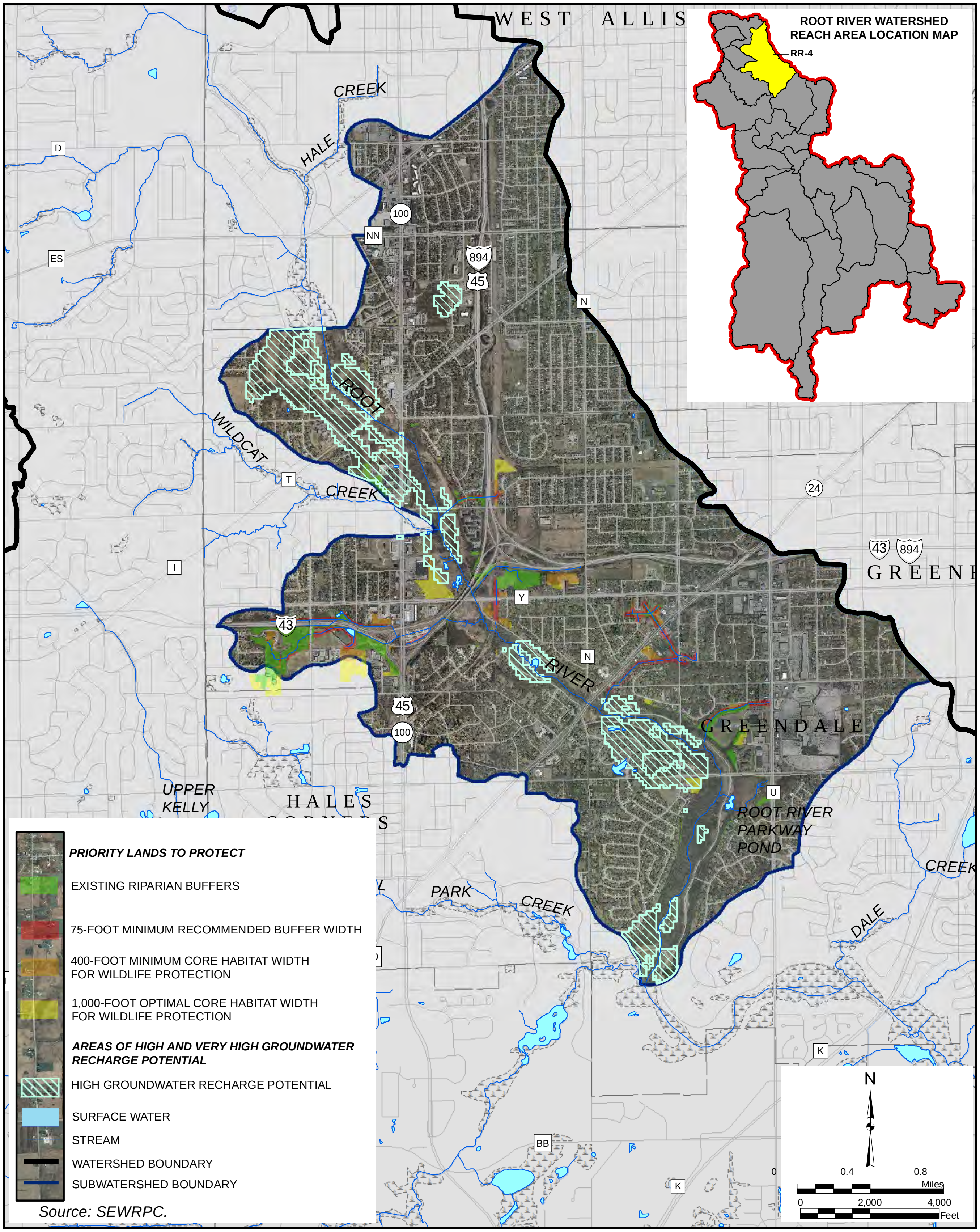
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 3 (INCLUDES PORTIONS OF THE CITIES OF GREENFIELD AND NEW BERLIN)



Source: SEWRPC.

Map D-4

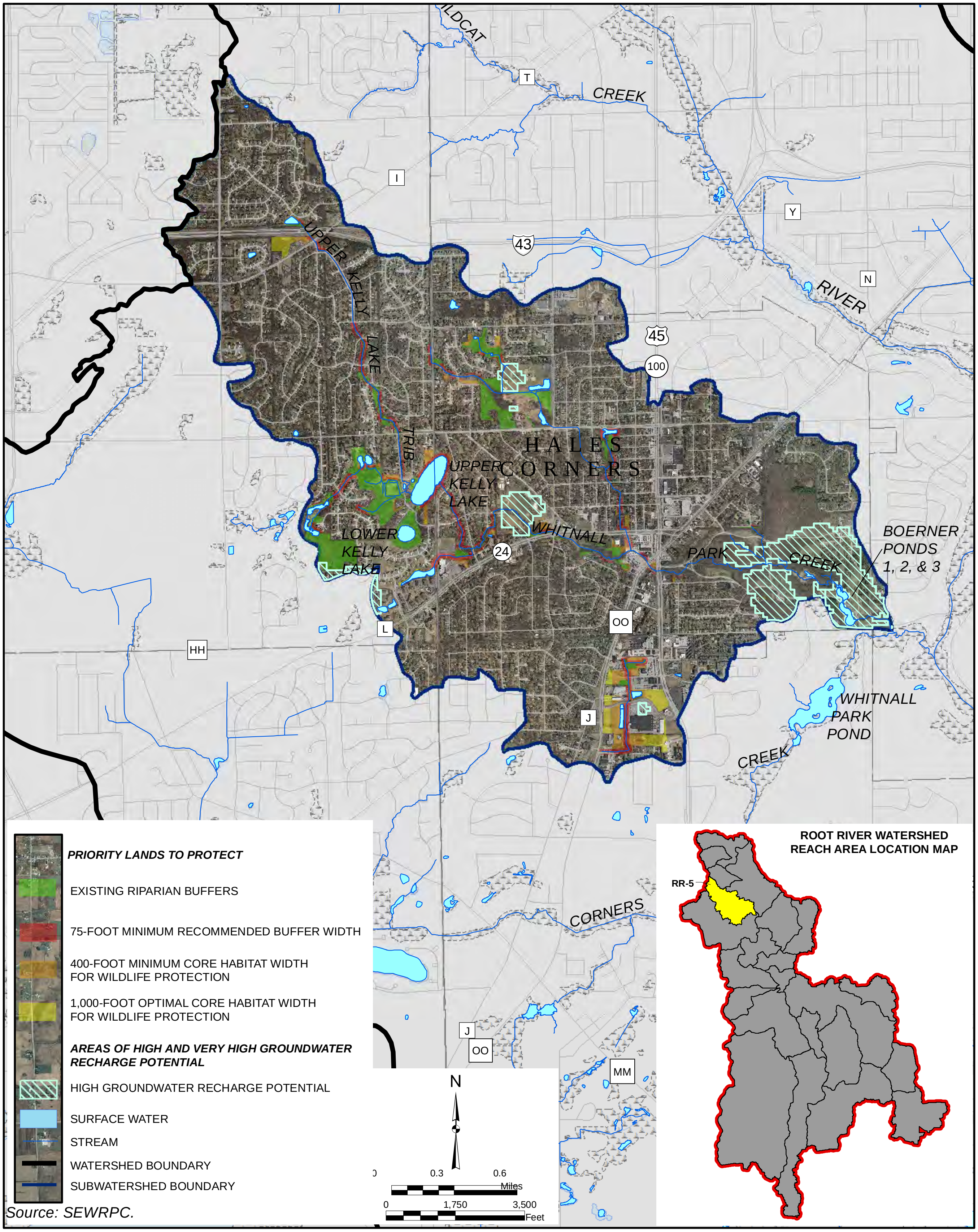
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 4 (INCLUDES PORTIONS OF THE CITIES OF GREENFIELD, MILWAUKEE, AND WEST ALLIS AND THE VILLAGES OF GREENDALE AND HALES CORNERS)



Source: SEWRPC.

Map D-5

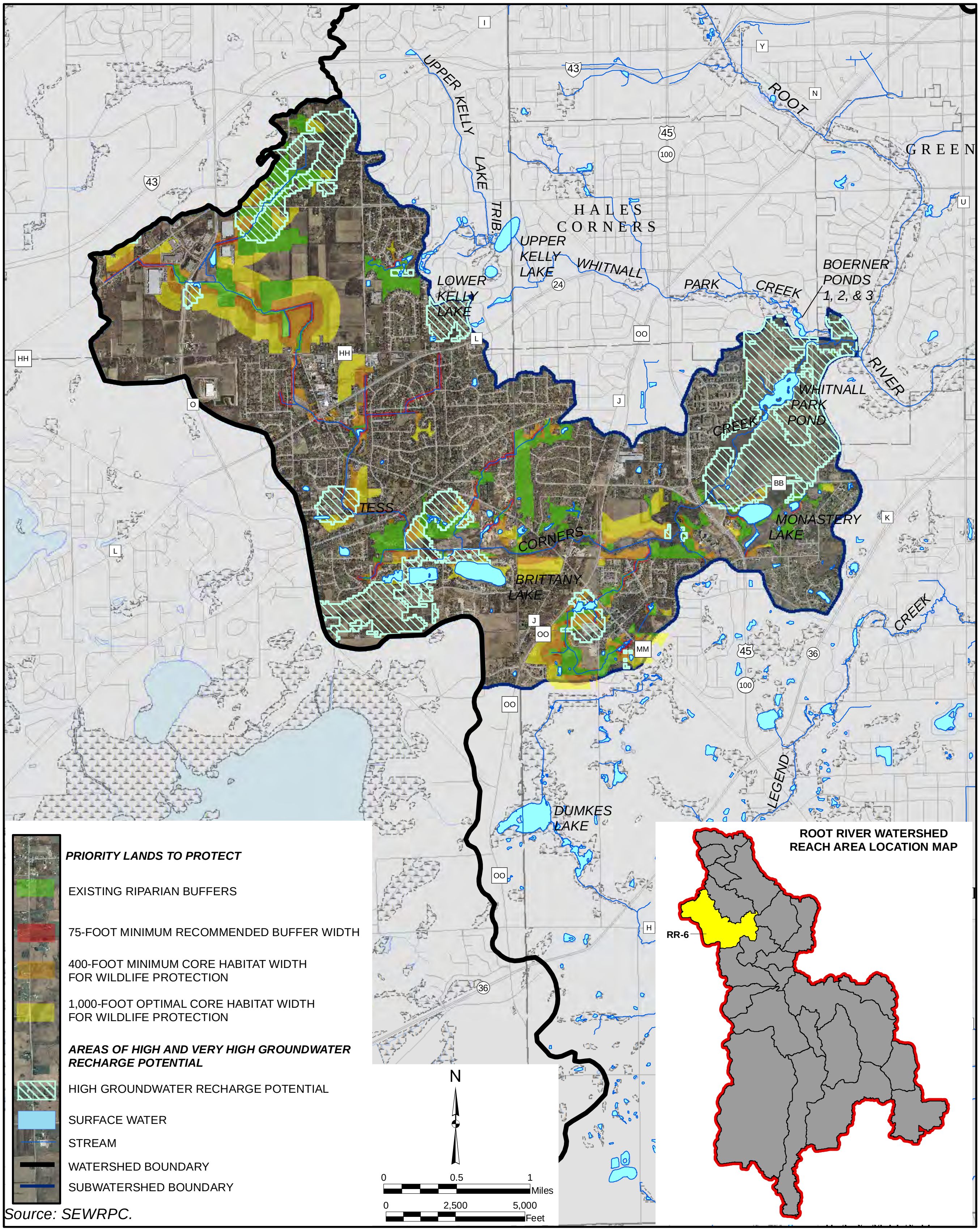
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 5 (INCLUDES PORTIONS OF THE CITIES OF FRANKLIN, GREENFIELD, MUSKEGO, AND NEW BERLIN, AND THE VILLAGE OF HALES CORNERS)



Source: SEWRPC.

Map D-6

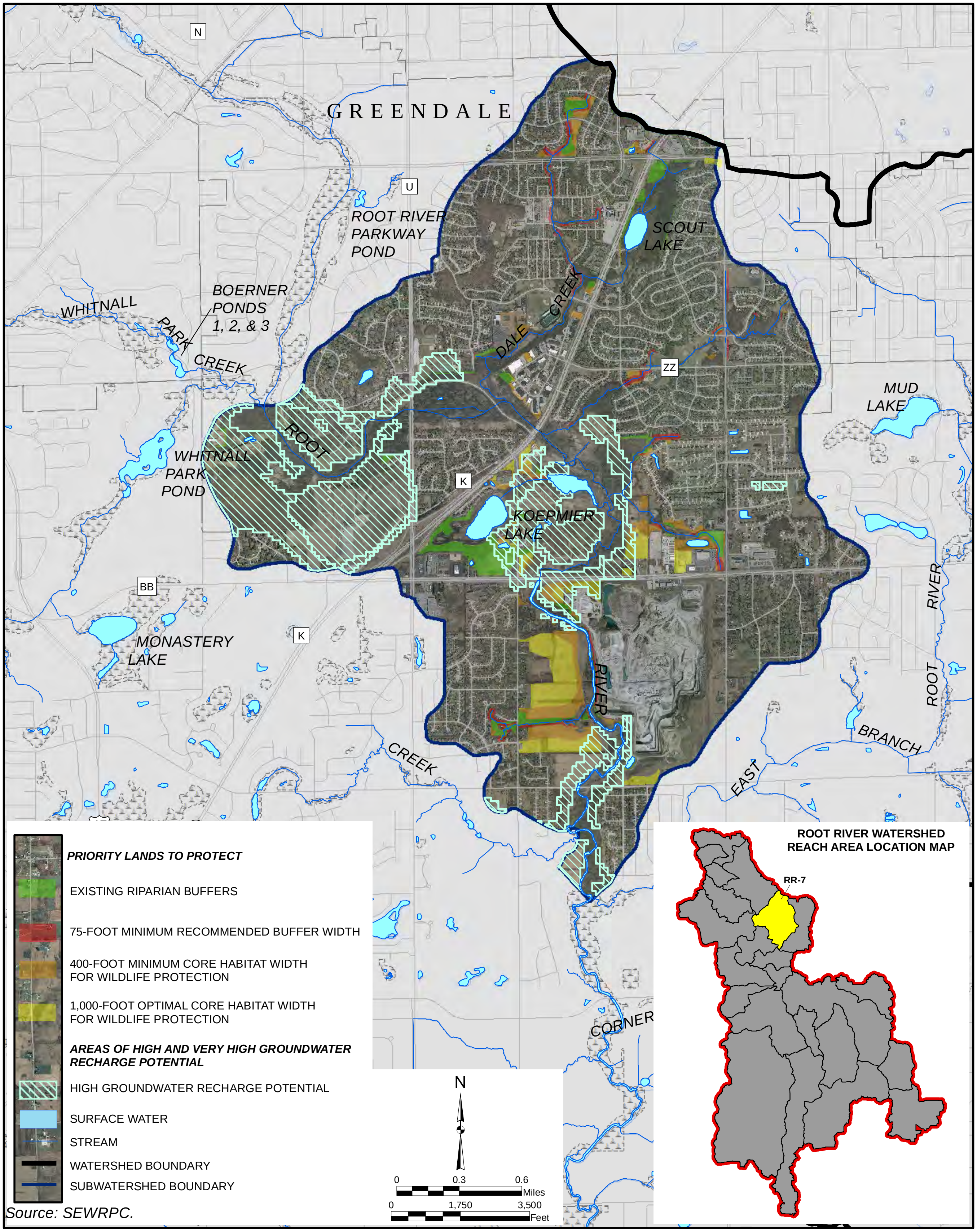
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 6 (INCLUDES PORTIONS OF THE CITIES OF FRANKLIN, MUSKEGO, AND NEW BERLIN, AND THE VILLAGES OF GREENDALE AND HALES CORNERS)



Source: SEWRPC.

Map D-7

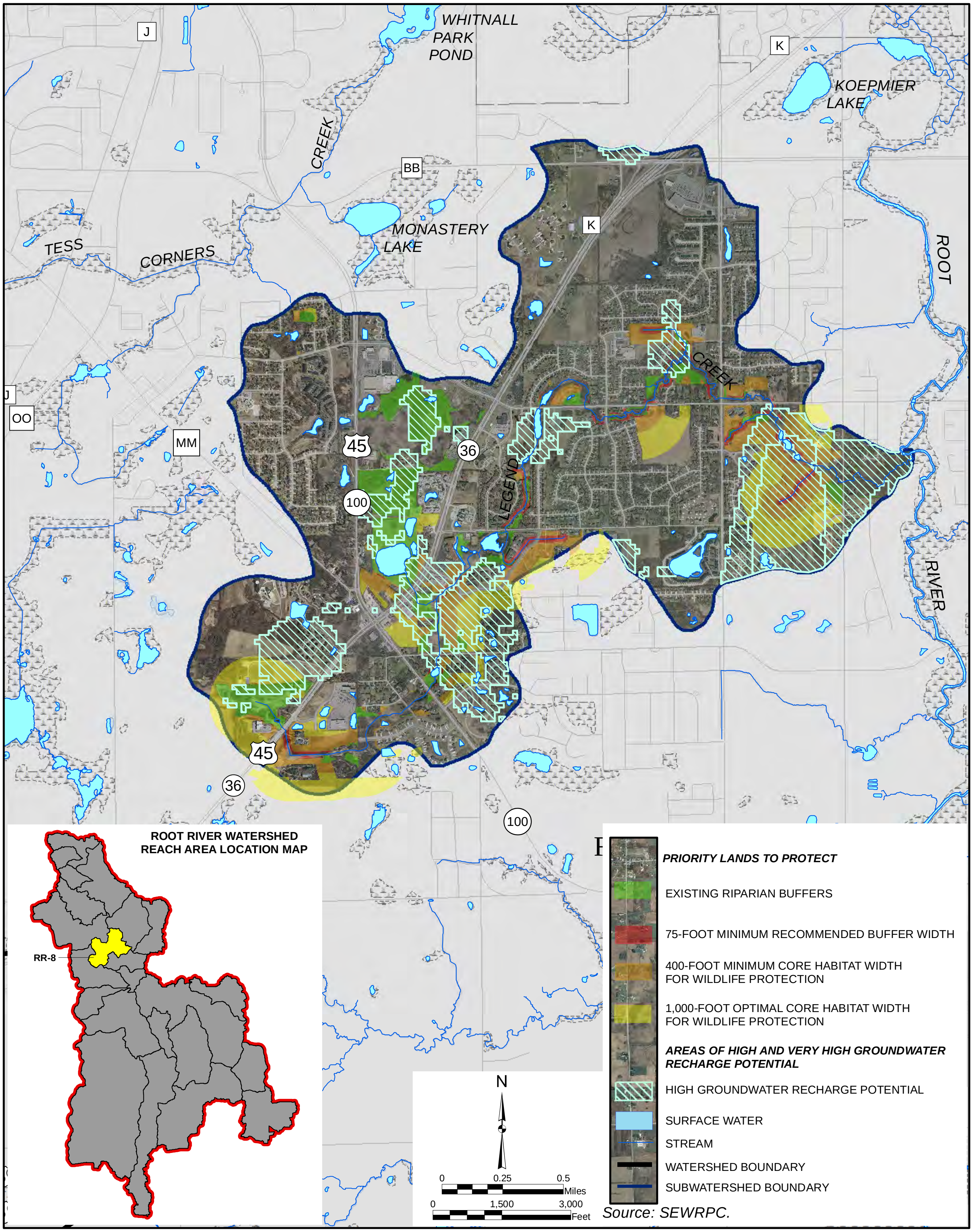
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 7 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN AND THE VILLAGE OF GREENDALE)



Source: SEWRPC.

Map D-8

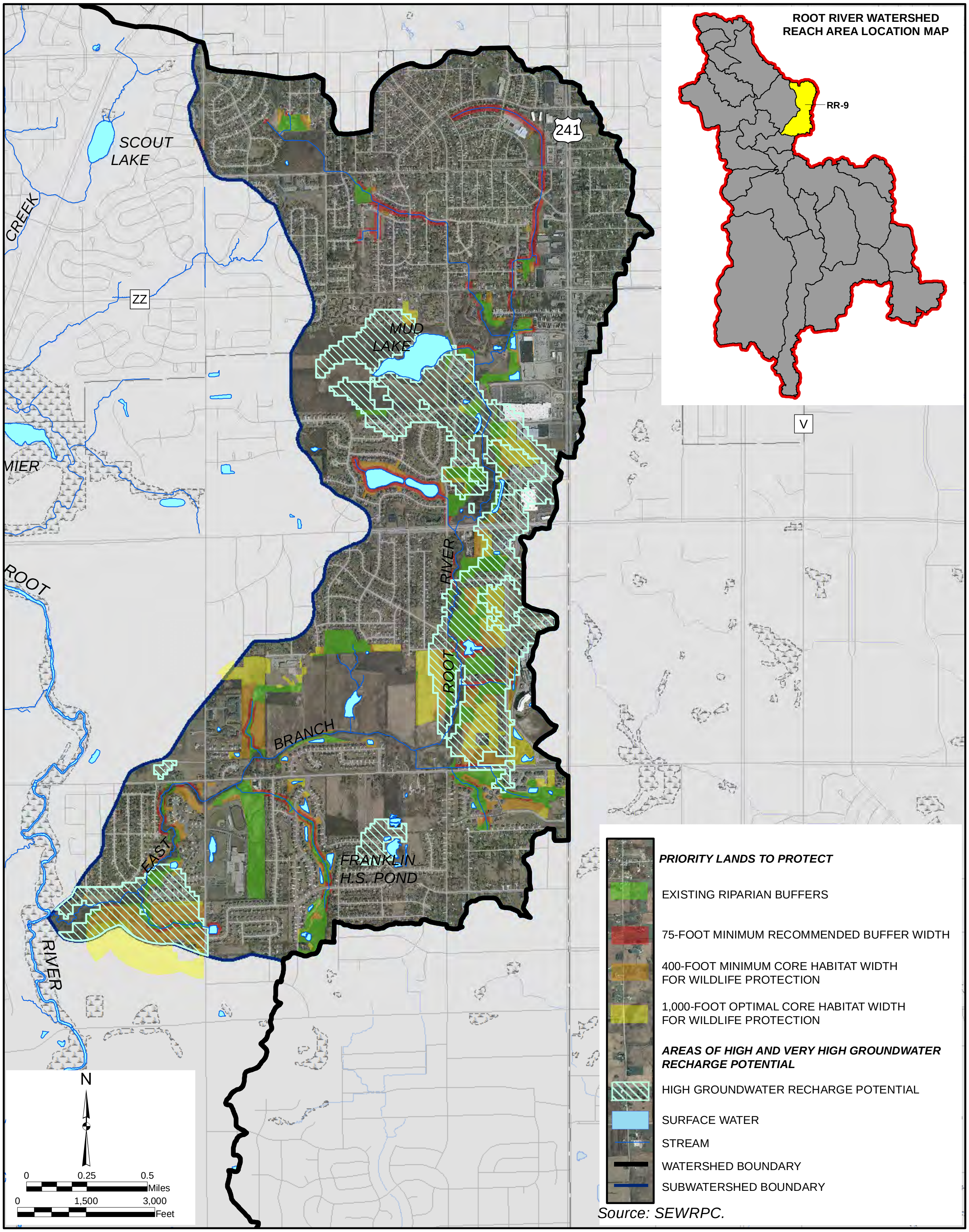
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 8 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN)



Source: SEWRPC.

Map D-9

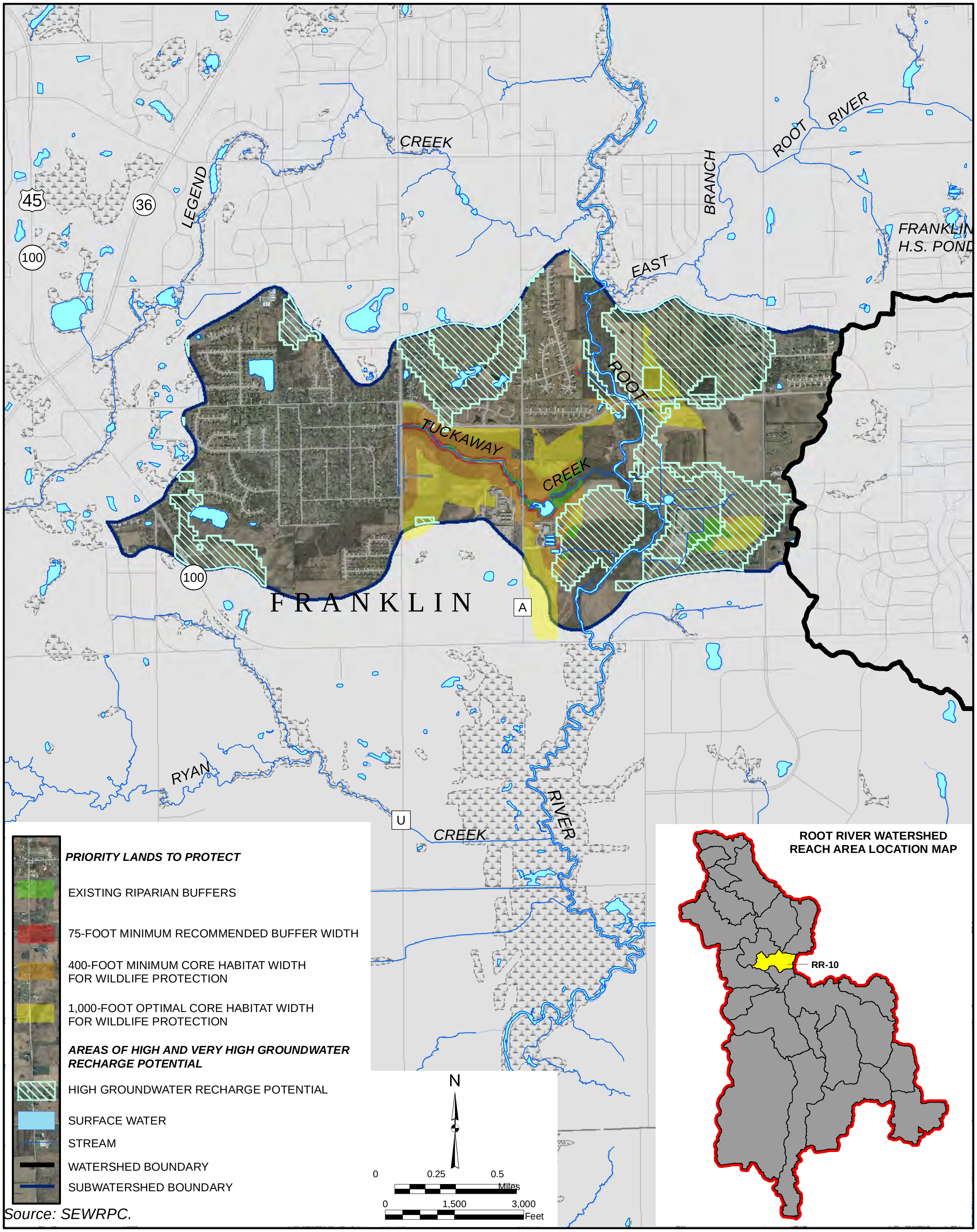
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 9 (INCLUDES PORTIONS OF THE CITIES OF FRANKLIN, GREENFIELD, MILWAUKEE, AND OAK CREEK, AND THE VILLAGE OF GREENDALE)



Source: SEWRPC.

Map D-10

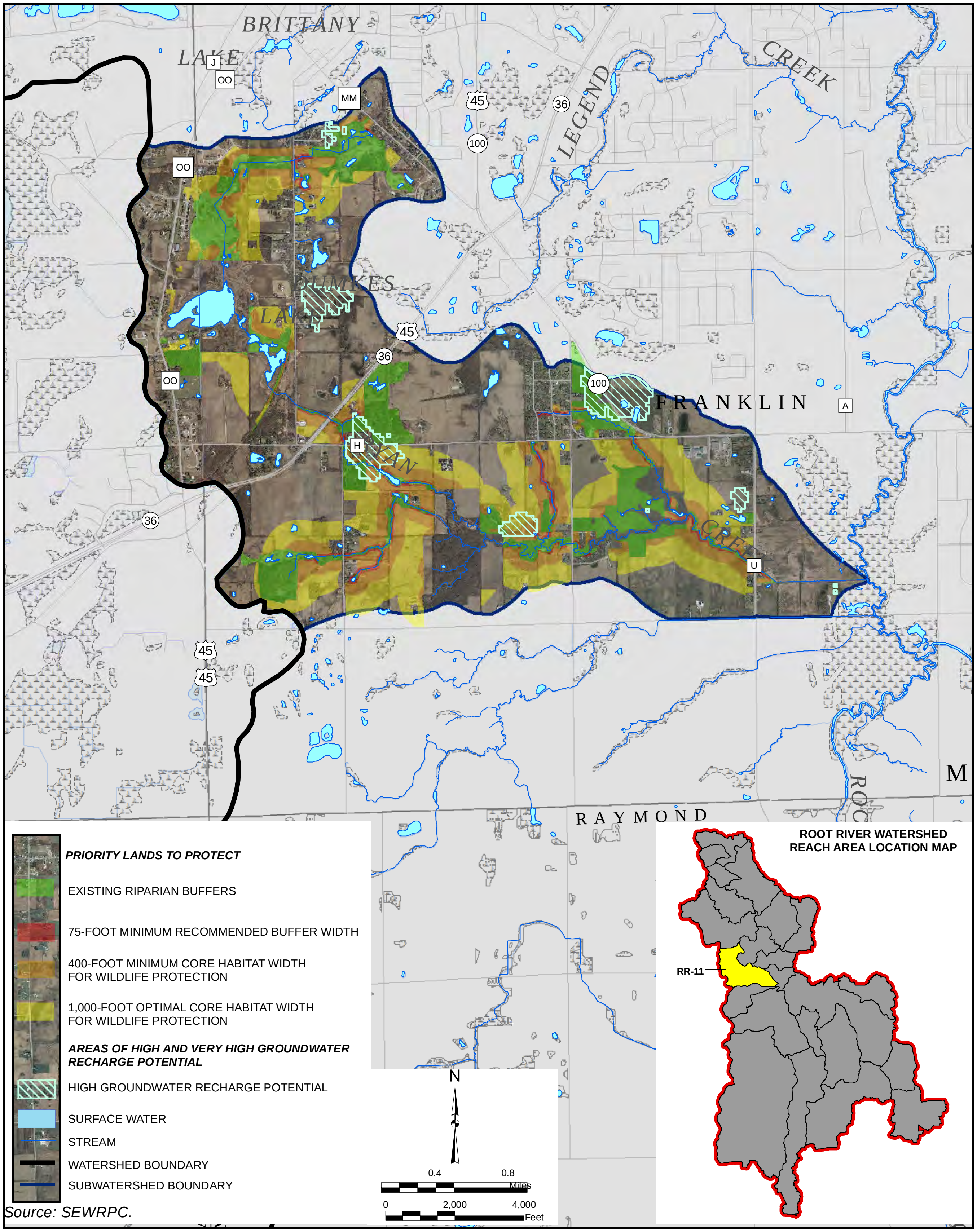
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 10 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN)



Source: SEWRPC.

Map D-11

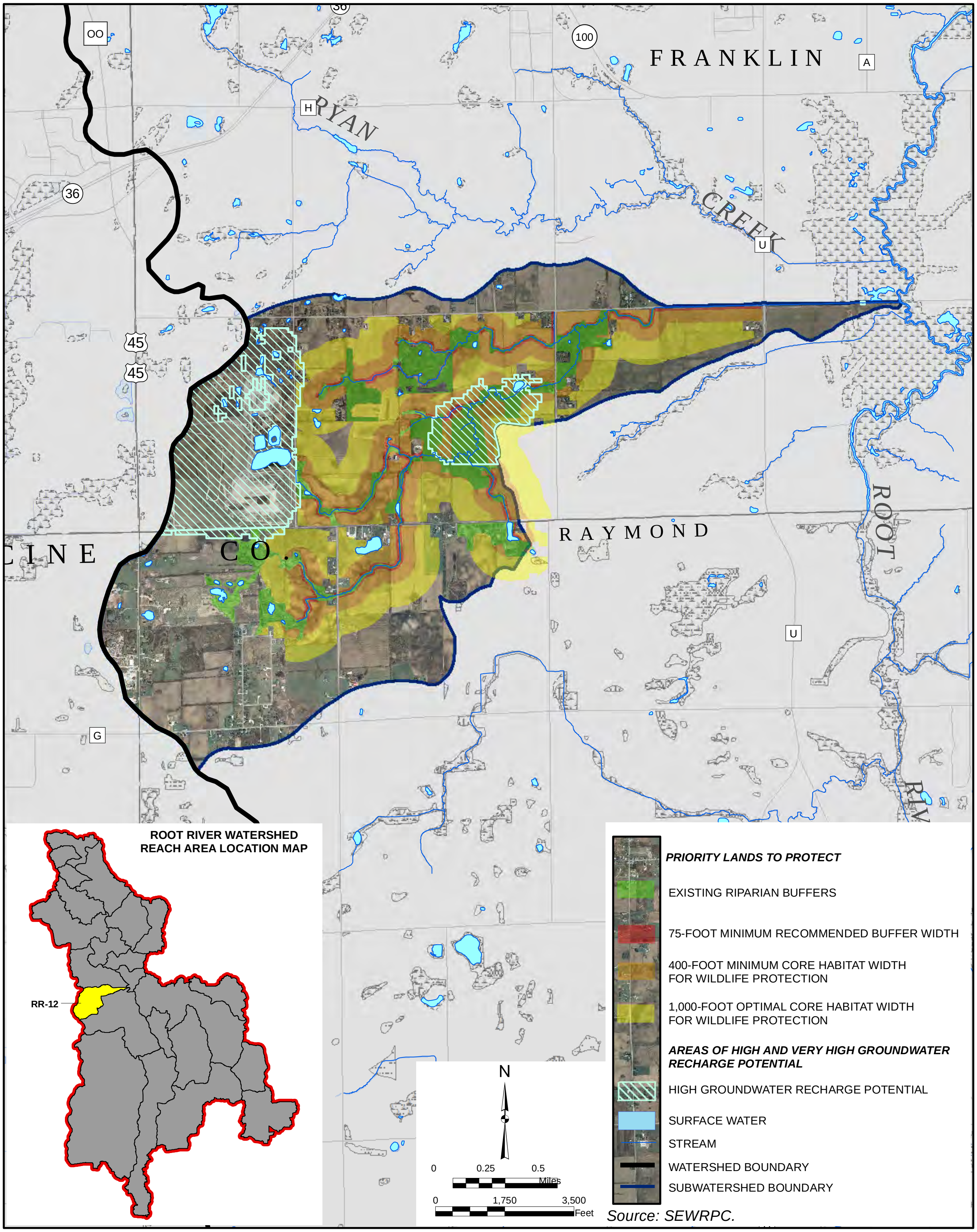
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 11 (INCLUDES PORTIONS OF THE CITES OF FRANKLIN AND MUSKEGO)



Source: SEWRPC.

Map D-12

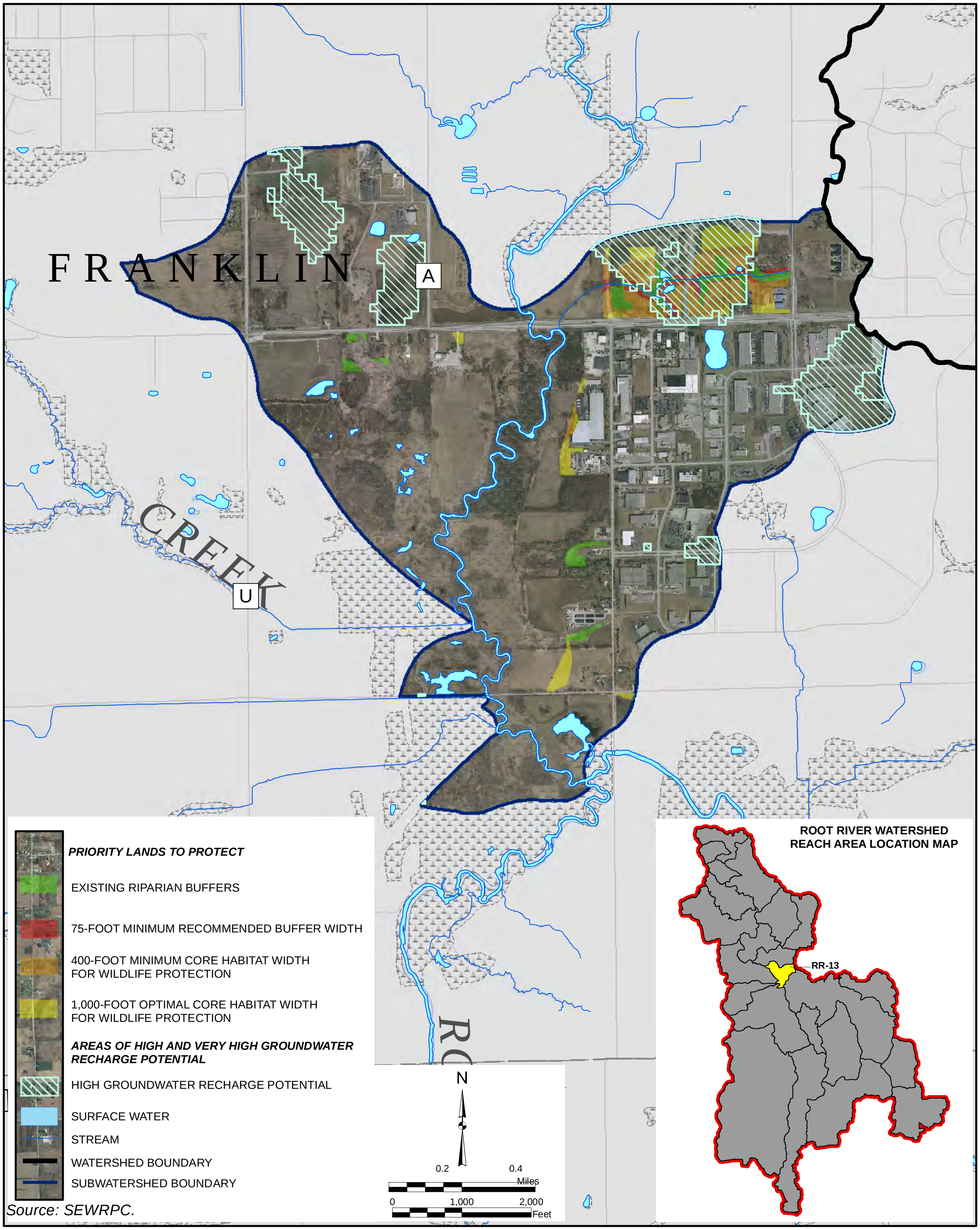
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 12 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN, AND THE TOWNS OF NORWAY AND RAYMOND)



Source: SEWRPC.

Map D-13

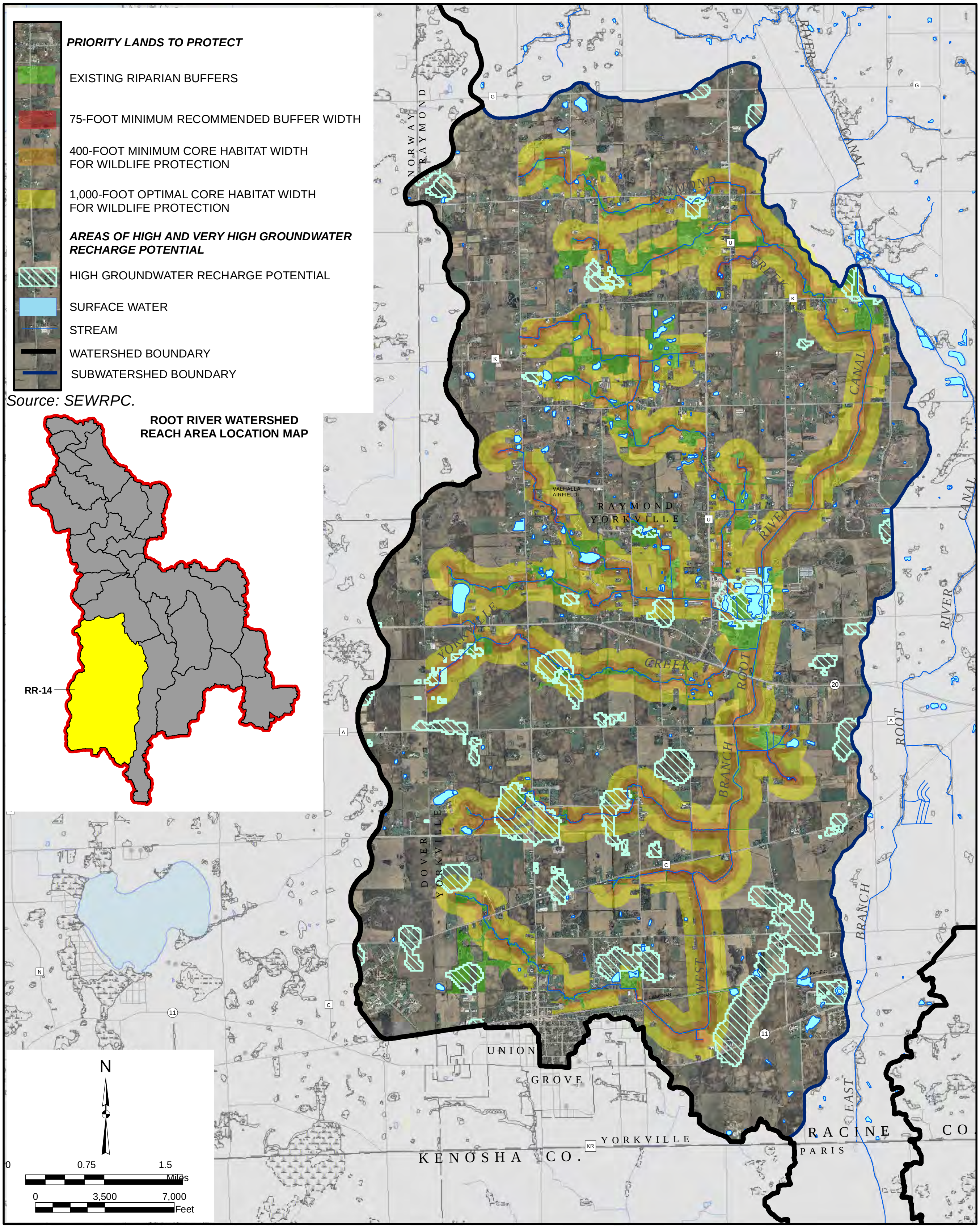
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 13 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN)



Source: SEWRPC.

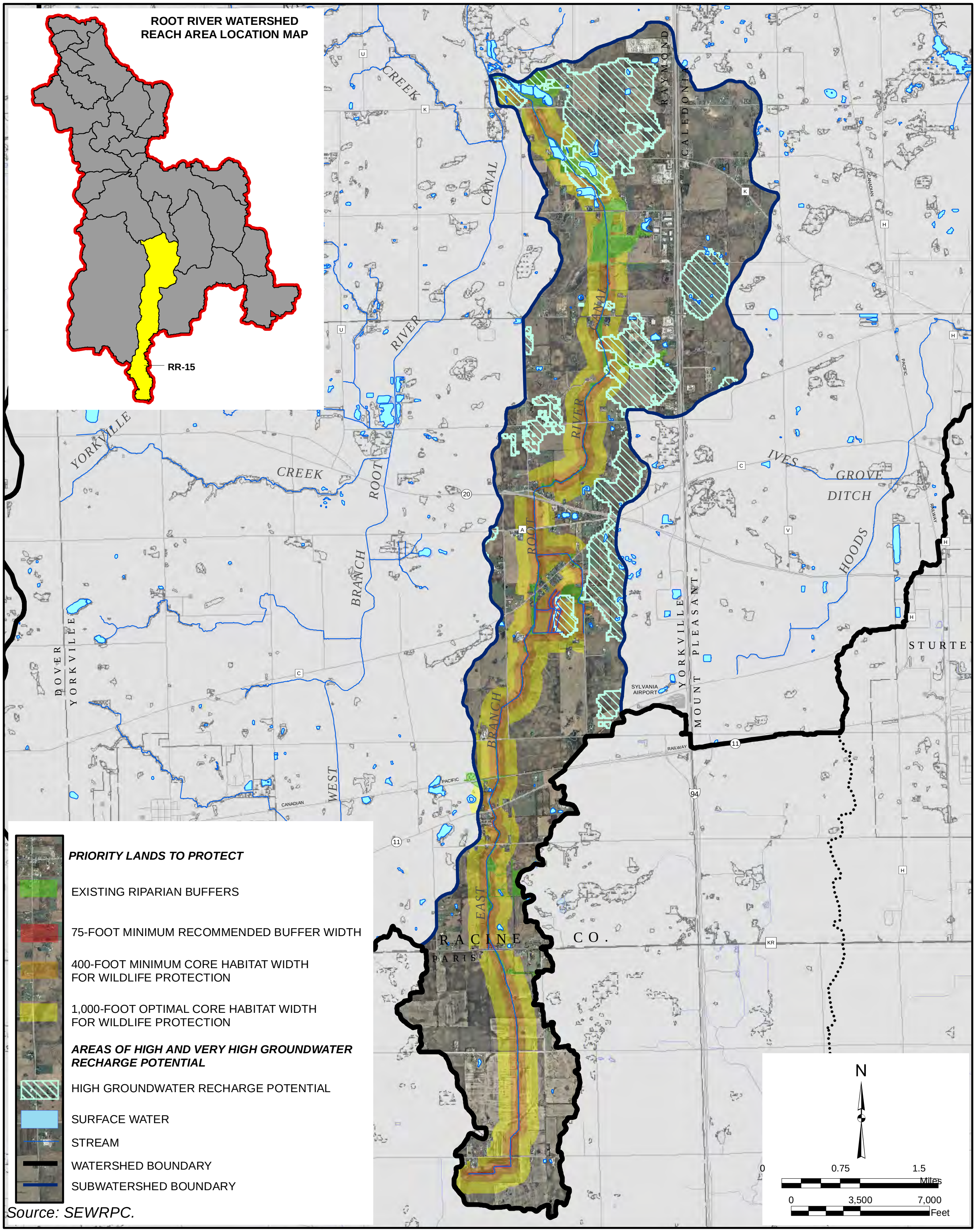
Map D-14

PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 14 (INCLUDES PORTIONS OF THE VILLAGE OF UNION GROVE, AND THE TOWNS OF DOVER, YORKVILLE, AND RAYMOND)



Map D-15

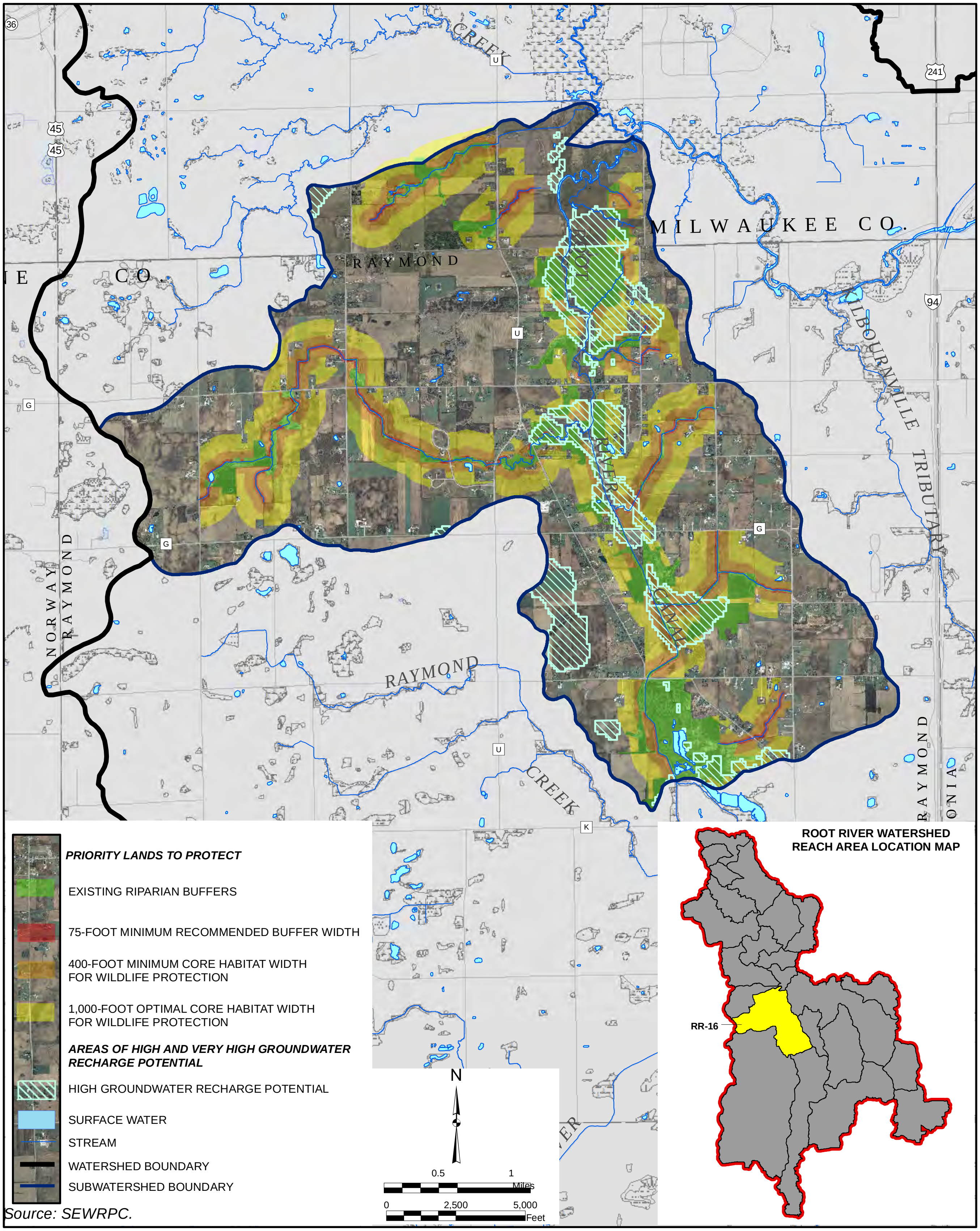
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 15 (INCLUDES PORTIONS OF THE VILLAGES OF CALEDONIA AND MOUNT PLEASANT, AND THE TOWNS OF PARIS, RAYMOND, AND YORKVILLE)



Source: SEWRPC.

Map D-16

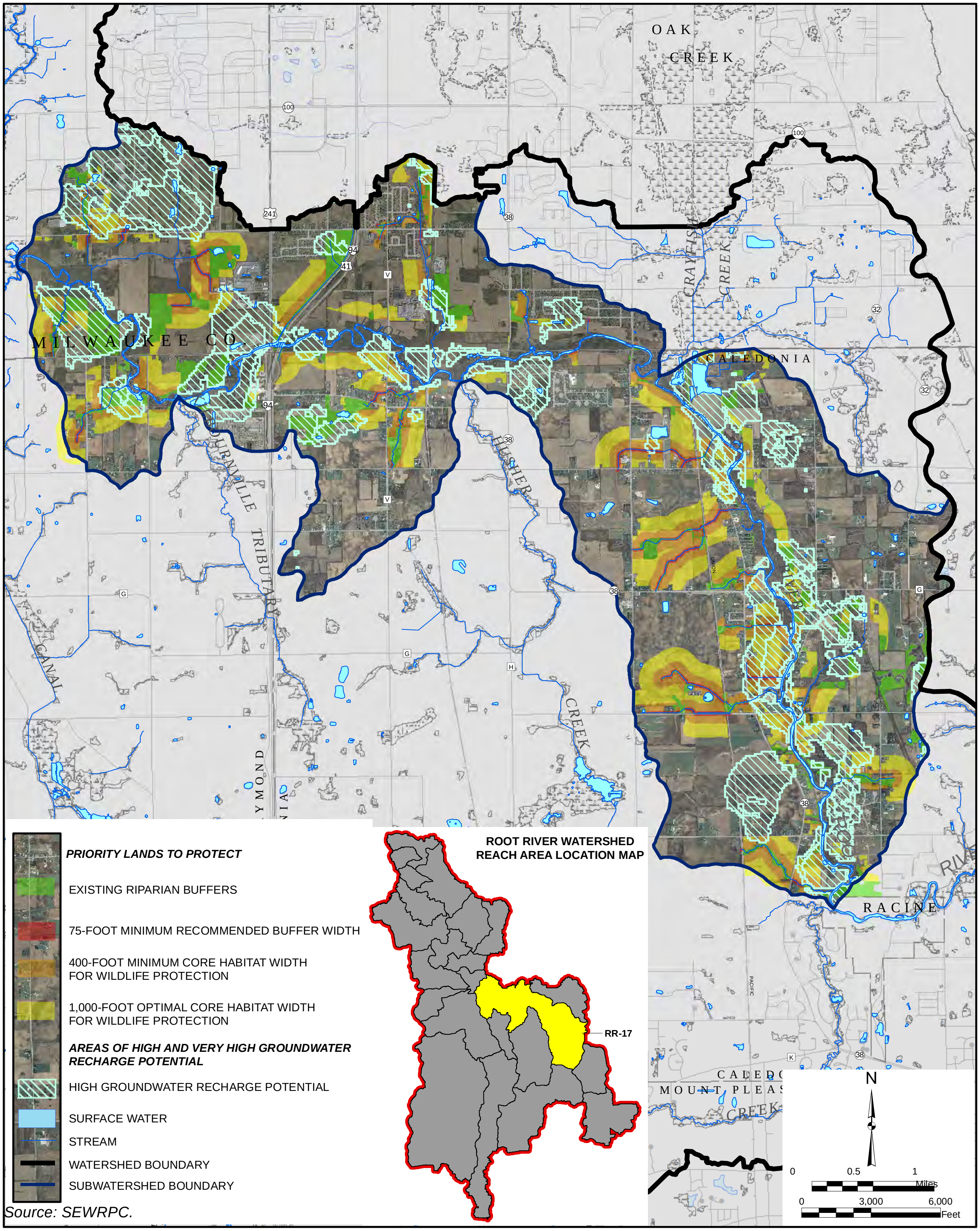
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND
GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 16
(INCLUDES PORTIONS OF THE CITY OF FRANKLIN AND TOWN OF RAYMOND)



Source: SEWRPC.

Map D-17

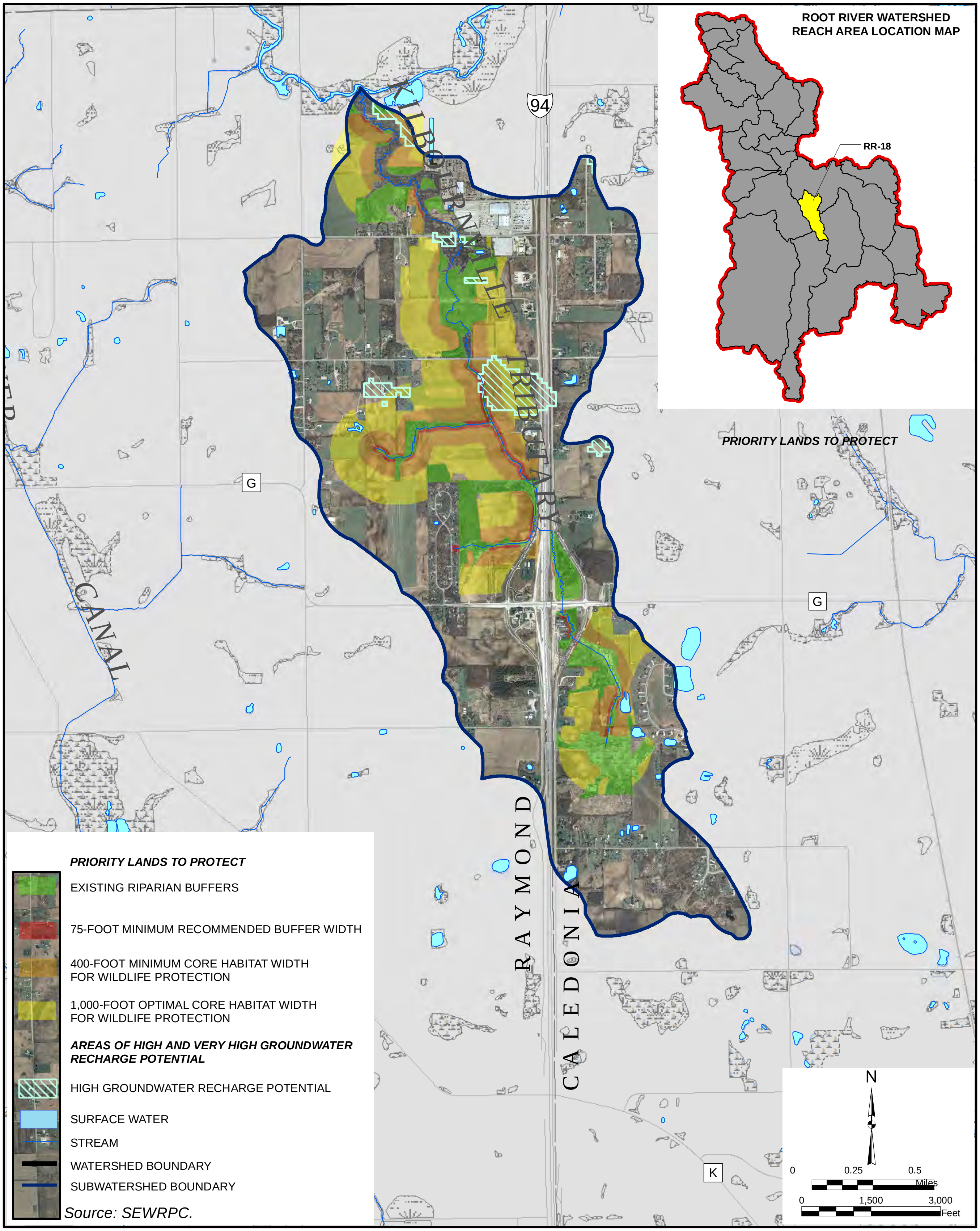
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 17 (INCLUDES PORTIONS OF THE CITES OF FRANKLIN, OAK CREEK AND RACINE, THE VILLAGE OF CALEDONIA, AND THE TOWN OF RAYMOND)



Source: SEWRPC.

Map D-18

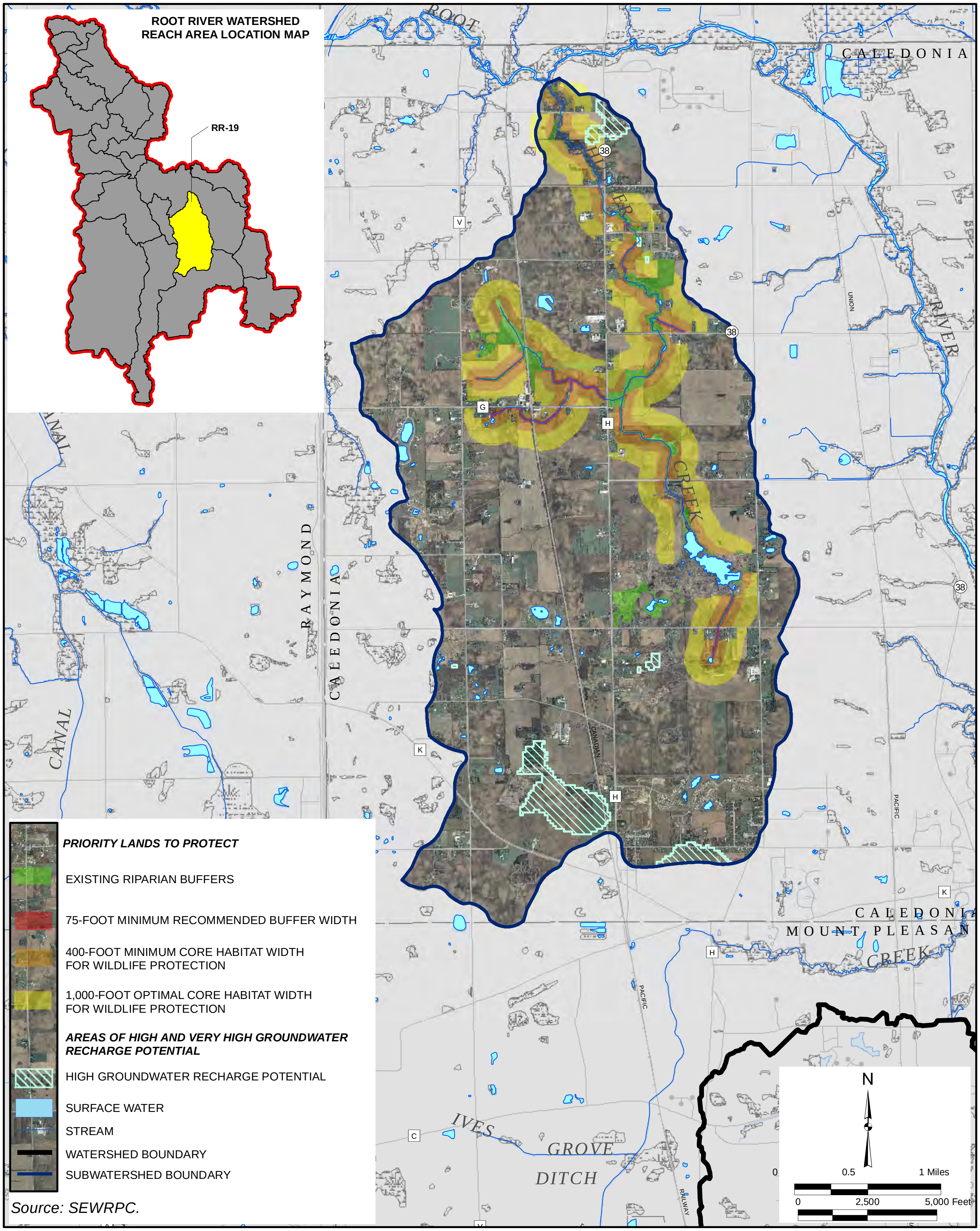
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 18 (INCLUDES PORTIONS OF THE VILLAGE OF CALEDONIA, AND THE TOWN OF RAYMOND)



Source: SEWRPC.

Map D-19

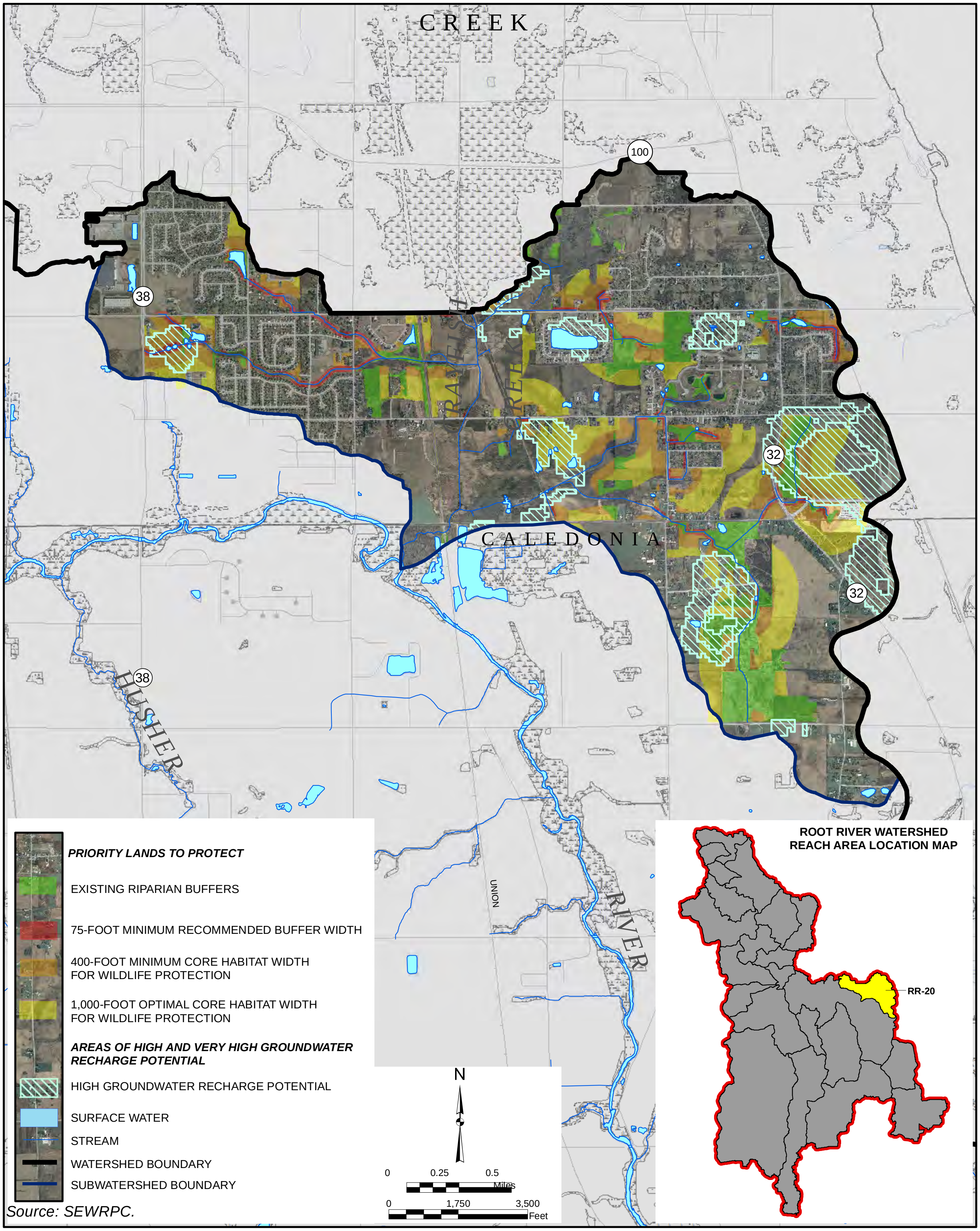
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 19 (INCLUDES PORTIONS OF THE VILLAGE OF CALEDONIA)



Source: SEWRPC.

Map D-20

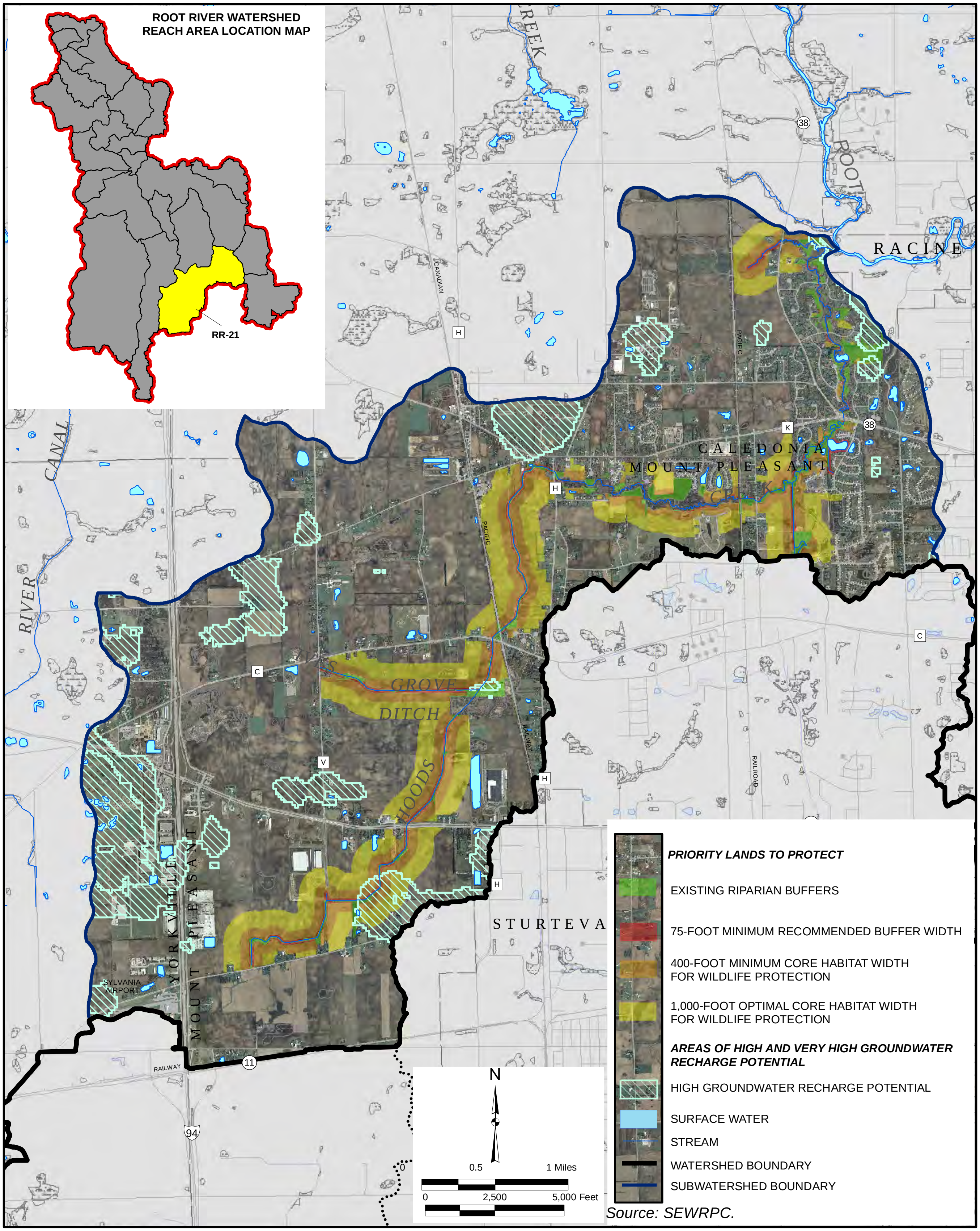
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 20 (INCLUDES PORTIONS OF THE CITY OF OAK CREEK AND VILLAGE OF CALEDONIA)



Source: SEWRPC.

Map D-21

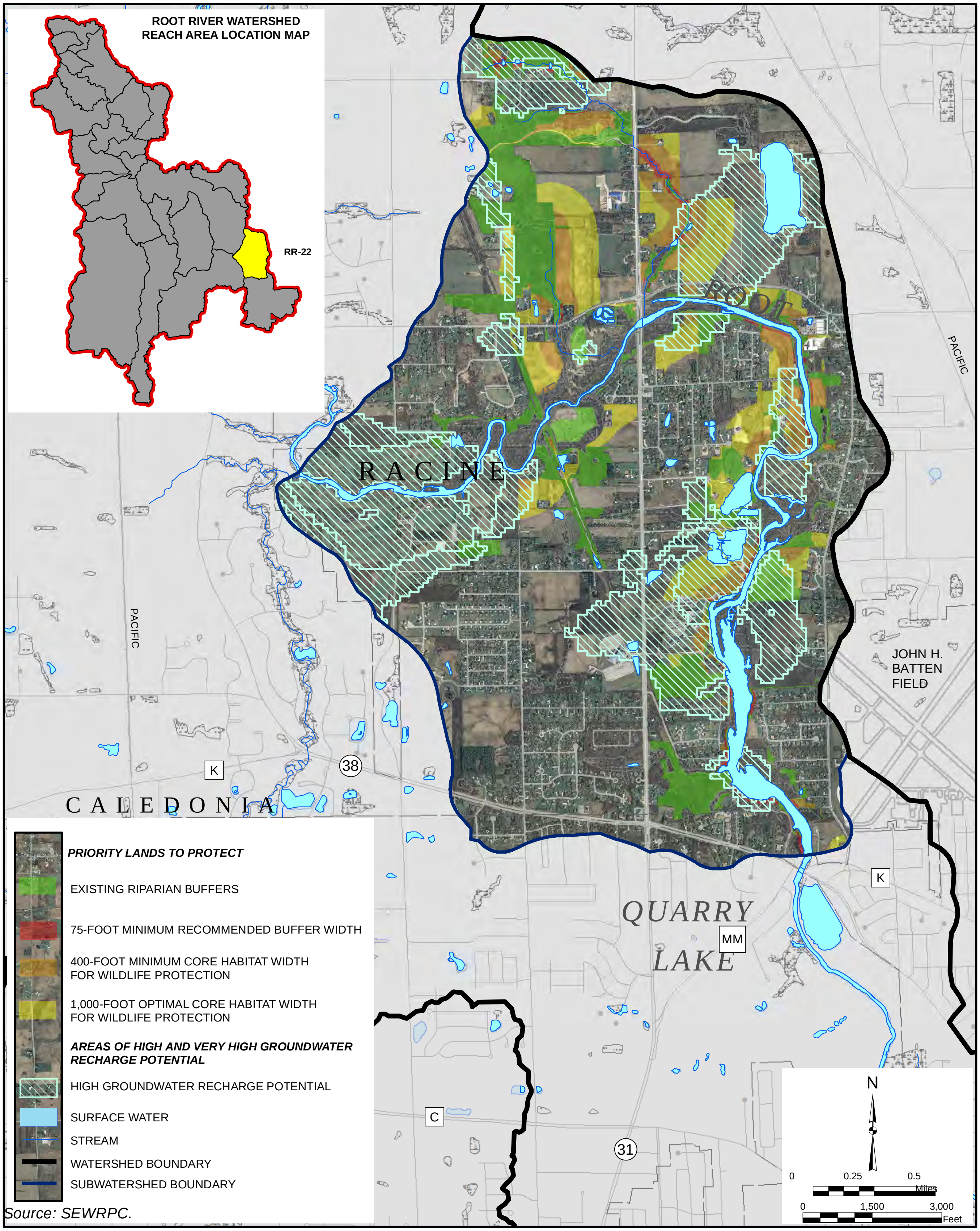
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 21 (INCLUDES PORTIONS OF THE CITY OF RACINE, THE VILLAGES OF CALEDONIA, MOUNT PLEASANT AND STURTEVANT, AND THE TOWN OF YORKVILLE)



Source: SEWRPC.

Map D-22

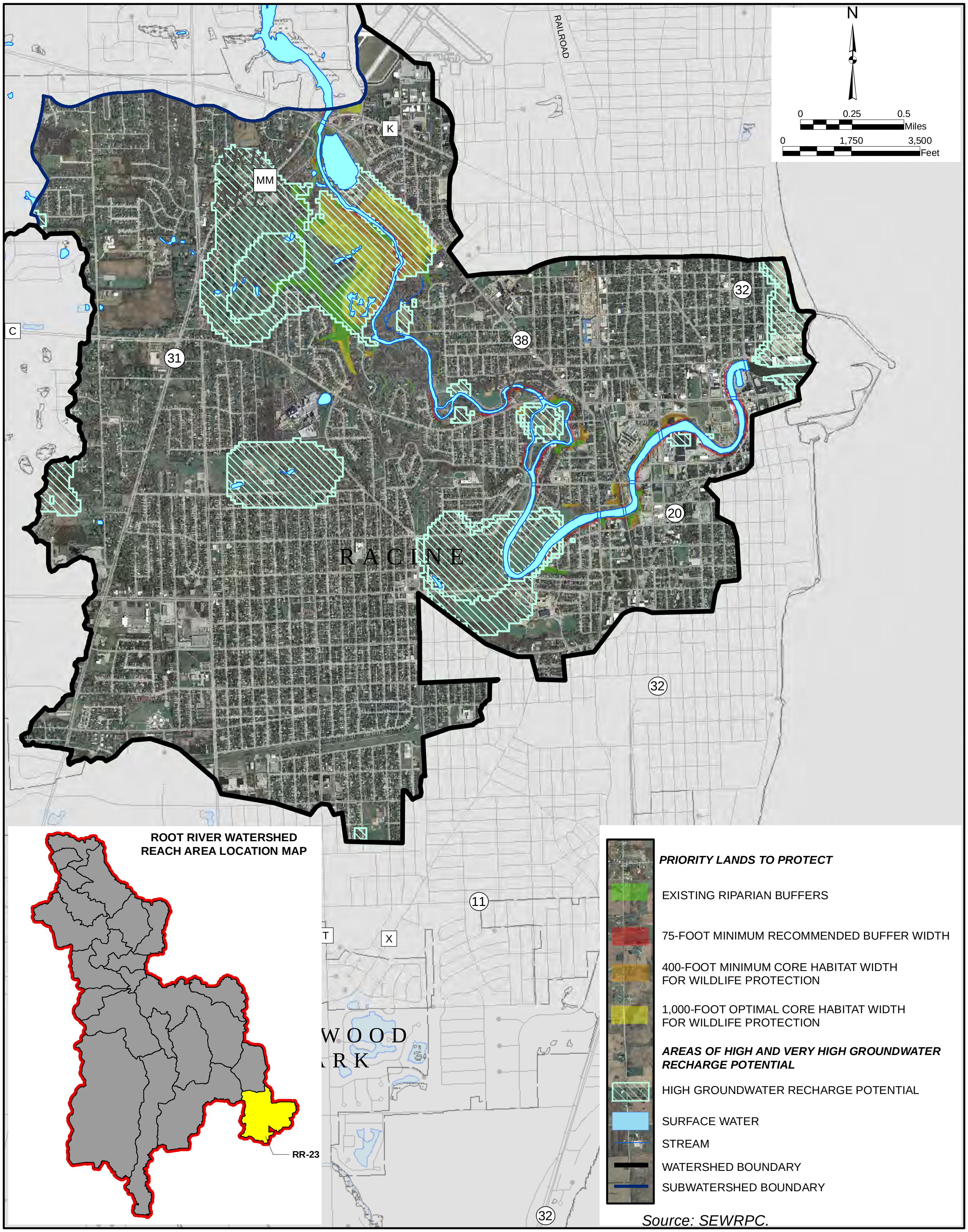
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND
GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 22
(INCLUDES PORTIONS OF THE CITY OF RACINE, AND THE VILLAGES OF CALEDONIA AND MOUNT PLEASANT)



Source: SEWRPC.

Map D-23

PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND GROUNDWATER RECHARGE AREAS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 23 (INCLUDES PORTIONS OF THE CITY OF RACINE, AND THE VILLAGE OF MOUNT PLEASANT)



Source: SEWRPC.

Appendix E

MAP TOOLS TO DETERMINE "VULNERABLE" EXISTING AND POTENTIAL RIPARIAN BUFFER LANDS THAT ARE WITHIN OR CONTIGUOUS WITH PRIMARY AND SECONDARY ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS

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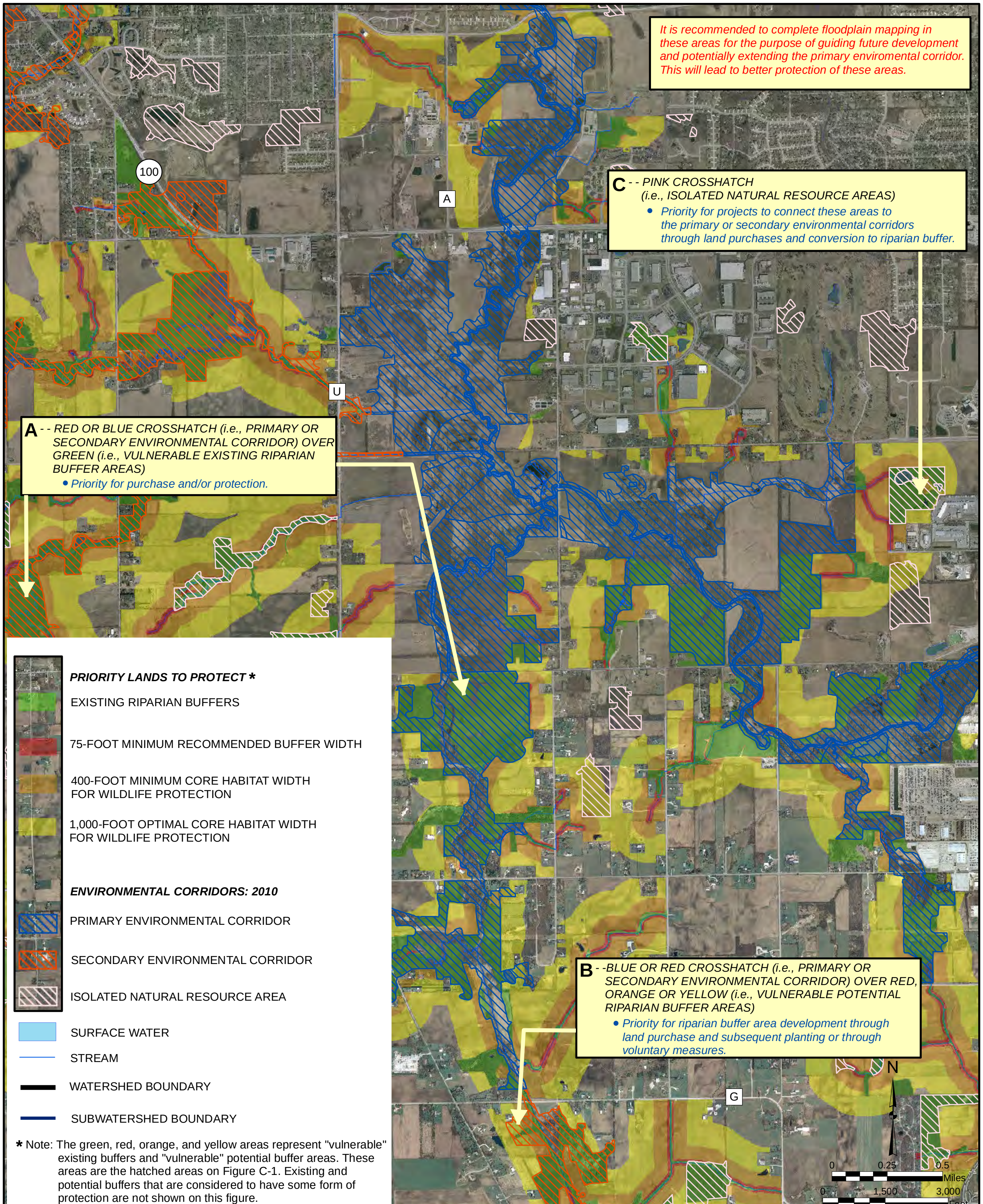
Figure E-1

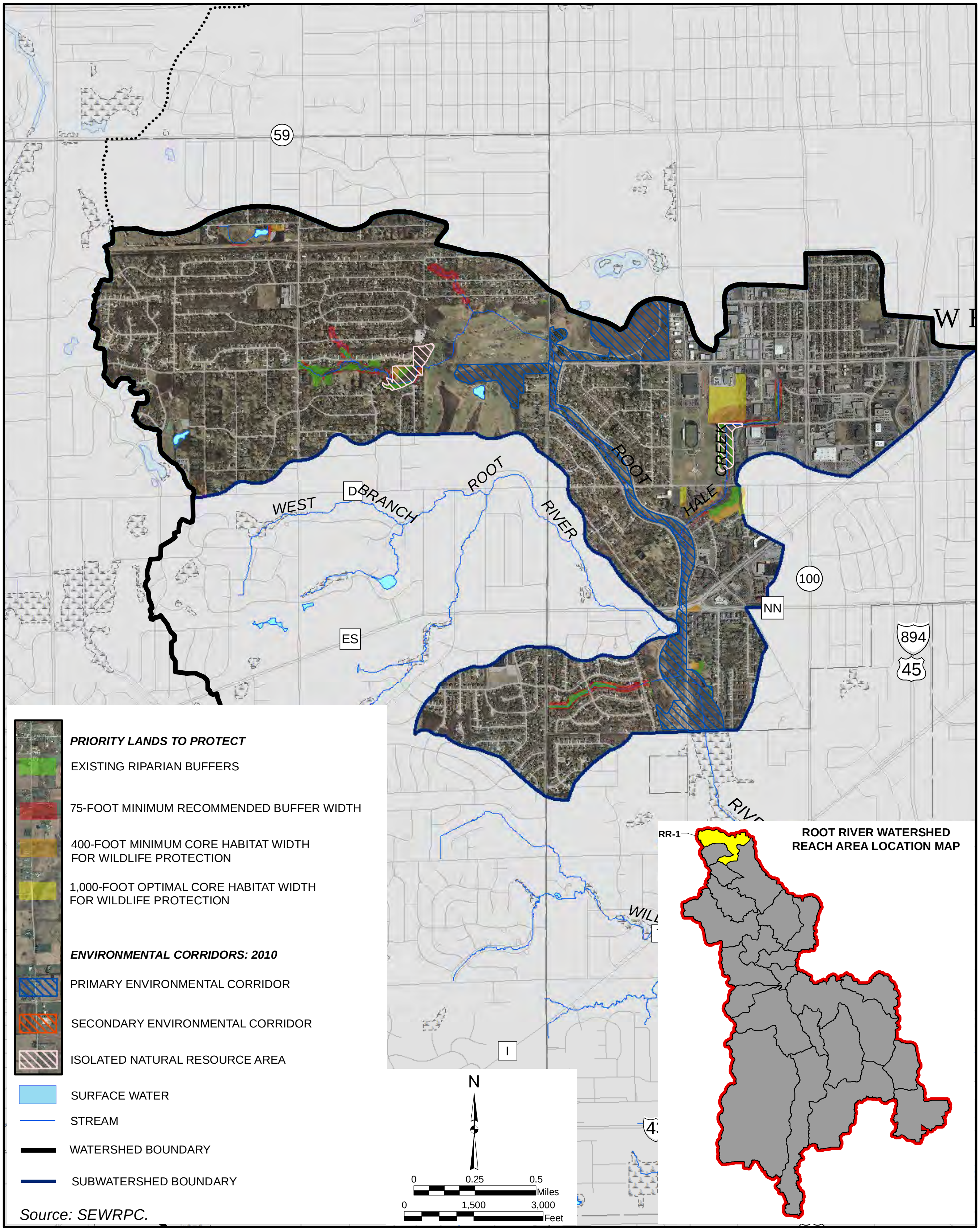
EXAMPLES OF AREAS THAT SHOULD BE IDENTIFIED IN MAPS E-1 THROUGH E-23 TO IMPLEMENT RECOMMENDATIONS



Source: SEWRPC.

Map E-1

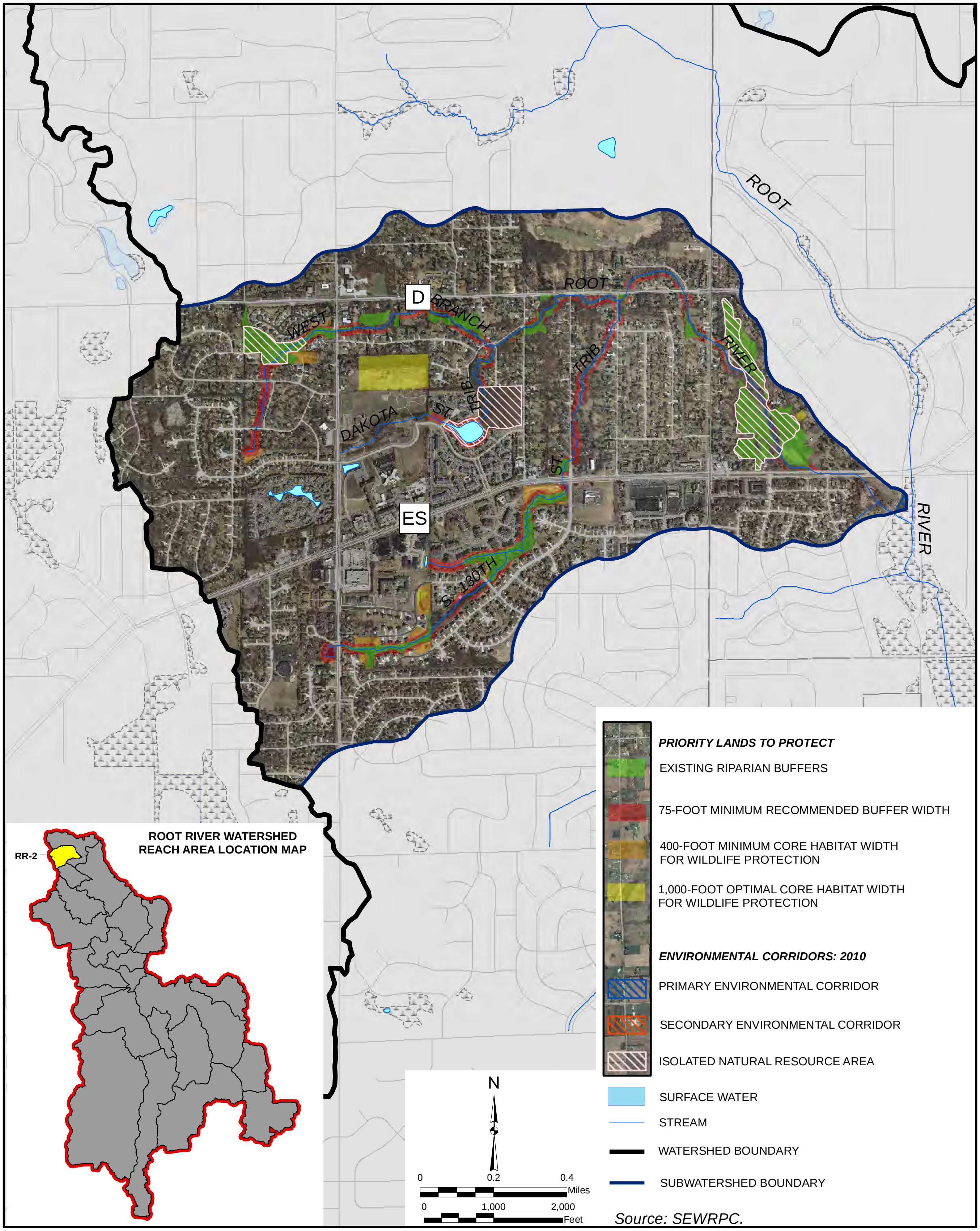
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 1 (INCLUDES PORTIONS OF THE CITIES OF GREENFIELD, NEW BERLIN, AND WEST ALLIS)



Source: SEWRPC.

Map E-2

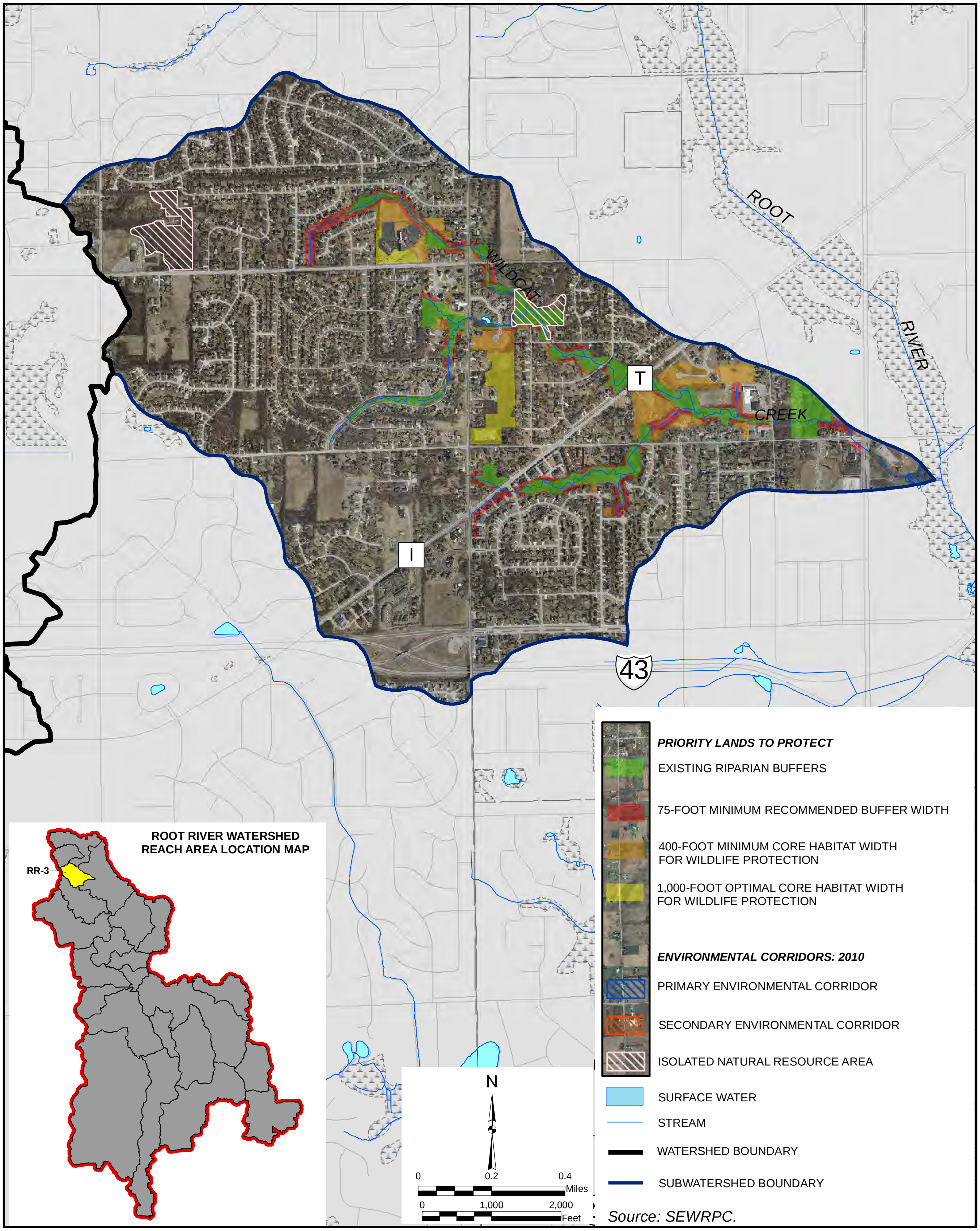
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 2 (INCLUDES PORTIONS OF THE CITIES OF NEW BERLIN AND WEST ALLIS)



Source: SEWRPC.

Map E-3

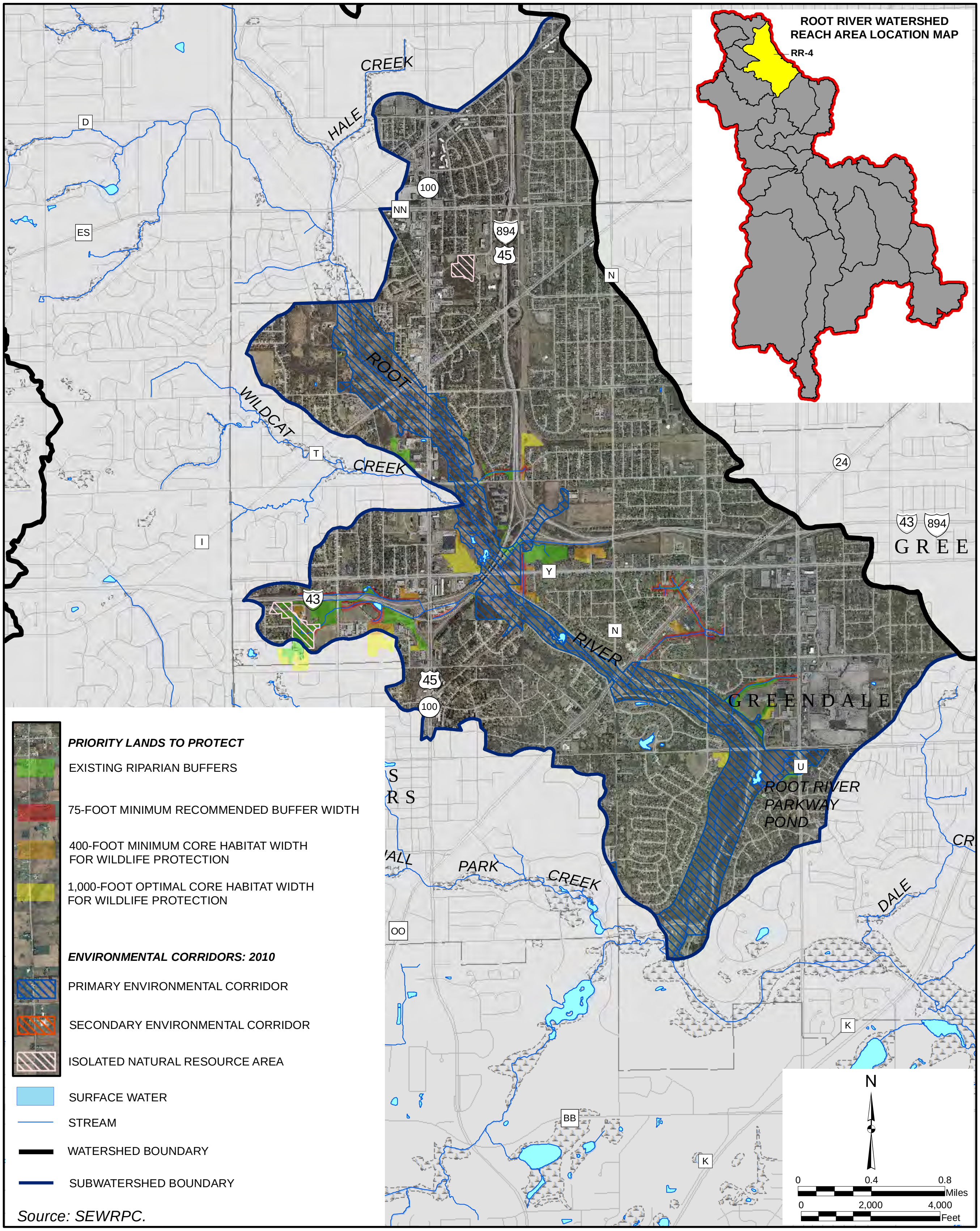
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 3 (INCLUDES PORTIONS OF THE CITIES OF GREENFIELD AND NEW BERLIN)



Source: SEWRPC.

Map E-4

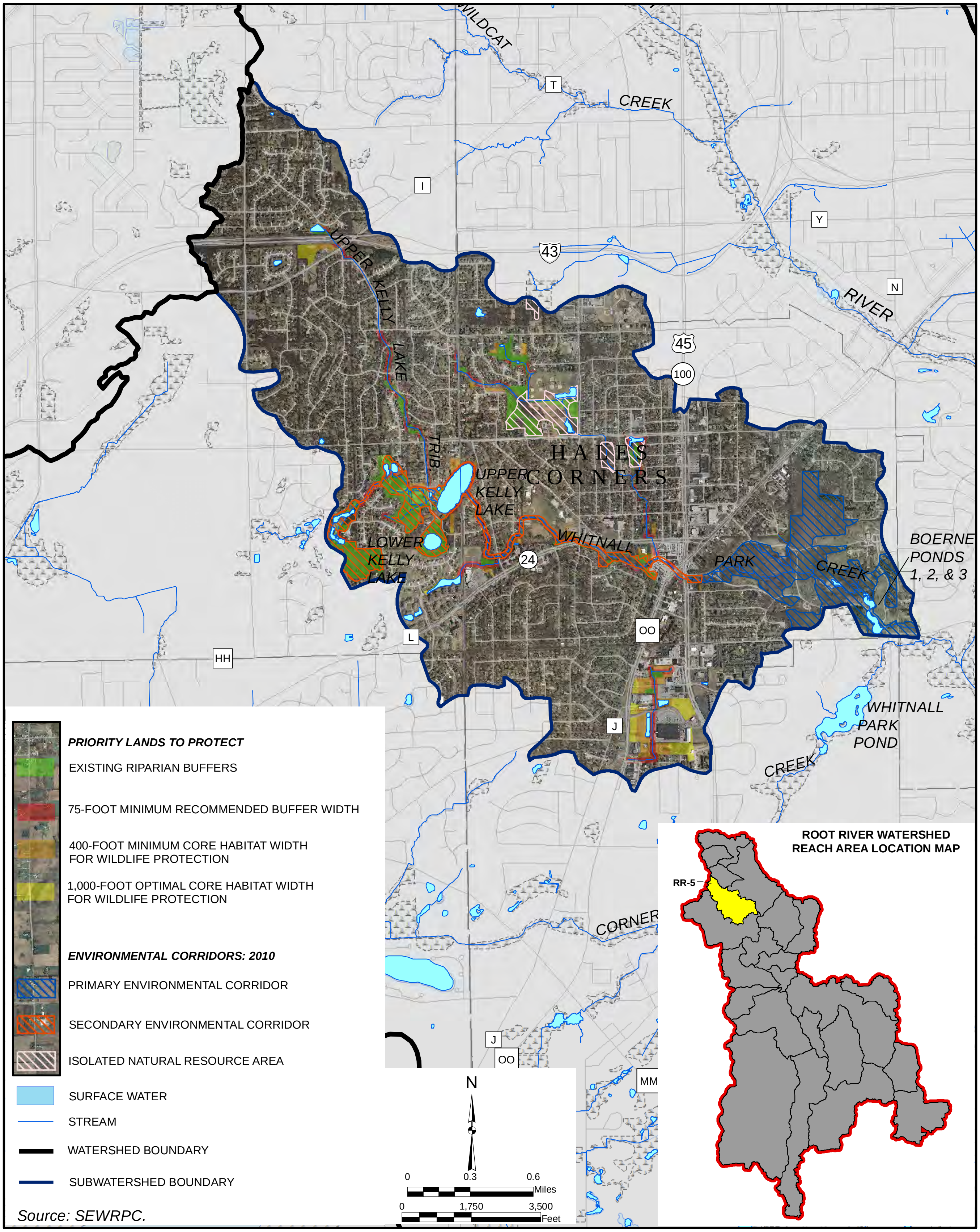
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 4 (INCLUDES PORTIONS OF THE CITIES OF GREENFIELD, MILWAUKEE, AND WEST ALLIS AND THE VILLAGES OF GREENDALE AND HALES CORNERS)



Source: SEWRPC.

Map E-5

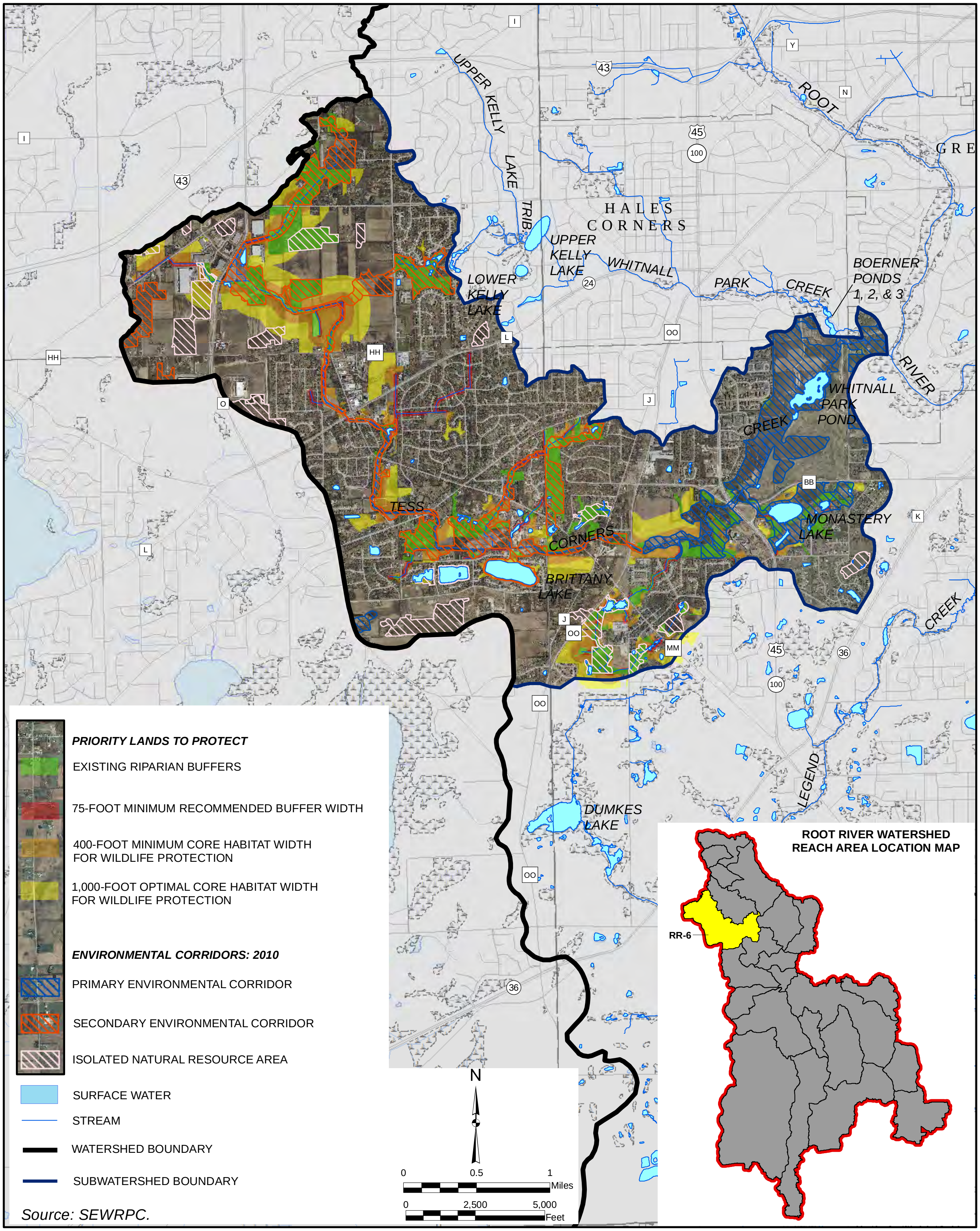
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 5 (INCLUDES PORTIONS OF THE CITIES OF FRANKLIN, GREENFIELD, MUSKEGO, AND NEW BERLIN, AND THE VILLAGE OF HALES CORNERS)



Source: SEWRPC.

Map E-6

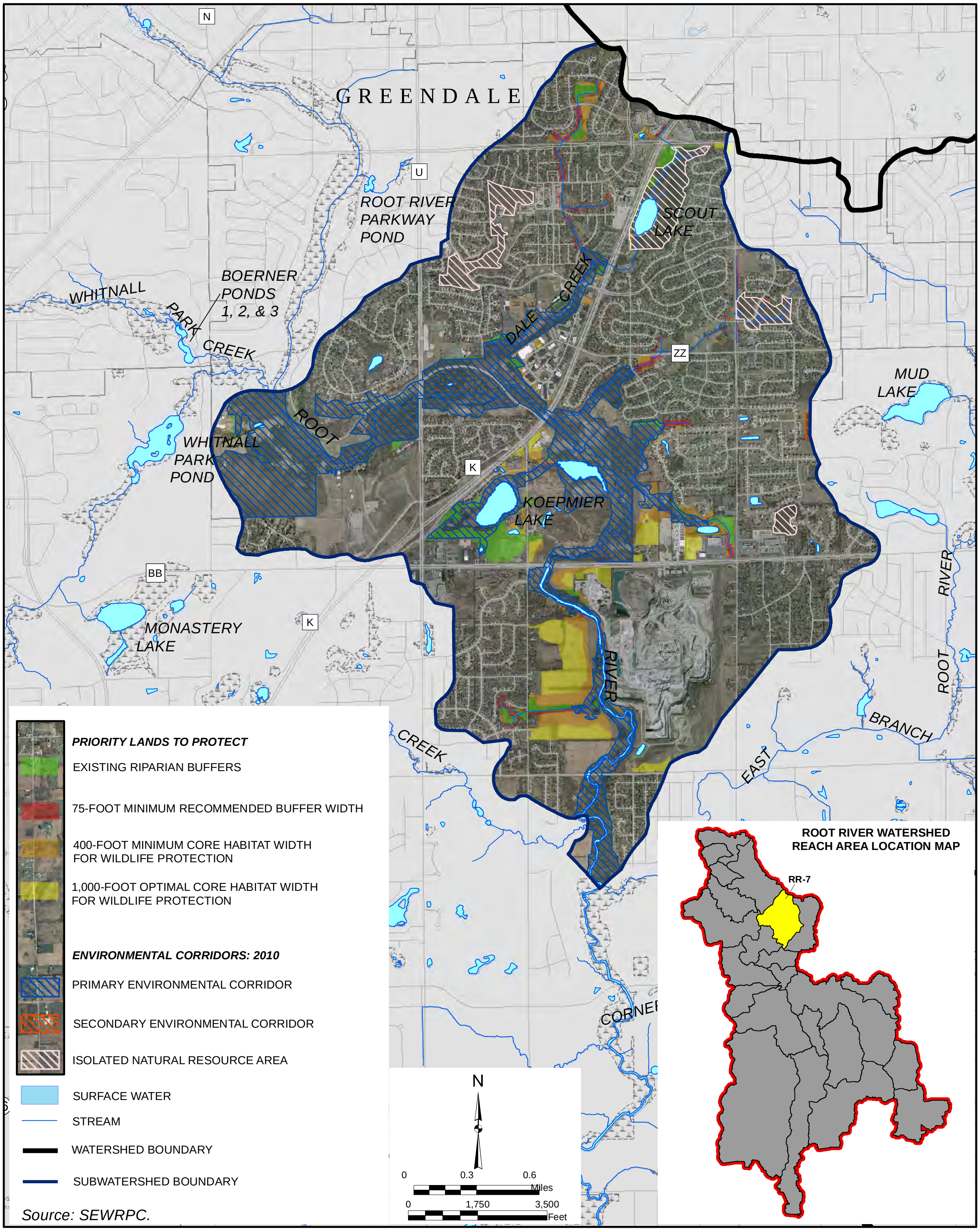
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 6 (INCLUDES PORTIONS OF THE CITIES OF FRANKLIN, MUSKEGO, AND NEW BERLIN, AND THE VILLAGES OF GREENDALE AND HALES CORNERS)



Source: SEWRPC.

Map E-7

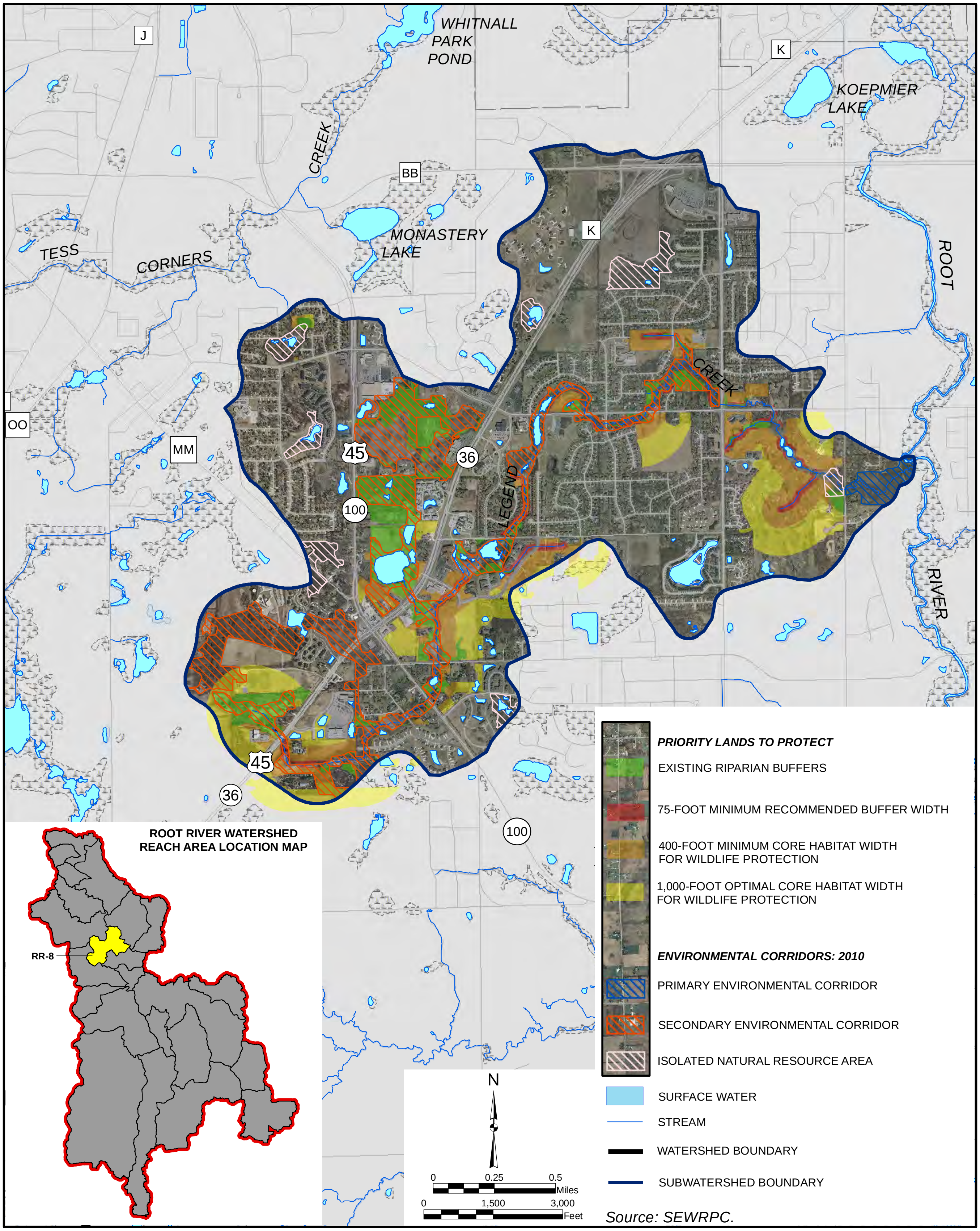
PROPOSED PRIORITY RIPARIAN BUFFER AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 7 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN AND THE VILLAGE OF GREENDALE)



Source: SEWRPC.

Map E-8

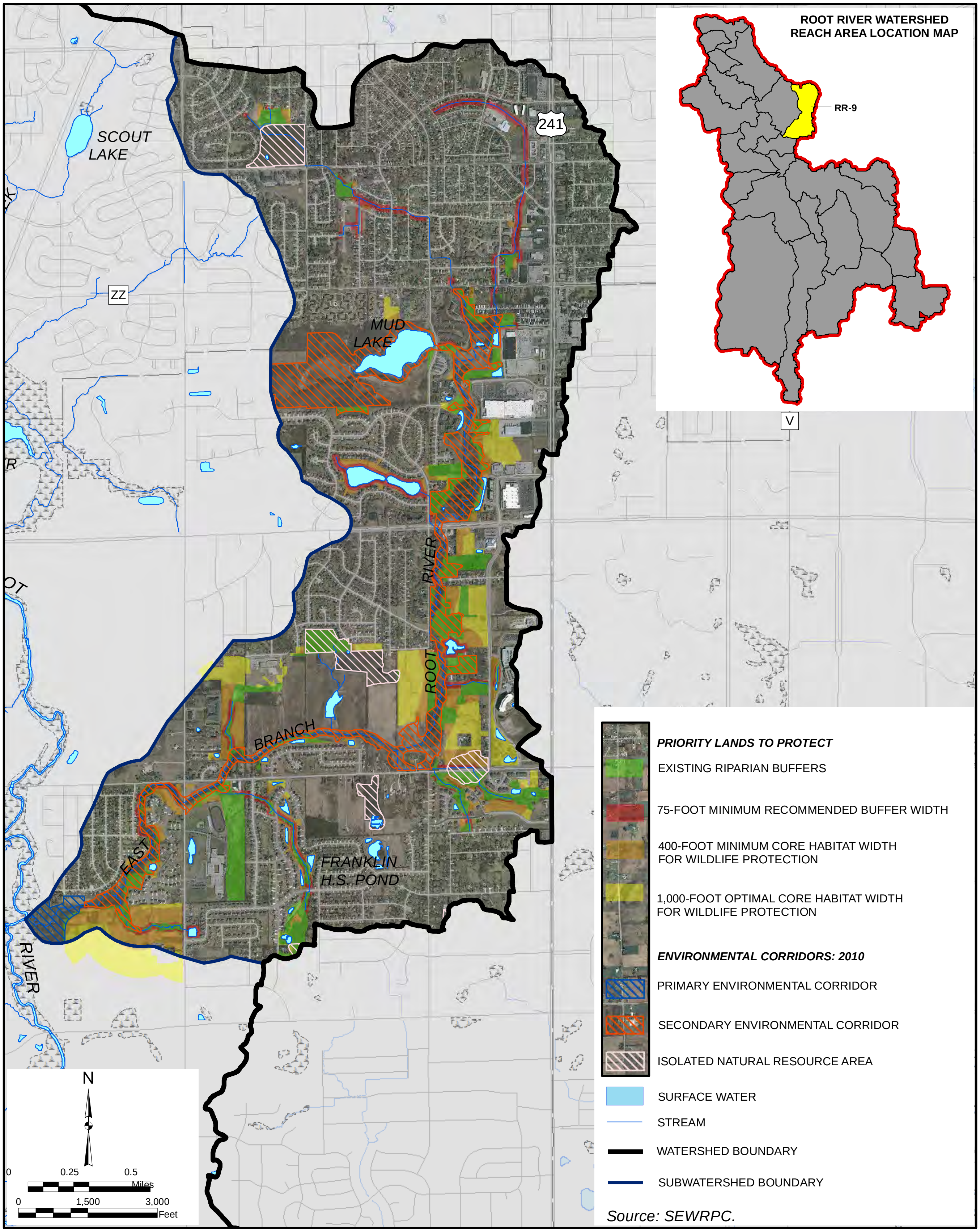
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 8 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN)



Source: SEWRPC.

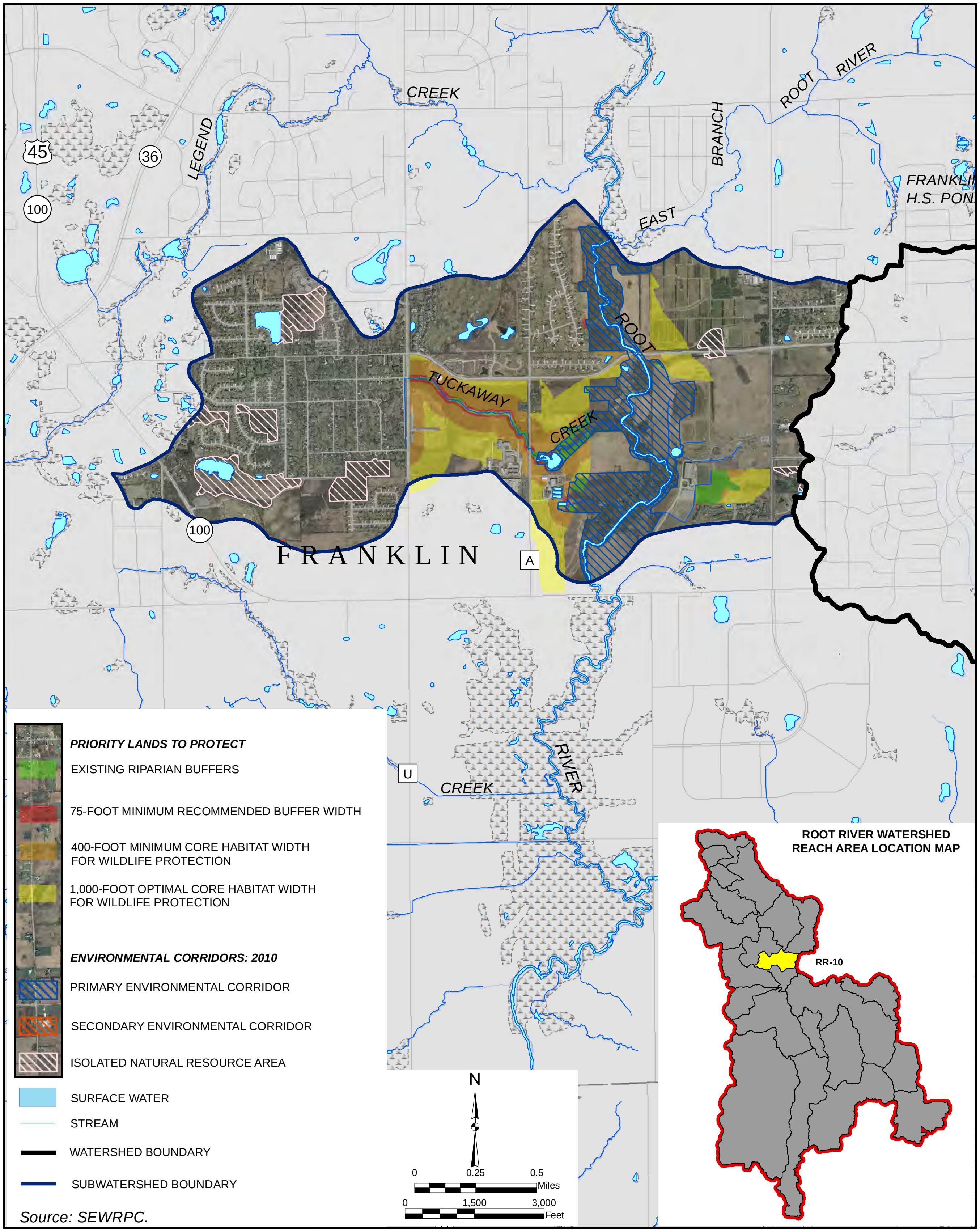
Map E-9

PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 9 (INCLUDES PORTIONS OF THE CITIES OF FRANKLIN, GREENFIELD, MILWAUKEE, AND OAK CREEK, AND THE VILLAGE OF GREENDALE)



Map E-10

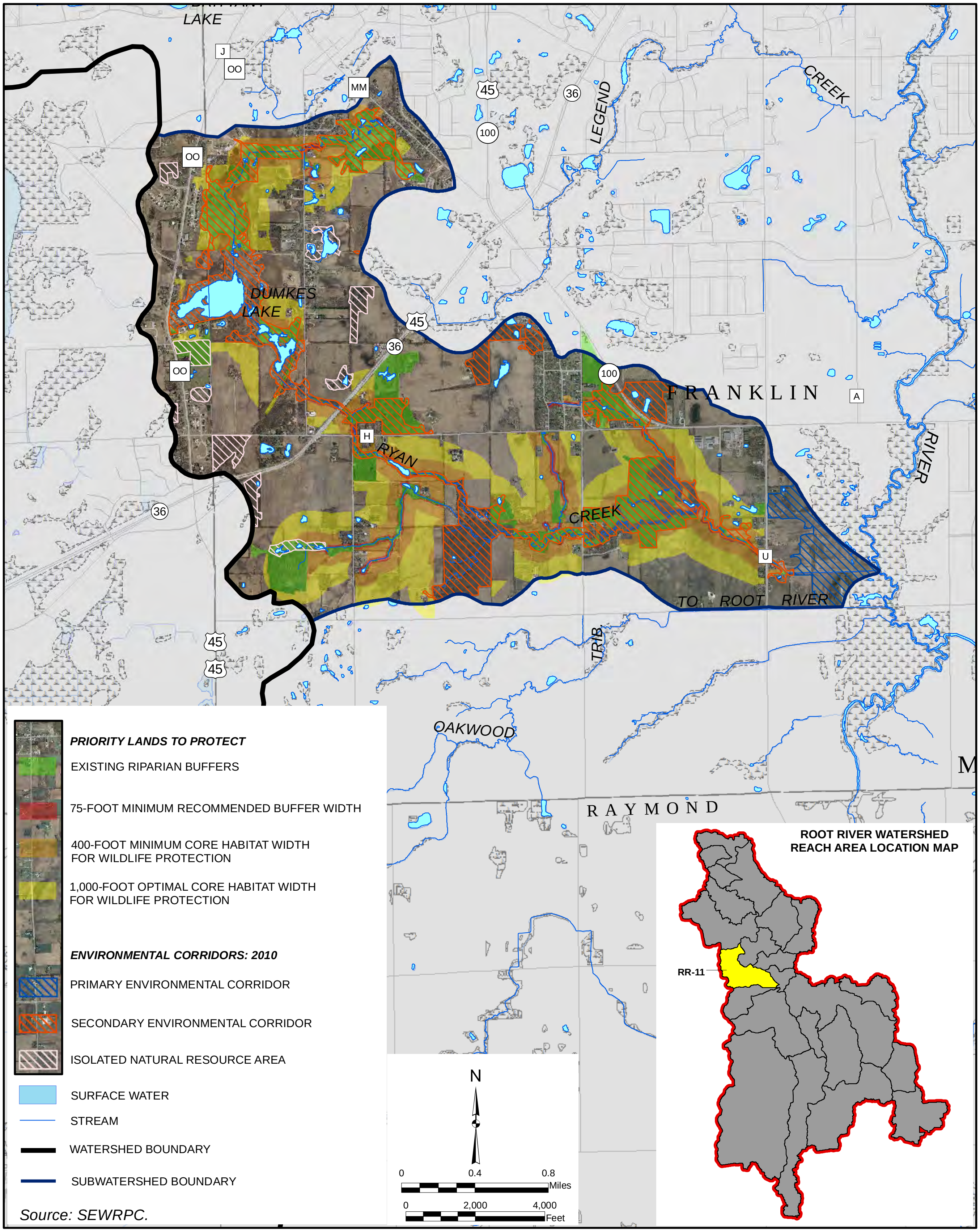
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 10 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN)



Source: SEWRPC.

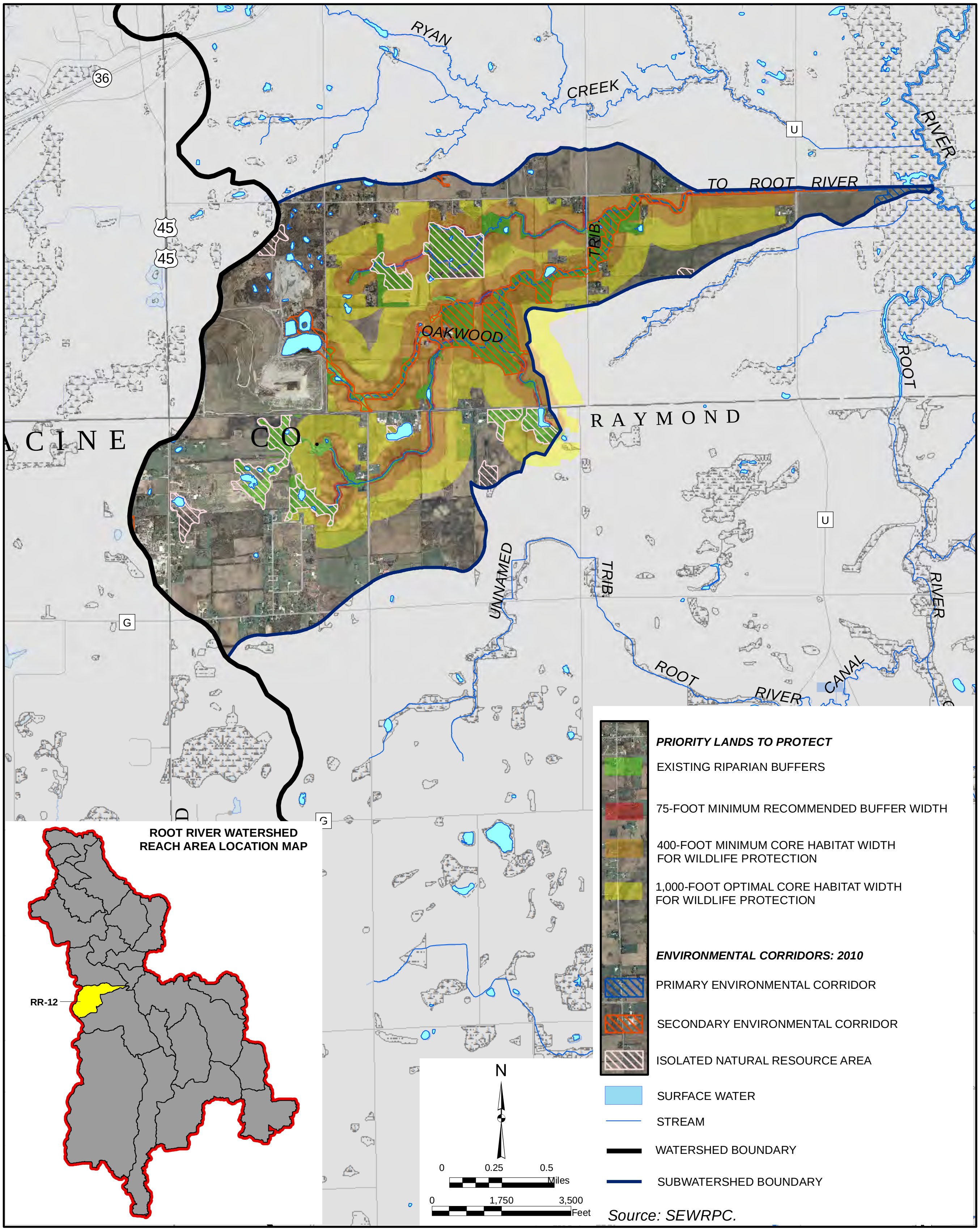
Map E-11

PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS
IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 11
(INCLUDES PORTIONS OF THE CITES OF FRANKLIN AND MUSKEGO)



Map E-12

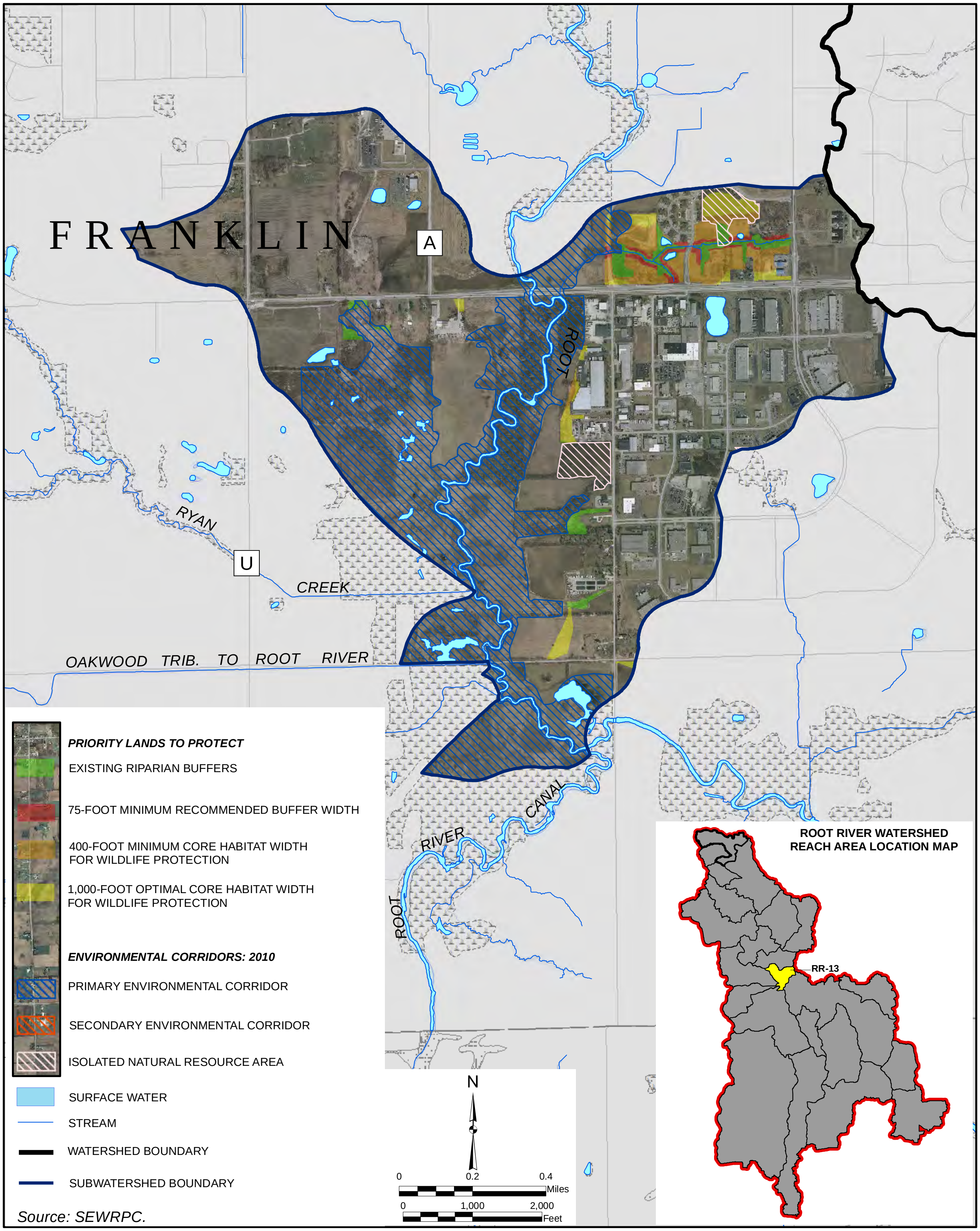
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 12 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN, AND THE TOWNS OF NORWAY AND RAYMOND)



Source: SEWRPC.

Map E-13

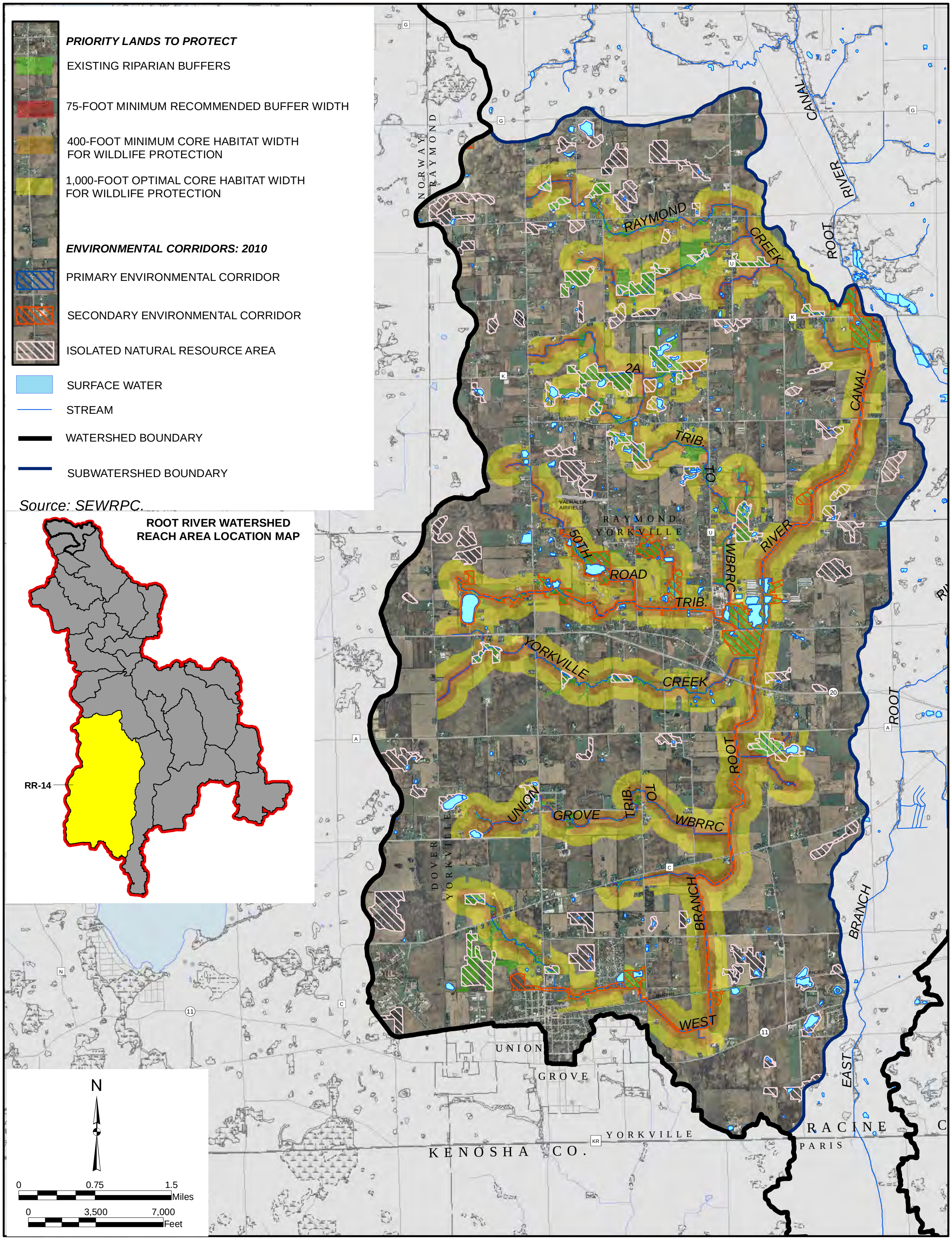
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 13 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN)



Source: SEWRPC.

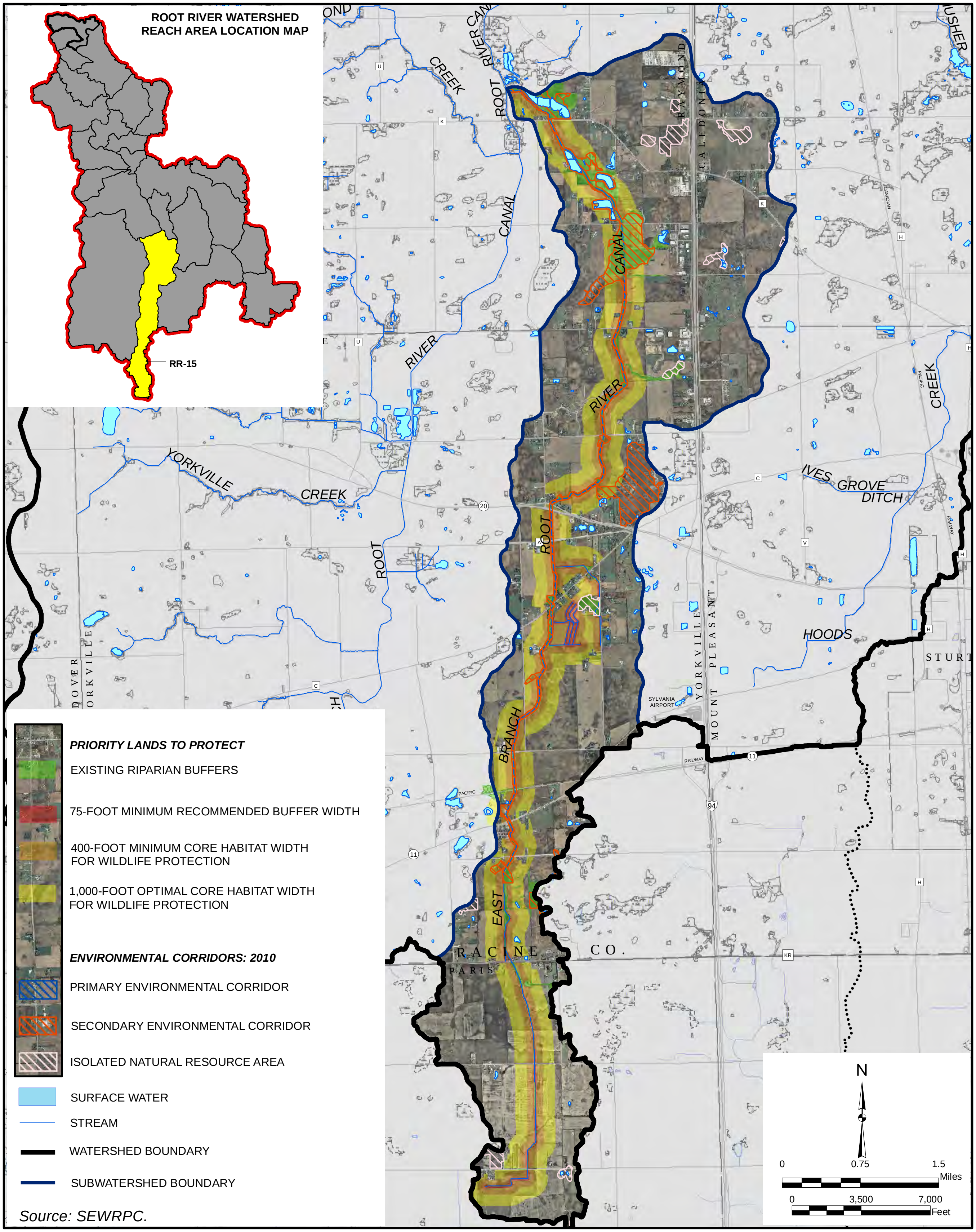
Map E-14

PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 14 (INCLUDES PORTIONS OF THE VILLAGE OF UNION GROVE, AND THE TOWNS OF DOVER, YORKVILLE, AND RAYMOND)



Map E-15

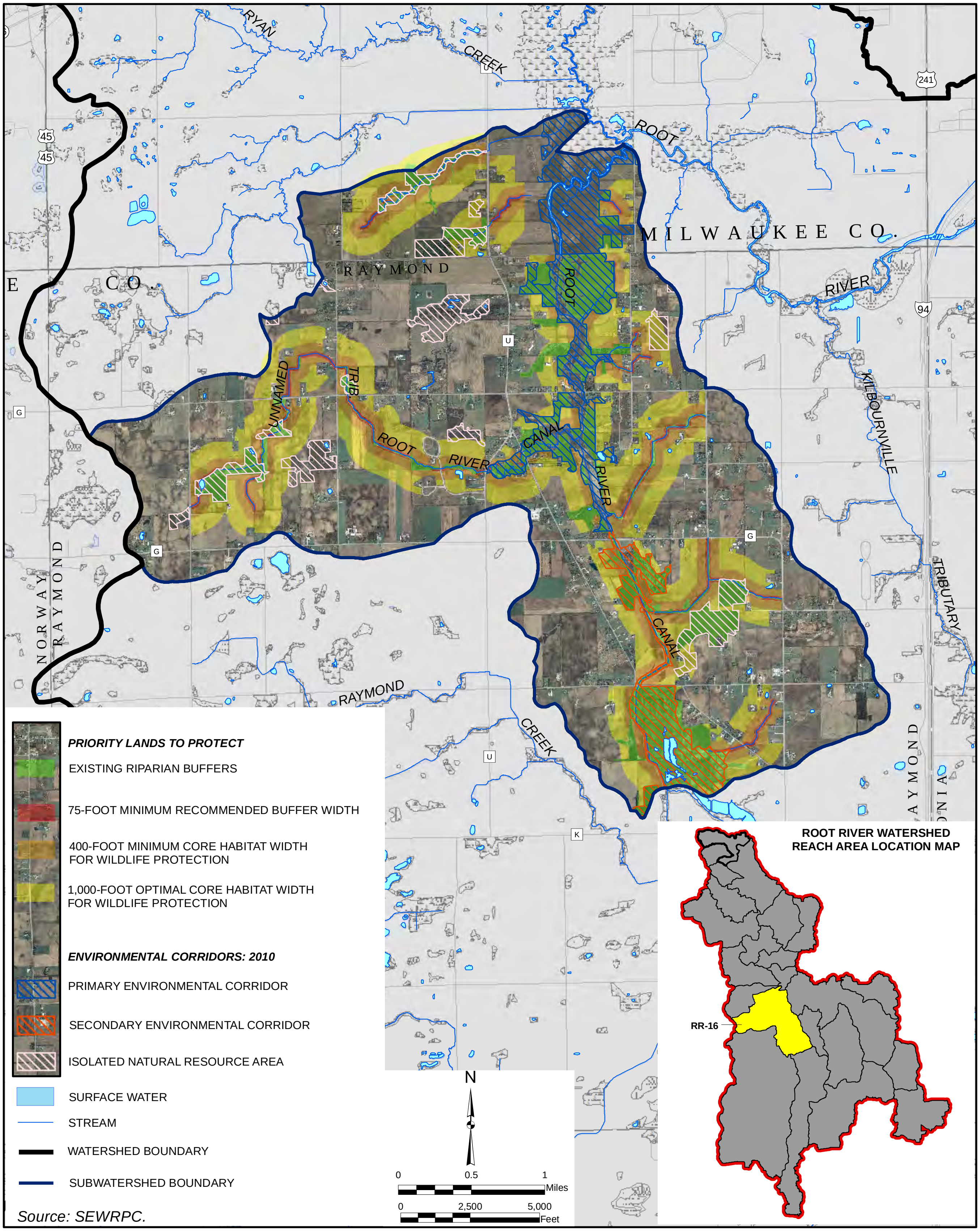
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 15 (INCLUDES PORTIONS OF THE VILLAGES OF CALEDONIA AND MOUNT PLEASANT, AND THE TOWNS OF PARIS, RAYMOND, AND YORKVILLE)



Source: SEWRPC.

Map E-16

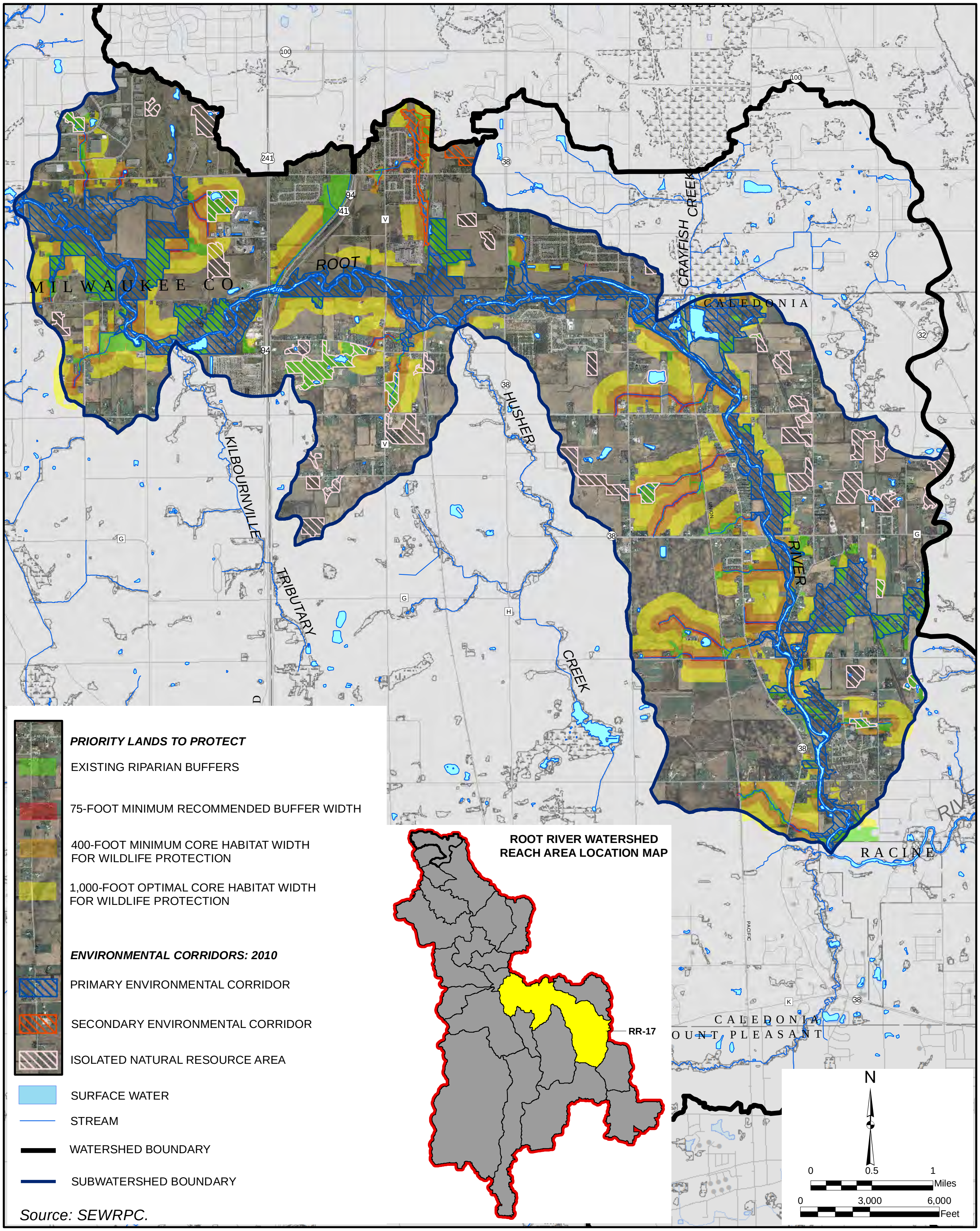
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 16 (INCLUDES PORTIONS OF THE CITY OF FRANKLIN AND TOWN OF RAYMOND)



Source: SEWRPC.

Map E-17

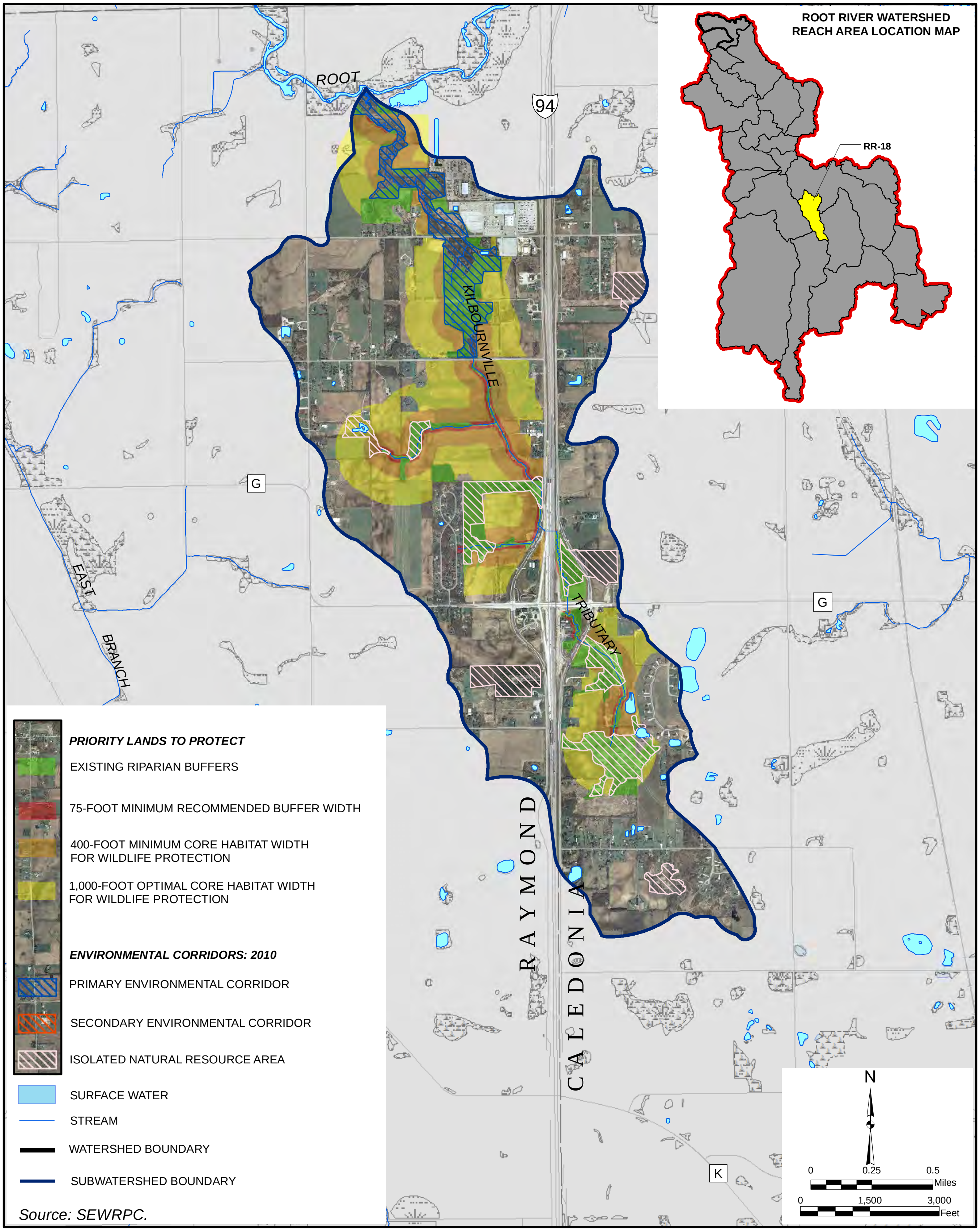
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 17 (INCLUDES PORTIONS OF THE CITES OF FRANKLIN, OAK CREEK AND RACINE, THE VILLAGE OF CALEDONIA, AND THE TOWN OF RAYMOND)



Source: SEWRPC.

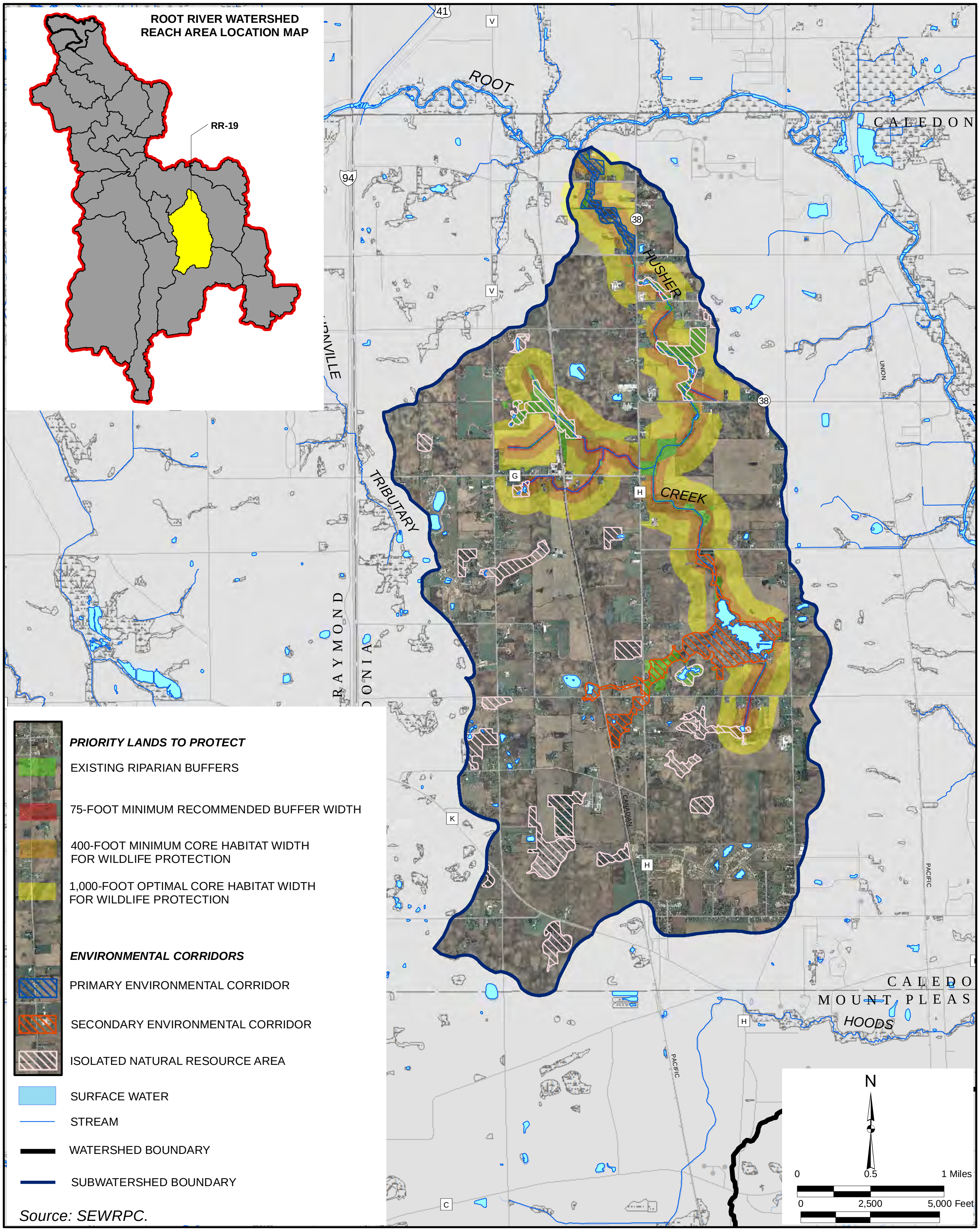
Map E-18

PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS
IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 18
(INCLUDES PORTIONS OF THE VILLAGE OF CALEDONIA, AND THE TOWN OF RAYMOND)



Map E-19

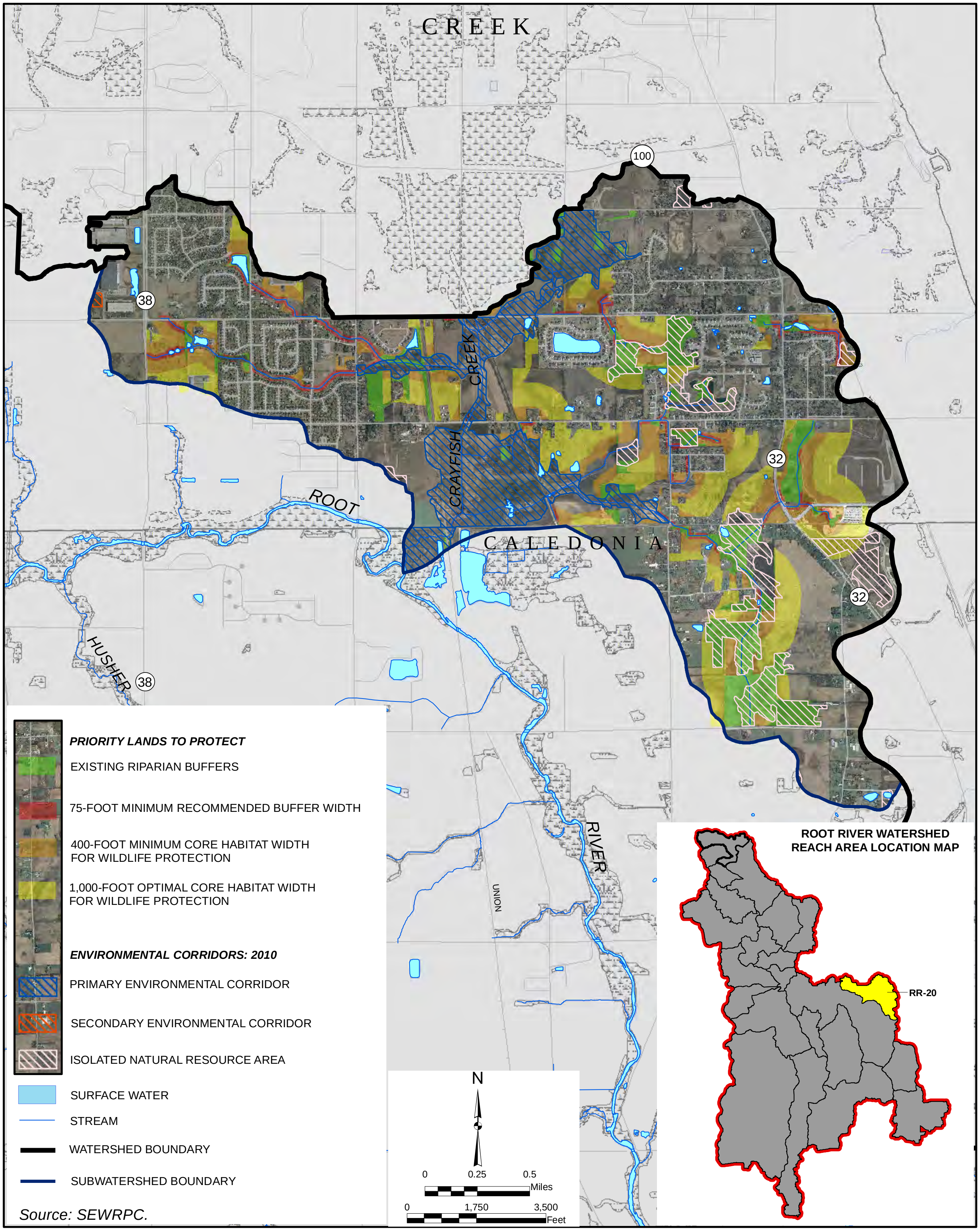
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 19 (INCLUDES PORTIONS OF THE VILLAGE OF CALEDONIA)



Source: SEWRPC.

Map E-20

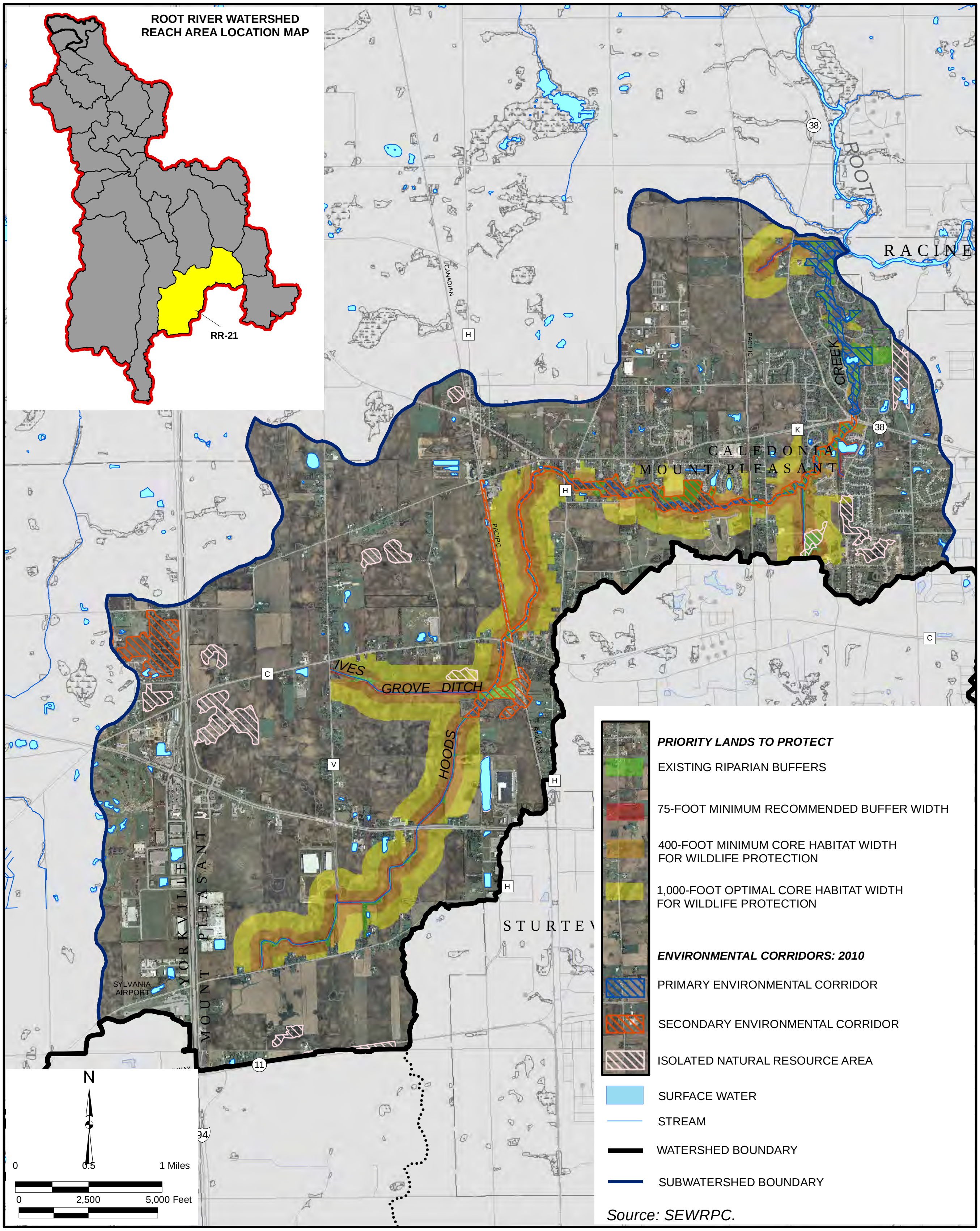
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 20 (INCLUDES PORTIONS OF THE CITY OF OAK CREEK AND VILLAGE OF CALEDONIA)



Source: SEWRPC.

Map E-21

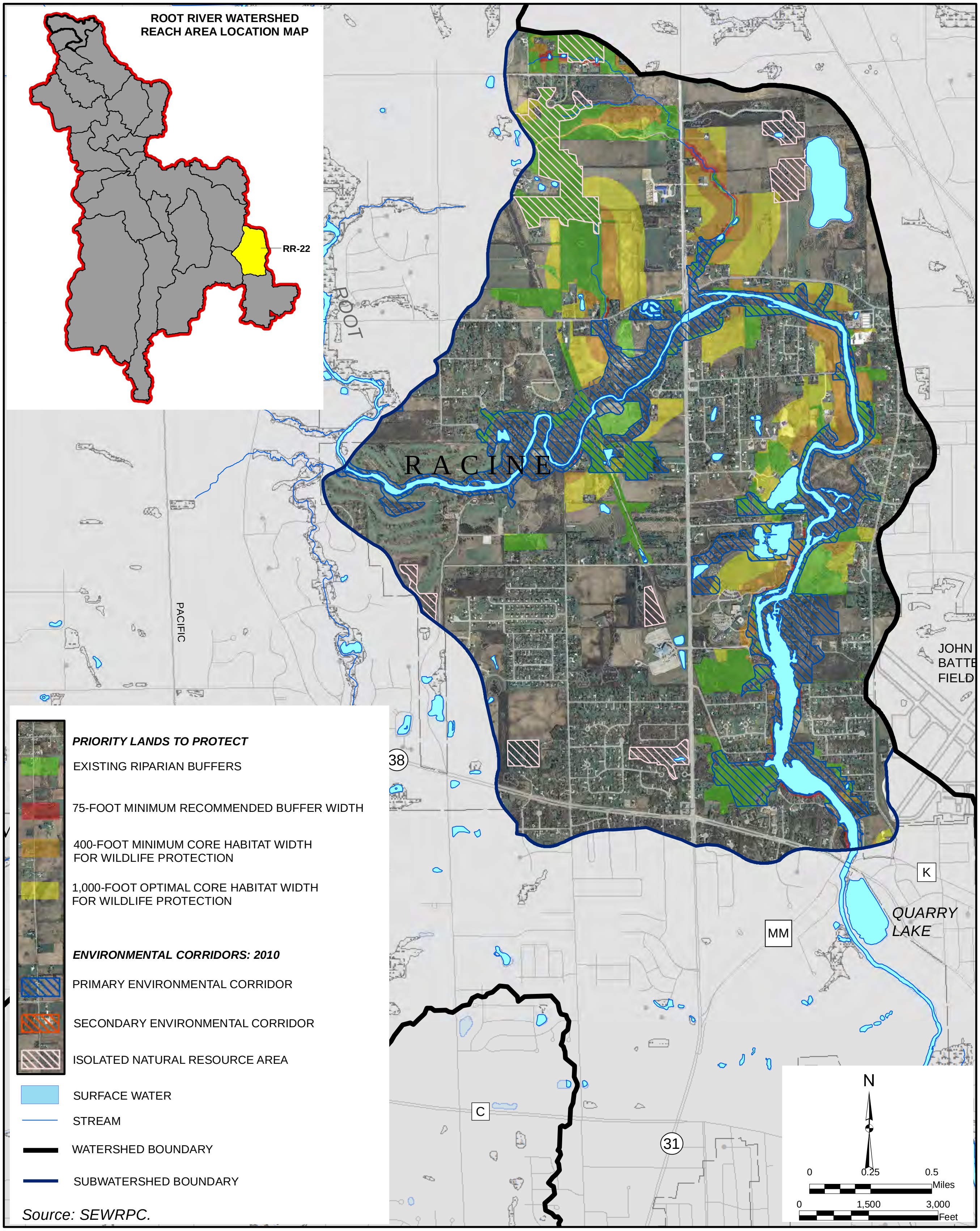
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENT CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 21 (INCLUDES PORTIONS OF THE CITY OF RACINE, THE VILLAGES OF CALEDONIA, MOUNT PLEASANT, AND STURTEVANT, AND THE TOWN OF YORKVILLE)



Source: SEWRPC.

Map E-22

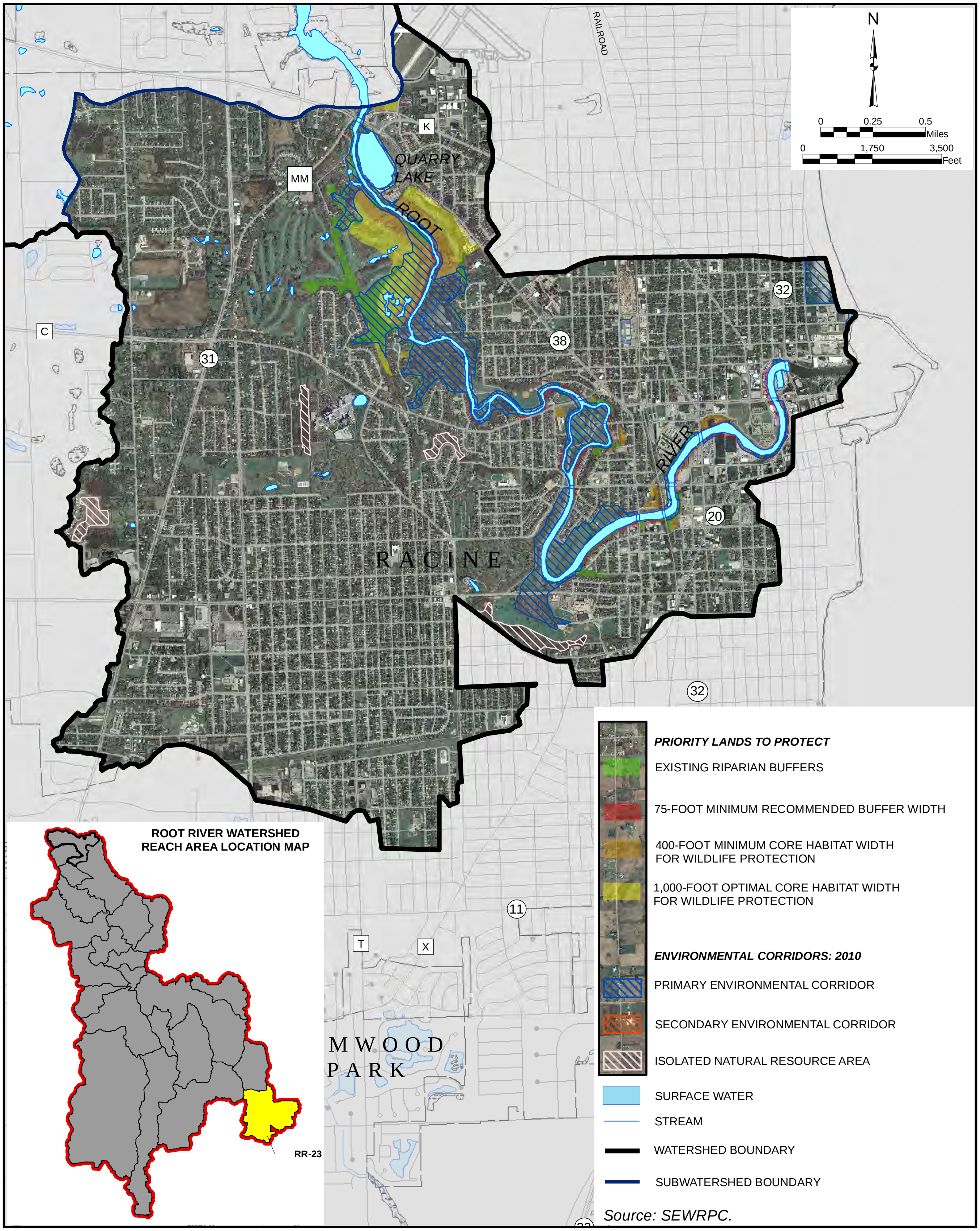
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 22 (INCLUDES PORTIONS OF THE CITY OF RACINE, AND THE VILLAGES OF CALEDONIA AND MOUNT PLEASANT)



Source: SEWRPC.

Map E-23

PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AREAS AND ENVIRONMENTAL CORRIDORS IN THE ROOT RIVER WATERSHED WITHIN REACH AREA 23 (INCLUDES PORTIONS OF THE CITY OF RACINE, AND THE VILLAGE OF MOUNT PLEASANT)



Source: SEWRPC.

Appendix F

ANIMALS OF THE ROOT RIVER WATERSHED

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Table F-1

MACROINVERTEBRATE TAXA REPORTED IN SAMPLES COLLECTED FROM STREAMS IN THE ROOT RIVER WATERSHED: 1977-2011

Organism	Sites[a]		Samples[b]	
	Number	Percent	Number	Percent
Phylum Annelida				
Order Arhynchobdellida				
Family Erpobdellidae				
Dina parva	2	2.9	2	1.0
Erpobdella punctata	8	11.4	8	4.2
Mooreobdella microstoma	2	2.9	2	1.0
Mooreobdella sp.	3	4.3	3	1.6
Erpobdellidae not further identified	14	20.0	19	9.9
Order Haplotaxida				
Family Enchytraeidae				
Enchytraeidae not further identified	8	11.4	8	4.2
Family Lumbricidae				
Lumbricidae not further identified	11	15.7	11	5.7
Family Naididae				
Naididae not futher identified	23	32.9	42	21.9
Family Tubificidae				
Tubificidae not further identified	59	84.3	103	53.6
Haplotaxida not further identified	17	24.3	37	19.3
Order Lumbriculida				
Family Lumbriculidae				
Lumbriculidae not futher identified	2	2.9	2	1.0
Order Rhynchobdellida				
Family Glossiphoniidae				
Gloiobdella elongata	1	1.4	1	0.5
Helobdella stagnalis	8	11.4	8	4.2
Class Arachnida (Phylum Arthropoda)				
Order Trombidiformes				
Trombidiformes not further identified	2	2.9	2	1.0
Class Crustacea (Phylum Arthropoda)				
Order Amphipoda				
Family Crangonuctidae				
Crangonyx pseudogracilis	3	4.3	3	1.6
Crangonyx sp.	9	12.9	10	5.2
Family Gammaridae				
Gammarus pseudolimnaeus	27	38.6	40	20.8
Family Hyalellidae				
Hyalella azteca	19	27.1	21	10.9
Amphipoda not further identified	1	1.4	1	0.5
Order Cyclopoida				
Family Cyclodidae				
Cyclodidae not further identified	6	8.6	6	3.1
Order Decopoda				
Family Cambaridae				
Orconectes rusticus	8	11.4	10	5.2
Orconectes virilis	3	4.3	3	1.6
Orconectes sp.	1	1.4	1	0.5
Cambaridae not further identified	4	5.7	8	4.2

Table F-1 (continued)

Organism	Sites[a]		Samples[b]	
	Number	Percent	Number	Percent
Class Crustacea (Phylum Arthropoda) (continued)				
Order Diplostraca				
Family Dahniidae				
Daphniidae not further identifie	1	1.4	1	0.5
Family Macrothricidae				
Macrothricidae not further identified	1	1.4	1	0.5
Diplostraca not further identified	1	1.4	1	0.5
Order Harpaticoida				
Harpaticoida not further identified	1	1.4	1	0.5
Order Isopoda				
Family Asellidae				
Caecidotea intermedia	64	91.4	148	77.1
Caecidotea sp.	4	5.7	5	2.6
Isopoda not further identified	2	2.9	2	1.0
Class Insecta (Phylum Arthropoda)				
Order Coleptera				
Family Chrysomelidae				
Chrysomelidae not further identified	4	5.7	4	2.1
Family Curculionidae				
Listronotus sp.	1	1.4	1	0.5
Helichus sp.	1	1.4	1	0.5
Curculionidae not further identified	3	4.3	3	1.6
Family Dytiscidae				
Agabus sp.	1	1.4	1	0.5
Agabus sp. or *Ilbyiosoma* sp.	1	1.4	1	0.5
Hydroporus notabilis	1	1.4	1	0.5
Ilybius sp.	1	1.4	1	0.5
Liodessus affinis	2	2.9	2	1.0
Dytiscidae not further identified	5	7.1	6	3.1
Family Elmidae				
Dubiraphia minima	8	11.4	12	6.3
Dubiriaphia quadrinotata	7	10.0	9	4.7
Dubiraphia vittata	12	17.1	17	8.9
Dubiraphia sp.	33	47.1	45	23.4
Macronychus glabratus	7	10.0	11	5.7
Optioservus fastiditus	28	40.0	49	25.5
Optioservus sp.	17	24.3	43	22.4
Stenelmis crenata	23	32.9	63	32.8
Stenelmis decorata	1	1.4	3	1.6
Stenelmis grossa	7	10.0	21	10.9
Stenelmis sp.	29	41.4	84	43.8
Elmidae not further identified	4	5.7	5	2.6
Family Gyrinidae				
Gyrinus sp.	1	1.4	1	0.5
Family Haliplidae				
Halipus sp.	3	4.3	3	1.6
Peltodytes sp.	3	4.3	3	1.6
Family Hydrophilidae				
Berosus sp.	7	10.0	7	3.6
Paracymus subcupreus	1	1.4	1	0.5
Tropisternus natator	1	1.4	1	0.5
Tropisternus sp.	1	1.4	1	0.5

Table F-1 (continued)

Organism	Sites[a]		Samples[b]	
	Number	Percent	Number	Percent
Class Insecta (Phylum Arthropoda) (continued)				
Order Coleptera (continued)				
Family Psephenidae				
Ectopria leechi or *nervosa*	1	1.4	1	0.5
Family Scirtidae				
Cyphon sp.	4	5.7	4	2.1
Scirtidae not further identified	1	1.4	1	0.5
Family Staphylinidae				
Staphylinidae not further identified	1	1.4	1	0.5
Coleoptera not further identified	1	1.4	1	0.5
Class Insecta (Phylum Arthropoda)				
Order Collembola				
Family Entomobryidae				
Entomobryidae not further identified	3	4.3	3	1.6
Class Insecta (Phylum Arthropoda)				
Order Diptera				
Family Ceratogonidae				
Atrichopogon sp.	1	1.4	1	0.5
Bezzia sp. or *Palpomyia* sp.	8	11.4	8	4.2
Culicoides sp.	3	4.3	3	1.6
Dasyhelea sp.	1	1.4	1	0.5
Mallochohelea sp.	11	15.7	12	6.3
Nilobezzia sp.	1	1.4	1	0.5
Probezzia sp	12	17.1	13	6.8
Ceratopogonidae not further identified	2	2.9	2	1.0
Family Chaoboridae				
Chaoborus sp.	1	1.4	1	0.5
Family Chironomidae				
Subfamily Chironominae				
Chironomus decorus species group	2	2.9	2	1.0
Chironomus plumosus	2	2.9	2	1.0
Chironomus riparius	1	1.4	1	0.5
Chironomus stigmaterus	3	4.3	3	1.6
Chironomus sp.	31	44.3	50	26.0
Cladopelma lateralis species group	1	1.4	1	0.5
Cladotanytarsus mancus species group	3	4.3	9	4.7
Cladotanytarsus species group A	2	2.9	2	1.0
Cladotanytarsus vanderwulpi species group	10	14.3	15	7.8
Cladotanytarsus sp	6	8.6	8	4.2
Cryptochironomus fulvus species complex	9	12.9	18	9.4
Cryptochironomus sp.	16	22.9	28	14.6
Dicrotendipes sp.	26	37.1	40	20.8
Glyptotendipes species B	1	1.4	1	0.5
Glyptotendipes sp.	12	17.1	14	7.3
Lauterborniella sp.	1	1.4	1	0.5
Microspectra sp.	39	55.7	59	30.7
Microspectra sp.—pupa	2	2.9	2	1.0
Microtendipes pedellus species group	34	48.6	67	34.9
Microtendipes sp.	15	21.4	34	17.7
Paracladopelma nigritula species group	2	2.9	2	1.0
Paralauterborniella sp.	1	1.4	1	0.5

Table F-1 (continued)

Organism	Sites[a]		Samples[b]	
	Number	Percent	Number	Percent
Class Insecta (Phylum Arthropoda) (continued)				
Subfamily Chironominae (continued)				
Paratanytarsus species A	18	25.7	18	9.4
Paratanytarsus species B	13	18.6	13	6.8
Paratanytarsus sp.	23	32.9	26	13.5
Paratanytarsus sp.—pupa	2	2.9	2	1.0
Paratendipes sp.	21	30.0	33	17.2
Phaenopsectra obediens species group	1	1.4	1	0.5
Phaenopsectra punctipes species group	10	14.3	10	5.2
Phaenopsectra sp.	9	12.9	9	4.7
Polypedilum fallax species group	8	11.4	12	6.3
Polypedilum flavum	22	31.4	26	13.5
Polypedilum halterale species group	3	4.3	5	2.6
Polypedilum illinoense species group	8	11.4	8	4.2
Polypedilum scalaenum species group	23	32.9	29	15.1
Polypedilum species A	1	1.4	1	0.5
Polypedilum tritum	4	5.7	4	2.1
Polypedilum sp.	30	42.9	62	32.3
Pseudochironomus fulviventris	1	1.4	1	0.5
Pseudochironomus richardsoni	2	2.9	2	1.0
Pseudochironomus sp.	2	1.4	2	1.0
Rheotanytarsus exiguous species group	10	14.3	10	5.2
Rheotanytarsus sp.	18	25.7	23	12.0
Stenochironomus sp.	6	8.6	6	3.1
Stictochironomus sp.	41	58.6	74	38.5
Tanytarsus sp.	24	34.3	33	17.2
Tanytarsus sp.—pupa	1	1.4	1	0.5
Tribelos quadripunctatus	2	2.9	2	1.0
Tribelos sp.	1	1.4	1	0.5
Chironominae not further identified	33	47.1	49	25.5
Subfamily Diamesinae				
Diamesa sp.	1	1.4	1	0.5
Diamesinae not further identified	2	2.9	2	1.0
Subfamily Orthorcladiinae				
Arcocotopus sp.	1	1.4	1	0.5
Brillia flavifrons	8	11.4	8	4.2
Brillia flavifrons species group	4	5.7	5	2.6
Brillia sp.	8	11.4	11	5.7
Chaetocladius sp.	28	40.0	41	21.4
Corynoneura sp.	15	21.4	15	7.8
Cricotopus annulator species complex	3	4.3	3	1.6
Cricotopus bicinctus species group	21	30.0	28	14.6
Cricotopus festivellus species group	2	2.9	2	1.0
Cricotopus infuscatus	1	1.4	1	0.5
Cricotopus infuscatus or *triannulatus*	7	10.0	8	4.2
Cricotopus intersectus species group	2	2.9	3	1.6
Cricotopus sylvestris species group	3	4.3	3	1.6
Cricotopus tremulus species group	7	10.0	18	9.4
Cricotopus trifascia species group	4	5.7	16	8.3
Cricotopus sp.	17	24.3	18	9.4
Cricotopus sp.—pupa	4	5.7	5	2.6
Diplocladius sp	12	17.1	12	6.3

Table F-1 (continued)

Organism	Sites[a]		Samples[b]	
	Number	Percent	Number	Percent
Class Insecta (Phylum Arthropoda) (continued)				
Subfamily Orthorcladiinae (continued)				
Eukiefferiella bremhi species group	3	4.3	3	1.6
Eukiefferiella claripennis species group	10	14.3	16	8.3
Eukiefferiella rectangularis species group	1	1.4	4	2.1
Eukiefferiella sp.	6	8.6	15	7.8
Hydorbaenus sp.	41	58.6	50	26.0
Limnophyes sp.	17	24.3	19	9.9
Limnophyes sp.—pupa	1	1.4	1	0.5
Microcricotopus sp.	1	1.4	1	0.5
Nanocladius distinctus	1	1.4	1	0.5
Nanocladius c.f. *rectinervis*	2	2.9	2	1.0
Nanocladius sp.	6	8.6	9	4.7
Orthocladius oliveri	24	34.3	24	12.5
Orthocladius sp.	34	48.6	73	38.0
Orthocladius sp.—pupa	4	5.7	4	2.1
Parakiefferiella sp.	25	35.7	27	14.1
Parakiefferiella sp.—pupa	1	1.4	1	0.5
Parametirocnemus sp.	21	30.0	21	10.9
Paraphaenocladius sp.	4	5.7	4	2.1
Pseudosmittia sp.	2	2.9	2	1.0
Rheocricotopus galbricollis	4	5.7	4	2.1
Rheocricotopus sp.	4	5.7	4	2.1
Smittia sp.	1	1.4	1	0.5
Stilocladius sp.	2	2.9	2	1.0
Thienemanniella xena	1	1.4	1	0.5
Thienemanniella sp.	15	21.4	19	9.9
Thienemanniella sp.—pupa	1	1.4	1	0.5
Tvetenia bavarica species group	3	4.3	3	1.6
Tvetenia discoloripes species group	1	1.4	1	0.5
Tvetenia paucunca	1	1.4	1	0.5
Orthocladiinae not further identified	46	65.7	103	54.7
Subfamily Tanypodinae				
Ablabesmyia peleensis	1	1.4	1	0.5
Ablabesmyia sp.	2	2.9	2	1.0
Clinotanypus pinguis	2	2.9	2	1.0
Conchapelopia sp.	32	45.7	55	28.6
Hayesomyia sp.	2	2.9	3	1.6
Helopelopia sp.	1	1.4	1	0.5
Larsia sp.	2	2.9	2	1.0
Macropelopia sp.	1	1.4	1	0.5
Natarsia species A	5	7.1	5	2.6
Natarsia sp.	3	4.3	3	1.6
Nilotanypus sp.	1	1.4	1	0.5
Procladius sp.	9	12.9	9	4.7
Psectrotanypus dyari	1	1.4	1	0.5
Psectrotanypus sp.	1	1.4	1	0.5
Rheopelopia sp.	5	7.1	6	3.1
Thienemannimyia complex	15	21.4	18	9.4
Thienemannimyia sp.	1	1.4	1	0.5
Zavrelimyia sp.	2	2.9	2	1.0
Tanypodinae not further identified	28	40.0	48	25.0
Chironomidae not further identified	28	40.0	50	26.0
Chironomidae not further identified—pupa	12	17.1	19	9.9

Table F-1 (continued)

Organism	Sites[a]		Samples[b]	
	Number	Percent	Number	Percent
Class Insecta (Phylum Arthropoda) (continued)				
Family Culicidae				
Anopheles sp.	3	4.3	3	1.6
Culicidae not further identified—pupa	2	2.9	2	1.0
Family Dolichopodidae				
Dolichopodidae not further identified	1	1.4	1	0.5
Family Empididae				
Chelifera sp.	2	2.9	2	1.0
Clinocera sp.	3	4.3	8	4.2
Hemerodromia sp.	18	25.7	37	19.3
Empididae not further identified	7	10.0	8	4.2
Empididae not further identified—pupa	1	1.4	10	5.2
Family Ephydridae				
Ephydridae not further identified	4	5.7	4	2.1
Ephydridae not further identified—pupa	2	2.9	2	1.0
Family Muscidae				
Muscidae not further identified	2	2.9	2	1.0
Family Psychodidae				
Pericoma sp.	2	2.9	2	1.0
Psychoda sp.	5	7.1	5	2.6
Psychodidae not further identified	1	1.4	1	0.5
Family Sciomyzidae				
Sciomyzidae not further identified—pupa	1	1.4	1	0.5
Family Simuliidae				
Cnephia ornithophilia	2	2.9	4	2.1
Parnassum sp.	1	1.4	1	0.5
Prosimulium sp.	1	1.4	1	0.5
Simulium aestivum	1	1.4	1	0.5
Simulium fibrinflatum	3	4.3	9	4.7
Simulium pictipes	1	1.4	1	0.5
Simulium tuberosum species complex	3	4.3	3	1.6
Simulium venustum species complex	1	1.4	11	5.7
Simulium vittatum species complex	38	54.3	77	40.1
Simulium sp.	7	10.0	20	10.4
Simulium sp.—pupa	5	7.1	10	5.2
Simuliidae not further identified	7	10.0	12	6.3
Simuliidae not further identified—pupa	1	1.4	1	0.5
Family Stratiomyidae				
Odontomyia sp.	4	5.7	4	2.1
Odontomyia sp. or *Hedriodiscus* sp.	1	1.4	1	0.5
Family Syrphidae				
Chrysogaster sp.	2	2.9	2	1.0
Eristalis sp.	2	2.9	2	1.0
Family Tabanidae				
Chrysops sp.	9	12.9	9	4.7
Hybomitra sp.	1	1.4	1	0.5
Tabanus sp. or *Atylotus* sp.	1	1.4	1	0.5
Family Tipulidae				
Antocha sp.	1	1.4	2	1.0
Dicranota sp.	2	2.9	4	2.1
Erioptera	4	5.7	4	2.1
Limnophila sp.	1	1.4	1	0.5
Limonia sp.	5	7.1	5	2.6

Table F-1 (continued)

Organism	Sites[a]		Samples[b]	
	Number	Percent	Number	Percent
Class Insecta (Phylum Arthropoda) (continued)				
Family Tipulidae (continued)				
Pedicia sp.	1	1.4	1	0.5
Pilaria sp.	10	14.3	11	5.7
Tipula sp.	33	47.1	47	24.5
Tipulidae not further identified	1	1.4	1	0.5
Diptera not further identified	3	4.3	6	3.1
Class Insecta (Phylum Arthropoda)				
Order Ephemeroptera				
Family Baetidae				
Baetis brunneicolor	6	8.6	8	4.2
Baetis flavistriga species complex	10	14.3	13	6.8
Baetis intercalaris	19	27.1	40	20.8
Baetis sp.	4	5.7	4	2.1
Callibaetis sp.	7	10.0	8	4.2
Plauditus dubius	1	1.4	1	0.5
Procoeon sp.	1	1.4	1	0.5
Baetidae not further identified	4	5.7	5	2.6
Family Caenidae				
Caenis latipennis	14	20.0	14	7.3
Caenis punctata	2	2.9	2	1.0
Caenis sp.	24	34.3	36	18.8
Family Ephemeridae				
Hexagenia limbata	2	2.9	3	1.6
Heagenia sp.	4	5.7	4	2.1
Family Heptageniidae				
Heptagenia elegantula	2	2.9	3	1.6
Leucrocuta hebe	4	5.7	11	5.7
Leucrocuta sp.	1	1.4	2	1.0
Maccaffertium terminatum	1	1.4	1	0.5
Maccaffertium sp.	4	5.7	6	3.1
Stenacron femoratum	1	1.4	1	0.5
Stenacron interpunctatum	31	44.3	80	41.7
Heptageniidae not further identified	3	4.3	3	1.6
Family Isonychiidae				
Isonychia sp.	2		3	
Family Leptohyphidae				
Tricorythodes sp.	4	5.7	4	2.1
Family Potamanthidae				
Anthopotamus myops	1	1.4	1	0.5
Ephemeroptera not further identified	1	1.4	1	0.5
Class Insecta (Phylum Arthropoda)				
Order Hemiptera				
Family Belostomatidae				
Belostoma flumineum	5	7.1	5	2.6
Family Corixidae				
Hesperocorixa atopodonta	2	2.9	2	1.0
Palmacorixa sp.	3	4.3	3	1.6
Sigara alternata	1	1.4	1	0.5
Sigara grossolineata	1	1.4	1	0.5
Sigara sp.	4	2.1	4	5.7
Tricorixa calva	6	8.6	6	3.1
Trichorixa sp.	5	7.1	5	2.6
Corixidae not further identified	12	17.1	16	8.3

Table F-1 (continued)

Organism	Sites[a]		Samples[b]	
	Number	Percent	Number	Percent
Class Insecta (Phylum Arthropoda) (continued)				
Family Gerridae				
Rheumatobates palosi	1	1.4	1	0.5
Trepobates sp.	1	1.4	1	0.5
Gerridae not further identified	1	1.4	1	0.5
Family Mesoveliidae				
Mesovelia mulsanti	1	1.4	1	0.5
Mesovelia sp.	1	1.4	1	0.5
Family Nepidae				
Ranatra fusca	1	1.4	1	0.5
Class Insecta (Phylum Arthropoda)				
Order Lepidoptera				
Family Crambidae				
Acentria sp.	2	2.9	2	1.0
Lepidoptera not further identified	2	2.9	2	1.0
Class Insecta (Phylum Arthropoda)				
Order Megaloptera				
Family Corydalidae				
Chauliodes sp.	1	1.4	1	0.5
Family Sialidae				
Sialis sp.	1	1.4	1	0.5
Class Insecta (Phylum Arthropoda)				
Order Neuroptera				
Family Sisyridae				
Climacia areolis	1	1.4	1	0.5
Class Insecta (Phylum Arthropoda)				
Order Odonata				
Family Aeschnidae				
Aeshna umbrosa	2	2.9	2	1.0
Aeshna sp.	2	2.9	2	1.0
Family Calopterygidae				
Calopteryx maculata	10	14.3	11	5.7
Calopteryx sp.	4	5.7	5	2.6
Hetaerina americana	1	1.4	1	0.5
Calopterygidae not further identified	1	1.4	1	0.5
Family Coenagrionidae				
Argia apicalis	8	11.4	9	4.7
Argia moesta	5	7.1	8	4.2
Argia sp.	11	15.7	12	6.3
Coenagrian sp. or *Enallagma* sp.	4	5.7	4	2.1
Enallagma sp.	11	15.7	12	6.3
Ischnura verticalis	2	2.9	3	1.6
Ischnura sp.	3	4.3	3	1.6
Coenagrionidae not further identified	13	18.6	15	7.8
Family Corduliidae				
Somatochlora sp.	1	1.4	1	0.5
Class Insecta (Phylum Arthropoda)				
Order Plecoptera				
Family Capniidae				
Allocapnia sp.	19	27.1	23	12.0
Family Perlidae				
Perlesta sp.	4	5.7	9	4.7

Table F-1 (continued)

Organism	Sites[a]		Samples[b]	
	Number	Percent	Number	Percent
Class Insecta (Phylum Arthropoda) (continued)				
Order Plecoptera (continued)				
Family Perlodidae				
Isoperla nana	2	2.9	2	1.0
Family Taeniopterygidae				
Taeniopteryx burksi	6	8.6	6	3.1
Taeniopteryx sp.	5	7.1	7	3.6
Class Insecta (Phylum Arthropoda)				
Order Trichoptera				
Family Helicopsychidae				
Helicopsyche borealis	2	2.9	2	1.0
Family Hydropsychidae				
Ceratopsyche alhedra	1	1.4	1	0.5
Ceratopsyche bronta	5	7.1	20	10.4
Ceratopsyche morose bifida form	3	4.3	14	7.3
Ceratopsyche slossonae	2	2.9	2	1.0
Ceratopsyche sparna	1	1.4	1	0.5
Ceratopsyche sp.	2	2.9	9	4.7
Cheumatopsyche sp.	47	67.1	131	68.2
Hydropsyche betteni	42	60.0	100	52.1
Hydropsyche scalaris	1	1.4	1	0.5
Hydropsyche simulans	4	5.7	4	2.1
Hydropsyche sp.	12	17.1	18	9.4
Hydropsychidae not further identified	23	32.9	41	21.4
Hydropsychidae not further identified—pupa	1	1.4	2	1.0
Family Hydroptilidae				
Hydroptila sp.	13	18.6	24	12.5
Hydroptilidae not further identified—pupa	2	2.9	4	2.1
Family Leptoceridae				
Nectopsyche sp.	2	2.9	2	1.0
Oecetis sp.	9	12.9	11	5.7
Triaenodes sp.	1	1.4	1	0.5
Family Limnephilidae				
Limnephilus sp.	1	1.4	1	0.5
Platycentropus sp.	1	1.4	1	0.5
Limnephilidae not further identified	3	4.3	3	1.6
Family Philopotamidae				
Chimarra obscura	11	15.7	18	9.4
Philopotamidae not further identified	1	1.4	1	0.5
Class Insecta (Phylum Arthropoda) (continued)				
Family Phryganeidae				
Ptilostomis sp.	4	5.7	4	2.1
Family Polycentropodidae				
Polycentropus sp	1	1.4	1	0.5
Polycentropodidae not further identified	1	1.4	1	0.5
Family Rhyacophilidae				
Rhyacophila lobifera	3	4.3	3	1.6
Rhyacophila manistee	1	1.4	1	0.5
Rhyacophila sp.	1	1.4	1	0.5
Trichoptera not further identified	1	1.4	1	0.5

Table F-1 (continued)

Organism	Sites[a]		Samples[b]	
	Number	Percent	Number	Percent
Class Insecta (Phylum Arthropoda) (continued)				
Phylum Mollusca				
Order Basommatophora				
Family Ancylidae				
Ferrissia sp.	3	4.3	3	1.6
Laevapex fuscus	2	2.9	2	1.0
Laevapes sp.	6	8.6	7	3.6
Ancylidae not further indentified	2	2.9	2	1.0
Family Lymnaeidae				
Fossaria sp.	11	15.7	11	5.7
Lymnaea sp.	3	4.3	3	1.6
Family Physidae				
Haitia acuta	1	1.4	1	0.5
Physa sp.	35	50.0	43	22.4
Physella sp.	2	2.9	2	1.0
Physidae not further identified	1	1.4	1	0.5
Family Planorbidae				
Gyraulus sp.	5	7.1	5	2.6
Helisoma anceps	1	1.4	1	0.5
Helisoma sp.	1	1.4	1	0.5
Basommatophora not further identified	1	1.4	1	0.5
Order Neotaenioglosa				
Family Hydrobiidae				
Hydrobiidae not further identified	2	2.9	2	1.0
Order Veneroida				
Family Pisidiidae				
Musculium transversum	4	5.7	4	2.1
Musculium sp.	1	1.4	1	0.5
Pisidium sp.	29	41.4	46	24.0
Sphaerium simile	2	2.9	2	1.0
Sphaerium striatinum	5	7.1	5	2.6
Sphaerium sp.	32	45.7	46	24.0
Pisidiidae not further identified	9	12.9	19	9.9
Phylum Nematoda				
Order Mermithida				
Mermithida not further identified	9	12.9	13	6.8
Phylum Turbellaria				
Order Tricladida				
Tricladida not further identified	31	44.3	51	26.6

[a]*Between 1979 and 2011, samples were collected at 70 sites.*

[b]*Between 1979 and 2011, 192 samples were collected.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table F-2

MAMMALS KNOWN TO OCCUR IN THE COUNTIES COMPRISING THE ROOT RIVER WATERSHED

Scientific (family) and Common Name	Scientific Name	Kenosha County	Milwaukee County	Racine County	Waukesha County
Didelphidae					
Virginia Opossum	*Didelphis virginiana*	X	X	X	X
Soricidae					
American Pigmy Shrew[a]	*Microsorex hoyi hoyi*	- -	X	X	- -
Cinerous Shrew	*Sorex cinereous*	- -	X	- -	X
Short-Tailed Shrew	*Blarina brevicauda*	- -	X	X	X
Smokey Shrew	*Sorex fumeus*	- -	- -	X	- -
Talpidae					
Prairie Mole	*Scalopus aquaticus*	- -	- -	X	- -
Star-Nosed Mole	*Condylura cristata*	- -	X	- -	- -
Vespertillionidae					
Big Brown Bat[b]	*Epitesicus fuscus*	- -	X	X	X
Hoary Bat[c]	*Lasiurus cinereus*	- -	X	X	- -
Little Brown Bat[b]	*Myotis lucifugus*	- -	X	X	X
Red Bat[c]	*Lasisurus borealis*	- -	X	X	X
Silver-Haired Bat[c]	*Lasisoncteris noctivagans*	- -	X	X	- -
Leporidae					
Cottontail Rabbit	*Sylvilgus floridanus*	X	X	X	X
Minnesota Varying Hare	*Lepus americanus*	- -	X[d]	- -	- -
White-Tailed Jack Rabbit[a,c]	*Lepus Townsendii*	X	X	X	X
Sciuridae					
Eastern Chipmunk	*Tamias striatus*	X	X	X	X
Eastern Fox Squirrel	*Sciurus niger*	X[d,e]	X	X	X
Franklin's Ground Squirrel[a,c]	*Citelllus franklinii*	X	- -	X	X
Grey Squirrel	*Sciurus carolinensis*	X[d]	X	X	X
Northern Flying Squirrel[a,c]	*Glaucomus sabrinus*	- -	X	- -	- -
Red Squirrel	*Tamiasciurus hudonicus*	X	X	X	X
Southern Flying Squirrel	*Glaucomys volans*	- -	X	X	X
Thirteen-Lined Ground Squirrel	*Spermophilus tridencemilineatus*	X	X	X	X
Woodchuck	*Marmota monax*	X	X	X	X
Castoridae					
American Beaver	*Castor canadensis*	- -	X	- -	X
Cricetidae					
Common Muskrat	*Ondatra zibethicus*	X	X	X	X
Gapper's Red-Backed Vole	*Clethrionomys gapperi*	- -	X	- -	- -
Meadow Vole	*Microtus pennsylvanicus*	X	X	X	X
Prairie Deer Mouse	*Peromyscus maniculatus bairdii*	- -	X	X	X
Prairie Vole[a,c]	*Microtus ochrogaster*	- -	- -	X	- -
White-Footed Mouse	*Peromyscus leucopus*	- -	X	X	X
Muridae					
House Mouse (introduced)	*Mus musculus*	X	X	X	X
Norway Rat (introduced)	*Rattus norvegicus*	X	X	X	X
Zapodidae					
Meadow Jumping Mouse	*Zapas hudonius*	- -	X	X	X
Canidae					
Coyote	*Canis latrans*	X	X	X	X
Eastern Red Fox	*Vulpes vulpes*	X	X	X	X
Eastern Wolf[a,c]	*Canis lupus*	X[d]	X[d]	- -	X[d]
Gray Fox	*Urocyon cinereoargenteus*	X	X	X	X
Procyonidae					
Raccoon	*Procyon lotor*	X	X	X	X

Table F-2 (continued)

Scientific (family) and Common Name	Scientific Name	Kenosha County	Milwaukee County	Racine County	Waukesha County
Mustelidae					
Allegheny Least Weasel	*Mustela rixosa*	X	- -	X	- -
Badger (occasional visitor)	*Taxidea taxus*	X	X	- -	X
Fisher	*Martes pennanti*	- -	X	- -	- -
Long-Tailed Weasel	*Mustela frenata*	- -	X	X	X
Mink	*Mustela vison*	X	X	X	X
Otter (occasional visitor)	*Lontra canadensis*	- -	X	X	- -
Short-Tailed Weasel	*Mustela erminea*	- -	- -	- -	X
Striped Skunk	*Mephitis mephitis*	X	X	X	X
Felidae					
Canada Lynx	*Lynx canadensis*	- -	X	- -	X
Lake Superior Bobcat	*Lynx rufus*	- -	X[d]	X[d]	- -
Wisconsin Puma[a]	*Felis concolor*	- -	- -	- -	X
Cervidae					
White-Tailed Deer	*Odecoileus virginianus*	X	X	X	X

[a]*Identified as a special concern species in Wisconsin.*

[b]*Identified as a threatened species in Wisconsin*

[c]*Species of greatest conservation need based upon the State of Wisconsin's wildlife action plan.*

[d]*Authentic records before 1900.*

[e]*Presence based on kill estimate numbers.*

Source: H.T. Jackson, Mammals of Wisconsin, *1961; U.S. Department of Agriculture Integrated Taxonomic Information System; National Museum of Natural History, Smithsonian Institution; Milwaukee County Department of Parks, Recreation and Culture; and SEWRPC.*

Table F-3

BIRDS KNOWN OR LIKELY TO OCCUR IN THE COUNTIES COMPRISING THE ROOT RIVER WATERSHED

Scientific (family) and Common Name	Scientific Name	Kenosha County	Milwaukee County	Racine County	Waukesha County
Gaviidae					
Common Loon[a]	*Gavia immer*	M	M	B,M	M
Red-Throated Loon	*Gavia stellata*	M	M	M	M
Podicipedidae					
Eared Grebe	*Podiceps nigricollis*	- -	M	M	- -
Horned Grebe[a,b]	*Podiceps auritus*	M	M	M	M
Pied-Billed Grebe	*Podilymbos podiceps*	M	B,M	B,M	B,M
Red-Necked Grebe[b,c]	*Podiceps grisegena*	M	M	- -	M
Phalacrocoracidae					
Double-Breasted Cormorant	*Phalacrocorax auritus*	M	M	M	M
Ardeidae					
American Bittern[a,b]	*Botaurus lentiginosus*	M	B,M	B,M	Bp
Black-Crowned Night Heron[a]	*Nycticorax nycticorax*	M	M	Bp,M	B,M
Cattle Egret[a,d]	*Bubulcus ibis*	M	M	M	M
Great Blue Heron[a]	*Ardea herodias*	B,M	B,M,W	M	B,M
Great Egret[b,e]	*Ardea alba*	M	M	M	B,M
Green Heron	*Butorides striatus*	B,M	B,M	B,M	B,M
Least Bittern[a]	*Ixobrychus exilis*	M	B,M	B,M	B,M
Yellow-Crowned Night Heron[b,e]	*Nyctanasa violacea*	M	B,M	- -	- -
Cathartidae					
Turkey Vulture	*Cathartes aura*	Bp,M	B,M	Bp,M	B,M
Anatidae					
American Black Duck[a,b]	*Anas rubripes*	M,W	M,W	M,W	M,W
American Wigeon[a]	*Anas americana*	M	M	M	M
Black Scoter	*Melanitta nigra*	- -	M	M	- -
Blue-Winged Teal[a,b]	*Anas discors*	Bp,M	B,M	B,M	B,M
Bufflehead	*Bucephala albeola*	M,W	M,W	M,W	M,W
Canada Goose	*Branta canadensis*	B,M,R,W	B,M,R,W	B,M,R,W	B,M,R,W
Canvasback[a,b]	*Aythya valisineria*	M	M	M	M
Common Goldeneye[a]	*Bucephala clangula*	M,W	M,W	M,W	M,W
Common Merganser[a]	*Mergus merganser*	M,W	M,W	M,W	M,W
Gadwall	*Anas strepera*	M	Bp,M	B,M	M
Greater Scaup	*Aythya marila*	M	M,W	M	M
Green-Winged Teal	*Anas crecca*	M	M	M	M
Harlequin Duck	*Histrionicus histrionicus*	- -	M,W	- -	- -
Hooded Merganser	*Lophodytes cucullatus*	M	B,M	B,M	B,M
Lesser Scaup[a,b]	*Aythya affinis*	M	M,W	M	M
Long-Tailed Duck	*Clangula hyemalis*	- -	M,W	M,W	- -
Mallard	*Anas platrhynchos*	B,R	B,M,R	B,R	B,R
Mute Swan[d]	*Cygnus olor*	Bp,R,W	B,M,R,W	B,R,W	B,R,W
Northern Pintail[a]	*Anas acuta*	M	M	M	M
Northern Shoveler	*Anas clypeata*	B,M	B,M	M	M
Red-Breasted Merganser[a]	*Mergus serrator*	M	M,W	M,W	M
Redhead[a,b]	*Aythya americana*	M	M	M	M
Ring-Necked Duck	*Aythya collaris*	M	M	M	M
Ruddy Duck[a]	*Oxyura jamaicensis*	M,R	B,M,R	B,M,R	B,M,R
Snow Goose	*Chen caerulescens*	M	M	M	M
Surf Scoter	*Melanitta perspicillata*	- -	M	--	M
Tundra Swan	*Cygnus columbianus*	M	M	M	B,M
White-Winged Scoter	*Melanitta fusca*	- -	M,W	M	M
Wood Duck	*Aix sponsa*	B,M	B,M	B,M	B,M
Accipitridae					
Bald Eagle[a,b]	*Haliaeetus leucocephalus*	M,R	M,R	B,M	M
Broad-Winged Hawk	*Buteo platypterus*	M	B,M	Bp,M	B,M
Cooper's Hawk	*Accipiter cooperii*	B,R	B,M,R,W	B,R	B,R
Northern Goshawk[a,b]	*Accipiter gentiles*	R	- -	M	R

Table F-3 (continued)

Scientific (family) and Common Name	Scientific Name	Kenosha County	Milwaukee County	Racine County	Waukesha County
Accipitridae (continued)					
Northern Harrier[a,b]	*Circus cyaneus*	R	Bp,M,R,W	B,R	B,R
Osprey[a,b]	*Pandion haliaetus*	M	M	M	M
Red-Shouldered Hawk[a,b]	*Buteo lineatus*	M,R	M,R	M,R	B,M,R
Red-Tailed Hawk	*Buteo jamaicensis*	B,R	B,M,R,W	B,R	B,R
Rough-Legged hawk	*Buteo lagopus*	M,W	M,W	M,W	M,W
Sharp-Shined Hawk	*Accipiter striatus*	M,R	B,M,R,W	M,R	B,M,R
Falconidae					
American Kestel	*Falco sparverius*	B,R	B,M,R,W	B,R	B,R
Merlin[a]	*Falco columbarius*	M	M	M	M
Peregrine Falcon[b,c]	*Falco peregrinus*	B,M	B,M,R,W	B,M	M
Tetraonidae					
Ruffed Grouse	*Bonasa umbellus*	- -	- -	- -	R
Phasianidae					
Grey Partridge[d]	*Perdix perdix*	R	R	- -	R
Northern Bobwhite[a,b]	*Colinus virginianus*	M	M	B	M
Ring-Necked Pheasant[d]	*Phasianus colchicus*	Bp,R	Bp,M,R,W	B,R	B,R
Wild Turkey	*Meleagris gallopavo*	B,R	B,M,R,W	B,R	B,R
Rallidae					
American Coot[a]	*Fullica americana*	Bp,M	B,M,W	B,M	B,M
Common Moorhen[a]	*Gallinula chloropus*	M	Bp,M	B,M	B,M
Sora	*Pozana carolina*	Bp,M	B,M	B,M	B,M
Virginia Rail	*Rallus limicola*	M	B,M	B,M	B,M
Gruidae					
Sandhill Crane	*Grus canadensis*	B	B,M	B	B
Charadriidae					
American Golden Plover[a,b]	*Pluvialis dominica*	M	M	M	M
Black-Bellied Plover	*Pluvialis squatarola*	M	M	M	M
Killdeer	*Charadrius vociferus*	B,M	B,M	B,M	B,M
Piping Plover[b,c,d,f]	*Charadrius melodus*	- -	M	M	- -
Semipalmated Plover	*Charadrius semipalmatus*	M	M	M	M
Scolopacidae					
American Woodcock[a,b]	*Scolopax minor*	M	B,M	B,M	B,M
Baird's Sandpiper	*Calidris bairdii*	- -	M	- -	M
Common Snipe	*Gallinago gallinago*	M	M	B,M	Bp,M
Dunlin[a,b]	*Calidris alpine*	M	M	B,M	M
Greater Yellowlegs	*Tringa melanoleuca*	M	M	M	M
Hudsonian Godwit[a,b]	*Limosa haemastica*	- -	M	M	M
Least Sandpiper	*Calidris minutilla*	M	M	M	M
Lesser Yellowlegs	*Tringa flavipes*	M	M	M	M
Long-Billed Dowitcher	*Limnodromus scolopaceus*	M	M	M	M
Marbled Godwit[a,b]	*Limosa fedoa*	M	M	M	- -
Pectoral Sandpiper	*Calidris melanotos*	M	M	M	M
Purple Sandpiper	*Calidris maritime*	- -	M,W	M	- -
Red Knot	*Calidris canutus*	- -	M	M	- -
Ruddy Turnstone	*Arenaria interpres*	M	M	M	M
Sanderling	*Calidris alba*	M	M	M	M
Semipalmated Sandpiper	*Calidris pusilla*	M	M	M	M
Short-Billed Dowitcher[a,b]	*Limnodromus griseus*	M	M	M	M
Solitary Sandpiper[a,b]	*Tringa solitaria*	M	M	M	M
Spotted Sandpiper	*Actitis macularia*	B,M	B,M	B,M	B,M
Stilt Sandpiper	*Calidris himantopus*	- -	M	M	- -
Upland Sandpiper[a,b]	*Bartramia longicauda*	B,M	M	M	M
Western Sandpiper	*Calidris mauri*	- -	M	- -	- -
Whimbrel[a,b]	*Numenius phaeopus*	- -	M	M	- -
White-Rumped Sandpiper	*Calidris fuscicollis*	M	M	M	M
Willet	*Catoptrophorus semipalmatus*	- -	M	M	- -
Wilson's Phalarope[a,b]	*Phalaropus tricolor*	- -	M	M	M

Table F-3 (continued)

Scientific (family) and Common Name	Scientific Name	Kenosha County	Milwaukee County	Racine County	Waukesha County
Laridae					
Black Tern[a,b]	*Childonius niger*	Bp,M	B,M	B,M	B,M
Black-Legged Kittiwake	*Rissa tridactyla*	- -	M,W	- -	- -
Boneparte's Gull[a]	*Larus philadelphia*	M	M	M	M
Caspian Tern[b,e]	*Sterna caspia*	M	M	Bp,M	M
Common Tern[b,e]	*Sterna hirundo*	M	M	M	M
Foster's Tern[b,e]	*Sterna fosteri*	M	B,M	B,M	B,M
Franklin's Gull	*Larus pipixcan*	- -	M	M	M
Glaucous Gull	*Larus hyperboreus*	- -	M,W	- -	- -
Great Black-Backed Gull[a]	*Larus marinus*	- -	M,W	M	- -
Herring Gull	*Larus argentatus*	R	B,M,R,W	B,R	R
Lesser Black-Backed Gull	*Larus fuscus*	- -	M,W	M	- -
Ring-Billed Gull	*Larus delawarensis*	R	B,M,R	R	R
Thayer's Gull	*Larus thayeri*	- -	M,W	M	- -
Columbidae					
Mourning Dove	*Zenaida macroura*	B,R	B,R	B,R	B,R
Rock Pigeon[d]	*Columba livia*	Bp,R	B,M,R	B,R	B,R
Cuculidae					
Black-Billed Cuckoo[a,b]	*Coccyzus erythropthalmus*	M	B,M	M	B,M
Yellow-Billed Cuckoo[a,b]	*Coccyzus americanus*	M	B,M	M	B,M
Strigidae					
Barn Owl[b,c,g]	*Tyto alba*	- -	- -	Bp	- -
Barred Owl	*Strix varia*	R	M,R	R	B,R
Eastern Screech Owl	*Otus asio*	R	B,M,R	B,R	B,R
Great Horned Owl	*Bubo virginianus*	B,R	B,M,R	B,R	B,R
Long-Eared Owl[a]	*Asio otus*	- -	M,W	M	R
Northern Saw-Whet Owl	*Aegolius acadicus*	M,R	M,W	M,R	Bp,M,R
Short-Eared Owl[a,b]	*Asio flammeus*	M,W	M,W	M,W	M,W
Snowy Owl	*Nyctea scandiaca*	M,W	M,W	M,W	M,W
Caprimulgidae					
Common Nighthawk[a]	*Chordeiles minor*	M	B,M	B,M	B,M
Whip-Poor-Will[a,b]	*Caprimulgus vociferus*	M	M	M	Bp,M
Apodidae					
Chimney Swift	*Chaetura pelagica*	B,M	B,M	B,M	B,M
Trochilidae					
Ruby-Throated Hummingbird	*Archilochus colubris*	M	B,M	B,M	B,M
Alcedinidae					
Belted Kingfisher	*Ceryle alcyon*	B,M	B,M	B,M	B,M
Picidae					
Downy Woodpecker	*Picoides pubescens*	B,R	B,R	B,R	B,R
Hairy Woodpecker	*Picoides villosus*	- -	B,R,W	B,R	B,R
Northern Flicker	*Colaptes auratus*	B,M,R	B,M,R	B,M,R	B,M,R
Pileated Woodpecker	*Dyocopus pileatus*	R	R	M	B,R
Red-Bellied Woodpecker	*Melanerpes carolinus*	B,R	B,M,R,W	B,R	B,R
Red-Headed Woodpecker[a,b]	*Melanerpes erythrocephalus*	Bp,M,R	B,M,R	B,M,R	B,M,R
Yellow-Bellied Sapsucker	*Sphyrapicus varius*	M	M	M	M
Tyrannidae					
Acadian Flycatcher[b,e]	*Empidonax virescens*	- -	M	Bp	B,M
Alder Flycatcher	*Empidonax alnorum*	M	Bp,M	Bp	Bp,M
Eastern Kingbird	*Tyrannus tyrannus*	B,M	B,M	B,M	B,M
Eastern Phoebe	*Sayornis phoebe*	B,M	B,M	B,M	B,M
Eastern Wood-Pewee	*Contopus virens*	B,M	B,M	B,M	B,M
Great Crested Flycatcher	*Myiarchus crinitus*	B,M	B,M	B,M	B,M
Least Flycatcher[a,b]	*Empidonax minimus*	Bp,M	B,M	B,M	B,M
Olive-Sided Flycatcher[a,b]	*Contopus cooperi*	M	M	M	M
Western Kingbird	*Tyrannus verticalis*	- -	M	- -	- -
Willow Flycatcher[a,b]	*Empidonax trailii*	B,M	B,M	B,M	B,M

Table F-3 (continued)

Scientific (family) and Common Name	Scientific Name	Kenosha County	Milwaukee County	Racine County	Waukesha County
Tyrannidae (continued)					
Yellow-Bellied Flycatcher[a]	*Empidonax flaviventris*	M	M	M	- -
Alaudidae					
Horned Lark	*Eremophila alpestris*	B,M,R	B,M,R	B,M,R	Bp,M,R
Hirundinidae					
Bank Swallow	*Riparia riparia*	B,M	B,M	B,M	B,M
Barn Swallow	*Hirundo rustica*	B,M	B,M	B,M	B,M
Cliff Swallow	*Petrochelidon pyrrhonta*	B,M	B,M	B,M	B,M
Northern Rough-Winged Swallow	*Stelgidopteryx serripennis*	B,M	B,M	B,M	B,M
Purple Martin[a]	*Progne subis*	B,M	B,M	B,M	B,M
Tree Swallow	*Tachycineta bicolor*	B,M	B,M	B,M	B,M
Corvidae					
American Crow	*Corvus brachyrhynchos*	B,R	B,M,R,W	B,R	B,R
Blue Jay	*Cyanocitta cristata*	B,R	B,M,R,W	B,R	B,R
Common Raven	*Corvus corax*	- -	M	- -	R
Paridae					
Black-Capped Chickadee	*Parus atricapillus*	B,R	B,M,R,W	B,R	B,R
Tufted Titmouse	*Baeolophus bicolor*	- -	B,M,R,W	B,R	B,R
Sittidae					
Red-Breasted Nuthatch	*Sitta canadensis*	R	B,M,R,W	M	B,R
White-Breasted Nuthatch	*Sitta carolinensis*	B,R	B,M,R,W	B,R	B,R
Certhiidae					
Brown Creeper	*Certhia americana*	R,M	Bp,M,R,W	R,M	B,M
Troglodytidae					
Bewick's Wren[c,g]	*Thryothorus bewickii*	- -	M	- -	- -
Carolina Wren	*Thryothorus ledovicianus*	- -	Bp,M,W	Bp	- -
House Wren	*Troglodytes aedon*	B,M	B,M	B,M	B,M
Marsh Wren	*Cistothorus palustris*	Bp,M	Bp,M	B,M	B,M
Sedge Wren	*Cistothorus platensis*	Bp,M	B,M	B	B,M
Winter Wren	*Troglodytes troglodytes*	M	M	M	M
Regulidae					
Golden-Crowned Kinglet	*Regulus satrapa*	M	M,W	M	Bp,M
Ruby-Crowned Kinglet[a]	*Regulus calendula*	M	M	M	M
Sylviidae					
Blue-Gray Gnatcatcher	*Polioptila caerulea*	B,M	B,M	B,M	B,M
Turidae					
American Robin	*Turdus migratorius*	B,M	B,M,W	B,M	B,M
Eastern Bluebird	*Sialia sialis*	B,M	B,M	B,M	B,M
Gray-Cheeked Thrush	*Catharus minimus*	M	M	M	M
Hermit Thrush	*Cathrus guttatus*	M	M,W	M	M
Swainson's Thrush[a]	*Catharus ustulatus*	M	M	M	M
Townsend's Solitaire	*Myadestes townsendi*	- -	M	- -	- -
Veery[a,b]	*Catharus fuscescens*	M	B,M	M	B,M
Wood Thrush[a,b]	*Hylocichla mustelina*	Bp,M	B,M	B,M	B,M
Mimidae					
Brown Thrasher[a,b]	*Toxostoma rufum*	B,M	B,M	B,M	B,M
Gray Catbird	*Dumatella carolinensis*	B,M	B,M	B,M	B,M
Northern Mockingbird	*Mimus polyglottus*	- -	M	M	M
Motacillidae					
American Pipit	*Anthus rubescens*	- -	M	M	- -
Bombycillidae					
Bohemian Waxwing	*Bombycilla garrulus*	- -	M,W	- -	- -
Cedar Waxwing	*Bombycilla cedorum*	B,M,R	B,M,R,W	B,M,R	B,M,R
Laniidae					
Loggerhead Shrike[b,c]	*Lanius ludovicianus*	M	M	M	M

Table F-3 (continued)

Scientific (family) and Common Name	Scientific Name	Kenosha County	Milwaukee County	Racine County	Waukesha County
Laniidae (continued)					
Northern Shrike	*Lanius excubitor*	M,W	M,W	M,W	M,W
Sturnidae					
European Starling[d]	*Sturnus vulgaris*	B,R	B,M,R	B,R	B,R
Vireonidae					
Bell's Vireo[b,e]	*Vireo bellii*	B	Bp,M	M	M
Blue-Headed Vireo	*Vireo solitarius*	M	M	M	B
Philadelphia Vireo	*Vireo philadelphicus*	M	M	- -	M
Red-Eyed Vireo	*Vireo olivaceus*	Bp,M	B,M	B,M	B,M
Warbling Vireo	*Vireo gilvus*	B,M	B,M	B,M	B,M
White-Eyed Vireo[a]	*Vireo griseus*	- -	Bp,M	M	Bp
Yellow-Throated Vireo	*Vireo flavifrons*	Bp,M	B,M	B,M	B,M
Parulidae					
American Redstart	*Setophaga ruticilla*	M	B,M	B,M	B,M
Bay-Breasted Warbler	*Dendroica castenea*	M	M	M	M
Black-and White Warbler	*Mniotitla varia*	M	M	M	Bp,M
Black-Throated Blue Warbler[a,b]	*Dendroica caerulescens*	M	M	M	M
Black-Throated Green Warbler	*Dendroica virens*	M	M	M	B,M
Blackburnian Warbler	*Dendroica fusca*	M	M	M	Bp,M
Blackpoll Warbler	*Dendroica striata*	M	M	M	M
Blue-Winged Warbler[a,b]	*Vermivora pinus*	Bp	Bp,M	B	B
Canada Warbler[a,b]	*Wilsonia canadensis*	M	B,M	M	M
Cape May Warbler[a]	*Dendroica tigrina*	M	M	M	M
Cerulean Warbler[b,e]	*Dendroica cerulea*	- -	Bp,M	M	Bp,M
Chestnut-Sided Warbler	*Dendroica pensylvanica*	M	Bp,M	Bp,M	B,M
Common Yellowthroat	*Geothlypis trichas*	B,M	B,M	B,M	B,M
Connecticut Warbler[a,b]	*Oporornis agilis*	M	M	- -	M
Golden-Winged Warbler[a,b]	*Vermivora chrysoptera*	M	B,M	M	Bp,M
Hooded Warbler[b,e]	*Wilsonia citrine*	M	Bp,M	Bp,M	B,M
Kentucky Warbler[b,e]	*Oporornis formosus*	M	M	M	Bp,M
Louisiana Waterthrush[a,b]	*Seiurus motacilla*	M	M	M	B,M
Magnolia Warbler	*Dendroica magnolia*	M	M	M	M
Mourning Warbler	*Oporornis philadelphia*	M	Bp,M	Bp,M	M
Nashville Warbler	*Vermivora ruficapilla*	M	M	M	M
Northern Parula	*Parula americana*	M	M	M	M
Northern Waterthrush[a]	*Seiurus novaboracensis*	M	M	M	Bp,M
Orange-Crowned Warbler	*Vermivora celata*	M	M	M	M
Ovenbird	*Seiurus aurocapillus*	M	Bp,M	B,M	B,M
Palm Warbler	*Dendroica palmarum*	M	M	M	M
Prairie Warbler	*Dendroica discolor*	- -	Bp,M	- -	- -
Pine Warbler	*Dendroica pinus*	M	Bp,M	M	Bp,M
Prothonotary Warbler[a,b]	*Protonotaria citrea*	M	Bp,M	M	Bp,M
Tennessee Warbler[a]	*Vermivora peregrina*	M	M	M	M
Wilson's Warbler[a,b]	*Wilsonia pusilla*	M	M	M	M
Worm-Eating Warbler[b,c]	*Helmitheros verimvorus*	- -	M	M	Bp
Yellow-Breasted Chat[a]	*Icteria virens*	M	M	Bp,M	M
Yellow-Rumped Warbler	*Dendroica coronata*	M	M	M	M
Yellow-Throated Warbler[c]	*Dendroica cominica*	- -	M	M	- -
Yellow Warbler	*Dendroica petechia*	B,M	B,M	B,M	B,M
Thraupidae					
Scarlet Tanager	*Prianga olivacea*	Bp,M	B,M	Bp,M	B,M
Western Tanager	*Piranga ludoviciana*	- -	M	- -	- -
Cardinalidae					
Dicksissel[a,b]	*Spiza americana*	Bp,M	B,M	B	B,M
Indigo Bunting	*Passerina cyanea*	B,M	B,M	B,M	B,M
Northern Cardinal	*Cardinalis cardinalis*	B,R	B,R,W	B,R	B,R
Rose-Breasted Grosbeak	*Pheucticus ludovicianus*	Bp,M	B,M	B,M	B,M
Emberizidae					
American Tree Sparrow	*Spizella arborea*	M,W	M,W	M,W	M,W

Table F-3 (continued)

Scientific (family) and Common Name	Scientific Name	Kenosha County	Milwaukee County	Racine County	Waukesha County
Emberizidae (continued)					
Chipping Sparrow	*Spizella passerina*	B,M	B,M	B,M	B,M
Clay-Colored Sparrow	*Spizella pallida*	M	B,M	B,M	M
Dark-Eyed Junco	*Junco hyemalis*	M,W	M,W	M,W	M,W
Eastern Towhee	*Pipilo erythrophthalmus*	B,M	B,M	B,M	B,M
Field Sparrow[a,b]	*Spizella pusilla*	B,M	B,M	B,M	B,M
Fox Sparrow	*Passerella iliaca*	M	M,W	M	M
Grasshopper Sparrow[a,b]	*Ammodramus savannarum*	Bp,M	B,M	Bp	Bp,M
Harris's Sparrow	*Zonotricha querula*	- -	M	M	M
Henslow's Sparrow[b,e]	*Ammodramus henslowii*	Bp,M	B,M	B,M	Bp,M
Lapland Longspur	*Calcarius lapponicus*	- -	M,W	- -	M,W
Lark Bunting	*Calamospiza melanocorys*	- -	M	- -	- -
Lark Sparrow[a,b]	*Chondestes grammacus*	M	M	- -	M
Le Conte's Sparrow[a,b]	*Ammodramus leconteii*	M	M	M	M
Lincoln's Sparrow	*Melospiza lincolnii*	M	M	M	M
Nelson's Sparrow[a,b]	*Ammodramus nelsoni*	- -	M	M	- -
Savannah Sparrow	*Passerculus sandwichensis*	B,M	B,M	B,M	B,M
Snow Bunting	*Plectophenax nivalis*	M,W	M,W	M,W	M,W
Song Sparrow	*Melospiza melodia*	B,M,R	B,M,R,W	B,M,R	B,M,R
Spotted Towhee	*Pipilo maculates*	- -	M	- -	- -
Swamp Sparrow	*Melospiza georgiana*	Bp,M	B,M,W	B,M	B,M
Vesper Sparrow	*Pooecetes graminues*	B,M	Bp,M	B,M	B,M
White-Crowned Sparrow	*Zonotrichia leucophrys*	M	M,W	M	M
White-Throated Sparrow	*Zonotrichia albicollis*	M	M,R,W	M	M,R
Icteridae					
Baltimore Oriole	*Icterus galbula*	B,M	B,M	B,M	B,M
Bobolink[a,b]	*Dolichonyx oryzivorus*	B,M	B,M	B,M	B,M
Brewer's Blackbird	*Euphagus cyanocephalus*	M	M	M	M
Brown-Headed Cowbird	*Molothrus ater*	B,M,R	B,M,R,W	B,M,R	B,M,R
Common Grackle	*Quiscalus quiscula*	B,M,R	B,M,R,W	B,M,R	B,M,R
Eastern Meadowlark[a,b]	*Sturnella magna*	B,M	B,M	B,M	B,M
Orchard Oriole[a]	*Icterus spurius*	B,M	B,M	B,M	Bp,M
Red-Winged Blackbird	*Agelaius phoeniceus*	B,M,R	B,M,R,W	B,M,R	B,M,R
Rusty Blackbird[a,b]	*Euphagus carolinus*	M	M,W	M	M
Western Meadowlark[a,b]	*Sturnella neglecta*	M	M	M	M
Yellow-Headed Blackbird[a]	*Xanthocephalus xanthocephalus*	B,M	M	B,M	B,M
Fringillidae					
American Goldfinch	*Carduelis tristis*	B,R,W	B,M,R,W	B,R,W	B,R,W
Common Redpoll	*Carduelis flammea*	M,W	M,W	M,W	M,W
Evening Grosbeak[a]	*Coccothraustes vespertinus*	M,R,W	M,W	M,R,W	M,R,W
Hoary Redpoll	*Carduelis hornemanni*	- -	W	- -	- -
House Finch	*Carpodacus mexicanus*	B,R	B,M,R,W	B,R	B,R
Pine Grosbeak	*Pinicola enucleator*	- -	M,W	M,W	- -
Pine Siskin[a]	*Carduelis pinus*	M,R,W	M,W	B,M,W	B,M,R,W
Purple Finch	*Carpodacus purpureua*	R	M,W	R	R
Red Crossbill[a,b]	*Loxia curvirostra*	- -	M,W	M	M,R
White-Winged Crossbill[a]	*Loxia leucoptera*	M,R,W	M,W	M	M,R,W
Passeridae					
House Sparrow[d]	*Passer domesticus*	B,R,W	B,M,R,W	B,R,W	B,R,W

NOTES: Total number of bird species: 283

The following abbreviations are used in this table:

B = Breeding: Nesting species
Bp = Probable Breeding
M = Migrant: Spring and/or fall transient
R = Resident: Present year round
W = Wintering: Present January through February

[a]*State-designated species of special concern. Fully protected by Federal and State Law under the Migratory Bird Act.*

Table F-3 (continued)

[b]*Species of greatest conservation need based upon the State of Wisconsin's wildlife action plan.*

[c]*State-designated endangered species.*

[d]*Nonnative bird species.*

[e]*State-designated threatened species.*

[f]*Federally-listed endangered species.*

[g] *This species has been proposed for delisting. As of July 3, 2013, the State Natural Resources Board and Governor Walker have approved the proposed delisting, and the proposal is being reviewed by the Wisconsin Legislature.*

Source: Samuel D. Robbins, Jr., Wisconsin Birdlife, Population & Distribution: Past and Present*, 1991; John E. Bielefeldt, Racine County Naturalist; National Audubon Society; Wisconsin Breeding Bird Atlas; Stanley Temple, John Cary, and Robert Rolley,* Wisconsin Birds: A Seasonal and Geographic Guide *(2nd Edition), 1997; Roger Tory Peterson,* A Field Guide to the Birds: Eastern Birds*, 1980; Milwaukee County Department of Parks, Recreation and Culture; and SEWRPC.*

Table F-4

AMPHIBIANS AND REPTILES KNOWN OR LIKELY TO OCCUR IN THE COUNTIES COMPRISING THE ROOT RIVER WATERSHED

Scientific (family) and Common Name	Scientific Name	Kenosha County	Milwaukee County	Racine County	Waukesha County
Amphibians					
Proteidae					
Mudpuppy[a,b]	*Necutrus maculosus maculosus*	X	X	X	X
Ambystomatidae					
Blue-Spotted Salamander	*Ambystoma laterale*	X	X	X	X
Eastern Tiger Salamander	*Ambystoma tigrinum tigrinum*	X	X	X	X
Spotted Salamander	*Ambystoma maculatum*	- -	X	- -	X
Salamandridae					
Central Newt	*Notophthalmus viridescens louisianensi*	X	X	X	X
Plethodontidae					
Four-Toed Salamander[a,b]	*Hemidactylium scutatum*	X	X	X	X
Bufonidae					
American Toad	*Bufo americanus americanus*	X	X	X	X
Hylidae					
Blanchard's Cricket Frog[b,c]	*Acris crepitans blanchardi*	X[d]	X[d]	X[d]	X[d]
Cope's Gray Tree Frog	*Hyla chrysoscelis*	X	X	X	X
Gray Tree Frog	*Hyla versicolor*	X	X	X	X
Northern Spring Peeper	*Hyla crucifer crucifer*	X	X	X	X
Western Chorus Frog	*Pseudacris triseriata triseriata*	X	X	X	X
Ranidae					
Bullfrog[a]	*Rana catesbeiana*	X	X	X	X
Green Frog	*Rana clamitans melanota*	X	X	X	X
Northern Leopard Frog	*Rana pipiens*	X	X	X	X
Pickerel Frog[a,b]	*Rana palustris*	X	X	X	X
Wood Frog	*Rana sylvatica*	X	X	X	X
Reptiles					
Chelydridae					
Common Snapping Turtle	*Chelydra serpentina serpentina*	X	X	X	X
Kinosternidae					
Musk Turtle (Stinkpot)	*Sternotherus odoatus*	X	X	X	X
Emydidae					
Blanding's Turtle[b,e,f]	*Embydoidea blandingii*	X	X	X	X
Midland Painted Turtle	*Chrysemys picta marginata*	X	X	X	X
Western Painted Turtle	*Chrysemys picta belli*	X	X	X	X
Trionychidae					
Eastern Spiny Softshell	*Trionyx spiniferus spiniferus*	X	X	X	X
Smooth Softshell Turtle[a,b]	*Apalone mutica mutica*	- -	X	- -	- -
Western Spiny Softshell	*Apalone spinifera hartwegi*	- -	X	X	X
Colubridae					
Butler's Garter Snake[b,e,f]	*Thamnophis butleri*	- -	X	X	X
Chicago Garter Snake	*Thamnosphis sirtalis semifasciata*	X	X	X	X
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*	X	X	X	X
Eastern Hognose Snake[a]	*Heterodon platyrhinos*	X	- -	X	X

Table F-4 (continued)

Scientific (family) and Common Name	Scientific Name	Kenosha County	Milwaukee County	Racine County	Waukesha County
Colubridae (continued)					
Eastern Milk Snake	*Lampropeltis triangulum triangulum*	X	X	X	X
Eastern Plains Garter Snake	*Thamnophis radix radis*	X	X	X	X
Midland Brown Snake	*Storeria dekayi wrightorum*	X	X	X	X
Northern Red-Bellied Snake	*Storeria occipitomaculata occipitomaculata*	X	X	X	X
Northern Ribbon Snake[c]	*Thamnophis sauratis septentrionalis*	- -	X[c]	- -	- -
Northern Ringneck Snake[a]	*Diadaphis punctatus edwardsii*	- -	X[d]	- -	X
Northern Water Snake	*Nerodia sipedon sipedon*	X	X	X	X
Queen Snake[b,c]	*Regina septemvittata*	X	X[d]	X[d]	X[d]
Smooth Green Snake	*Opheodrys vernalis vernalis*	X	X	X	X
Western Fox Snake	*Elaphe vulpine vulpine*	X	X	X	X
Western Ribbon Snake[b,c]	*Thamnophis proximus proximus*	- -	- -	X	- -

[a]*Identified as a special concern species in Wisconsin.*

[b]*Species of greatest conservation need based upon the State of Wisconsin's wildlife action plan.*

[c]*Identified as endangered in Wisconsin.*

[d]*Likely to be extirpated from the County.*

[e]*Identified as threatened in Wisconsin.*

[f]*This species has been proposed for delisting. As of July 3, 2013, the State Natural Resources Board and Governor Walker have approved the proposed delisting, and the proposal is being reviewed by the Wisconsin Legislature.*

Source: Gary S. Casper, Geographical Distribution of the Amphibians and Reptiles of Wisconsin*, 1991; Rebecca Christoffel, Robert Hay, and Lisa Ramirez,* Snakes of Wisconsin, *2000; Wisconsin Department of Natural Resources; and SEWRPC.*

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Appendix G

ROOT RIVER SEDIMENT-TRANSPORT PLANNING STUDY PREPARED FOR THE MILWAUKEE METROPOLITAN SEWERAGE DISTRICT BY MUSSETTER ENGINEERING, INC. SEPTEMBER 2007

NOTE: Appendix G is on a DVD located at the back of this report

Appendix H

ROOT RIVER STREAMBANK EROSION AND OUTFALL ASSESSMENT PREPARED FOR THE CITY OF RACINE BY AECOM DECEMBER 2013

NOTE: Appendix H is on a DVD located at the back of this report

Appendix I

PHYSICAL STREAM CONDITIONS AND HABITAT CHARACTERISTICS OF THE MAINSTEM ROOT RIVER WITHIN STREAM REACH AREAS RR-17 AND RR-22 AND HOODS CREEK WITHIN STREAM REACH AREA RR-21

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ROOT RIVER AND HOODS CREEK CROSS-SECTION SURVEY SUMMER 2013: DESCRIPTION OF FIELD MEASUREMENTS

STREAMBANK CHARACTERISTICS

Bankfull Width: The stream channel that is formed by the dominant discharge, also referred to as the active channel, which meanders across the floodplain as it forms pools and riffles. Defined by the discharge that occurs when water just begins to leave the channel and spread onto the floodplain.

Undercut Depth: A bank that has had its toe of slope, or base, cut away by the water action creating overhangs in the stream as shown in Photo 1.

Bank Height: Height of the bank from the streambed to the top edge of the lateral scour line as shown in Photo 2.

Slope: Ratio of horizontal distance divided by the vertical height of the streambank as shown in Photo 3.

INSTREAM HABITAT CHARACTERISTICS

Width: The width of the existing water surface measured at a right angle to the direction of flow from shore to shore.

Maximum Depth: The vertical height of the water column from the existing water surface level to the lowest point of the streambed.

Habitat Type: An aquatic unit, consisting of an aggregation of habitats having equivalent structure, function, and responses to disturbance. Pool, riffle, and run habitat types were observed in the Root River watershed.

- A pool is that area of the water column that has slow water velocity and is usually deeper than a riffle or run (see Photos 4 and 5). Pools usually form around bends or around large-scale obstructions that laterally constrict the channel or cause a sharp drop in the water surface profile.

- Riffles are portions of the water column where water velocity is fast, stream depths are relatively shallow, and the water surface gradient is relatively steep (see Photos 6 and 7).

- A run is that area of the water column that does not form distinguishable pools or riffles, but has a rapid nonturbulent flow. A run is usually too deep to be a riffle and has flow velocities too fast to be a pool.

Substrates: Refers to the materials that make up the streambed. Substrate composition in the streams of the Root River watershed was determined visually by recording the dominant substrate types within the transect. The following categories of substrate type were used.

- Bedrock: Solid rock forming a continuous surface.

- Boulder: Rocks with a diameter of 10 to 20 inches.

- Cobble: Rocks with a diameter of 2.5 to 10 inches.

- Gravel: Rocks with a diameter of 0.07 to 2.5 inches.

EXAMPLE OF BANK HEIGHT AND UNDERCUT DEPTH MEASURED AT AN ACTIVELY ERODING SITE

PHOTO 1

PHOTO 2

NOTE: These photos were not taken within the Root River watershed and are for illustrative purposes only.

Source: SEWRPC.

EXAMPLE OF LENGTH OF EROSION AND BANK SLOPE MEASURED AT AN ACTIVELY ERODING SITE

PHOTO 3

NOTE: This photo was not taken within the Root River watershed and is for illustrative purposes only.

Source: SEWRPC.

TYPICAL POOL HABITATS IN THE ROOT RIVER WATERSHED: 2013

PHOTO 4

Root River

PHOTO 5

Hoods Creek

Source: SEWRPC.

TYPICAL RIFFLE HABITATS IN THE ROOT RIVER WATERSHED: 2013

PHOTO 6

Root River

PHOTO 7

Hoods Creek

Source: SEWRPC.

- Sand: Inorganic particles smaller than gravel, but coarser than silt with a diameter of 0.002 to 0.07 inch.

- Silt: Fine inorganic particles, typically dark brown in color. Feels greasy and muddy in hands. The material is loose and does not retain shape when compacted into a ball and will not support a person's weight when it makes up the stream bottom. Silt particles have a diameter of less than 0.0001 inch.

- Peat: A fibrous mass of organic matter in various stages of decomposition, generally dark brown to black in color and of spongy consistency.

- Clay: Very fine, inorganic, dark brown or gray particles. Individual particles are barely visible or not visible to the unaided eye. The particles feel gummy and sticky and slippery underfoot. Clay particles retain shape when compacted and partially or completely support a person's weight when they comprise the stream bottom. Clay particles have a diameter of less than 0.0001 inch.

Sediment Depth: The depth of fine sediments (usually silt) that overlay or comprise the streambed. Sediment depth is an indicator of sediment deposition and was measured to the nearest 0.1 foot.

Woody Debris: Large pieces or aggregations of smaller pieces of wood (e.g., logs, large tree branches, root tangles) located in, or in contact with, the water surface.

Cover: This can be one, or any combination, of characteristics that include undercut banks, overhanging vegetation, water velocities, logs or woody debris, deep pools, oxbows, backwaters, or side channels, boulders and other substrates, aquatic macrophytes, and algae that provide 1) protection from predators, 2) feeding areas, 3) spawning habitat, or 4) some other benefit such as shading.

Maps I-5 through I-7 identify the locations of cross-sections surveyed, as well as observed deep pools and riffles within the mainstem of the Root River in reach areas RR-22 and RR-17.

Maps I-18 through I-20 identify the locations of cross-sections surveyed, as well as observed deep pools and riffles within Hoods Creek in reach area RR-21. Tables I-4 through I-6 identify the habitat characteristics associated with these surveyed cross-sections.

CROSS-SECTION SURVEY DATA SHEET

Site ID: ____________________ Latitude: ____________________

Stream Name: ____________________ Longitude: ____________________

Date and Time: ____________________ Collectors: ____________________

Substrates Present: ☐ Muck ☐ Silt ☐ Sand(gritty) ☐ Hardpan/Clay ☐ Gravel(0.1-2.5") ☐ Cobble(3-11") ☐ Small Boulder(12-23") ☐ Large Boulder(>24") ☐ Bedrock

Embeddedness: ☐ None(0%) ☐ Normal(<25%) ☐ Moderate(25-75%) ☐ Extensive(>75%)

Stream Shading: ☐ Mostly ☐ Halfway ☐ Partially ☐ Unshaded

Amount Cover: ☐ None(0%) ☐ Low(<25%) ☐ Moderate(25-75%) ☐ High(>75%)

Woody Debris: ☐ None(0%) ☐ Low(<25%) ☐ Moderate(25-75%) ☐ High(>75%)

Stream Cover: ☐ Overhanging vegetation ☐ Macrophytes ☐ Algae ☐ Logs/Woody Debris ☐ Roots

Aquatic Plants in Stream: ☐ None(0%) ☐ Low(<25%) ☐ Moderate(25-75%) ☐ High(>75%)

Algae: ☐ None(0%) ☐ Low(<25%) ☐ Moderate(25-75%) ☐ High(>75%)

Habitat: ☐ Pool ☐ Riffle ☐ Run

Stream Velocity (Pools and Riffles): ☐ Eddies ☐ Fast ☐ Moderate ☐ Slow

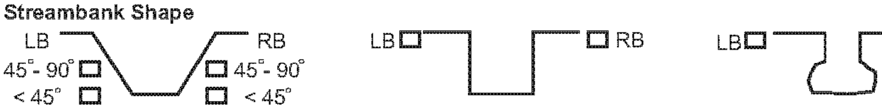
Pool Forming Feature: ☐ Log/Woody Debris Jam ☐ Meander ☐ Weir/Other Manmade ☐ Beaver Dam

Wildlife in/ around Stream ☐ Fish ☐ Beaver ☐ Frog ☐ Deer ☐ Turtle ☐ Raccoon ☐ Mussels ☐ Other

Riparian Zone: ☐ Shrubs ☐ Trees ☐ Grass (Natural/Mowed) ☐ Row Crop

Other Features: ☐ Oxbows/Backwater ☐ Islands ☐ Tributary Outlets

Streambank Shape

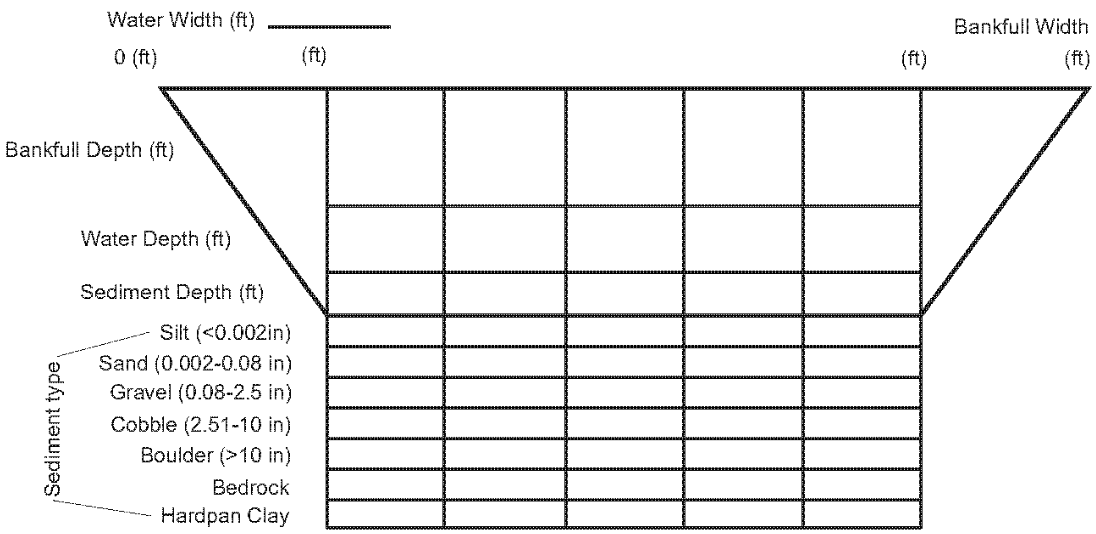


LB Undercut Bank Maximum (ft) ______

RB Undercut Bank Maximum (ft) ______

LB Undercut Bank Average (ft) ______

RB Undercut Bank Average (ft) ______



Comments:
Photo Numbers:

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ROOT RIVER MAINSTEM: REACH AREAS RR-17 AND RR-22

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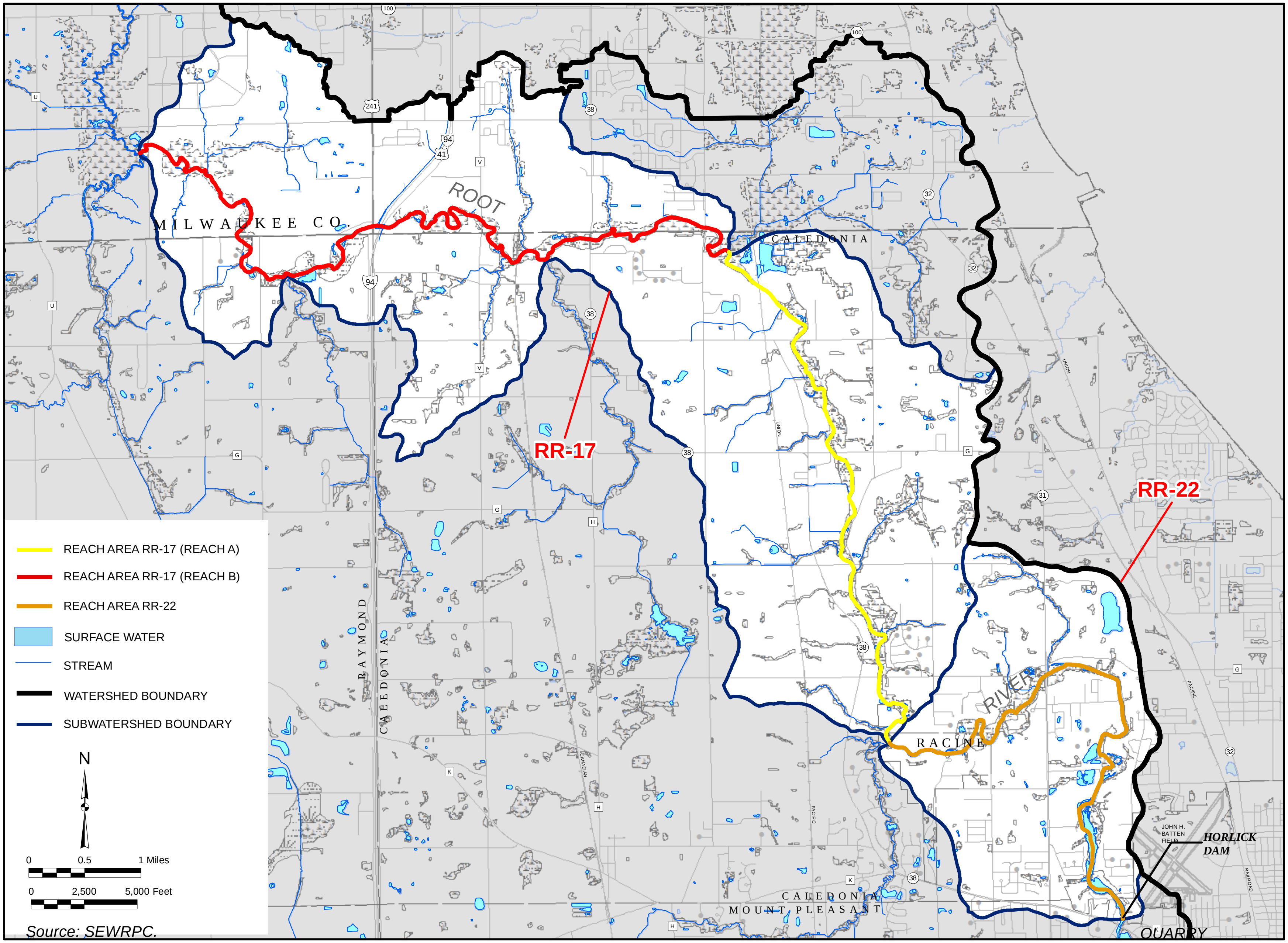
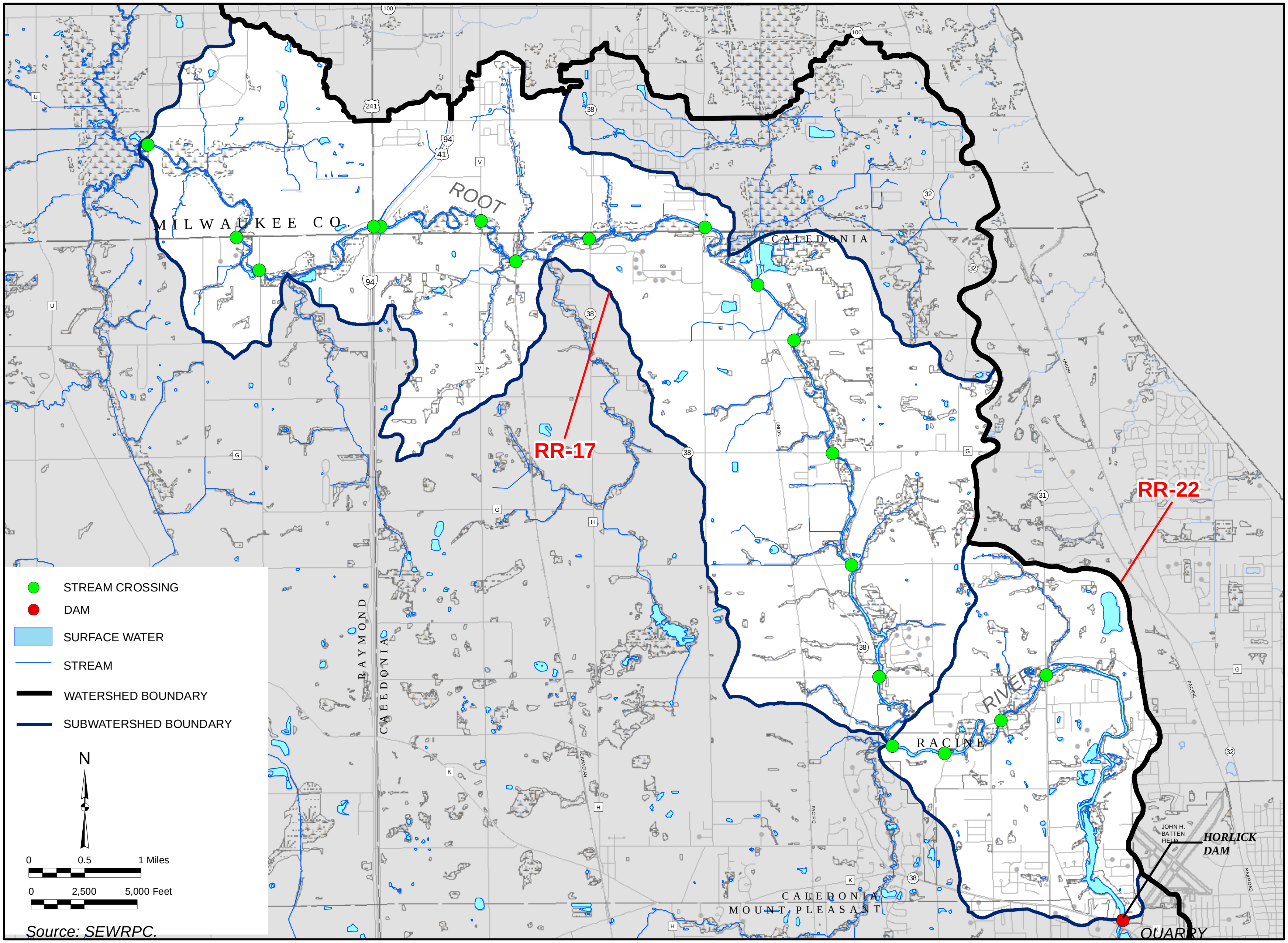
Map I-1

REACHES SURVEYED ALONG THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREAS RR-17 AND RR-22: 2013



Map I-2

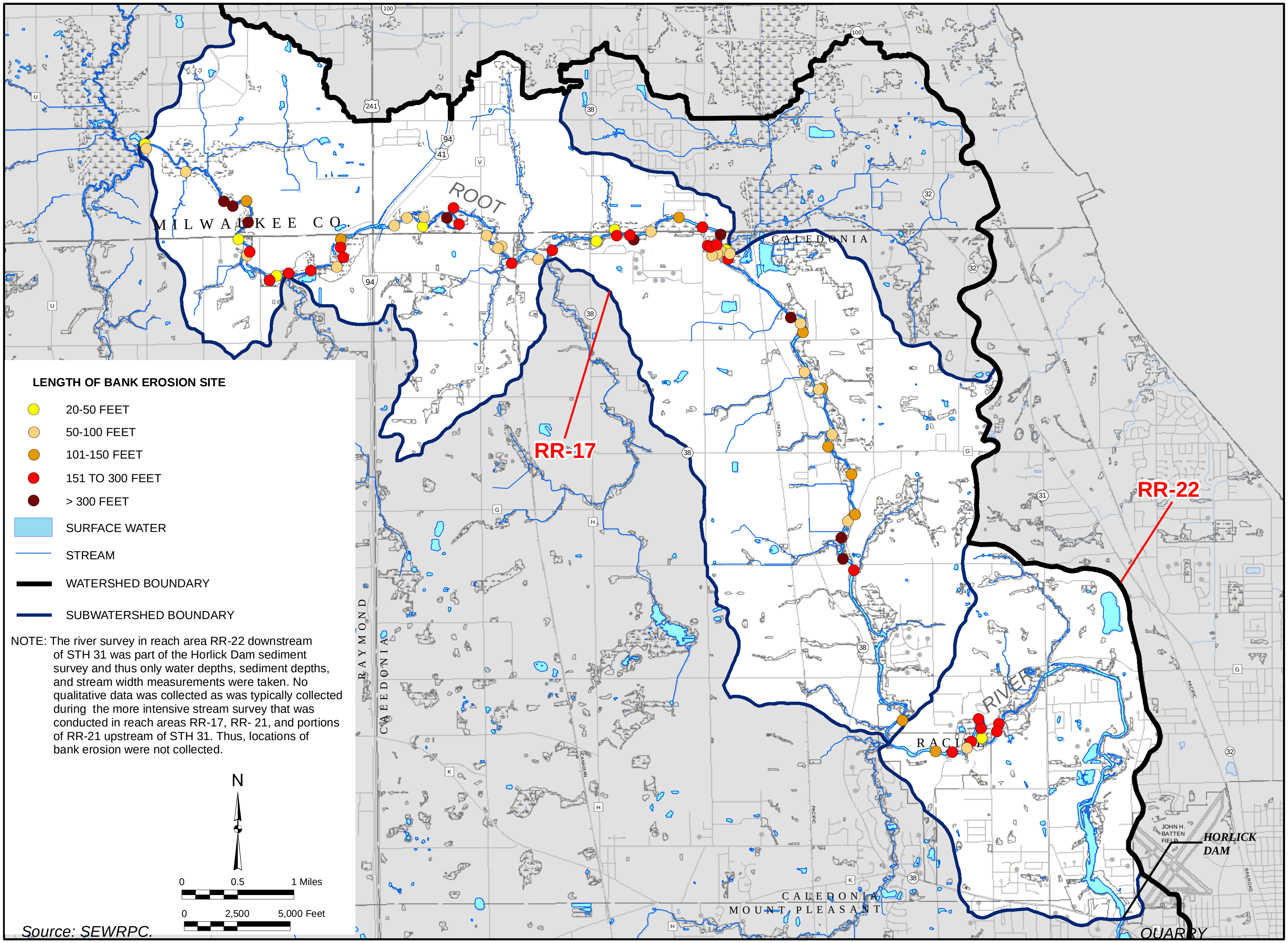
STREAM CROSSINGS AND DAMS ALONG THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREAS RR-17 AND RR-22: 2013



Source: SEWRPC.

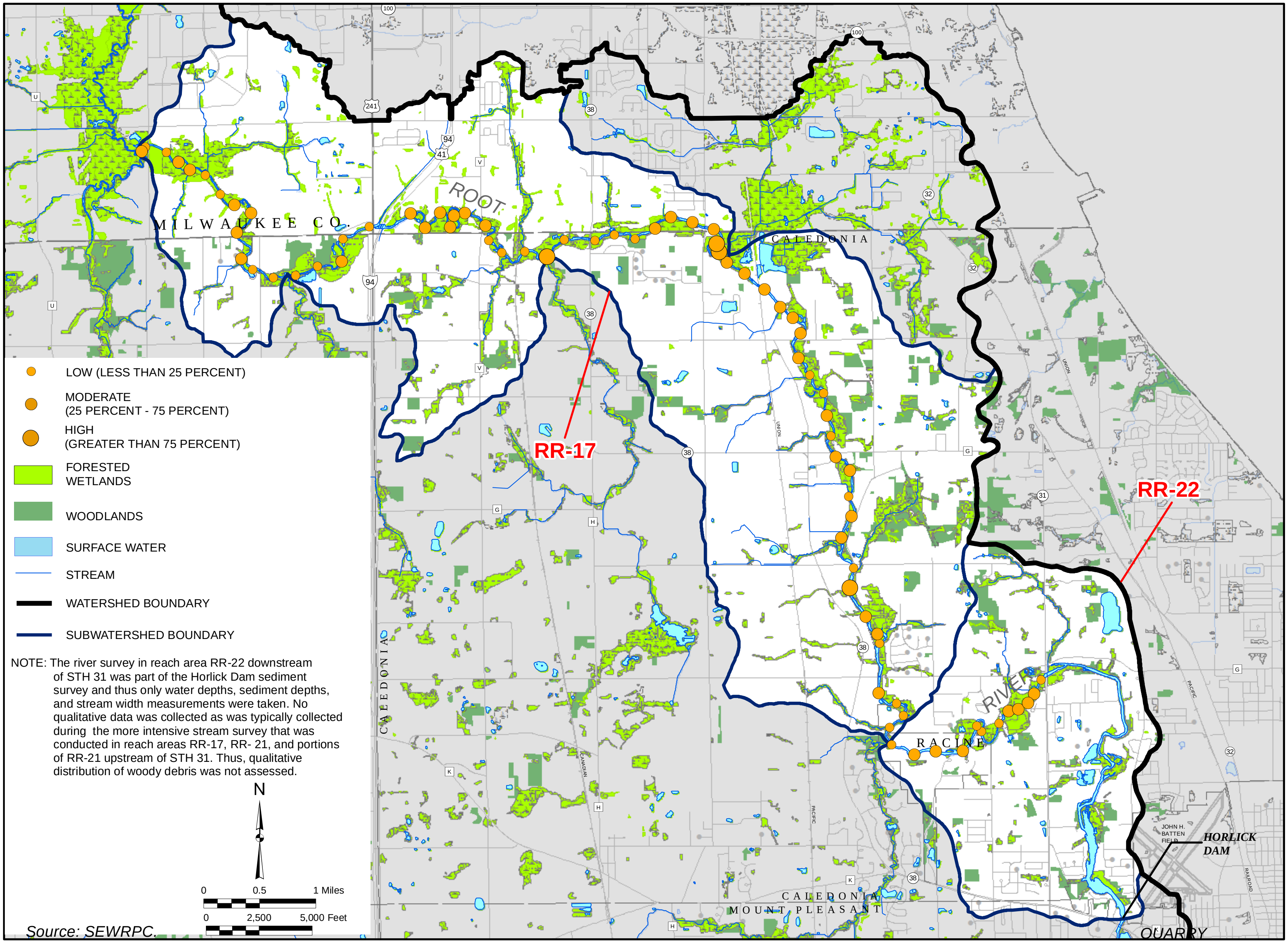
Map I-3

BANK EROSION SITES ALONG THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREAS RR-17 AND RR-22: 2013



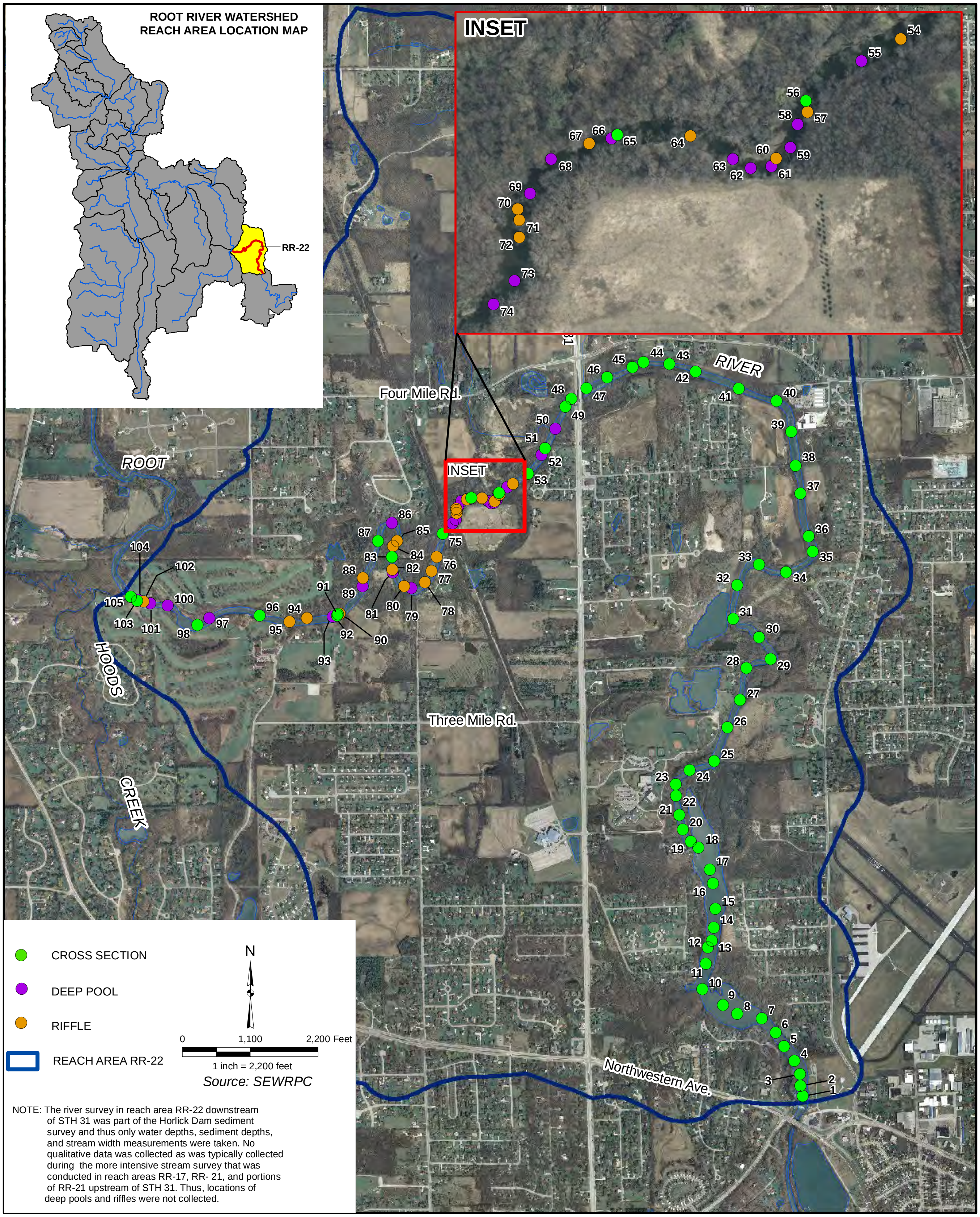
Map I-4

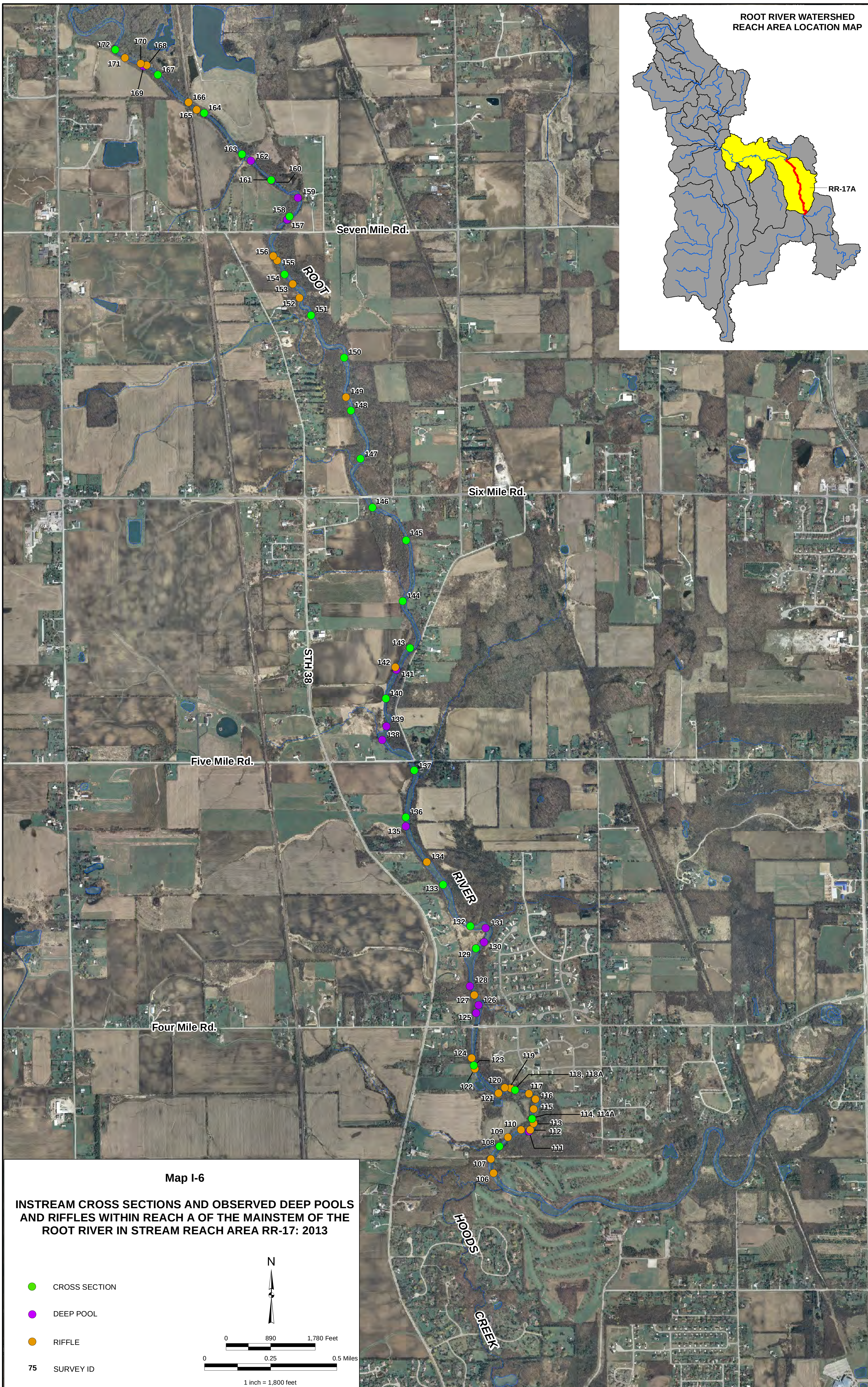
QUALITATIVE DISTRIBUTION OF WOODY DEBRIS AMONG SURVEYED CROSS SECTIONS ON THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREAS RR-17 AND RR-22: 2013



Map I-5

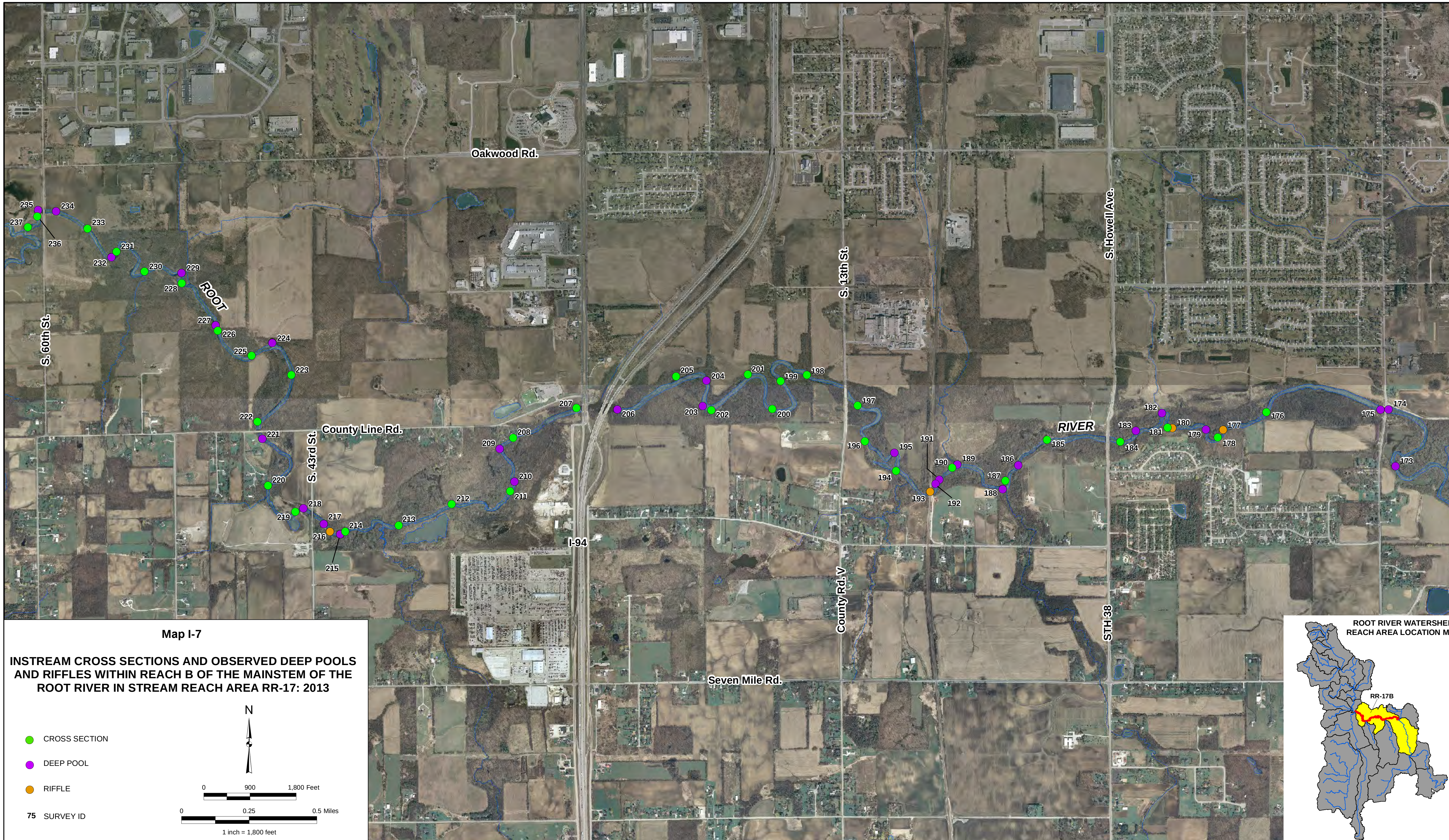
INSTREAM CROSS SECTIONS AND OBSERVED DEEP POOLS AND RIFFLES WITHIN THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREA RR-22





Map I-6

INSTREAM CROSS SECTIONS AND OBSERVED DEEP POOLS AND RIFFLES WITHIN REACH A OF THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREA RR-17: 2013

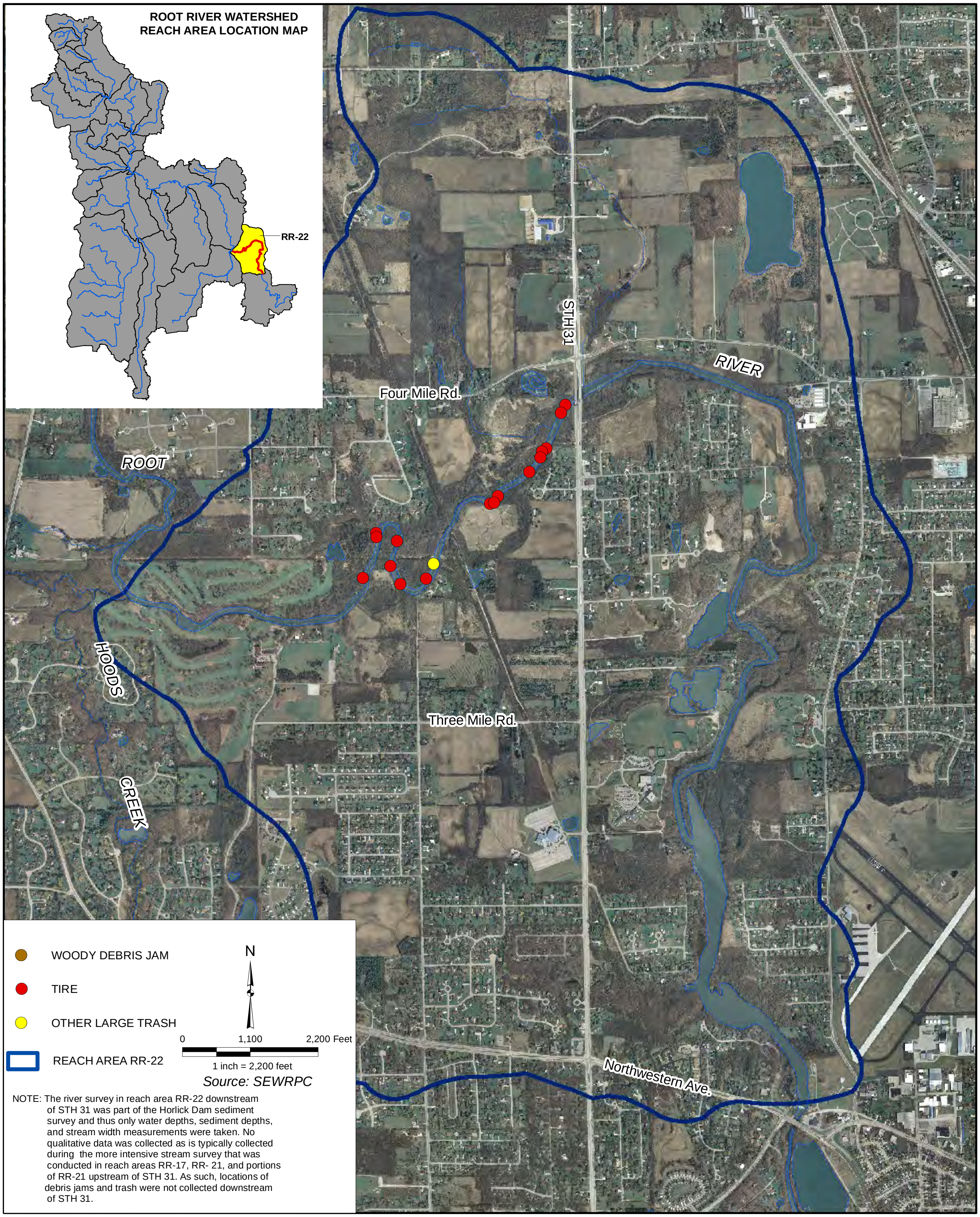


Map I-7

INSTREAM CROSS SECTIONS AND OBSERVED DEEP POOLS AND RIFFLES WITHIN REACH B OF THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREA RR-17: 2013

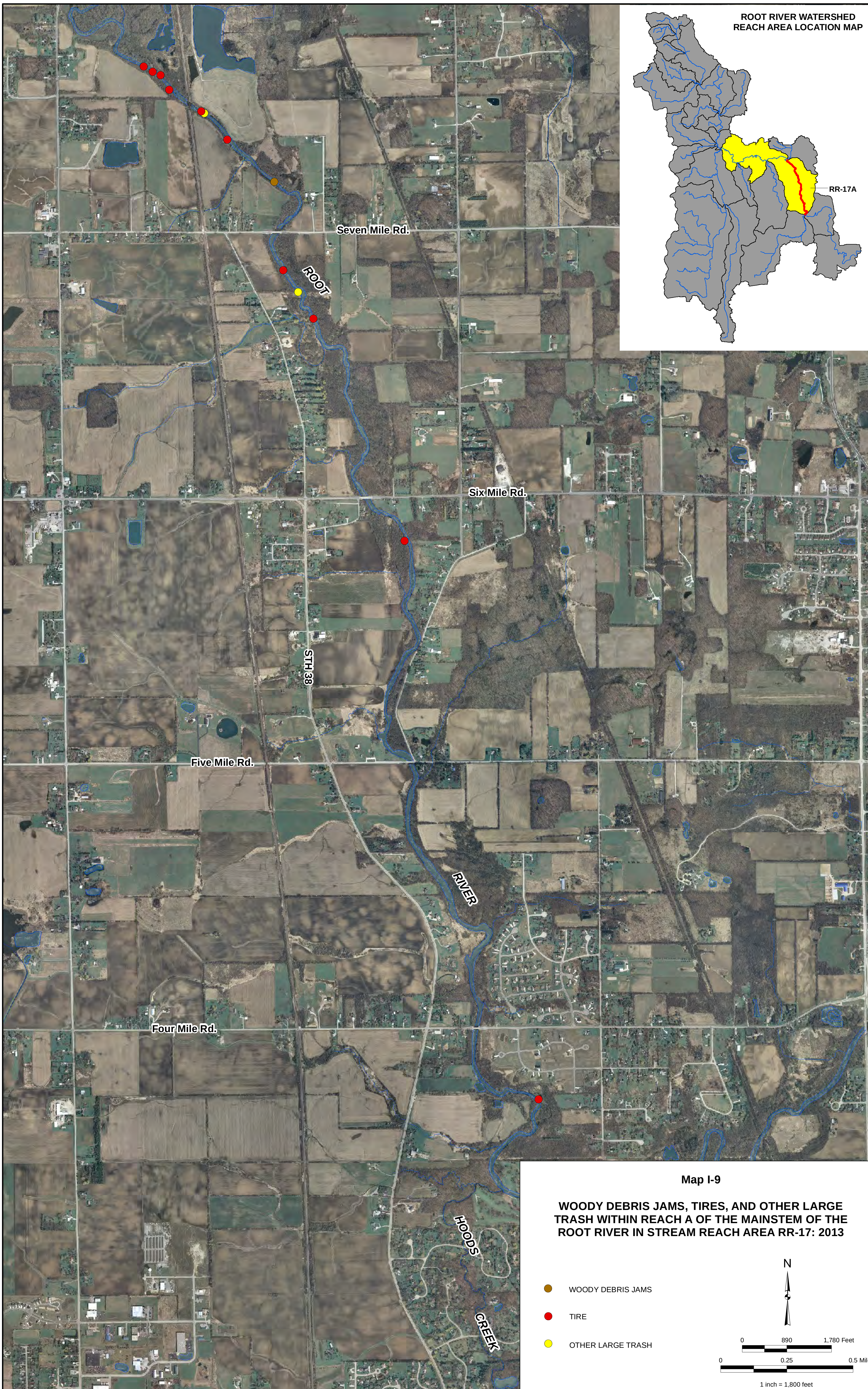
Map I-8

WOODY DEBRIS JAMS, TIRES, AND OTHER LARGE TRASH WITHIN THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREA RR-22: 2013



Source: SEWRPC

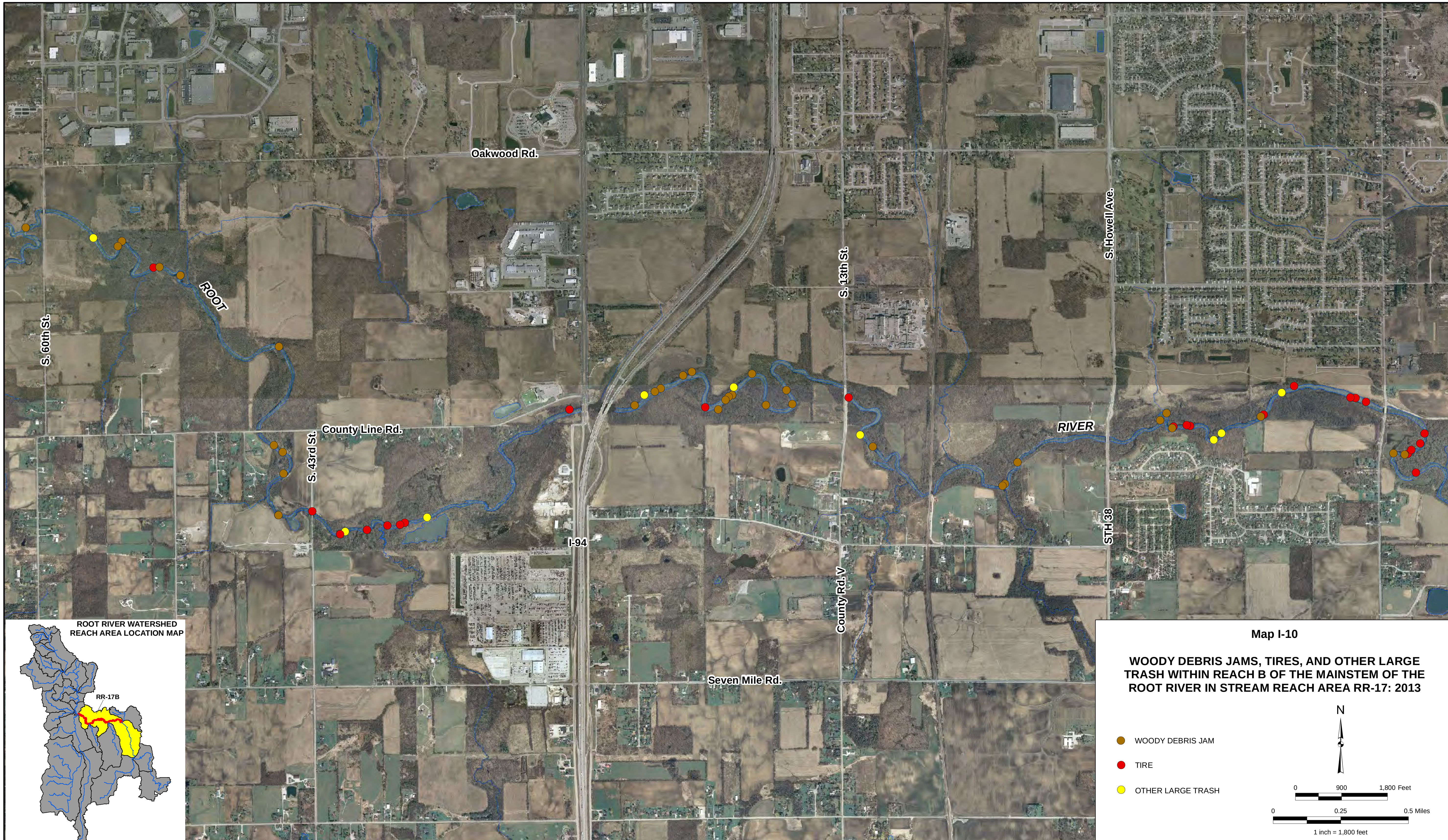
NOTE: The river survey in reach area RR-22 downstream of STH 31 was part of the Horlick Dam sediment survey and thus only water depths, sediment depths, and stream width measurements were taken. No qualitative data was collected as is typically collected during the more intensive stream survey that was conducted in reach areas RR-17, RR- 21, and portions of RR-21 upstream of STH 31. As such, locations of debris jams and trash were not collected downstream of STH 31.



Map I-9

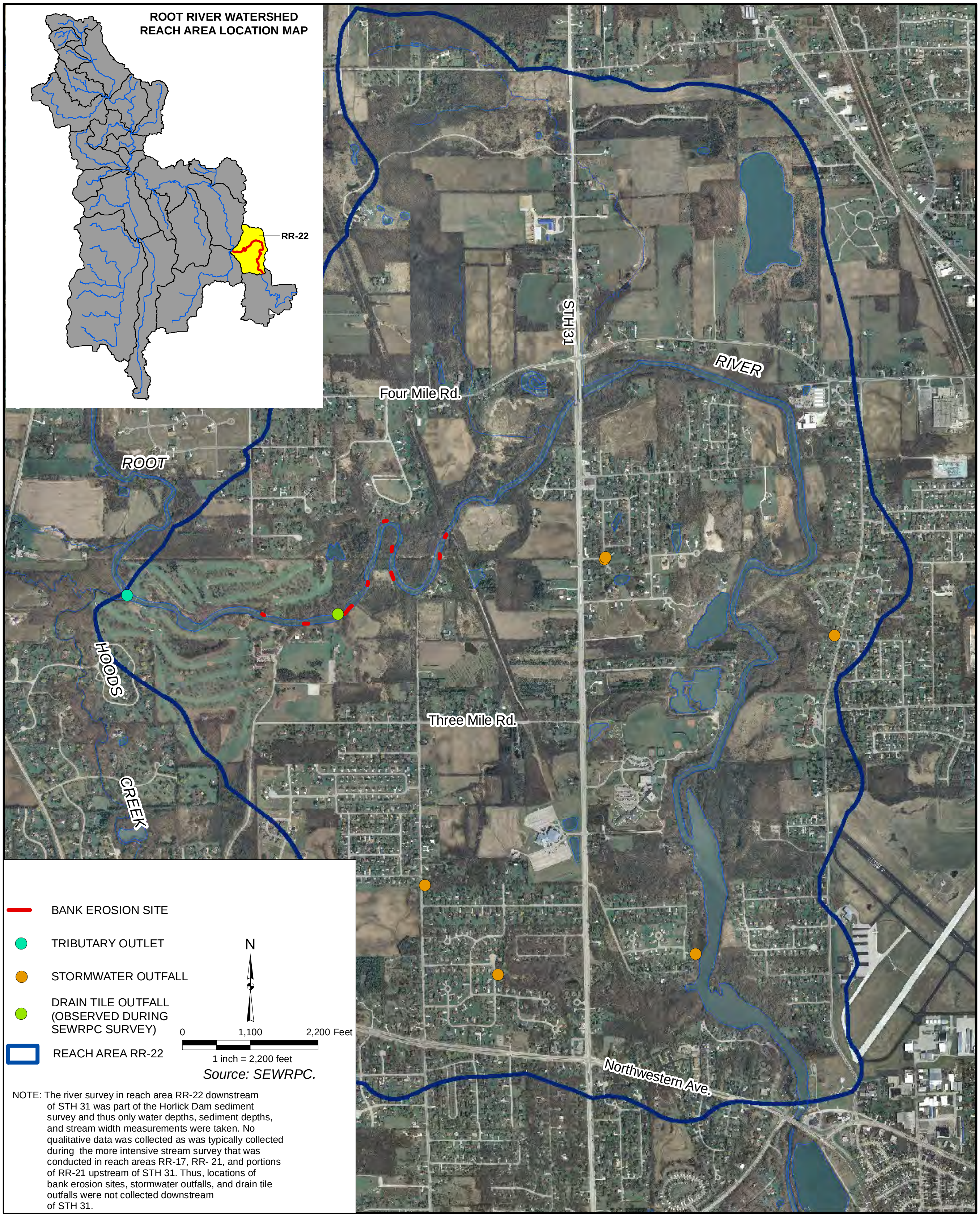
WOODY DEBRIS JAMS, TIRES, AND OTHER LARGE TRASH WITHIN REACH A OF THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREA RR-17: 2013

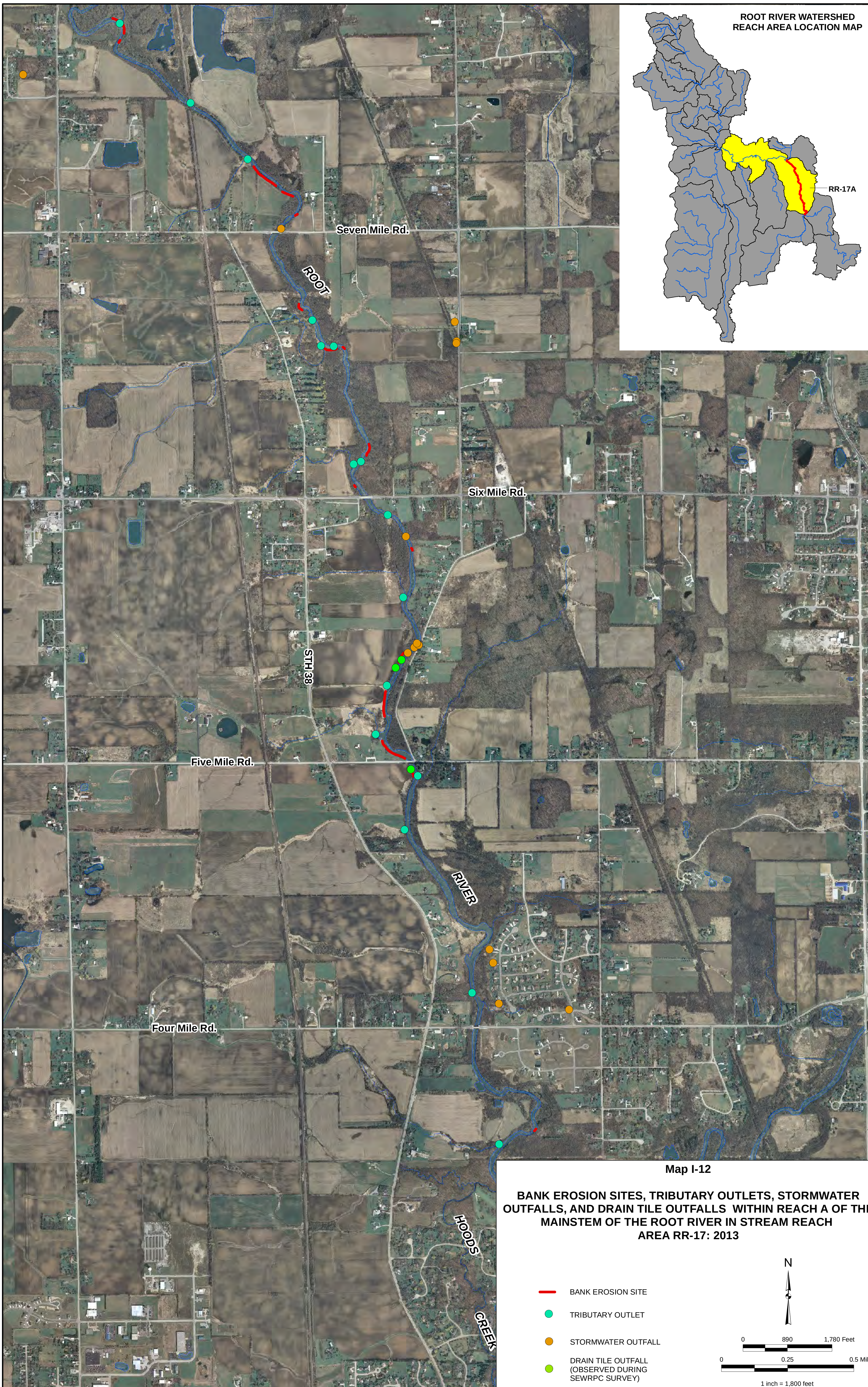
Source: SEWRPC


Oakwood Rd.
ROOT
RIVER
S. 60th St.
S. 43rd St.
County Line Rd.
I-94
S. 13th St.
County Rd. V
S. Howell Ave.
STH 38
Seven Mile Rd.
ROOT RIVER WATERSHED
REACH AREA LOCATION MAP
RR-17B
Map I-10
WOODY DEBRIS JAMS, TIRES, AND OTHER LARGE TRASH WITHIN REACH B OF THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREA RR-17: 2013
WOODY DEBRIS JAM
TIRE
OTHER LARGE TRASH
N
0 900 1,800 Feet
0 0.25 0.5 Miles
1 inch = 1,800 feet
Source: SEWRPC

Map I-11

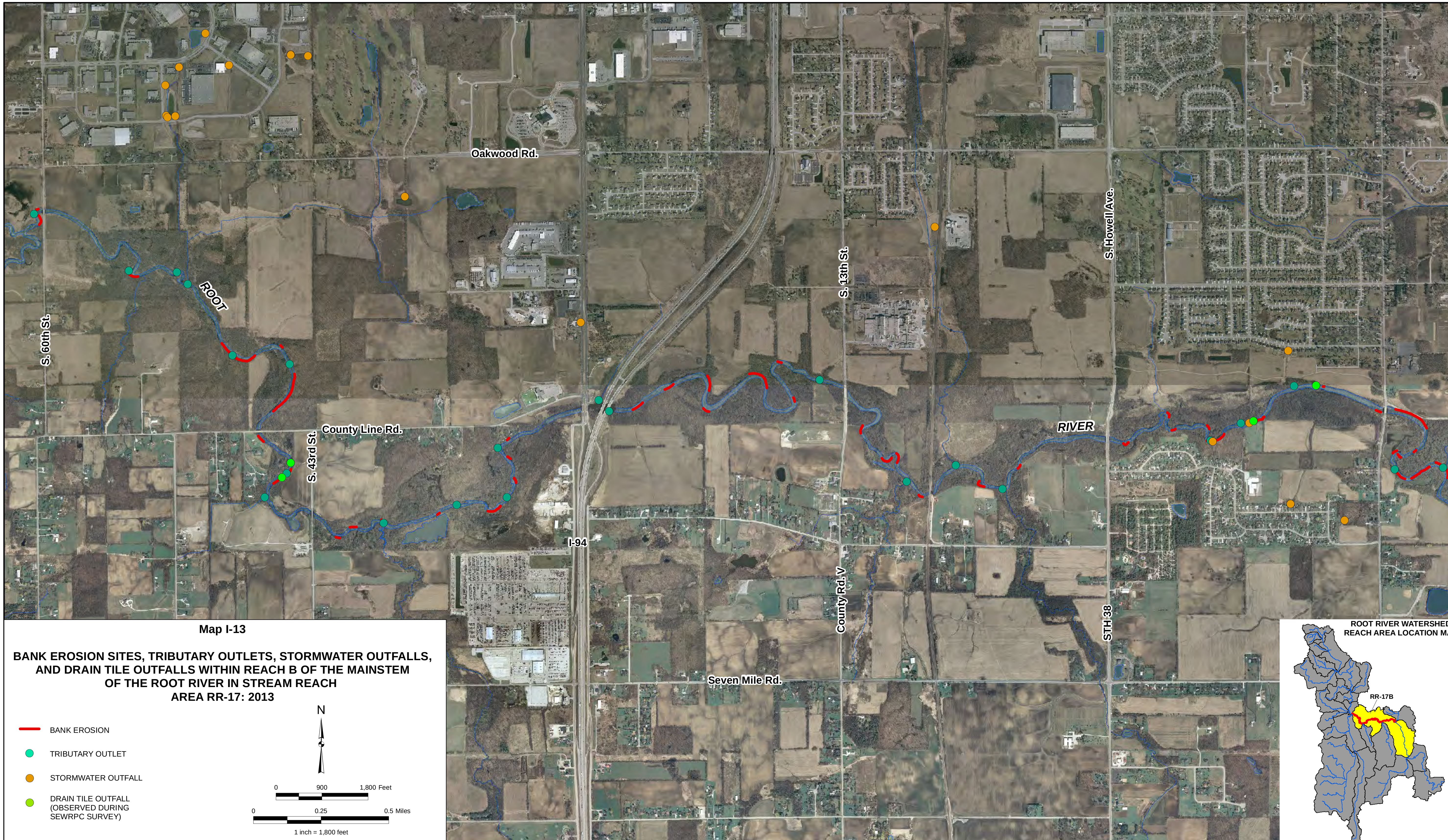
BANK EROSION, TRIBUTARY OUTLETS, STORMWATER OUTFALLS, AND DRAIN TILE OUTFALLS WITHIN THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREA RR-22: 2013





Map I-12

BANK EROSION SITES, TRIBUTARY OUTLETS, STORMWATER OUTFALLS, AND DRAIN TILE OUTFALLS WITHIN REACH A OF THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREA RR-17: 2013



Map I-13

BANK EROSION SITES, TRIBUTARY OUTLETS, STORMWATER OUTFALLS, AND DRAIN TILE OUTFALLS WITHIN REACH B OF THE MAINSTEM OF THE ROOT RIVER IN STREAM REACH AREA RR-17: 2013

Source: SEWRPC

Table I-1

PHYSICAL HABITAT CHARACTERISTICS OF THE MAINSTEM ROOT RIVER STREAM REACHES RR-17 AND RR-22: 2013

Parameters	Mainstem Root River		
	RR-22[a]	RR-17A	RR-17B
Transects			
Number of Transects	47	39	38
Transects (number per mile)	8.3	7.0	8.8
Habitat			
Composition			
Number of Pools per mile	10.6	2.9	3.1
Number of Riffles per mile	9.2	5.2	0.5
Pool/Riffle Ratio	1.2	0.6	6.75
Average Width (feet)	126.2	65.6	48.1
Standard Deviation	94.5	19.4	13.4
Depth			
Average Pool Depth (feet)	3.0	4.0	4.1
Standard Deviation	1.1	1.0	0.9
Residual Pool Depth (feet)	2.4	3.4	3.6
Standard Deviation	1.1	1.0	0.9
Average Riffle Depth (feet)	0.6	0.6	0.5
Standard Deviation	0.1	0.3	0.3
Average Run Depth (feet)	3.5	1.6	1.5
Standard Deviation	1.6	0.5	0.4
Substrate			
Flocculent Sediment Depth			
Average Depth (feet)	0.8	0.1	0.3
Maximum Depth (feet)	7.7	2.0	1.8
Composition[b]			
Silt (percent)	4	13	33
Sand (percent)	29	29	38
Gravel (percent)	33	30	20
Cobble (percent)	23	20	2
Boulder (percent)	11	6	1
Bedrock (percent)	0	2	0
Clay (percent)	0	0	6
Peat (percent)	0	0	0
Cover			
Undercut Banks			
Deep (percent >1.0 feet)	0	8	0
Moderate (percent >0.5 and $\leq$1.0 feet)	8	0	3
Shallow (percent <0.5 feet)	0	0	0
None (percent)	92	92	97
Amount of Cover			
High Abundance (percent)	0	0	5
Moderate Abundance (percent)	50	60	44
Low Abundance (percent)	50	40	51
None (percent)	0	0	0
Woody Debris			
High Abundance (percent)	0	4	8
Moderate Abundance (percent)	58	60	49
Low Abundance (percent)	42	36	43
None (percent)	0	0	0
Macrophytes			
High Abundance (percent)	0	0	2
Moderate Abundance (percent)	8	20	13
Low Abundance (percent)	42	40	49
None (percent)	50	40	36

Table I-1 (continued)

Parameters	Mainstem Root River		
	RR-22[a]	RR-17A	RR-17B
Cover (continued)			
Algae			
High Abundance (percent)	0	0	0
Moderate Abundance (percent)	0	8	0
Low Abundance (percent)	42	8	5
None (percent)	58	84	95
Shading			
High Abundance (percent)	8	12	15
Moderate Abundance (percent)	50	48	26
Low Abundance (percent)	42	40	44
None (percent)		0	15
Obstructions			
Beaver Dams (total number)	0	0	1
Debris Jams (total number)	0	1	33
Road Crossings (total number)	4	5	9
Subtotal			
Reach Length Assessed (miles)	2.2	5.6	8.8
Total Obstructions (number per mile)	1.8	1.1	7.4
Stream Inputs			
Stormwater Outlet Pipes (total number)	0	6	2
Tributary Inlets (total number)	1	15	23
Trash			
Tires (total number)	16	10	24
Other Large Trash (total number)	1	2	9
Qualitative Habitat Environmental Index (QHEI) Rating			
QHEI Score Range (minimum-maximum)	38-59	45-62	41-56
QHEI Score Range (minimum-maximum)	Poor-fair	Fair-good	Poor-fair

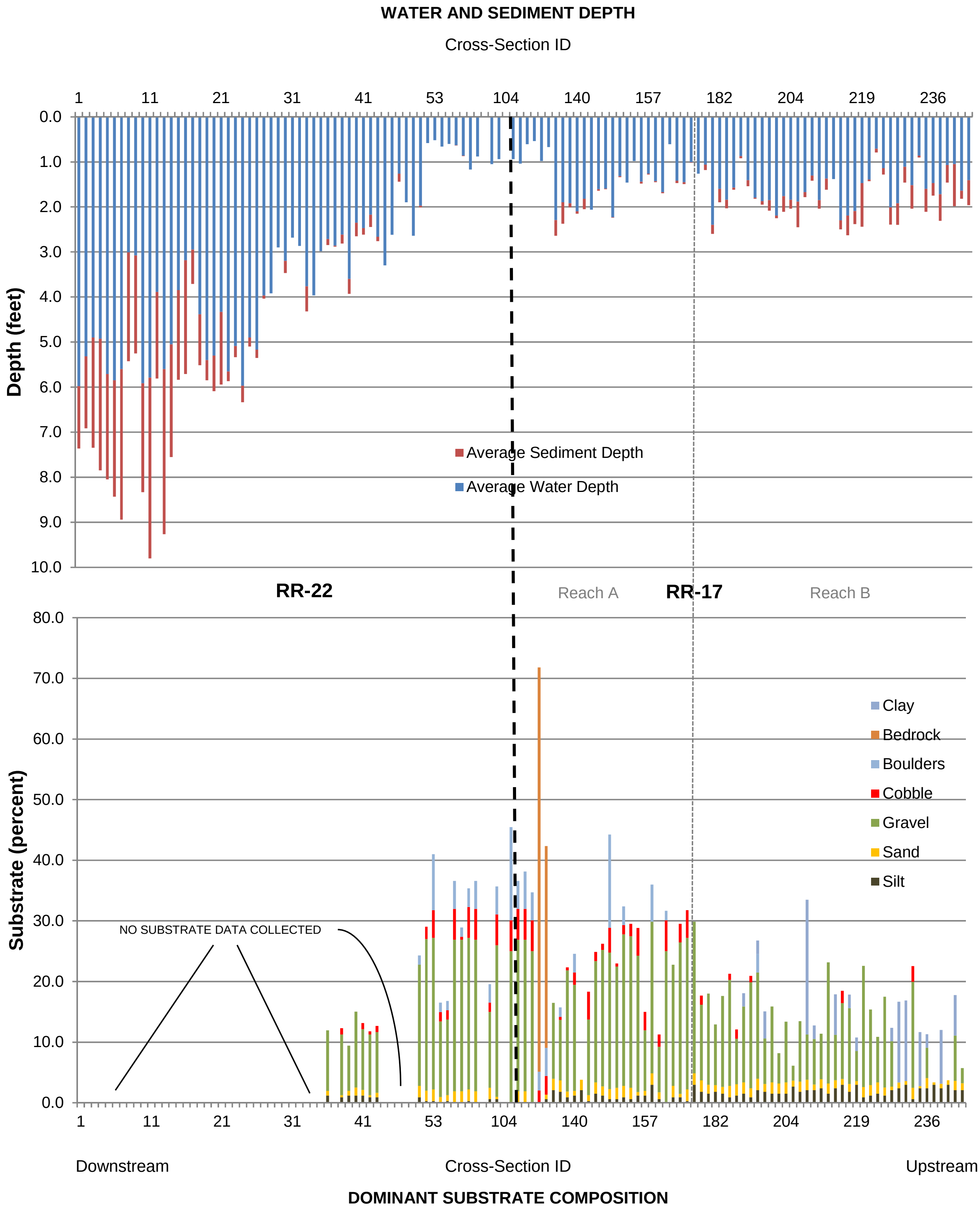
[a]*The portion of the Root River downstream of STH 31 was assessed as part of the Horlick Dam sediment survey and was not assessed for physical habitat conditions.*

[b]*Based on generalized evaluation of substrate composition at each transect.*

Source: SEWRPC.

Figure I-1

MEAN WATER DEPTH, SEDIMENT DEPTH, AND DOMINANT SUBSTRATE COMPOSITION AMONG CROSS-SECTIONS WITHIN THE MAINSTEM ROOT RIVER REACH AREAS RR-17 AND RR-22: 2013

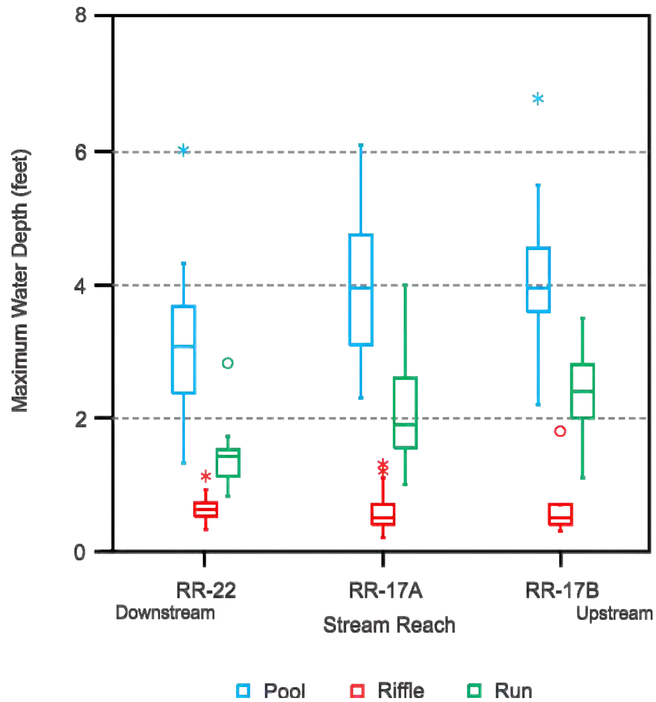


NOTE: Horlick Dam is located immediately downstream of cross section No. 1 in this figure. Cross section ID's are not continuous.

Source: SEWRPC.

Figure I-2

MAXIMUM WATER DEPTH AMONG HABITAT TYPE AND REACHES IN THE MAINSTEM ROOT RIVER WITHIN STREAM REACHES RR-22 AND RR17A AND RR-17B: 2013



NOTE: The maximum depths within the impoundment of Horlick dam were not included among the pool depths in this figure. Maximum water depths within the impoundment range from a minimum of 3.2 feet to maximum of 10.5 feet with an average of 6.2 feet among 39 cross-sections.

Source: SEWRPC.

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HOODS CREEK: REACH AREA RR-21

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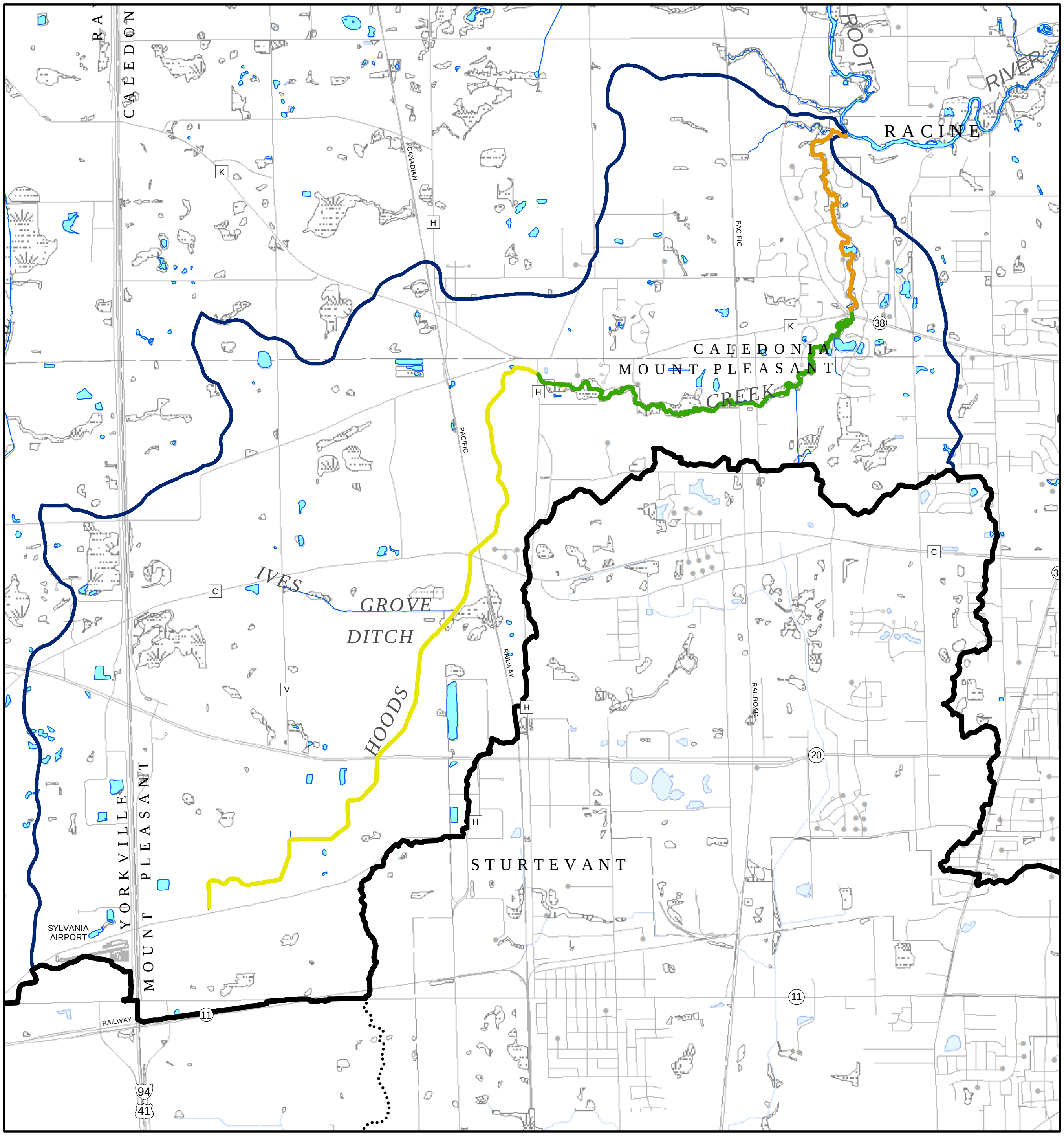
Map I-14

STREAM REACHES SURVEYED ALONG HOODS CREEK IN REACH AREA RR-21: 2013



HOODS CREEK STREAM REACHES:

HOODS 1

HOODS 2

HOODS 3

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

N

0 0.5 1 Miles

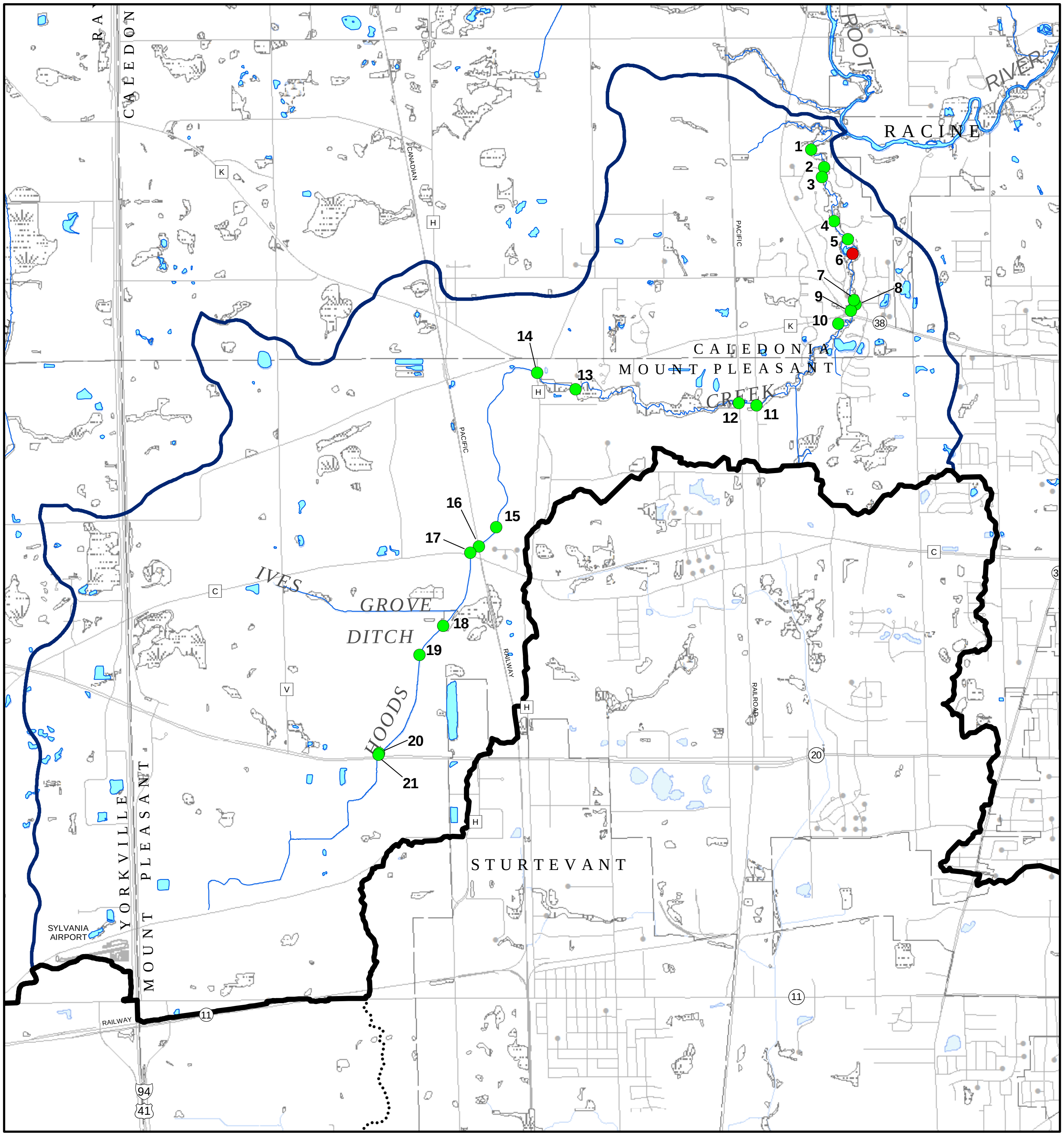
0 2,500 5,000 Feet

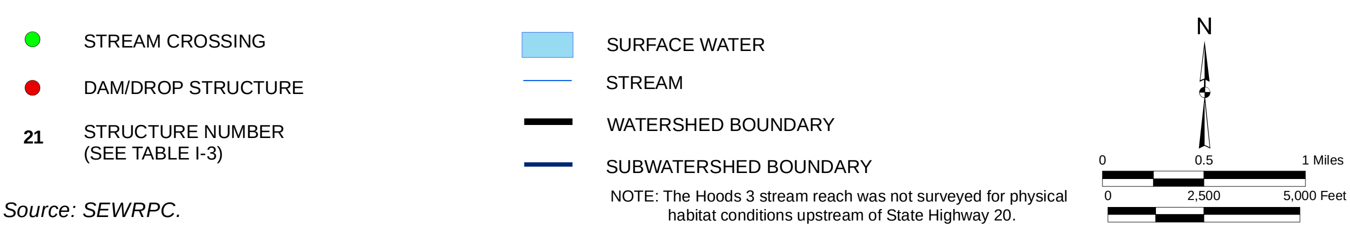
NOTE: The Hoods 3 stream reach was not surveyed for physical habitat conditions upstream of State Highway 20.

Source: SEWRPC.

Map I-15

STREAM CROSSINGS AND DAMS ALONG HOODS CREEK IN REACH AREA RR-21: 2013



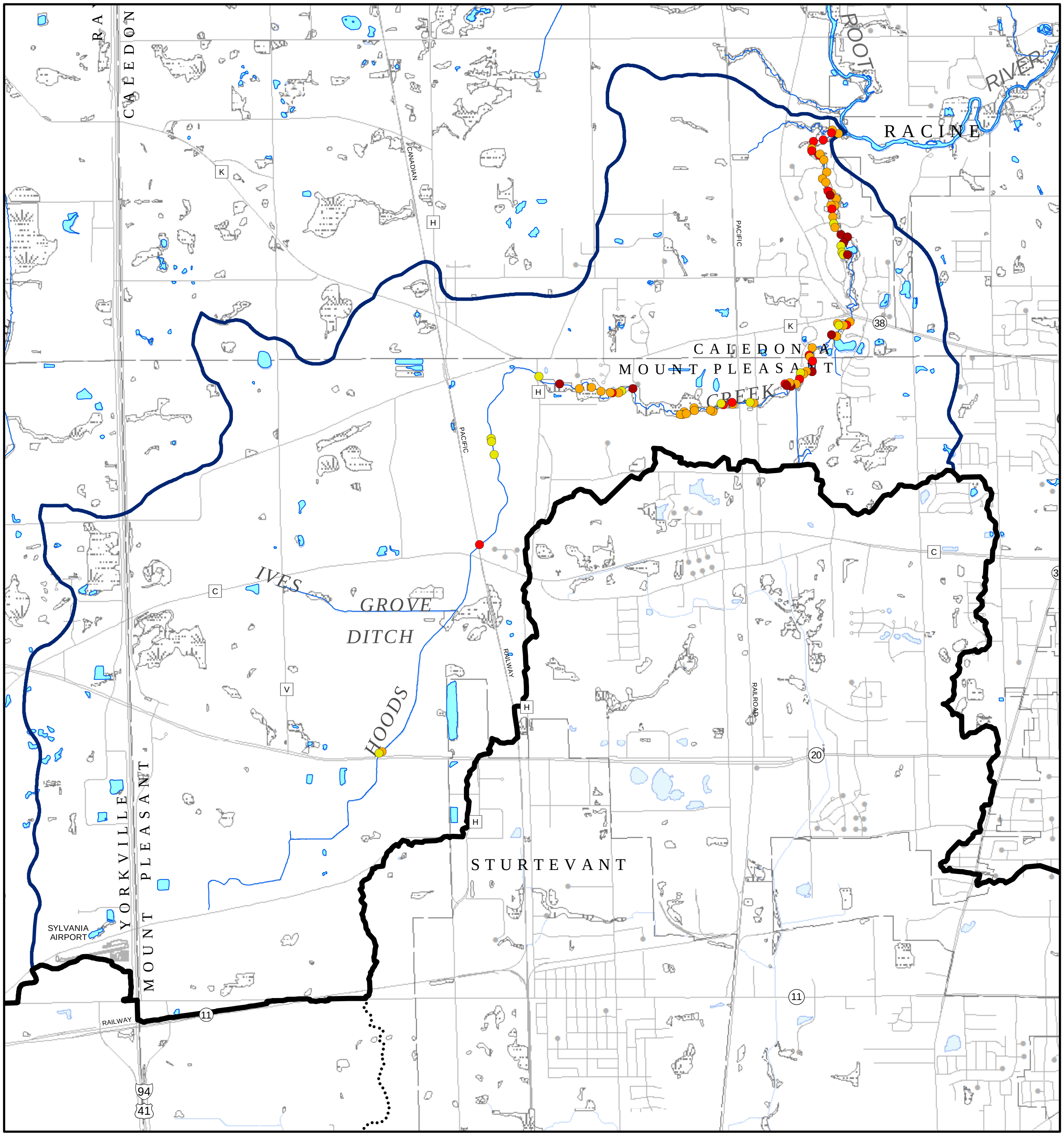


NOTE: The Hoods 3 stream reach was not surveyed for physical habitat conditions upstream of State Highway 20.

Source: SEWRPC.

Map I-16

BANK EROSION SITES ALONG HOODS CREEK IN REACH AREA RR-21: 2013



LENGTH OF BANK EROSION SITE

- 10-50 FEET
- 51-100 FEET
- 101-150 FEET
- >150

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

NOTES: See Maps I-24 through I-26 for a more detailed location and lengths of erosion sites.

The Hoods 3 stream reach was not surveyed for physical conditions upstream of State Highway 20.

N

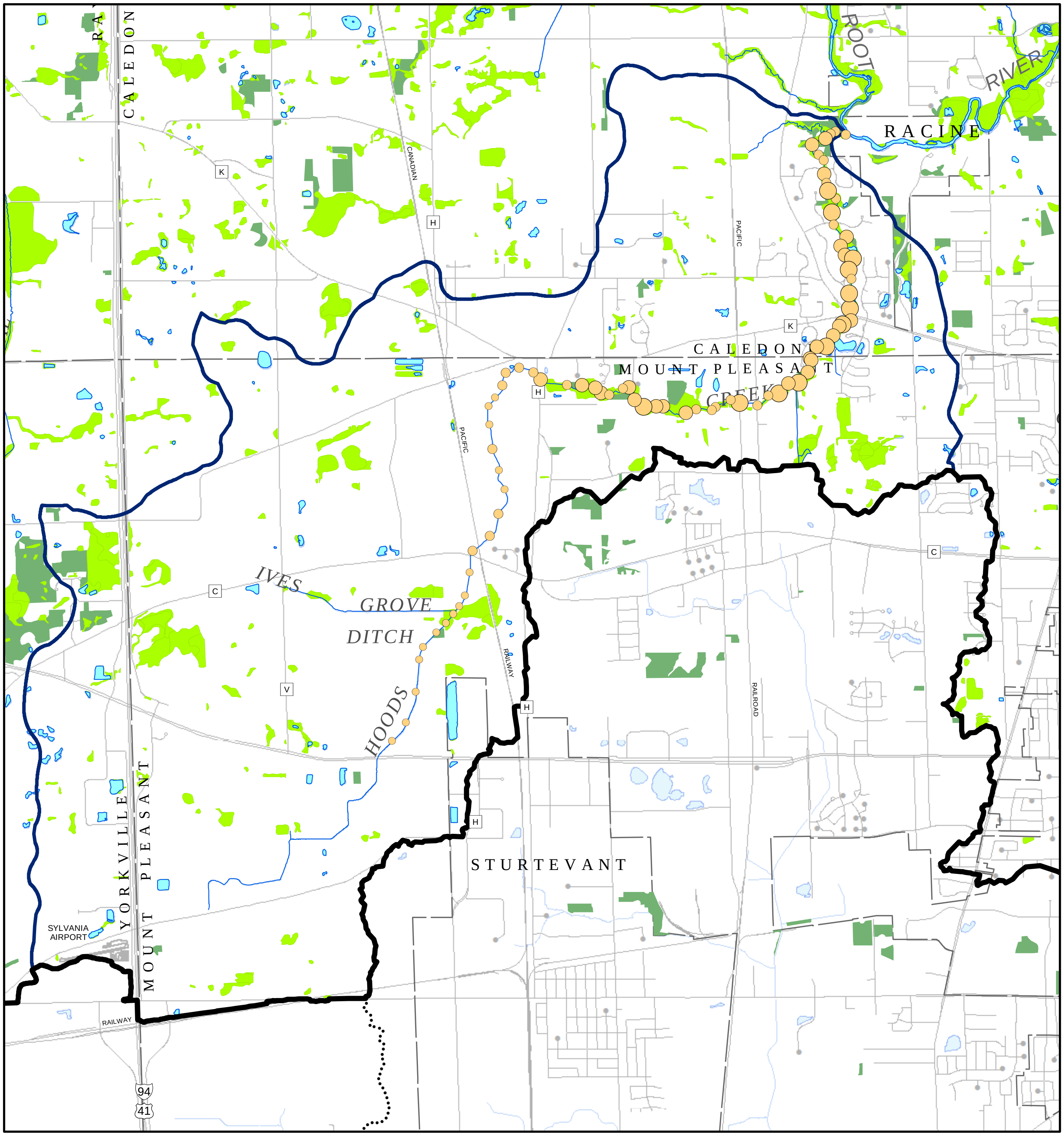
0 0.5 1 Miles

0 2,500 5,000 Feet

Source: SEWRPC.

Map I-17

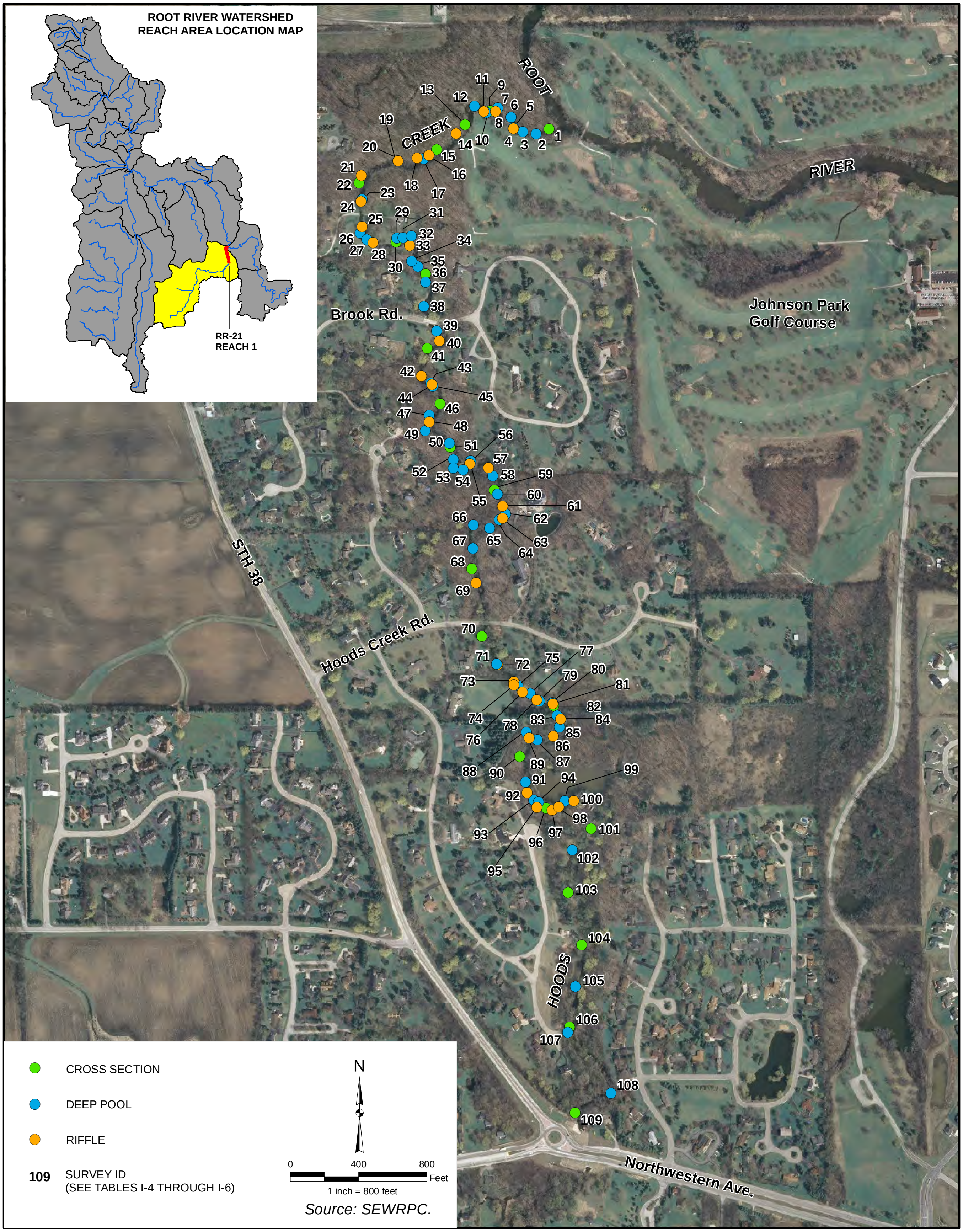
QUALITATIVE DISTRIBUTION OF WOODY DEBRIS AMONG SURVEYED CROSS SECTIONS WITHIN HOODS CREEK IN REACH AREA RR-21: 2013

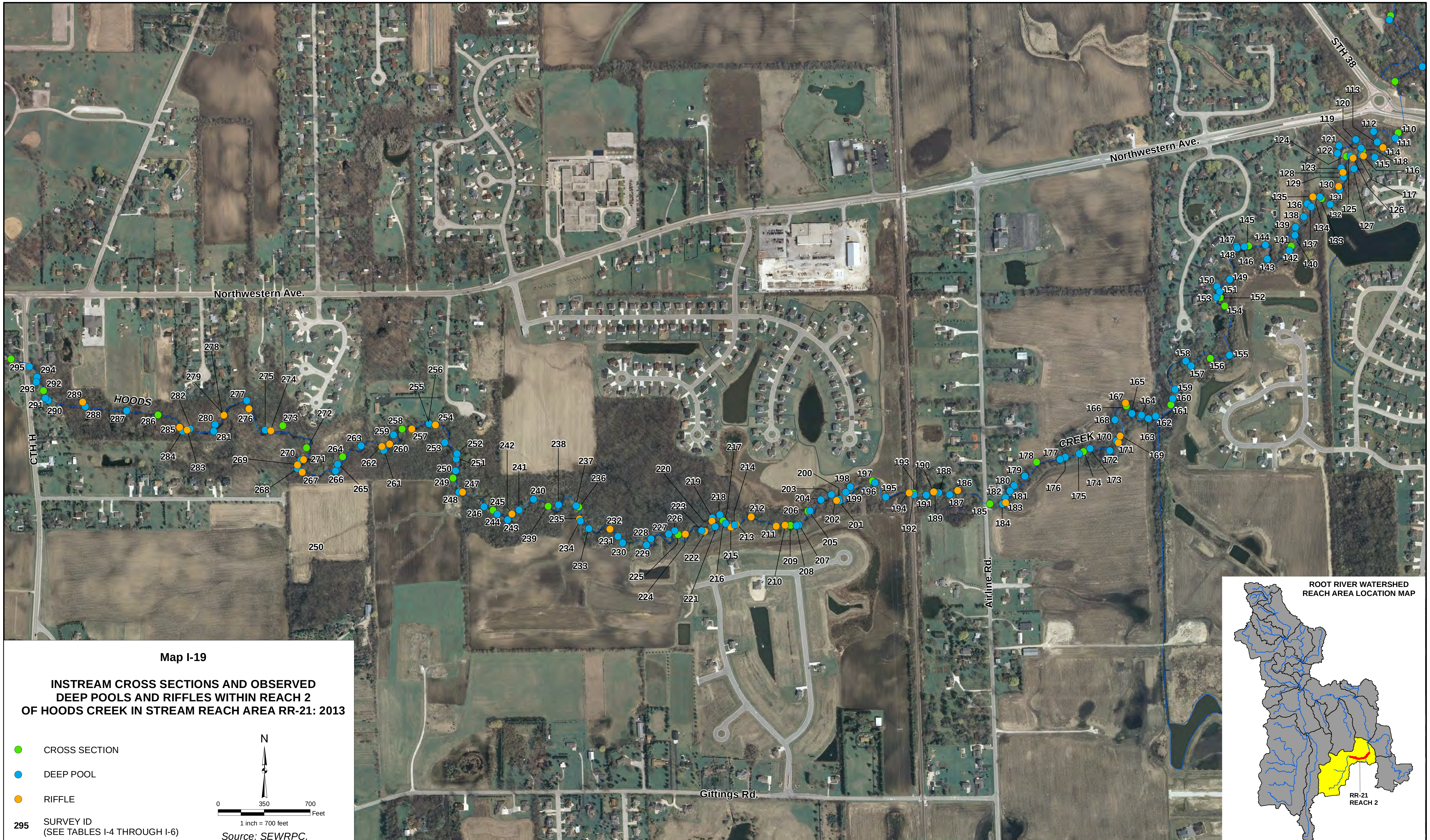


Source: SEWRPC.

Map I-18

INSTREAM CROSS SECTIONS AND OBSERVED DEEP POOLS AND RIFFLES WITHIN REACH 1 OF HOODS CREEK IN STREAM REACH AREA RR-21: 2013





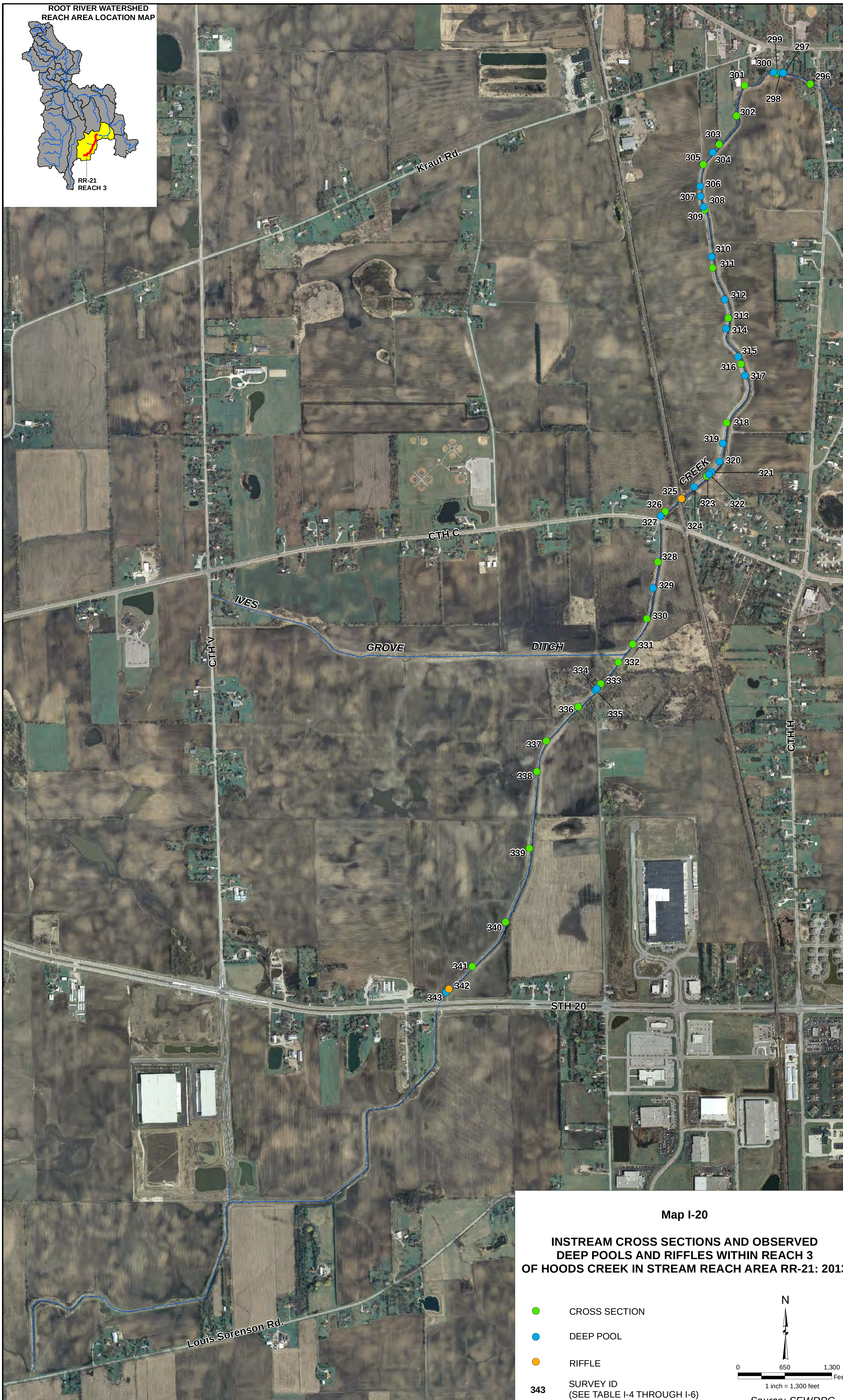
Map I-19

INSTREAM CROSS SECTIONS AND OBSERVED DEEP POOLS AND RIFFLES WITHIN REACH 2 OF HOODS CREEK IN STREAM REACH AREA RR-21: 2013

- CROSS SECTION
- DEEP POOL
- RIFFLE

295 SURVEY ID (SEE TABLES I-4 THROUGH I-6)

Source: SEWRPC.

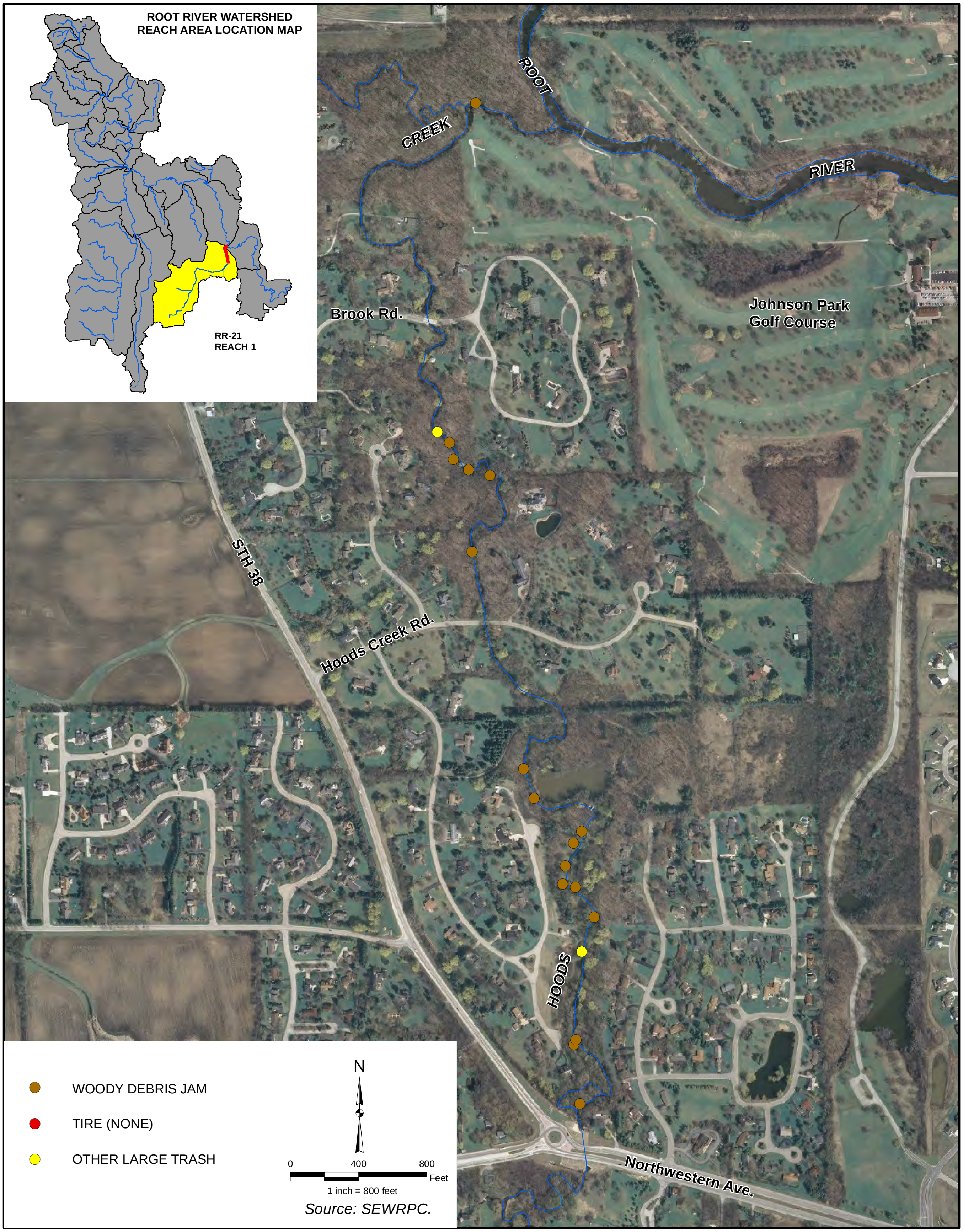


Map I-20

INSTREAM CROSS SECTIONS AND OBSERVED DEEP POOLS AND RIFFLES WITHIN REACH 3 OF HOODS CREEK IN STREAM REACH AREA RR-21: 2013

Map I-21

WOODY DEBRIS JAMS, TIRES, AND OTHER LARGE TRASH WITHIN REACH 1 OF HOODS CREEK IN STREAM REACH AREA RR-21: 2013



Map I-22

WOODY DEBRIS JAMS, TIRES, AND OTHER LARGE TRASH WITHIN REACH 2 OF HOODS CREEK IN STREAM REACH AREA RR-21: 2013

Source: SEWRPC.

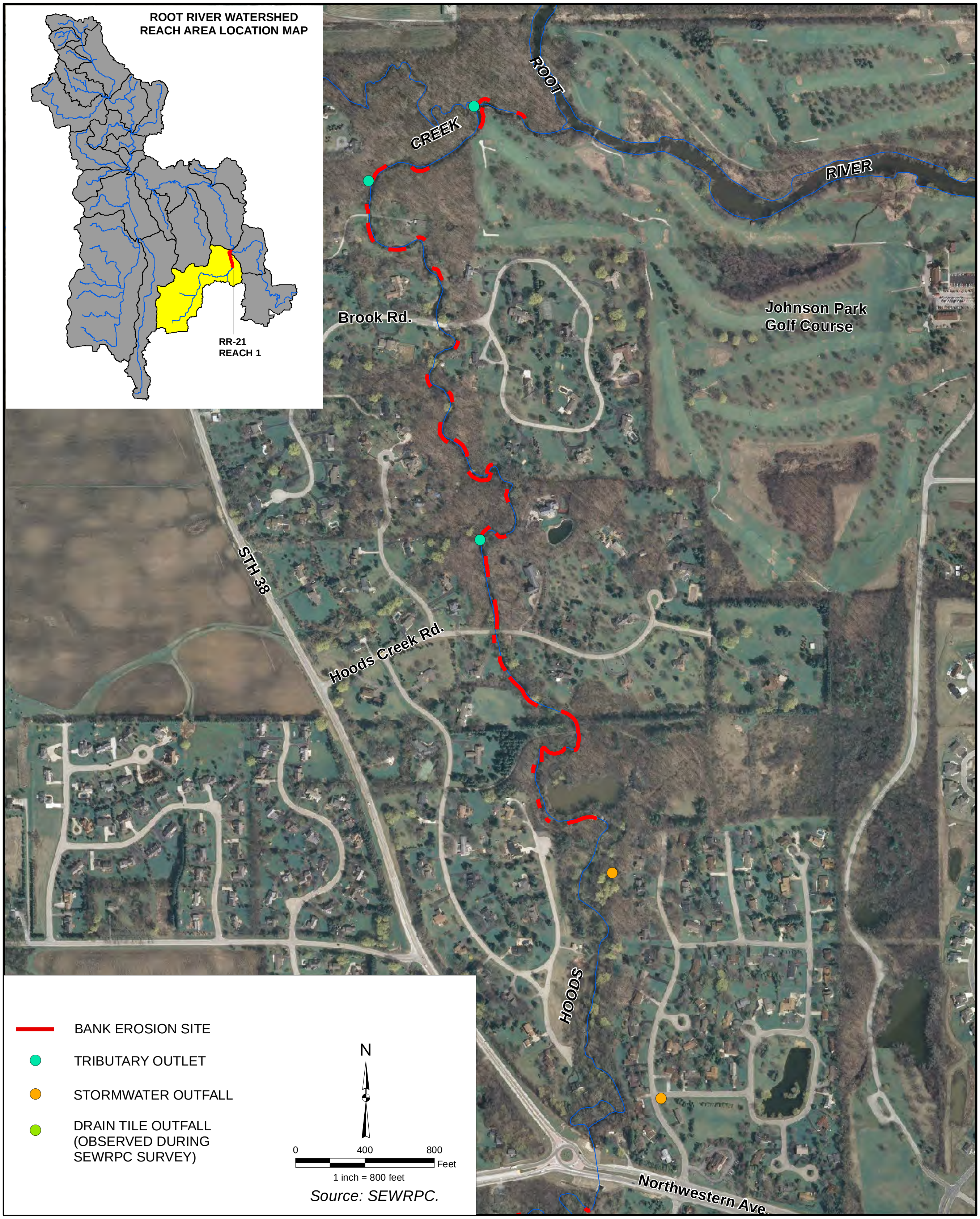
Map I-23

WOODY DEBRIS JAMS, TIRES, AND OTHER LARGE TRASH WITHIN REACH 3 OF HOODS CREEK IN STREAM REACH AREA RR-21: 2013

Source: SEWRPC.

Map I-24

BANK EROSION SITES, TRIBUTARY OUTLETS, STORMWATER OUTFALLS,
AND DRAIN TILE OUTFALLS WITHIN REACH 1 OF HOODS CREEK IN STREAM REACH AREA RR-21: 2013



Source: SEWRPC.


Northwestern Ave.
Northwestern Ave.
STH 38
HOODS
CREEK
CTH H
Airline Rd.
Gittings Rd.
Map I-25
BANK EROSION SITES, TRIBUTARY OUTLETS, STORMWATER OUTFALLS, AND DRAIN TILE OUTFALLS WITHIN REACH 2 OF HOODS CREEK IN STREAM REACH AREA RR-21: 2013
BANK EROSION SITE
TRIBUTARY OUTLET
STORMWATER OUTFALL
DRAIN TILE OUTFALL (OBSERVED DURING SEWRPC SURVEY)
N
0
350
700
Feet
1 inch = 700 feet
Source: SEWRPC.
ROOT RIVER WATERSHED REACH AREA LOCATION MAP
RR-21 REACH 2

Map I-26

BANK EROSION SITES, TRIBUTARY OUTLETS, STORMWATER OUTFALLS, AND DRAIN TILE OUTFALLS WITHIN REACH 3 OF HOODS CREEK IN STREAM REACH AREA RR-21: 2013

BANK EROSION SITE

TRIBUTARY OUTLET

STORMWATER OUTFALL

DRAIN TILE OUTFALL (OBSERVED DURING SEWRPC SURVEY)

Source: SEWRPC.

Table I-2

PHYSICAL HABITAT CHARACTERISTICS OF STREAM REACHES WITHIN HOODS CREEK IN STREAM REACH AREA RR-21: 2013

Parameters	Hoods Creek		
	Hoods-1	Hoods-2	Hoods-3
Transects			
Number of Transects	21	29	27
Transects (number per mile)	12	8.7	9.0
Habitat			
Composition			
Number of Pools per mile	30.3	31.3	11.0
Number of Riffles per mile	22.3	10.8	2.3
Pool/Riffle Ratio	1.4	3.0	4.7
Average Width (feet)	22.9	17.3	13.6
Standard Deviation	4.3	4.7	3.9
Depth[a]			
Average Pool Depth (feet)	2.3	2.8	2.6
Standard Deviation	0.7	0.8	0.6
Residual Pool Depth (feet)	1.9	2.3	2.0
Standard Deviation	0.7	0.8	0.6
Average Riffle Depth (feet)	0.4	0.5	0.6
Standard Deviation	0.1	0.2	0.3
Average Run Depth (feet)	1.0	1.2	1.3
Standard Deviation	0.5	0.5	0.4
Substrate			
Flocculent Sediment Depth			
Average Depth (feet)	0.1	0.1	0.4
Maximum Depth (feet)	1.7	0.7	2.9
Composition[a]			
Silt (percent)	48.6	64.8	84.8
Sand (percent)	69.5	60.7	64.0
Gravel (percent)	73.3	55.2	36.0
Cobble (percent)	59.0	37.2	16.0
Boulder (percent)	18.1	4.1	3.2
Bedrock (percent)	0.0	0.0	0.0
Clay (percent)	11.4	13.8	1.6
Peat (percent)	0.0	0.0	0.0
Cover			
Undercut Banks			
Deep (percent >1.0 feet)	0	4	4
Moderate (percent >0.5 and ≤1.0 feet)	0	4	11
Shallow (percent <0.5 feet)	0	0	0
None (percent)	100	92	85
Amount of Cover			
High Abundance (percent)	14	10	7
Moderate Abundance (percent)	52	45	52
Low Abundance (percent)	33	45	41
None (percent)	0	0	0
Woody Debris			
High Abundance (percent)	29	21	0
Moderate Abundance (percent)	29	52	7
Low Abundance (percent)	42	27	33
None (percent)	0	0	60
Macrophytes			
High Abundance (percent)	0	0	33
Moderate Abundance (percent)	9	0	48
Low Abundance (percent)	29	10	15
None (percent)	62	90	4

Table I-2 (continued)

Parameters	Hoods Creek		
	Hoods-1	Hoods-2	Hoods-3
Cover (continued)			
Algae			
High Abundance (percent)	0	0	0
Moderate Abundance (percent)	5	0	0
Low Abundance (percent)	24	0	30
None (percent)	71	100	70
Shading			
High Abundance (percent)	29	52	7
Moderate Abundance (percent)	33	34	0
Low Abundance (percent)	33	14	41
None (percent)	5	0	52
Obstructions			
Beaver Dams (total number)	0	1	0
Debris Jams (total number)	17	40	1
Road Crossings (total number)	9	6	8
Total Obstructions (number per mile)	14.8	14.2	3
Trash			
Tires (total number)	0	11	1
Other Large Trash (total number)	2	19	1
Qualitative Habitat Environmental Index (QHEI) Rating			
QHEI Score Range (minimum-maximum)	47-66	44-67	28-53
QHEI Score Range (minimum-maximum)	Fair-good	Fair-good	Very poor-fair

[a]*Based on generalized evaluation of substrate composition at each transect.*

Source: SEWRPC.

Table I-3

STRUCTURE DESCRIPTION, LOCATION, CONDITION, AND POTENTIAL FISH PASSAGE ASSESSMENT WITHIN HOODS CREEK IN STREAM REACH AREA RR-21: 2013

Structure Number (see Map I-15)	Description	Road Crossing	River Mile	Culvert/Bridge Length (feet)	Erosion	General Condition	Limiting Water Depth (feet)	Embedded Depth (feet)	Potential Fish Passage Obstruction	Potential Remedial Actions
1	Metal/concrete bridge with abutments	Private bridge	0.31	15.4	Moderate (right bank at outlet)	Good	2.0	- -	None	Erosion Control
2	Concrete bridge with abutments	Brook Road	0.50	30.6	Stable	Good	1.5	- -	None	None
3	Metal/concrete/wood bridge with abutments	Private bridge	0.58	14.0	Severe (inlet and outlet)	Poor	1.0	- -	None	General maintenance, erosion control
4	Metal/concrete/wood bridge with abutments	Hoods Creek Road	0.96	26.0	Moderate (right bank at outlet)	Poor	1.4	- -	None	General maintenance, consider replacement
5	Metal/concrete/wood bridge with abutments	Private bridge	1.12	10.0	Severe (left bank both inlet and outlet)	Fair	1.6	- -	None	General maintenance, erosion control
6	Concrete dam	Private dam	1.32		Severe (right bank at outlet)	Fair	0.1	- -	Complete obstruction	General maintenance, fish passage, erosion control
7	Wood bridge with side slopes	Private bridge	1.65	4.0	Minor	Fair	2.0	- -	None	General maintenance
8	Wood bridge with side slopes and abutments	Private bridge	1.67	3.6	Moderate	Good	1.9	- -	None	None
9	One 24.0-foot-wide, nine-feet-high concrete square/rectangle culvert	STH 38	1.80	217.0	Stable	Good	1.8	4.7	Partial	Length of culvert with no resting areas makes passage for fish troublesome. Strategically place boulders to slow flow and create resting areas for passing fish
10	Wood bridge with side slopes	Private bridge	2.03	6.2	Severe (right bank at inlet)	Poor	2.2	- -	None	Remove and rebuild
11	One 16.0-foot-wide, eight-feet-high open bottom square/rectangle culvert	Airline Road	3.21	39.3	Stable	Good	2.0	1.0	None	None
12	Concrete/metal/wood bridge with abutments	Rail Road bridge	3.32	27.0	Severe (left bank at outlet)	Fair	0.8	- -	Partial during low flow	Direct flow to narrower channel under bridge to increase water depths
13	Metal and wood bridge with open bottom arch and side slopes and abutments	Private bridge	4.84	8.0	Moderate	Good	1.6	- -	None	Erosion control
14	Concrete bridge with abutments	CTH H	5.13	44.0	Stable	Fair	1.2	- -	None	General maintenance (wingwall failure)
15	One 10.0-foot-wide, ten-foot-high smooth metal culvert	Farm road crossing	6.41	36.0	Stable	Fair	1.0	0.0	Partial during low flow	General maintenance, strategically place boulders to slow flow and create resting areas for passing fish
16	Concrete bridge with abutments	Rail road bridge	6.57	33.0	Stable	Fair	1.0	- -	Partial during low flow	Divert flow through northwest channel to increase water depths, strategically place boulders to slow flow and create resting areas for passing fish
17	One 17.5-foot-wide, ten-foot-high corrugated metal culvert	CTH C (Spring Street)	6.64	70.0	Stable	Good	0.9	0.0	None	None

Table I-3 (continued)

Structure Number (see Map I-15)	Description	Road Crossing	River Mile	Culvert/Bridge Length (feet)	Erosion	General Condition	Limiting Water Depth (feet)	Embedded Depth (feet)	Potential Fish Passage Obstruction	Potential Remedial Actions
18	One 7.0-foof-wide, seven-foot-tall smooth metal culvert	Mt. Pleasant compost yard private road crossing	7.14	24.0	Minor	Good	1.8	0.1	- -	None
19	One 8.0-foot-wide, eight-foot-high corrugated metal culvert	Farm road crossing	7.38	30.0	Moderate (right bank at inlet)	Good	1.0	0.1	None	None
20	One 4.5-foot-wide, four and half-foot-high corrugated metal culvert	Farm road crossing	8.07	62.0	Severe (left bank at outlet)	Crushed	1.4	0.0	None	General maintenance
21	One 15.0-foot-wide, ten-foot-high smooth concrete culvert	STH 20	8.10	164.0		Good	0.3	0.3	Partial during low flow	Clear debris and accumulated sediments

Source: SEWRPC.

Table I-4

QUANTITATIVE INSTREAM COVER CHARACTERISTICS AMONG HABITAT TYPES WITHIN HOODS CREEK: 2013

Reach	Survey ID[a] (see Maps I-18 through I-20)	River Mile	Sample Date	Longitude[b]	Latitude[b]	Habitat Type	Water Velocity	Amount of Cover (rank)	Woody Debris (rank)	Macrophytes (rank)	Algae (rank)	Shading (rank)
Hoods Creek 1	1		4-Jun-13	2573543.7677	290090.4468	Riffle	Fast	1	1	0	1	2
Hoods Creek 1	2		4-Jun-13	2573466.5618	290060.9662	Deep Pool						
Hoods Creek 1	3		4-Jun-13	2573390.2952	290071.2660	Deep Pool						
Hoods Creek 1	4		4-Jun-13	2573335.1975	290091.8260	Riffle						
Hoods Creek 1	5		4-Jun-13	2573335.4144	290093.9094	Deep Pool						
Hoods Creek 1	6		4-Jun-13	2573320.8304	290159.6641	Deep Pool						
Hoods Creek 1	7		4-Jun-13	2573244.3385	290211.3038	Deep Pool						
Hoods Creek 1	8		4-Jun-13	2573229.2447	290191.4823	Riffle						
Hoods Creek 1	9		4-Jun-13	2573200.4321	290194.8698	Run	Moderate	2	1	0	1	3
Hoods Creek 1	10		4-Jun-13	2573177.1975	290186.1464	Deep Pool						
Hoods Creek 1	11		4-Jun-13	2573160.9476	290190.3754	Riffle						
Hoods Creek 1	12		4-Jun-13	2573105.5536	290221.6539	Deep Pool						
Hoods Creek 1	13		4-Jun-13	2573051.0252	290116.2682	Run	Moderate	2	1	0	0	1
Hoods Creek 1	14		4-Jun-13	2572998.1159	290063.6978	Riffle						
Hoods Creek 1	15		4-Jun-13	2572884.5725	289968.2915	Riffle	Moderate	1	2	1	0	3
Hoods Creek 1	16		4-Jun-13	2572839.8383	289934.9077	Riffle						
Hoods Creek 1	17		4-Jun-13	2572810.0175	289914.3425	Deep Pool						
Hoods Creek 1	18		4-Jun-13	2572771.5389	289918.0331	Riffle						
Hoods Creek 1	19		4-Jun-13	2572659.4085	289901.9629	Deep Pool						
Hoods Creek 1	20		4-Jun-13	2572659.4085	289901.9629	Riffle						
Hoods Creek 1	21		4-Jun-13	2572442.7190	289816.7239	Riffle						
Hoods Creek 1	22		4-Jun-13	2572428.7623	289771.7827	Run	Moderate	2	2	0	1	3
Hoods Creek 1	23		6-Jun-13	2572449.1343	289675.9227	Deep Pool						
Hoods Creek 1	24		6-Jun-13	2572440.9585	289664.6212	Riffle						
Hoods Creek 1	25		6-Jun-13	2572448.8883	289517.4108	Riffle						
Hoods Creek 1	26		6-Jun-13	2572435.7508	289480.9244	Deep Pool						
Hoods Creek 1	27		6-Jun-13	2572476.2872	289439.9438	Deep Pool						
Hoods Creek 1	28		6-Jun-13	2572511.5607	289423.3969	Riffle						
Hoods Creek 1	29		6-Jun-13	2572651.4154	289450.5960	Deep Pool						
Hoods Creek 1	30		6-Jun-13	2572647.9643	289426.2142	Run	Slow	2	1	0	0	1
Hoods Creek 1	31		6-Jun-13	2572688.3245	289452.8549	Deep Pool						
Hoods Creek 1	32		6-Jun-13	2572735.9363	289461.8043	Deep Pool						
Hoods Creek 1	33		6-Jun-13	2572728.0055	289407.4826	Riffle						
Hoods Creek 1	34		6-Jun-13	2572738.3779	289315.3400	Deep Pool						
Hoods Creek 1	35		6-Jun-13	2572775.4254	289284.0488	Deep Pool						

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

Variable rank numbers are defined as follows: 0 = None or Nearly Absent (< 5.0 percent), 1 = Low Abundance (5 to 25 percent), 2 = Moderate Abundance (25 to 75 percent), and 3 = High Abundance (greater than 75 percent).

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *These coordinates are in North American Datum (NAD) 1927 State Plane Wisconsin South Federal Information Processing Standard (FIPS) 4803.*

Table I-4 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	River Mile	Sample Date	Longitude[b]	Latitude[b]	Habitat Type	Water Velocity	Amount of Cover (rank)	Woody Debris (rank)	Macrophytes (rank)	Algae (rank)	Shading (rank)
Hoods Creek 1	36		6-Jun-13	2572819.6421	289240.9317	Run	Slow	1	1	0	0	1
Hoods Creek 1	37		6-Jun-13	2572821.0509	289191.1579	Deep Pool						
Hoods Creek 1	38		6-Jun-13	2572810.4056	289050.2566	Deep Pool						
Hoods Creek 1	39		6-Jun-13	2572885.7824	288905.9642	Deep Pool						
Hoods Creek 1	40		6-Jun-13	2572901.8303	288846.3282	Riffle						
Hoods Creek 1	41		6-Jun-13	2572829.6247	288803.3486	Run	Slow	2	2	0	0	1
Hoods Creek 1	42		7-Jun-13	2572795.6291	288640.5809	Riffle						
Hoods Creek 1	43		7-Jun-13	2572851.0879	288598.9744	Deep Pool						
Hoods Creek 1	44		7-Jun-13	2572857.4623	288590.9478	Riffle						
Hoods Creek 1	45		7-Jun-13	2572861.8543	288582.0761	Deep Pool						
Hoods Creek 1	46		7-Jun-13	2572905.1925	288479.2259	Run	Slow	1	1	0	0	3
Hoods Creek 1	47		7-Jun-13	2572840.2254	288412.0161	Deep Pool						
Hoods Creek 1	48		7-Jun-13	2572842.1811	288374.2960	Riffle						
Hoods Creek 1	49		7-Jun-13	2572818.6080	288321.5297	Deep Pool						
Hoods Creek 1	50		7-Jun-13	2572960.4001	288248.6713	Deep Pool						
Hoods Creek 1	51		7-Jun-13	2572964.3955	288225.3964	Run	Slow	1	3	0	0	1
Hoods Creek 1	52		7-Jun-13	2572982.7944	288152.2223	Deep Pool						
Hoods Creek 1	53		7-Jun-13	2572982.9620	288102.5695	Deep Pool						
Hoods Creek 1	54		7-Jun-13	2573039.1939	288092.3963	Deep Pool						
Hoods Creek 1	55		7-Jun-13	2573078.6141	288126.8060	Riffle						
Hoods Creek 1	56		7-Jun-13	2573084.4008	288141.7443	Deep Pool						
Hoods Creek 1	57		7-Jun-13	2573188.9524	288104.1761	Riffle						
Hoods Creek 1	58		7-Jun-13	2573212.8894	288056.5374	Deep Pool						
Hoods Creek 1	59		7-Jun-13	2573223.8431	287972.5688	Run	Moderate	2	1	1	0	1
Hoods Creek 1	60		7-Jun-13	2573241.6118	287949.5245	Deep Pool						
Hoods Creek 1	61		7-Jun-13	2573272.1265	287879.8081	Riffle						
Hoods Creek 1	62		7-Jun-13	2573288.1514	287833.4339	Deep Pool						
Hoods Creek 1	63		7-Jun-13	2573270.6186	287808.5688	Riffle						
Hoods Creek 1	64		7-Jun-13	2573251.9575	287798.7401	Deep Pool						
Hoods Creek 1	65		7-Jun-13	2573195.6775	287749.2303	Deep Pool						
Hoods Creek 1	66		7-Jun-13	2573099.0012	287768.4517	Deep Pool						
Hoods Creek 1	67		7-Jun-13	2573097.6393	287630.8129	Deep Pool						
Hoods Creek 1	68		7-Jun-13	2573089.7433	287510.9447	Run	Moderate	3	3	1	0	2
Hoods Creek 1	69		7-Jun-13	2573116.2866	287430.1250	Riffle						
Hoods Creek 1	70		10-Jun-13	2573149.2553	287115.9442	Riffle	Moderate	1	1	0	0	1
Hoods Creek 1	71		10-Jun-13	2573235.8057	286955.0403	Deep Pool						
Hoods Creek 1	72		10-Jun-13	2573240.7955	286950.0954	Riffle						

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

Variable rank numbers are defined as follows: 0 = None or Nearly Absent (< 5.0 percent), 1 = Low Abundance (5 to 25 percent), 2 = Moderate Abundance (25 to 75 percent), and 3 = High Abundance (greater than 75 percent).

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *These coordinates are in North American Datum (NAD) 1927 State Plane Wisconsin South Federal Information Processing Standard (FIPS) 4803.*

Table I-4 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	River Mile	Sample Date	Longitude[b]	Latitude[b]	Habitat Type	Water Velocity	Amount of Cover (rank)	Woody Debris (rank)	Macrophytes (rank)	Algae (rank)	Shading (rank)
Hoods Creek 1	73		10-Jun-13	2573336.5788	286849.8420	Riffle						
Hoods Creek 1	74		10-Jun-13	2573338.0220	286831.2994	Riffle						
Hoods Creek 1	75		10-Jun-13	2573359.7034	286828.7076	Deep Pool						
Hoods Creek 1	76		10-Jun-13	2573387.8756	286789.8559	Riffle						
Hoods Creek 1	77		10-Jun-13	2573432.7754	286780.0662	Deep Pool						
Hoods Creek 1	78		10-Jun-13	2573471.3337	286743.5896	Riffle						
Hoods Creek 1	79		10-Jun-13	2573488.3189	286738.0047	Deep Pool						
Hoods Creek 1	80		10-Jun-13	2573564.0980	286727.8452	Deep Pool						
Hoods Creek 1	81		10-Jun-13	2573565.4264	286720.8203	Riffle						
Hoods Creek 1	82		10-Jun-13	2573571.4346	286708.6592	Run	Slow	2	2	0	0	3
Hoods Creek 1	83		10-Jun-13	2573591.6951	286652.5842	Deep Pool						
Hoods Creek 1	84		10-Jun-13	2573612.6884	286631.1509	Riffle						
Hoods Creek 1	85		10-Jun-13	2573605.4509	286584.9751	Deep Pool						
Hoods Creek 1	86		10-Jun-13	2573568.1439	286531.2757	Riffle						
Hoods Creek 1	87		10-Jun-13	2573474.3524	286510.6295	Deep Pool						
Hoods Creek 1	88		10-Jun-13	2573411.5182	286553.3597	Deep Pool						
Hoods Creek 1	89		10-Jun-13	2573425.6206	286519.6793	Riffle						
Hoods Creek 1	90		10-Jun-13	2573371.2299	286412.0962	Run	Slow	2	2	0	0	2
Hoods Creek 1	91		10-Jun-13	2573405.7663	286261.0446	Deep Pool						
Hoods Creek 1	92		10-Jun-13	2573414.9959	286200.4703	Riffle						
Hoods Creek 1	93		10-Jun-13	2573454.5149	286155.5537	Deep Pool						
Hoods Creek 1	94		10-Jun-13	2573482.2058	286146.0564	Deep Pool						
Hoods Creek 1	95		10-Jun-13	2573471.1937	286114.4826	Riffle						
Hoods Creek 1	96		10-Jun-13	2573527.4908	286109.8743	Riffle	Fast	2	2	0	0	3
Hoods Creek 1	97		10-Jun-13	2573561.6328	286097.3035	Riffle						
Hoods Creek 1	98		10-Jun-13	2573599.8046	286116.4022	Riffle						
Hoods Creek 1	99		10-Jun-13	2573636.3416	286151.8388	Deep Pool						
Hoods Creek 1	100		10-Jun-13	2573688.2470	286150.7854	Riffle						
Hoods Creek 1	101		11-Jun-13	2573789.8334	285990.3608	Run	Slow	3	3	1	1	0
Hoods Creek 1	102		11-Jun-13	2573679.6952	285863.2882	Deep Pool						
Hoods Creek 1	103		11-Jun-13	2573655.6424	285613.9272	Run	Slow	3	3	1	0	2
Hoods Creek 1	104		11-Jun-13	2573734.9028	285307.2890	Run	Slow	1	1	2	2	2
Hoods Creek 1	105		11-Jun-13	2573697.7070	285064.6504	Deep Pool						
Hoods Creek 1	106		11-Jun-13	2573664.1427	284826.1381	Run	Slow	2	3	2	1	2
Hoods Creek 1	107		11-Jun-13	2573653.5306	284796.4997	Deep Pool						
Hoods Creek 1	108		11-Jun-13	2573905.6222	284440.6313	Deep Pool						
Hoods Creek 1	109		11-Jun-13	2573697.0554	284326.4672	Run	Slow	2	3	1	0	2

NOTES: Color shades correspond to the following aquatic habitat types: Pool, Riffle, Run

Variable rank numbers are defined as follows: 0 = None or Nearly Absent (< 5.0 percent), 1 = Low Abundance (5 to 25 percent), 2 = Moderate Abundance (25 to 75 percent), and 3 = High Abundance (greater than 75 percent).

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*These coordinates are in North American Datum (NAD) 1927 State Plane Wisconsin South Federal Information Processing Standard (FIPS) 4803.*

Table I-4 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	River Mile	Sample Date	Longitude[b]	Latitude[b]	Habitat Type	Water Velocity	Amount of Cover (rank)	Woody Debris (rank)	Macrophytes (rank)	Algae (rank)	Shading (rank)
Hoods Creek 2	110		12-Jun-13	2573720.1899	283938.6339	Run	Slow	1	2	0	0	3
Hoods Creek 2	111		12-Jun-13	2573698.2792	283899.0802	Deep Pool						
Hoods Creek 2	112		12-Jun-13	2573534.6315	283947.5391	Deep Pool						
Hoods Creek 2	113		12-Jun-13	2573562.9166	283867.4979	Deep Pool						
Hoods Creek 2	114		12-Jun-13	2573605.0891	283824.6355	Riffle						
Hoods Creek 2	115		12-Jun-13	2573541.7834	283751.8745	Deep Pool						
Hoods Creek 2	116		12-Jun-13	2573458.3430	283761.8380	Riffle						
Hoods Creek 2	117		12-Jun-13	2573442.9706	283765.9053	Deep Pool						
Hoods Creek 2	118		12-Jun-13	2573450.5408	283800.0496	Run	Moderate	2	3	1	0	2
Hoods Creek 2	119		12-Jun-13	2573440.2173	283820.6568	Deep Pool						
Hoods Creek 2	120		12-Jun-13	2573398.4677	283886.5711	Deep Pool						
Hoods Creek 2	121		12-Jun-13	2573272.0234	283840.0016	Deep Pool						
Hoods Creek 2	122		12-Jun-13	2573258.8450	283781.2671	Deep Pool						
Hoods Creek 2	123		12-Jun-13	2573290.4243	283671.9130	Deep Pool						
Hoods Creek 2	124		12-Jun-13	2573328.6369	283759.0661	Run	Slow	1	2	1	0	1
Hoods Creek 2	125		12-Jun-13	2573359.0138	283763.5109	Deep Pool						
Hoods Creek 2	126		12-Jun-13	2573378.4501	283746.7124	Riffle						
Hoods Creek 2	127		12-Jun-13	2573385.5048	283664.6916	Deep Pool						
Hoods Creek 2	128		12-Jun-13	2573301.8121	283637.0013	Riffle						
Hoods Creek 2	129		12-Jun-13	2573306.1205	283601.5421	Deep Pool						
Hoods Creek 2	130		12-Jun-13	2573270.4601	283529.9172	Riffle						
Hoods Creek 2	131		12-Jun-13	2573275.8374	283505.4859	Deep Pool						
Hoods Creek 2	132		12-Jun-13	2573203.7903	283394.0898	Deep Pool						
Hoods Creek 2	133		19-Jun-13	2573138.2550	283439.1051	Run	Moderate	2	2	0	0	3
Hoods Creek 2	134		19-Jun-13	2573126.5526	283451.1205	Deep Pool						
Hoods Creek 2	135		19-Jun-13	2573073.7637	283451.2665	Riffle						
Hoods Creek 2	136		19-Jun-13	2573030.7264	283399.4687	Deep Pool						
Hoods Creek 2	137		19-Jun-13	2573060.7325	283376.1872	Deep Pool						
Hoods Creek 2	138		19-Jun-13	2573003.5476	283298.2061	Deep Pool						
Hoods Creek 2	139		19-Jun-13	2572942.2078	283219.7515	Deep Pool						
Hoods Creek 2	140		19-Jun-13	2572937.3817	283159.3061	Deep Pool						
Hoods Creek 2	141		19-Jun-13	2572909.9303	283076.5851	Run	Slow	2	3	0	0	1
Hoods Creek 2	142		19-Jun-13	2572894.8041	283044.6315	Deep Pool						
Hoods Creek 2	143		19-Jun-13	2572726.9025	282979.2802	Deep Pool						
Hoods Creek 2	144		19-Jun-13	2572712.1132	283086.4368	Deep Pool						
Hoods Creek 2	145		19-Jun-13	2572585.4120	283077.8483	Run	Slow	2	2	0	0	3
Hoods Creek 2	146		19-Jun-13	2572552.2903	283072.3870	Deep Pool						

NOTES: Color shades correspond to the following aquatic habitat types: Pool, Riffle, Run

Variable rank numbers are defined as follows: 0 = None or Nearly Absent (< 5.0 percent), 1 = Low Abundance (5 to 25 percent), 2 = Moderate Abundance (25 to 75 percent), and 3 = High Abundance (greater than 75 percent).

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *These coordinates are in North American Datum (NAD) 1927 State Plane Wisconsin South Federal Information Processing Standard (FIPS) 4803.*

Table I-4 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	River Mile	Sample Date	Longitude[b]	Latitude[b]	Habitat Type	Water Velocity	Amount of Cover (rank)	Woody Debris (rank)	Macrophytes (rank)	Algae (rank)	Shading (rank)
Hoods Creek 2	147		19-Jun-13	2572491.8751	283077.4729	Deep Pool						
Hoods Creek 2	148		19-Jun-13	2572497.7045	283064.3906	Deep Pool						
Hoods Creek 2	149		19-Jun-13	2572441.5514	282823.5003	Deep Pool						
Hoods Creek 2	150		19-Jun-13	2572344.6267	282770.6012	Deep Pool						
Hoods Creek 2	151		19-Jun-13	2572364.7536	282732.9484	Deep Pool						
Hoods Creek 2	152		19-Jun-13	2572369.9852	282686.8782	Run	Moderate	1	2	0	0	2
Hoods Creek 2	153		19-Jun-13	2572342.0361	282689.5862	Deep Pool						
Hoods Creek 2	154		19-Jun-13	2572402.4835	282622.4975	Riffle	Moderate	1	2	0	0	3
Hoods Creek 2	155		19-Jun-13	2572439.0140	282248.9096	Deep Pool						
Hoods Creek 2	156		19-Jun-13	2572293.8354	282224.6941	Run	Slow	2	2	0	0	3
Hoods Creek 2	157		19-Jun-13	2572148.9118	282168.4606	Deep Pool						
Hoods Creek 2	158		19-Jun-13	2572107.5081	282205.0196	Deep Pool						
Hoods Creek 2	159		19-Jun-13	2572025.9826	281988.2343	Deep Pool						
Hoods Creek 2	160		20-Jun-13	2572008.3741	281918.4785	Deep Pool						
Hoods Creek 2	161		20-Jun-13	2571995.2452	281871.7253	Run	Slow	2	3	0	0	1
Hoods Creek 2	162		20-Jun-13	2571879.6332	281785.8062	Deep Pool						
Hoods Creek 2	163		20-Jun-13	2571824.5844	281766.7072	Deep Pool						
Hoods Creek 2	164		20-Jun-13	2571772.5839	281793.1566	Deep Pool						
Hoods Creek 2	165		20-Jun-13	2571699.6641	281805.3820	Deep Pool						
Hoods Creek 2	166		20-Jun-13	2571655.7022	281861.8924	Run	Moderate	2	2	0	0	2
Hoods Creek 2	167		20-Jun-13	2571649.9834	281883.8707	Riffle						
Hoods Creek 2	168		20-Jun-13	2571569.2349	281757.2843	Deep Pool						
Hoods Creek 2	169		20-Jun-13	2571610.9792	281634.1612	Riffle						
Hoods Creek 2	170		20-Jun-13	2571581.3982	281596.6445	Deep Pool						
Hoods Creek 2	171		20-Jun-13	2571595.5127	281585.4234	Riffle						
Hoods Creek 2	172		20-Jun-13	2571532.0007	281523.7552	Deep Pool						
Hoods Creek 2	173		20-Jun-13	2571381.5023	281540.1131	Deep Pool						
Hoods Creek 2	174		20-Jun-13	2571330.1139	281516.0971	Run	Moderate	3	3	0	0	3
Hoods Creek 2	175		20-Jun-13	2571298.6668	281500.5046	Deep Pool						
Hoods Creek 2	176		20-Jun-13	2571192.1529	281472.6986	Deep Pool						
Hoods Creek 2	177		20-Jun-13	2571152.2554	281458.1743	Deep Pool						
Hoods Creek 2	178		20-Jun-13	2570975.4575	281437.2249	Run	Slow	2	1	0	0	3
Hoods Creek 2	179		20-Jun-13	2570884.7500	281330.0361	Deep Pool						
Hoods Creek 2	180		20-Jun-13	2570804.2823	281257.5481	Deep Pool						
Hoods Creek 2	181		20-Jun-13	2570772.8198	281216.0426	Deep Pool						
Hoods Creek 2	182		20-Jun-13	2570736.8218	281166.0181	Deep Pool						

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

Variable rank numbers are defined as follows: 0 = None or Nearly Absent (< 5.0 percent), 1 = Low Abundance (5 to 25 percent), 2 = Moderate Abundance (25 to 75 percent), and 3 = High Abundance (greater than 75 percent).

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *These coordinates are in North American Datum (NAD) 1927 State Plane Wisconsin South Federal Information Processing Standard (FIPS) 4803.*

Table I-4 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	River Mile	Sample Date	Longitude[b]	Latitude[b]	Habitat Type	Water Velocity	Amount of Cover (rank)	Woody Debris (rank)	Macrophytes (rank)	Algae (rank)	Shading (rank)
Hoods Creek 2	183		20-Jun-13	2570739.1784	281129.2249	Riffle						
Hoods Creek 2	184		20-Jun-13	2570715.5168	281119.1793	Deep Pool						
Hoods Creek 2	185		20-Jun-13	2570621.3618	281118.8879	Run	Slow	1	1	0	0	3
Hoods Creek 2	186		20-Jun-13	2570375.4666	281220.7683	Riffle						
Hoods Creek 2	187		20-Jun-13	2570314.6718	281190.1896	Deep Pool						
Hoods Creek 2	188		20-Jun-13	2570232.6847	281204.6945	Deep Pool						
Hoods Creek 2	189		20-Jun-13	2570208.5076	281206.9206	Deep Pool						
Hoods Creek 2	190		20-Jun-13	2570193.5706	281210.6653	Riffle						
Hoods Creek 2	191		20-Jun-13	2570135.8742	281186.6444	Deep Pool						
Hoods Creek 2	192		20-Jun-13	2570043.5384	281189.2136	Deep Pool						
Hoods Creek 2	193		20-Jun-13	2570041.6047	281201.4793	Run	Fast	2	3	0	0	2
Hoods Creek 2	194		20-Jun-13	2570007.3154	281202.8369	Riffle						
Hoods Creek 2	195		20-Jun-13	2569829.0458	281172.3554	Deep Pool						
Hoods Creek 2	196		20-Jun-13	2569747.2648	281279.6724	Deep Pool						
Hoods Creek 2	197		20-Jun-13	2569728.2773	281293.0323	Run	Slow	1	1	0	0	3
Hoods Creek 2	198		21-Jun-13	2569560.0860	281248.8447	Deep Pool						
Hoods Creek 2	199		21-Jun-13	2569525.0339	281207.5856	Deep Pool						
Hoods Creek 2	200		21-Jun-13	2569475.1354	281140.8305	Deep Pool						
Hoods Creek 2	201		21-Jun-13	2569474.4077	281153.4935	Deep Pool						
Hoods Creek 2	202		21-Jun-13	2569455.8729	281145.5047	Riffle						
Hoods Creek 2	203		21-Jun-13	2569416.8743	281190.3504	Deep Pool						
Hoods Creek 2	204		21-Jun-13	2569337.9362	281152.2842	Deep Pool						
Hoods Creek 2	205		21-Jun-13	2569255.1335	281066.0219	Deep Pool						
Hoods Creek 2	206		21-Jun-13	2569238.3701	281065.4123	Run	Slow	1	1	0	0	2
Hoods Creek 2	207		21-Jun-13	2569168.0087	280957.4952	Deep Pool						
Hoods Creek 2	208		21-Jun-13	2569151.3030	280952.8535	Deep Pool						
Hoods Creek 2	209		21-Jun-13	2569105.5288	280955.0208	Run	Moderate	1	1	0	0	2
Hoods Creek 2	210		21-Jun-13	2569064.3055	280957.1514	Riffle						
Hoods Creek 2	211		21-Jun-13	2568997.8693	280949.0763	Riffle						
Hoods Creek 2	212		21-Jun-13	2568807.2220	281020.9639	Riffle						
Hoods Creek 2	213		21-Jun-13	2568694.0110	280962.2587	Riffle						
Hoods Creek 2	214		21-Jun-13	2568682.0244	280960.6707	Deep Pool						
Hoods Creek 2	215		21-Jun-13	2568653.9966	280942.4798	Riffle						
Hoods Creek 2	217		1-Jul-13	2568613.4517	280969.3190	Deep Pool						
Hoods Creek 2	216		1-Jul-13	2568594.3786	280990.5001	Run	Slow	1	1	0	0	3
Hoods Creek 2	218		1-Jul-13	2568567.7382	281035.6306	Deep Pool						

NOTES: Color shades correspond to the following aquatic habitat types: Pool, Riffle, Run

Variable rank numbers are defined as follows: 0 = None or Nearly Absent (< 5.0 percent), 1 = Low Abundance (5 to 25 percent), 2 = Moderate Abundance (25 to 75 percent), and 3 = High Abundance (greater than 75 percent).

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *These coordinates are in North American Datum (NAD) 1927 State Plane Wisconsin South Federal Information Processing Standard (FIPS) 4803.*

Table I-4 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	River Mile	Sample Date	Longitude[b]	Latitude[b]	Habitat Type	Water Velocity	Amount of Cover (rank)	Woody Debris (rank)	Macrophytes (rank)	Algae (rank)	Shading (rank)
Hoods Creek 2	219		1-Jul-13	2568511.1501	281013.1391	Deep Pool						
Hoods Creek 2	220		1-Jul-13	2568510.5494	280988.0053	Riffle						
Hoods Creek 2	221		1-Jul-13	2568533.8361	280945.4483	Deep Pool						
Hoods Creek 2	222		1-Jul-13	2568453.4478	280910.3129	Riffle						
Hoods Creek 2	223		1-Jul-13	2568431.6401	280917.6738	Deep Pool						
Hoods Creek 2	224		1-Jul-13	2568306.3598	280888.9776	Riffle						
Hoods Creek 2	225		1-Jul-13	2568252.3357	280885.2227	Run	Moderate	2	2	0	0	3
Hoods Creek 2	226		1-Jul-13	2568227.1018	280914.8962	Deep Pool						
Hoods Creek 2	227		1-Jul-13	2568180.3050	280891.7070	Deep Pool						
Hoods Creek 2	228		1-Jul-13	2568045.2852	280853.6283	Deep Pool						
Hoods Creek 2	229		1-Jul-13	2568012.0143	280806.8249	Deep Pool						
Hoods Creek 2	230		1-Jul-13	2567831.9484	280821.2343	Deep Pool						
Hoods Creek 2	231		1-Jul-13	2567794.3992	280872.0781	Deep Pool						
Hoods Creek 2	232		1-Jul-13	2567735.2018	280927.5678	Riffle						
Hoods Creek 2	233		1-Jul-13	2567575.4866	280931.7082	Deep Pool						
Hoods Creek 2	234		1-Jul-13	2567510.6567	280987.3006	Deep Pool						
Hoods Creek 2	235		1-Jul-13	2567504.7807	281004.9974	Riffle						
Hoods Creek 2	236		1-Jul-13	2567497.1610	281095.0422	Run	Slow	2	2	0	0	1
Hoods Creek 2	237		1-Jul-13	2567478.4510	281104.5911	Deep Pool						
Hoods Creek 2	238		1-Jul-13	2567343.7751	281111.6291	Deep Pool						
Hoods Creek 2	239		1-Jul-13	2567264.5394	281101.1875	Run	Slow	1	2	0	0	3
Hoods Creek 2	240		1-Jul-13	2567154.3569	281153.0647	Deep Pool						
Hoods Creek 2	241		1-Jul-13	2567044.5057	281073.6124	Deep Pool						
Hoods Creek 2	242		1-Jul-13	2566990.8201	281043.1620	Riffle						
Hoods Creek 2	243		1-Jul-13	2566957.0315	280998.9443	Deep Pool						
Hoods Creek 2	244		1-Jul-13	2566879.2492	281040.4898	Deep Pool						
Hoods Creek 2	245		1-Jul-13	2566846.5983	281070.5268	Run	Moderate	3	3	1	0	2
Hoods Creek 2	246		1-Jul-13	2566778.3370	281098.0733	Deep Pool						
Hoods Creek 2	247		2-Jul-13	2566615.6125	281207.8448	Riffle						
Hoods Creek 2	248		2-Jul-13	2566586.3137	281208.6925	Deep Pool						
Hoods Creek 2	249		2-Jul-13	2566542.4467	281316.2160	Run	Moderate	2	2	0	0	2
Hoods Creek 2	250		2-Jul-13	2566562.4463	281371.3602	Deep Pool						
Hoods Creek 2	251		2-Jul-13	2566567.2422	281461.2915	Deep Pool						
Hoods Creek 2	252		2-Jul-13	2566572.6596	281499.0762	Deep Pool						
Hoods Creek 2	253		2-Jul-13	2566479.0823	281584.6544	Deep Pool						
Hoods Creek 2	254		2-Jul-13	2566409.6438	281718.4530	Riffle						

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

Variable rank numbers are defined as follows: 0 = None or Nearly Absent (< 5.0 percent), 1 = Low Abundance (5 to 25 percent), 2 = Moderate Abundance (25 to 75 percent), and 3 = High Abundance (greater than 75 percent).

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *These coordinates are in North American Datum (NAD) 1927 State Plane Wisconsin South Federal Information Processing Standard (FIPS) 4803.*

Table I-4 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	River Mile	Sample Date	Longitude[b]	Latitude[b]	Habitat Type	Water Velocity	Amount of Cover (rank)	Woody Debris (rank)	Macrophytes (rank)	Algae (rank)	Shading (rank)
Hoods Creek 2	255		2-Jul-13	2566359.5120	281728.2778	Deep Pool						
Hoods Creek 2	256		2-Jul-13	2566358.5842	281731.1269	Run	Moderate	2	2	0	0	2
Hoods Creek 2	257		2-Jul-13	2566229.5979	281687.8943	Riffle						
Hoods Creek 2	258		2-Jul-13	2566156.4176	281689.1916	Run	Moderate	1	1	0	0	3
Hoods Creek 2	259		2-Jul-13	2566091.2917	281642.7160	Deep Pool						
Hoods Creek 2	260		2-Jul-13	2566060.2921	281572.7797	Riffle						
Hoods Creek 2	261		2-Jul-13	2566015.7132	281525.9682	Deep Pool						
Hoods Creek 2	262		2-Jul-13	2566001.4737	281554.7302	Riffle						
Hoods Creek 2	263		2-Jul-13	2565844.9779	281560.0032	Deep Pool						
Hoods Creek 2	264		2-Jul-13	2565704.6911	281477.2826	Run	Slow	1	1	0	0	3
Hoods Creek 2	265		2-Jul-13	2565665.6069	281420.6491	Deep Pool						
Hoods Creek 2	266		2-Jul-13	2565651.1260	281368.9458	Deep Pool						
Hoods Creek 2	267		2-Jul-13	2565397.8341	281359.9508	Riffle						
Hoods Creek 2	268		2-Jul-13	2565361.1610	281386.1604	Deep Pool						
Hoods Creek 2	269		2-Jul-13	2565359.7456	281414.5744	Riffle						
Hoods Creek 2	270		2-Jul-13	2565386.0986	281453.6816	Deep Pool						
Hoods Creek 2	271		2-Jul-13	2565407.0228	281456.2573	Riffle						
Hoods Creek 2	272		2-Jul-13	2565429.8170	281546.2152	Run	Slow	3	2	0	0	3
Hoods Creek 2	273		3-Jul-13	2565249.7258	281714.5039	Run	Moderate	1	2	0	0	2
Hoods Creek 2	274		3-Jul-13	2565157.5584	281673.0939	Riffle						
Hoods Creek 2	275		3-Jul-13	2565116.4679	281680.7349	Deep Pool						
Hoods Creek 2	276		3-Jul-13	2564991.6184	281839.3888	Riffle						
Hoods Creek 2	277		3-Jul-13	2564976.3087	281903.4799	Deep Pool						
Hoods Creek 2	278		3-Jul-13	2564802.2120	281793.3265	Riffle	Moderate	2	2	1	0	1
Hoods Creek 2	279		3-Jul-13	2564802.2120	281793.3265	Riffle						
Hoods Creek 2	280		3-Jul-13	2564736.3302	281719.5783	Deep Pool						
Hoods Creek 2	281		3-Jul-13	2564725.0966	281672.9692	Deep Pool						
Hoods Creek 2	282		3-Jul-13	2564544.7663	281690.2401	Deep Pool						
Hoods Creek 2	283		3-Jul-13	2564523.0560	281680.4334	Riffle						
Hoods Creek 2	284		3-Jul-13	2564489.0240	281672.5168	Deep Pool						
Hoods Creek 2	285		3-Jul-13	2564465.6831	281700.5915	Riffle						
Hoods Creek 2	286		3-Jul-13	2564301.7986	281794.4906	Run	Slow	1	1	0	0	3
Hoods Creek 2	287		3-Jul-13	2564063.5117	281825.6756	Deep Pool						
Hoods Creek 2	288		3-Jul-13	2563750.3778	281858.2477	Deep Pool						
Hoods Creek 2	289		3-Jul-13	2563730.0744	281892.7253	Riffle						
Hoods Creek 2	290		3-Jul-13	2563468.8882	281904.1495	Deep Pool						

NOTES: Color shades correspond to the following aquatic habitat types: Pool, Riffle, Run

Variable rank numbers are defined as follows: 0 = None or Nearly Absent (< 5.0 percent), 1 = Low Abundance (5 to 25 percent), 2 = Moderate Abundance (25 to 75 percent), and 3 = High Abundance (greater than 75 percent).

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *These coordinates are in North American Datum (NAD) 1927 State Plane Wisconsin South Federal Information Processing Standard (FIPS) 4803.*

Table I-4 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	River Mile	Sample Date	Longitude[b]	Latitude[b]	Habitat Type	Water Velocity	Amount of Cover (rank)	Woody Debris (rank)	Macrophytes (rank)	Algae (rank)	Shading (rank)
Hoods Creek 2	291		3-Jul-13	2563445.6842	281923.2758	Deep Pool						
Hoods Creek 2	292		3-Jul-13	2563432.1475	281980.6283	Run	Moderate	3	2	2	0	1
Hoods Creek 2	293		3-Jul-13	2563376.8605	282045.9451	Deep Pool						
Hoods Creek 2	294		3-Jul-13	2563382.9783	282083.8378	Deep Pool						
Hoods Creek 2	295		3-Jul-13	2563325.7992	282161.7277	Deep Pool						
Hoods Creek 3	296		5-Jul-13	2563186.2211	282218.9658	Run	Slow	1	1	1	0	3
Hoods Creek 3	297		5-Jul-13	2562810.5755	282376.2135	Deep Pool						
Hoods Creek 3	298		5-Jul-13	2562782.4024	282374.4356	Deep Pool						
Hoods Creek 3	299		5-Jul-13	2562714.8815	282372.0052	Run	Slow	1	1	1	1	1
Hoods Creek 3	300		5-Jul-13	2562678.1437	282381.2883	Deep Pool						
Hoods Creek 3	301		5-Jul-13	2562277.6186	282200.5298	Run	Slow	1	1	2	1	1
Hoods Creek 3	302		5-Jul-13	2562165.1671	281779.3377	Run	Slow	1	1	2	1	1
Hoods Creek 3	303		5-Jul-13	2561923.2079	281383.5902	Run	Slow	1	0	2	1	1
Hoods Creek 3	304		8-Jul-13	2561835.7619	281275.7879	Deep Pool						
Hoods Creek 3	305		8-Jul-13	2561705.6463	281105.7075	Run	Slow	2	0	3	2	0
Hoods Creek 3	306		8-Jul-13	2561662.6477	280805.1619	Deep Pool						
Hoods Creek 3	307		8-Jul-13	2561666.6251	280665.4594	Deep Pool						
Hoods Creek 3	308		8-Jul-13	2561711.3038	280522.8665	Deep Pool						
Hoods Creek 3	309		8-Jul-13	2561727.7887	280478.9099	Run	Slow	3	0	2	2	0
Hoods Creek 3	310		8-Jul-13	2561820.2937	279828.6976	Deep Pool						
Hoods Creek 3	311		8-Jul-13	2561837.3081	279675.6936	Run	Slow	2	1	2	2	0
Hoods Creek 3	312		9-Jul-13	2562004.0014	279236.6952	Deep Pool						
Hoods Creek 3	313		9-Jul-13	2562052.2270	278979.9053	Run	Slow	2	0	3	2	0
Hoods Creek 3	314		9-Jul-13	2562020.0729	278834.1625	Deep Pool						
Hoods Creek 3	315		9-Jul-13	2562188.8753	278443.4084	Deep Pool						
Hoods Creek 3	316		9-Jul-13	2562230.9074	278343.7140	Run	Slow	2	0	3	2	0
Hoods Creek 3	317		9-Jul-13	2562279.7157	278186.7718	Deep Pool						
Hoods Creek 3	318		9-Jul-13	2562029.6450	277531.0473	Run	Slow	2	1	3	2	1
Hoods Creek 3	319		9-Jul-13	2561976.9617	277243.7339	Deep Pool						
Hoods Creek 3	320		12-Jul-13	2561930.9303	276995.5796	Deep Pool						
Hoods Creek 3	321		12-Jul-13	2561818.6815	276851.2498	Deep Pool						
Hoods Creek 3	322		12-Jul-13	2561784.1002	276819.1216	Deep Pool						
Hoods Creek 3	323		12-Jul-13	2561755.1344	276793.8874	Run	Slow	2	1	3	1	0
Hoods Creek 3	324		12-Jul-13	2561580.7683	276643.7532	Deep Pool						
Hoods Creek 3	325		12-Jul-13	2561406.1528	276480.1075	Riffle						
Hoods Creek 3	326		12-Jul-13	2561178.0785	276301.2814	Run	Slow	2	1	2	0	0

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

Variable rank numbers are defined as follows: 0 = None or Nearly Absent (< 5.0 percent), 1 = Low Abundance (5 to 25 percent), 2 = Moderate Abundance (25 to 75 percent), and 3 = High Abundance (greater than 75 percent).

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*These coordinates are in North American Datum (NAD) 1927 State Plane Wisconsin South Federal Information Processing Standard (FIPS) 4803.*

Table I-4 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	River Mile	Sample Date	Longitude[b]	Latitude[b]	Habitat Type	Water Velocity	Amount of Cover (rank)	Woody Debris (rank)	Macrophytes (rank)	Algae (rank)	Shading (rank)
Hoods Creek 3	327		12-Jul-13	2561114.0104	276243.0217	Deep Pool						
Hoods Creek 3	328		12-Jul-13	2561077.2736	275603.5948	Run	Slow	2	0	3	0	0
Hoods Creek 3	329		12-Jul-13	2561010.9141	275242.8164	Deep Pool						
Hoods Creek 3	330		12-Jul-13	2560925.7145	274821.0620	Run	Moderate	2	0	3	1	0
Hoods Creek 3	331		15-Jul-13	2560729.4143	274465.4954	Run	Slow	1	0	2	2	0
Hoods Creek 3	332		15-Jul-13	2560532.3842	274219.8594	Run	Slow	2	0	3	1	0
Hoods Creek 3	333		15-Jul-13	2560286.4497	273918.9453	Run	Slow	1	0	1	0	0
Hoods Creek 3	334		15-Jul-13	2560229.7008	273852.3152	Deep Pool						
Hoods Creek 3	335		15-Jul-13	2560213.5276	273830.6118	Deep Pool						
Hoods Creek 3	336		15-Jul-13	2559973.4811	273600.2232	Run	Slow	1	0	2	2	0
Hoods Creek 3	337		15-Jul-13	2559531.3672	273126.4072	Run	Slow	2	0	2	0	0
Hoods Creek 3	338		16-Jul-13	2559401.7382	272703.2132	Run	Slow	2	0	2	0	1
Hoods Creek 3	339		16-Jul-13	2559297.2230	271639.4223	Run	Slow	1	0	2	0	1
Hoods Creek 3	340		16-Jul-13	2558969.2125	270623.1944	Run	Slow	1	0	3	0	1
Hoods Creek 3	341		16-Jul-13	2558506.6619	270006.9190	Run	Slow	2	0	2	0	1
Hoods Creek 3	342		16-Jul-13	2558184.2780	269693.8258	Riffle						
Hoods Creek 3	343		16-Jul-13	2558145.4950	269647.9089	Deep Pool						

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

Variable rank numbers are defined as follows: 0 = None or Nearly Absent (< 5.0 percent), 1 = Low Abundance (5 to 25 percent), 2 = Moderate Abundance (25 to 75 percent), and 3 = High Abundance (greater than 75 percent).

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *These coordinates are in North American Datum (NAD) 1927 State Plane Wisconsin South Federal Information Processing Standard (FIPS) 4803.*

Source: SEWRPC.

Table I-5

QUANTITATIVE STREAMBANK AND BANKFULL CHARACTERISTICS AMONG HABITAT TYPES WITHIN HOODS CREEK: 2013

Reach	Survey ID[a] (see Maps I-18 through I-20)	Left Bank Length (feet)	Left Bank Height (feet)	Left Bank Slope	Left Bank Undercut (feet)	Right Bank Length (feet)	Right Bank Height (feet)	Right Bank Slope	Right Bank Undercut (feet)	Bankfull Width (feet)	Bankfull Depth-1 (feet)[b]	Bankfull Depth-2 (feet)[b]	Bankfull Depth-3 (feet)[b]	Bankfull Depth-4 (feet)[b]	Bankfull Depth-5 (feet)[b]	Bankfull Mean Depth (feet)	Bankfull Maximum Depth (feet)
Hoods Creek 1	1	6.5	3.0	0.5		7.0	3.3	0.5		33.1	3.2	3.2	3.3	3.4	3.4	3.3	3.4
Hoods Creek 1	2																
Hoods Creek 1	2																
Hoods Creek 1	4																
Hoods Creek 1	5																
Hoods Creek 1	6																
Hoods Creek 1	7																
Hoods Creek 1	8																
Hoods Creek 1	9	8.1	3.9	0.5		10.1	3.9	0.4		52.5	4.3	4.5	4.4	3.6	3.5	4.1	4.5
Hoods Creek 1	10																
Hoods Creek 1	11																
Hoods Creek 1	12																
Hoods Creek 1	13	5.8	3.3	0.6		13.4	3.1	0.2		44.7	4.5	4.9	5.1	4.4	3.4	4.5	5.1
Hoods Creek 1	14																
Hoods Creek 1	15	6.5	3.0	0.5		4.4	3.2	0.7		40.5	3.3	3.2	3.1	3.1	3.1	3.2	3.3
Hoods Creek 1	16																
Hoods Creek 1	17																
Hoods Creek 1	18																
Hoods Creek 1	19																
Hoods Creek 1	20																
Hoods Creek 1	21																
Hoods Creek 1	22	2.5	1.9	0.8		6.8	2.5	0.4		39.3	2.5	2.2	2.2	2.8	2.7	2.5	2.8
Hoods Creek 1	23																
Hoods Creek 1	24																
Hoods Creek 1	25																
Hoods Creek 1	26																
Hoods Creek 1	27																
Hoods Creek 1	28																
Hoods Creek 1	29																
Hoods Creek 1	30	3.6	3.1	0.9		1.7	3.2	1.9		27.8	3.7	3.8	3.8	3.7	3.4	3.7	3.8
Hoods Creek 1	31																
Hoods Creek 1	33																
Hoods Creek 1	33																
Hoods Creek 1	34																
Hoods Creek 1	35																
Hoods Creek 1	36	3.9	3.1	0.8		12.3	3.2	0.3		38.5	4.1	4.5	4.0	4.1	3.5	4.0	4.5

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

Table I-5 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Left Bank Length (feet)	Left Bank Height (feet)	Left Bank Slope	Left Bank Undercut (feet)	Right Bank Length (feet)	Right Bank Height (feet)	Right Bank Slope	Right Bank Undercut (feet)	Bankfull Width (feet)	Bankfull Depth-1 (feet)[b]	Bankfull Depth-2 (feet)[b]	Bankfull Depth-3 (feet)[b]	Bankfull Depth-4 (feet)[b]	Bankfull Depth-5 (feet)[b]	Bankfull Mean Depth (feet)	Bankfull Maximum Depth (feet)
Hoods Creek 1	37																
Hoods Creek 1	38																
Hoods Creek 1	39																
Hoods Creek 1	40																
Hoods Creek 1	41	0.5	2.1	4.2		1.4	2.6	1.9		28.5	3.1	3.5	3.9	4.0	4.2	3.7	4.2
Hoods Creek 1	42																
Hoods Creek 1	43																
Hoods Creek 1	44																
Hoods Creek 1	45																
Hoods Creek 1	46	4.1	2.4	0.6		2.8	2.7	1.0		30.3	3.4	3.5	3.5	1.3	3.2	3.0	3.5
Hoods Creek 1	47																
Hoods Creek 1	48																
Hoods Creek 1	49																
Hoods Creek 1	50																
Hoods Creek 1	51	0.4	1.8	4.5		3.9	1.9	0.5		31.9	2.4	1.9	2.0	2.0	2	2.1	2.4
Hoods Creek 1	52																
Hoods Creek 1	53																
Hoods Creek 1	54																
Hoods Creek 1	55																
Hoods Creek 1	56																
Hoods Creek 1	57																
Hoods Creek 1	58																
Hoods Creek 1	59	3.5	2.6	0.7		2.8	2.9	1.0		32.9	2.8	3.0	3.1	3.2	3.5	3.1	3.5
Hoods Creek 1	60																
Hoods Creek 1	61																
Hoods Creek 1	62																
Hoods Creek 1	63																
Hoods Creek 1	64																
Hoods Creek 1	65																
Hoods Creek 1	66																
Hoods Creek 1	67																
Hoods Creek 1	68	2.3	2.3	1.0		4.8	2.5	0.5		28.4	2.7	2.9	3.1	2.9	2.8	2.9	3.1
Hoods Creek 1	69																
Hoods Creek 1	70	3.5	1.2	0.3		6.6	1.6	0.2		30.3	1.8	1.7	1.8	2.0	2.1	1.9	2.1
Hoods Creek 1	71																
Hoods Creek 1	72																
Hoods Creek 1	73																

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

Table I-5 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Left Bank				Right Bank				Bankfull							
		Length (feet)	Height (feet)	Slope	Undercut (feet)	Length (feet)	Height (feet)	Slope	Undercut (feet)	Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 1	74																
Hoods Creek 1	75																
Hoods Creek 1	76																
Hoods Creek 1	77																
Hoods Creek 1	78																
Hoods Creek 1	79																
Hoods Creek 1	80																
Hoods Creek 1	81																
Hoods Creek 1	82	3.2	3.0	0.9		5.9	3.2	0.5		30.5	4.1	4.2	3.5	3.2	3.2	3.6	4.2
Hoods Creek 1	83																
Hoods Creek 1	84																
Hoods Creek 1	85																
Hoods Creek 1	86																
Hoods Creek 1	87																
Hoods Creek 1	88																
Hoods Creek 1	89																
Hoods Creek 1	90	2.9	1.7	0.6		3.0	2.0	0.7		29.1	2.0	2.5	2.6	3.0	2.7	2.6	3.0
Hoods Creek 1	91																
Hoods Creek 1	92																
Hoods Creek 1	93																
Hoods Creek 1	94																
Hoods Creek 1	95																
Hoods Creek 1	96	12.3	2.4	0.2		11.4	2.6	0.2		39.2	2.8	2.6	2.7	2.8		2.7	2.8
Hoods Creek 1	97																
Hoods Creek 1	98																
Hoods Creek 1	99																
Hoods Creek 1	100																
Hoods Creek 1	101	0.6	1.5	2.5		2.9	1.5	0.5		28.3	2.5	2.9	2.9	2.6	1.6	2.5	2.9
Hoods Creek 1	102																
Hoods Creek 1	103	1.5	2.0	1.3		4.1	1.9	0.5		29.8	2.7	2.5	2.1	2.3	2.3	2.4	2.7
Hoods Creek 1	104	3.9	1.3	0.3		3.8	1.8	0.5		30.0	1.7	2.1	2.0	2.1	2.4	2.1	2.4
Hoods Creek 1	105																
Hoods Creek 1	106	4.3	1.9	0.4		1.7	2.2	1.3		19.7	2.2	2.4	2.8	3.3	3.4	2.8	3.4
Hoods Creek 1	107																
Hoods Creek 1	108																
Hoods Creek 1	109	2.7	2.9	1.1		3.1	2.8	0.9		28.8	4.5	4.9	4.8	4.4	3.8	4.5	4.9

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

Table I-5 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Left Bank Length (feet)	Left Bank Height (feet)	Left Bank Slope	Left Bank Undercut (feet)	Right Bank Length (feet)	Right Bank Height (feet)	Right Bank Slope	Right Bank Undercut (feet)	Bankfull Width (feet)	Bankfull Depth-1 (feet)[b]	Bankfull Depth-2 (feet)[b]	Bankfull Depth-3 (feet)[b]	Bankfull Depth-4 (feet)[b]	Bankfull Depth-5 (feet)[b]	Bankfull Mean Depth (feet)	Bankfull Maximum Depth (feet)
Hoods Creek 2	110	6.0	1.5	0.3		2.9	1.6	0.6		21.3	2.3	2.6	2.7	2.7	2.7	2.6	2.7
Hoods Creek 2	111																
Hoods Creek 2	112																
Hoods Creek 2	113																
Hoods Creek 2	114																
Hoods Creek 2	115																
Hoods Creek 2	116																
Hoods Creek 2	117																
Hoods Creek 2	118	1.6	1.7	1.1		3.3	1.4	0.4		21.6	2.0	1.8	1.8	1.0	1.9	1.7	2.0
Hoods Creek 2	119																
Hoods Creek 2	120																
Hoods Creek 2	121																
Hoods Creek 2	122																
Hoods Creek 2	123																
Hoods Creek 2	124	4.1	2.4	0.6		3.4	2.3	0.7		14.9	3.0	3.5	3.6	3.3	2.9	3.3	3.6
Hoods Creek 2	125																
Hoods Creek 2	126																
Hoods Creek 2	127																
Hoods Creek 2	128																
Hoods Creek 2	129																
Hoods Creek 2	130																
Hoods Creek 2	131																
Hoods Creek 2	132																
Hoods Creek 2	133	1.9	0.7	0.4		3.3	1.0	0.3		18.7	1.1	1.7	2.1	2.7	2.2	2.0	2.7
Hoods Creek 2	134																
Hoods Creek 2	135																
Hoods Creek 2	136																
Hoods Creek 2	137																
Hoods Creek 2	138																
Hoods Creek 2	139																
Hoods Creek 2	140																
Hoods Creek 2	141	4.9	1.2	0.2		2.2	1.5	0.7		34.3	2.9	4.2	3.5	2.9	2.5	3.2	4.2
Hoods Creek 2	142																
Hoods Creek 2	143																
Hoods Creek 2	144																
Hoods Creek 2	145	2.1	1.8	0.9		3.1	2.1	0.7		35.9	3.1	2.9	4.1	3.7	3	3.4	4.1

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *Depth measurements were spaced approximately evenly across each section.*

Table I-5 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Left Bank				Right Bank				Bankfull							
		Length (feet)	Height (feet)	Slope	Undercut (feet)	Length (feet)	Height (feet)	Slope	Undercut (feet)	Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 2	146																
Hoods Creek 2	147																
Hoods Creek 2	148																
Hoods Creek 2	149																
Hoods Creek 2	150																
Hoods Creek 2	151																
Hoods Creek 2	152	2.5	1.4	0.6		2.5	1.9	0.8		21.8	2.0	2.4	3.1	3.6	4	3.0	4.0
Hoods Creek 2	153																
Hoods Creek 2	154	2.5	2.2	0.9		4.0	2.9	0.7		25.2	3.1	3.2	3.1	3.1	3.1	3.1	3.2
Hoods Creek 2	155																
Hoods Creek 2	156	5.1	2.0	0.4	0.6	4.2	2.1	0.5		23.0	5.0	5.0	4.7	4.6	3.8	4.6	5.0
Hoods Creek 2	157																
Hoods Creek 2	158																
Hoods Creek 2	159																
Hoods Creek 2	160																
Hoods Creek 2	161	4.0	2.2	0.6	0.8	3.9	2.6	0.7		27.1	4.1	4.1	4.2	4.2	3.8	4.1	4.2
Hoods Creek 2	162																
Hoods Creek 2	163																
Hoods Creek 2	164																
Hoods Creek 2	165																
Hoods Creek 2	166	2.8	3.2	1.1		5.3	3.1	0.6		27.1	3.9	4.2	4.4	4.1	3.8	4.1	4.4
Hoods Creek 2	167																
Hoods Creek 2	168																
Hoods Creek 2	169																
Hoods Creek 2	170																
Hoods Creek 2	171																
Hoods Creek 2	172																
Hoods Creek 2	173																
Hoods Creek 2	174	4.6	2.4	0.5		2.9	2.5	0.9		24.8	2.8	3.0	3.0	0.9	3	2.5	3.0
Hoods Creek 2	175																
Hoods Creek 2	176																
Hoods Creek 2	177																
Hoods Creek 2	178	3.1	2.5	0.8		4.3	2.8	0.7		24.3	3.1	3.4	3.8	4.4	4.1	3.8	4.4
Hoods Creek 2	179																
Hoods Creek 2	180																
Hoods Creek 2	181																

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *Depth measurements were spaced approximately evenly across each section.*

Table I-5 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Left Bank				Right Bank				Bankfull							
		Length (feet)	Height (feet)	Slope	Undercut (feet)	Length (feet)	Height (feet)	Slope	Undercut (feet)	Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 2	182																
Hoods Creek 2	183																
Hoods Creek 2	184																
Hoods Creek 2	185	5.1	3.7	0.7		5.4	3.3	0.6		28.3	4.9	5.7	5.2	4.9	4.6	5.1	5.7
Hoods Creek 2	186																
Hoods Creek 2	187																
Hoods Creek 2	188																
Hoods Creek 2	189																
Hoods Creek 2	190																
Hoods Creek 2	191																
Hoods Creek 2	192																
Hoods Creek 2	193	2.5	1.7	0.7		5.0	2.0	0.4		26.1	2.6	3.3	3.6	3.5	3.2	3.2	3.6
Hoods Creek 2	194																
Hoods Creek 2	195																
Hoods Creek 2	196																
Hoods Creek 2	197	1.2	1.2	1.0		2.4	1.3	0.5		18.1	2.4	2.9	2.6	2.3	2.3	2.5	2.9
Hoods Creek 2	198																
Hoods Creek 2	199																
Hoods Creek 2	200																
Hoods Creek 2	201																
Hoods Creek 2	202																
Hoods Creek 2	203																
Hoods Creek 2	204																
Hoods Creek 2	205																
Hoods Creek 2	206	2.8	2.2	0.8		5.1	2.6	0.5		27.0	3.5	3.9	4.0	3.9	3.5	3.8	4.0
Hoods Creek 2	207																
Hoods Creek 2	208																
Hoods Creek 2	209	2.1	1.4	0.7		2.7	1.7	0.6		15.8	2.2	2.6	2.8	2.9	2.7	2.6	2.9
Hoods Creek 2	210																
Hoods Creek 2	211																
Hoods Creek 2	212																
Hoods Creek 2	213																
Hoods Creek 2	214																
Hoods Creek 2	215																
Hoods Creek 2	216	1.0	1.9	1.9		3.9	2.2	0.6		22.4	3.0	3.7	3.3	2.7	2.4	3.0	3.7
Hoods Creek 2	217																

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *Depth measurements were spaced approximately evenly across each section.*

Table I-5 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Left Bank				Right Bank				Bankfull							
		Length (feet)	Height (feet)	Slope	Undercut (feet)	Length (feet)	Height (feet)	Slope	Undercut (feet)	Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 2	218																
Hoods Creek 2	219																
Hoods Creek 2	220																
Hoods Creek 2	221																
Hoods Creek 2	222																
Hoods Creek 2	223																
Hoods Creek 2	224																
Hoods Creek 2	225	1.8	1.2	0.7		1.4	1.4	1.0		14.6	3.0	3.3	3.4	3.2	3	3.2	3.4
Hoods Creek 2	226																
Hoods Creek 2	227																
Hoods Creek 2	228																
Hoods Creek 2	229																
Hoods Creek 2	230																
Hoods Creek 2	231																
Hoods Creek 2	232																
Hoods Creek 2	232																
Hoods Creek 2	234																
Hoods Creek 2	235																
Hoods Creek 2	236	2.1	2.4	1.1		2.6	2.8	1.1		22.4	3.7	3.8	4.0	4.3	3.6	3.9	4.3
Hoods Creek 2	237																
Hoods Creek 2	238																
Hoods Creek 2	239	2.7	3.2	1.2		3.2	3.3	1.0		24.8	3.9	2.8	3.9	3.9	3.9	3.7	3.9
Hoods Creek 2	240																
Hoods Creek 2	241																
Hoods Creek 2	242																
Hoods Creek 2	243																
Hoods Creek 2	244																
Hoods Creek 2	245	2.3	2.4	1.0		3.0	2.7	0.9		22.7	3.1	3.0	3.3	3.2	3.6	3.2	3.6
Hoods Creek 2	246																
Hoods Creek 2	247																
Hoods Creek 2	248																
Hoods Creek 2	249	2.0	2.0	1.0		4.7	2.1	0.4		25.5	3.9	2.8	3.2	3.0	2.5	3.1	3.9
Hoods Creek 2	250																
Hoods Creek 2	251																
Hoods Creek 2	252																
Hoods Creek 2	253																

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

Table I-5 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Left Bank Length (feet)	Left Bank Height (feet)	Left Bank Slope	Left Bank Undercut (feet)	Right Bank Length (feet)	Right Bank Height (feet)	Right Bank Slope	Right Bank Undercut (feet)	Bankfull Width (feet)	Bankfull Depth-1 (feet)[b]	Bankfull Depth-2 (feet)[b]	Bankfull Depth-3 (feet)[b]	Bankfull Depth-4 (feet)[b]	Bankfull Depth-5 (feet)[b]	Bankfull Mean Depth (feet)	Bankfull Maximum Depth (feet)
Hoods Creek 2	254																
Hoods Creek 2	255																
Hoods Creek 2	256	2.3	1.4	0.6		7.1	1.6	0.2		19.4	3.1	3.2	2.7	3.1	3	3.0	3.2
Hoods Creek 2	257																
Hoods Creek 2	258	3.1	1.4	0.5		2.2	1.7	0.8		19.7	2.5	3.1	3.2	3.5	3	3.1	3.5
Hoods Creek 2	259																
Hoods Creek 2	260																
Hoods Creek 2	261																
Hoods Creek 2	262																
Hoods Creek 2	263																
Hoods Creek 2	264	4.5	2.9	0.6		3.7	3.1	0.8		24.5	3.5	3.7	3.5	3.6	3.8	3.6	3.8
Hoods Creek 2	265																
Hoods Creek 2	266																
Hoods Creek 2	267																
Hoods Creek 2	268																
Hoods Creek 2	269																
Hoods Creek 2	270																
Hoods Creek 2	271																
Hoods Creek 2	272	2.3	2.3	1.0		3.9	3.0	0.8		23.7	4.2	4.1	3.5	3.8	3.8	3.9	4.2
Hoods Creek 2	273	1.4	2.4	1.7		3.6	2.2	0.6		27.2	2.8	2.9	3.0	3.0	3.1	3.0	3.1
Hoods Creek 2	274																
Hoods Creek 2	275																
Hoods Creek 2	276																
Hoods Creek 2	277																
Hoods Creek 2	278	5.4	2.6	0.5		1.5	3.3	2.2	0.7	29.4	3.2	2.9	3.0	2.9	3.1	3.0	3.2
Hoods Creek 2	279																
Hoods Creek 2	280																
Hoods Creek 2	281																
Hoods Creek 2	282																
Hoods Creek 2	283																
Hoods Creek 2	284																
Hoods Creek 2	285																
Hoods Creek 2	286	1.4	2.2	1.6		2.9	2.2	0.8		21.9	3.1	3.3	3.2	2.9	2.8	3.1	3.3
Hoods Creek 2	287																

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *Depth measurements were spaced approximately evenly across each section.*

Table I-5 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Left Bank				Right Bank				Bankfull							
		Length (feet)	Height (feet)	Slope	Undercut (feet)	Length (feet)	Height (feet)	Slope	Undercut (feet)	Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 2	288																
Hoods Creek 2	289																
Hoods Creek 2	290																
Hoods Creek 2	291																
Hoods Creek 2	292	2.6	2.9	1.1		2.7	3.5	1.3		23.4	3.9	4.0	4.0	4.1	4.6	4.1	4.6
Hoods Creek 2	293																
Hoods Creek 2	294																
Hoods Creek 2	295																
Hoods Creek 3	296	3.0	2.5	0.8		2.2	2.8	1.3		22.2	4.1	4.5	4.8	4.6	3.8	4.4	4.8
Hoods Creek 3	297																
Hoods Creek 3	298																
Hoods Creek 3	299	1.6	2.4	1.5		5.3	3.8	0.7	1.5	22.0	3.8	4.8	5.1	5.1	4.2	4.6	5.1
Hoods Creek 3	300																
Hoods Creek 3	301	1.3	2.4	1.8		3.4	2.8	0.8		20.2	3.8	5.1	5.3	5.3	4.8	4.9	5.3
Hoods Creek 3	302	1.9	2.0	1.1		0.6	2.2	3.7		17.2	3.1	3.5	3.5	2.5	3	3.1	3.5
Hoods Creek 3	303	3.3	2.6	0.8		3.5	2.7	0.8		20.7	3.9	4.3	3.9	3.7	3.4	3.8	4.3
Hoods Creek 3	304																
Hoods Creek 3	305	1.9	2.8	1.5		3.4	3.0	0.9		17.5	3.5	4.0	3.7			3.7	4.0
Hoods Creek 3	306																
Hoods Creek 3	307																
Hoods Creek 3	308																
Hoods Creek 3	309	1.7	2.4	1.4		16.5	2.3	0.1		17.1	2.8	3.5	4.1	3.3	2.7	3.3	4.1
Hoods Creek 3	310																
Hoods Creek 3	311	1.8	2.8	1.6		3.8	3.0	0.8	0.3	16.8	3.8	4.4	4.8	4.7	3.9	4.3	4.8
Hoods Creek 3	312																
Hoods Creek 3	313	3.1	1.7	0.5		1.5	2.3	1.5		15.8	2.6	3.1	2.9	2.8	2.7	2.8	3.1
Hoods Creek 3	314																
Hoods Creek 3	315																
Hoods Creek 3	316	1.7	2.4	1.4		3.8	2.8	0.7		17.0	3.8	3.9	3.6	3.8	3.7	3.8	3.9
Hoods Creek 3	317																
Hoods Creek 3	318	2.0	2.0	1.0		2.9	1.8	0.6		16.3	2.6	2.6	3.1	3.5	3.1	3.0	3.5
Hoods Creek 3	319																
Hoods Creek 3	320																
Hoods Creek 3	321																
Hoods Creek 3	322																
Hoods Creek 3	322	0.9	3.0	3.3	0.4	2.5	2.5	1.0		18.1	3.7	3.7	3.8	3.8	3.9	3.8	3.9
Hoods Creek 3	324																

NOTES: Color shades correspond to the following aquatic habitat types: Pool (blue) Riffle (yellow) Run (green)

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

Table I-5 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Left Bank Length (feet)	Left Bank Height (feet)	Left Bank Slope	Left Bank Undercut (feet)	Right Bank Length (feet)	Right Bank Height (feet)	Right Bank Slope	Right Bank Undercut (feet)	Bankfull Width (feet)	Bankfull Depth-1 (feet)[b]	Bankfull Depth-2 (feet)[b]	Bankfull Depth-3 (feet)[b]	Bankfull Depth-4 (feet)[b]	Bankfull Depth-5 (feet)[b]	Bankfull Mean Depth (feet)	Bankfull Maximum Depth (feet)
Hoods Creek 3	325																
Hoods Creek 3	326	1.1	2.6	2.4		1.8	2.2	1.2		17.5	3.6	3.8	3.8	4.1	3.9	3.8	4.1
Hoods Creek 3	327																
Hoods Creek 3	328	1.2	2.3	1.9		2.3	2.5	1.1		21.4	3.4	3.6	3.5	3.5	3.5	3.5	3.6
Hoods Creek 3	329																
Hoods Creek 3	330	1.9	2.2	1.2		3.9	2.4	0.6		22.0	4.0	4.3	4.2	4.2	3.3	4.0	4.3
Hoods Creek 3	331	0.9	1.7	1.9		4.1	2.1	0.5		22.5	2.2	2.2	2.2	2.3	3.1	2.4	3.1
Hoods Creek 3	332	1.7	1.4	0.8		3.1	1.3	0.4		16.4	2.4	2.6	2.5	2.6	2.1	2.4	2.6
Hoods Creek 3	333	3.3	2.3	0.7		3.0	2.7	0.9		16.2	3.2	3.4	3.6	3.4	3.2	3.4	3.6
Hoods Creek 3	334																
Hoods Creek 3	335																
Hoods Creek 3	336	1.4	1.8	1.3		3.8	2.1	0.6		17.1	2.8	2.7	2.4	2.5	2.4	2.6	2.8
Hoods Creek 3	337	1.7	2.5	1.5		2.3	2.6	1.1		14.4	3.2	3.7	3.8	3.7	3.4	3.6	3.8
Hoods Creek 3	338	1.7	2.1	1.2		1.9	2.2	1.2		12.3	2.8	2.9	3.4			3.0	3.4
Hoods Creek 3	339	1.9	2.7	1.4		3.3	2.7	0.8		13.3	2.9	3.6	3.5			3.3	3.6
Hoods Creek 3	340	1.1	2.0	1.8		3.3	2.1	0.6		10.5	2.7	2.9	2.8			2.8	2.9
Hoods Creek 3	341	1.5	2.0	1.3		1.2	2.3	1.9		8.6	2.6	2.9	3.1			2.9	3.1
Hoods Creek 3	342																
Hoods Creek 3	343																

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

Source: SEWRPC.

Table I-6

QUANTITATIVE INSTREAM LOW FLOW CHARACTERISTICS AMONG HABITAT TYPES WITHIN HOODS CREEK: 2013

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow												
		Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 1	1	19.2	0.2	0.2	0.4	0.4	0.4						0.3	0.4
Hoods Creek 1	2													1.7
Hoods Creek 1	3													1.7
Hoods Creek 1	4												0.4	
Hoods Creek 1	5													2.0
Hoods Creek 1	6													2.1
Hoods Creek 1	7													1.8
Hoods Creek 1	8												0.4	
Hoods Creek 1	9	16.1	0.4	0.7	0.5	0.0	0.0						0.3	0.7
Hoods Creek 1	10													1.5
Hoods Creek 1	11												0.3	
Hoods Creek 1	12													3.4
Hoods Creek 1	13	26.1	1.4	1.9	2.2	1.5	0.5						1.5	2.2
Hoods Creek 1	14												0.6	
Hoods Creek 1	15	29.8	0.2	0.2	0.3	0.3	0.2						0.2	0.3
Hoods Creek 1	16												0.4	
Hoods Creek 1	17													2.6
Hoods Creek 1	18												0.5	
Hoods Creek 1	19													1.8
Hoods Creek 1	20												0.5	
Hoods Creek 1	21												0.4	
Hoods Creek 1	22	30.1	0.6	0.5	0.4	0.9	0.6						0.6	0.9
Hoods Creek 1	23													1.5
Hoods Creek 1	24												0.5	
Hoods Creek 1	25												0.6	
Hoods Creek 1	26													2.0
Hoods Creek 1	27													2.1
Hoods Creek 1	28												0.3	
Hoods Creek 1	29													2.3
Hoods Creek 1	30	23.0	0.7	0.8	0.8	0.7	0.4						0.7	0.8

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

[c]*Based on limited relative water level measurements and observations of water level changes between high and normal flow conditions, mean water depths and maximum water depths were adjusted down 0.7 foot for pools, 0.5 foot for runs, and 0.2 foot for riffles, due to being surveyed during higher than normal flow conditions.*

Table I-6 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 1	31													1.6
Hoods Creek 1	32													2.1
Hoods Creek 1	33												0.5	
Hoods Creek 1	34													3.4
Hoods Creek 1	35													3.4
Hoods Creek 1	36	22.4	1.2	1.6	1.2	1.2	0.6						1.2	1.6
Hoods Creek 1	37													3.6
Hoods Creek 1	38													3.9
Hoods Creek 1	39													2.4
Hoods Creek 1	40												0.5	
Hoods Creek 1	41	26.7	1.1	1.5	1.9	1.9	1.8						1.6	1.9
Hoods Creek 1	42												0.3	
Hoods Creek 1	43													1.4
Hoods Creek 1	44												0.2	
Hoods Creek 1	45													1.6
Hoods Creek 1	46	23.6	1.1	1.2	1.2	0.9	0.7						1.0	1.2
Hoods Creek 1	47													1.5
Hoods Creek 1	48												0.4	
Hoods Creek 1	49													2.4
Hoods Creek 1	50													
Hoods Creek 1	51	27.6	0.8	0.4	0.4	0.3	0.1						0.4	0.8
Hoods Creek 1	52													3.2
Hoods Creek 1	53													2.7
Hoods Creek 1	54													2.1
Hoods Creek 1	55												0.3	
Hoods Creek 1	56													2.7
Hoods Creek 1	57												0.5	
Hoods Creek 1	58													3.0
Hoods Creek 1	59	19.4	0.0	0.2	0.4	0.5	0.7						0.4	0.7
Hoods Creek 1	60													1.8
Hoods Creek 1	61												0.7	
Hoods Creek 1	62													1.9
Hoods Creek 1	63												0.6	

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

[c]*Based on limited relative water level measurements and observations of water level changes between high and normal flow conditions, mean water depths and maximum water depths were adjusted down 0.7 foot for pools, 0.5 foot for runs, and 0.2 foot for riffles, due to being surveyed during higher than normal flow conditions.*

Table I-6 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow												
		Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 1	64													2.0
Hoods Creek 1	65													
Hoods Creek 1	66													2.1
Hoods Creek 1	67													2.0
Hoods Creek 1	68	21.6	0.6	0.8	0.9	0.7	0.4						0.7	0.9
Hoods Creek 1	69												0.6	
Hoods Creek 1	70	21.2	0.6	0.6	0.6	0.7	0.7						0.6	0.7
Hoods Creek 1	71													2.0
Hoods Creek 1	72												0.3	
Hoods Creek 1	73												0.3	
Hoods Creek 1	74												0.5	
Hoods Creek 1	75													1.6
Hoods Creek 1	76												0.2	
Hoods Creek 1	77													2.0
Hoods Creek 1	78												0.2	
Hoods Creek 1	79													1.5
Hoods Creek 1	80													1.5
Hoods Creek 1	81												0.4	
Hoods Creek 1	82	21.4	1.3	1.4	0.6	0.2	0.2						0.7	1.4
Hoods Creek 1	83													3.2
Hoods Creek 1	84												0.3	
Hoods Creek 1	85													
Hoods Creek 1	86												0.2	
Hoods Creek 1	87													1.8
Hoods Creek 1	88													3.3
Hoods Creek 1	89												0.3	
Hoods Creek 1	90	23.3	0.4	0.9	1.0	1.3	2.9						1.3	2.9
Hoods Creek 1	91													
Hoods Creek 1	92													
Hoods Creek 1	93													
Hoods Creek 1	94													2.3
Hoods Creek 1	95													
Hoods Creek 1	96	15.8	0.4	0.2	0.2	0.3							0.3	0.4

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

[c]*Based on limited relative water level measurements and observations of water level changes between high and normal flow conditions, mean water depths and maximum water depths were adjusted down 0.7 foot for pools, 0.5 foot for runs, and 0.2 foot for riffles, due to being surveyed during higher than normal flow conditions.*

Table I-6 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow												
		Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 1	97												0.3	
Hoods Creek 1	98												0.2	
Hoods Creek 1	99													2.5
Hoods Creek 1	100												0.3	
Hoods Creek 1	101	25.0	1.3	1.8	1.9	1.6	0.5						1.4	1.9
Hoods Creek 1	102													3.2
Hoods Creek 1	103	24.8	1.0	0.8	0.4	0.6	0.6						0.7	1.0
Hoods Creek 1	104	22.7	0.5	1.0	0.9	1.0	1.2						0.9	1.2
Hoods Creek 1	105													2.8
Hoods Creek 1	106	13.7	0.4	0.6	1.1	1.6	1.7						1.1	1.7
Hoods Creek 1	107													2.7
Hoods Creek 1	108													2.8
Hoods Creek 1	109	23.3	2.0	2.4	2.4	1.9	1.2						2.0	2.4
Hoods Creek 2	110	12.9	1.1	1.4	1.5	1.5	1.4						1.4	1.5
Hoods Creek 2	111													
Hoods Creek 2	112													1.5
Hoods Creek 2	113													1.3
Hoods Creek 2	114												0.3	
Hoods Creek 2	115													1.8
Hoods Creek 2	116												0.3	
Hoods Creek 2	117													2.3
Hoods Creek 2	118	16.9	0.6	0.5	0.5	0.0	0.6						0.4	0.6
Hoods Creek 2	119													2.1
Hoods Creek 2	120													1.9
Hoods Creek 2	121													2.7
Hoods Creek 2	122													2.5
Hoods Creek 2	123													2.3
Hoods Creek 2	124	7.9	0.7	1.2	1.4	1.0	0.6						1.0	1.4
Hoods Creek 2	125													2.1
Hoods Creek 2	126												0.2	
Hoods Creek 2	127													3.6
Hoods Creek 2	128												0.2	
Hoods Creek 2	129													2.5

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

[c]*Based on limited relative water level measurements and observations of water level changes between high and normal flow conditions, mean water depths and maximum water depths were adjusted down 0.7 foot for pools, 0.5 foot for runs, and 0.2 foot for riffles, due to being surveyed during higher than normal flow conditions.*

Table I-6 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 2	130												0.3	
Hoods Creek 2	131													3.0
Hoods Creek 2	132													3.7
Hoods Creek 2	133	13.8	0.5	1.1	1.4	2.0	1.3						0.8[c]	1.5[c]
Hoods Creek 2	134													1.4[c]
Hoods Creek 2	135												0.1[c]	
Hoods Creek 2	136													1.3[c]
Hoods Creek 2	137													3.0[c]
Hoods Creek 2	138													3.0[c]
Hoods Creek 2	139													2.9[c]
Hoods Creek 2	140													4.3[c]
Hoods Creek 2	141	27.0	1.9	3.3	2.6	1.9	1.4						1.7[c]	2.8[c]
Hoods Creek 2	142													3.7[c]
Hoods Creek 2	143													3.3[c]
Hoods Creek 2	144													2.8[c]
Hoods Creek 2	145	31.0	1.5	1.3	2.5	2.1	1.2						1.2[c]	2.0[c]
Hoods Creek 2	146													3.1[c]
Hoods Creek 2	147													4.3[c]
Hoods Creek 2	148													4.6[c]
Hoods Creek 2	149													3.5[c]
Hoods Creek 2	150													3.7[c]
Hoods Creek 2	151													3.1[c]
Hoods Creek 2	152	17.2	0.7	1.1	1.8	2.2	2.6						1.2[c]	2.1[c]
Hoods Creek 2	153													3.9[c]
Hoods Creek 2	154	18.8	0.9	1.1	0.9	0.8	0.7						0.7[c]	0.9[c]
Hoods Creek 2	155													3.4[c]
Hoods Creek 2	156	14.0	3.1	3.0	2.4	2.6	1.8						2.1[c]	2.6[c]
Hoods Creek 2	157													
Hoods Creek 2	158													2.9[c]
Hoods Creek 2	159													1.5[c]
Hoods Creek 2	160													3.6[c]
Hoods Creek 2	161	19.7	1.9	2.0	2.1	2.1	1.7						1.5[c]	1.6[c]
Hoods Creek 2	162													2.1[c]

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b]*Depth measurements were spaced approximately evenly across each section.*

[c]*Based on limited relative water level measurements and observations of water level changes between high and normal flow conditions, mean water depths and maximum water depths were adjusted down 0.7 foot for pools, 0.5 foot for runs, and 0.2 foot for riffles, due to being surveyed during higher than normal flow conditions.*

Table I-6 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 2	163													1.9[c]
Hoods Creek 2	164													3.7[c]
Hoods Creek 2	165													3.8[c]
Hoods Creek 2	166	19.4	0.8	1.1	1.4	1.1	0.8						0.5[c]	0.9[c]
Hoods Creek 2	167												0.3[c]	
Hoods Creek 2	168													2.8[c]
Hoods Creek 2	169												0.1[c]	
Hoods Creek 2	170													1.8[c]
Hoods Creek 2	171												0.3[c]	
Hoods Creek 2	172													3.0[c]
Hoods Creek 2	173													2.1[c]
Hoods Creek 2	174	17.4	0.5	0.8	0.8	0.7	0.7						0.2[c]	0.3[c]
Hoods Creek 2	175													3.2[c]
Hoods Creek 2	176													2.8[c]
Hoods Creek 2	177													2.4[c]
Hoods Creek 2	178	17.0	0.8	1.1	1.5	2.0	1.6						0.9[c]	1.5[c]
Hoods Creek 2	179													2.3[c]
Hoods Creek 2	180													2.1[c]
Hoods Creek 2	181													2.7[c]
Hoods Creek 2	182													2.3[c]
Hoods Creek 2	183												0.2[c]	
Hoods Creek 2	184													3.0[c]
Hoods Creek 2	185	18.1	1.4	2.3	1.9	1.6	1.4						1.2[c]	1.8[c]
Hoods Creek 2	186												0.2[c]	
Hoods Creek 2	187													1.9[c]
Hoods Creek 2	188													2.8[c]
Hoods Creek 2	189													2.0[c]
Hoods Creek 2	190												0.2[c]	
Hoods Creek 2	191													2.3[c]
Hoods Creek 2	192													2.0[c]
Hoods Creek 2	193	17.8	1.0	1.6	1.9	1.7	1.3						1.0[c]	1.4[c]
Hoods Creek 2	194												0.2[c]	
Hoods Creek 2	195													1.8[c]

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

[a] *Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

[b] *Depth measurements were spaced approximately evenly across each section.*

[c] *Based on limited relative water level measurements and observations of water level changes between high and normal flow conditions, mean water depths and maximum water depths were adjusted down 0.7 foot for pools, 0.5 foot for runs, and 0.2 foot for riffles, due to being surveyed during higher than normal flow conditions.*

Table I-6 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow												
		Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 2	196													1.4[c]
Hoods Creek 2	197	14.7	1.4	1.9	1.6	1.3	1.0						0.9[c]	1.4[c]
Hoods Creek 2	198													2.5
Hoods Creek 2	199													3.2
Hoods Creek 2	200													2.3
Hoods Creek 2	201													3.0
Hoods Creek 2	202												0.9	
Hoods Creek 2	203													3.0
Hoods Creek 2	204													2.7
Hoods Creek 2	205													3.6
Hoods Creek 2	206	19.7	1.3	1.7	1.7	1.6	1.1						1.5	1.7
Hoods Creek 2	207													3.6
Hoods Creek 2	208													2.9
Hoods Creek 2	209	11.2	0.8	1.2	1.3	1.4	1.7						1.3	1.7
Hoods Creek 2	210												0.6	
Hoods Creek 2	211												0.4	
Hoods Creek 2	212												0.4	
Hoods Creek 2	213												0.3	
Hoods Creek 2	214													1.3
Hoods Creek 2	215												0.5	
Hoods Creek 2	216													2.7
Hoods Creek 2	217	17.5	1.2	2.0	1.5	0.8	0.4						1.2	2.0
Hoods Creek 2	218													3.2
Hoods Creek 2	219													3.3
Hoods Creek 2	220												0.7	
Hoods Creek 2	221													3.5
Hoods Creek 2	222												0.5	
Hoods Creek 2	223													4.2
Hoods Creek 2	224												1.0	
Hoods Creek 2	225	11.6	2.0	2.3	2.4	2.1	1.8						2.1	2.4
Hoods Creek 2	226													3.1
Hoods Creek 2	227													3.9
Hoods Creek 2	228													3.5

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

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[c]*Based on limited relative water level measurements and observations of water level changes between high and normal flow conditions, mean water depths and maximum water depths were adjusted down 0.7 foot for pools, 0.5 foot for runs, and 0.2 foot for riffles, due to being surveyed during higher than normal flow conditions.*

Table I-6 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow												
		Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 2	229													3.0
Hoods Creek 2	230													3.8
Hoods Creek 2	231													2.9
Hoods Creek 2	232												0.8	
Hoods Creek 2	233													2.8
Hoods Creek 2	234													2.5
Hoods Creek 2	235												0.7	
Hoods Creek 2	236	17.8	1.4	1.6	1.7	1.8	1.0						1.5	1.8
Hoods Creek 2	237													3.2
Hoods Creek 2	238													3.0
Hoods Creek 2	239	19.5	0.9	0.9	1.0	1.0	0.8						0.9	1.0
Hoods Creek 2	240													4.5
Hoods Creek 2	241													3.0
Hoods Creek 2	242												0.6	
Hoods Creek 2	243													2.7
Hoods Creek 2	244													3.4
Hoods Creek 2	245	15.9	2.0	0.9	0.9	0.9	1.2						1.2	2.0
Hoods Creek 2	246													3.0
Hoods Creek 2	247												0.5	
Hoods Creek 2	248													2.8
Hoods Creek 2	249	19.3	2.0	2.0	1.4	1.2	0.5						1.4	2.0
Hoods Creek 2	250													2.7
Hoods Creek 2	251													3.8
Hoods Creek 2	252													4.0
Hoods Creek 2	253													
Hoods Creek 2	254												0.7	
Hoods Creek 2	255													2.7
Hoods Creek 2	256	10.0	1.8	1.9	1.4	1.7	1.5						1.7	1.9
Hoods Creek 2	257												0.6	
Hoods Creek 2	258	14.2	1.2	1.8	1.8	2.1	1.5						1.7	2.1
Hoods Creek 2	259													2.6
Hoods Creek 2	260													
Hoods Creek 2	261													2.6

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

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Table I-6 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow												
		Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 2	262												0.6	
Hoods Creek 2	263													
Hoods Creek 2	264	20.3	0.6	0.9	0.7	0.8	0.9						0.8	0.9
Hoods Creek 2	265													2.1
Hoods Creek 2	266													3.3
Hoods Creek 2	267												0.8	
Hoods Creek 2	268													4.7
Hoods Creek 2	269												0.7	
Hoods Creek 2	270													2.0
Hoods Creek 2	271												0.8	
Hoods Creek 2	272	17.9	1.9	1.9	1.3	1.8	1.5						1.7	1.9
Hoods Creek 2	273	22.6	1.0	1.0	1.0	1.0	1.0						1.0	1.0
Hoods Creek 2	274												0.4	
Hoods Creek 2	275													2.6
Hoods Creek 2	276												0.5	
Hoods Creek 2	277													2.0
Hoods Creek 2	278	22.0	0.7	0.6	0.6	0.5	0.7						0.6	0.7
Hoods Creek 2	279												0.6	
Hoods Creek 2	280													1.9
Hoods Creek 2	281													2.1
Hoods Creek 2	282													2.9
Hoods Creek 2	283												0.9	
Hoods Creek 2	284													2.6
Hoods Creek 2	285												0.9	
Hoods Creek 2	286	17.8	1.3	1.5	1.3	1.0	0.8						1.2	1.5
Hoods Creek 2	287													3.1
Hoods Creek 2	288													
Hoods Creek 2	289												1.0	
Hoods Creek 2	290													2.5
Hoods Creek 2	291													3.0
Hoods Creek 2	292	18.6	1.1	1.2	1.2	1.2	1.4						1.2	1.4
Hoods Creek 2	293													2.3
Hoods Creek 2	294													2.7
Hoods Creek 2	295													4.0

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

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Table I-6 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow												
		Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 3	296	17.4	1.7	2.2	2.4	2.1	1.2						1.4[c]	1.9[c]
Hoods Creek 3	297													2.3[c]
Hoods Creek 3	298													2.6[c]
Hoods Creek 3	299	15.9	1.5	2.5	2.9	2.8	1.7						1.8[c]	2.4[c]
Hoods Creek 3	300													3.1[c]
Hoods Creek 3	301	15.5	1.6	2.9	3.0	3.0	2.4						2.1[c]	2.5[c]
Hoods Creek 3	302	15.3	1.3	1.9	1.9	1.9	1.2						1.1[c]	1.4[c]
Hoods Creek 3	303	14.6	1.6	2.1	1.7	1.6	1.2						1.1[c]	1.6[c]
Hoods Creek 3	304													2.1
Hoods Creek 3	305	13.1	1.5	2.0	1.7								1.7	2.0
Hoods Creek 3	306													2.7
Hoods Creek 3	307													2.8
Hoods Creek 3	308													3.1
Hoods Creek 3	309	12.8	0.7	1.5	2.1	1.3	0.6						1.2	2.1
Hoods Creek 3	310													2.5
Hoods Creek 3	311	11.8	1.2	1.8	2.3	2.2	1.3						1.8	2.3
Hoods Creek 3	312													2.4
Hoods Creek 3	313	11.2	0.9	1.5	1.3	1.2	1.1						1.2	1.5
Hoods Creek 3	314													
Hoods Creek 3	315													2.4
Hoods Creek 3	316	11.7	1.9	2.1	1.9	2.1	1.9						2.0	2.1
Hoods Creek 3	317													3.0
Hoods Creek 3	318	11.6	0.8	0.9	1.5	1.9	1.5						1.3	1.9
Hoods Creek 3	319													2.5
Hoods Creek 3	320													2.2[c]
Hoods Creek 3	321													2.1[c]
Hoods Creek 3	322													2.3[c]
Hoods Creek 3	323	15.7	1.7	1.7	2.8	1.8	1.8						1.5[c]	2.3[c]
Hoods Creek 3	324													1.7[c]
Hoods Creek 3	325												0.1[c]	
Hoods Creek 3	326	14.8	2.0	2.3	2.3	2.5	2.2						1.8[c]	2.0[c]
Hoods Creek 3	327													

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

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Table I-6 (continued)

Reach	Survey ID[a] (see Maps I-18 through I-20)	Low Flow												
		Width (feet)	Depth-1 (feet)[b]	Depth-2 (feet)[b]	Depth-3 (feet)[b]	Depth-4 (feet)[b]	Depth-5 (feet)[b]	Depth-6 (feet)[b]	Depth-7 (feet)[b]	Depth-8 (feet)[b]	Depth-9 (feet)[b]	Water Depth-10 (feet)[b]	Mean Depth (feet)	Maximum Depth (feet)
Hoods Creek 3	328	18.5	1.6	1.8	1.8	1.8	1.6						1.2[c]	1.3[c]
Hoods Creek 3	329													2.1[c]
Hoods Creek 3	330	16.2	1.9	2.3	2.3	2.3	1.4						1.5[c]	1.8[c]
Hoods Creek 3	331	18.4	1.3	1.4	1.4	1.4	2.1						1.5	2.1
Hoods Creek 3	332	11.1	1.2	1.4	1.3	1.4	0.9						1.2	1.4
Hoods Creek 3	333	10.2	0.6	0.8	1.0	0.8	0.6						0.8	1.0
Hoods Creek 3	334													1.9
Hoods Creek 3	335													4.0
Hoods Creek 3	336	12.1	1.1	1.0	0.7	0.7	0.5						0.8	1.1
Hoods Creek 3	337	10.3	0.8	1.3	1.4	1.2	0.8						1.1	1.4
Hoods Creek 3	338	9.0	0.8	0.9	1.4								1.0	1.4
Hoods Creek 3	339	8.7	0.4	1.1	0.9								0.8	1.1
Hoods Creek 3	340	6.2	0.7	0.9	0.8								0.8	0.9
Hoods Creek 3	341	7.4	0.7	1.0	1.1								0.9	1.1
Hoods Creek 3	342												0.3	
Hoods Creek 3	343													3.7

NOTES: Color shades correspond to the following aquatic habitat types: Pool Riffle Run

The number of points at which water depths were measured within a cross-section was dependent upon stream width. In general, if wetted width was less than 10 feet, three points per transect were taken; for widths ranging from 10 to 75 feet, five to 10 points per transect were taken; and where width was greater than 75 feet, 10-14 points were taken.

[a]*Cross-section surveys were not conducted in every pool or riffle habitat location, however maximum pool depths and average depths across a riffle were recorded.*

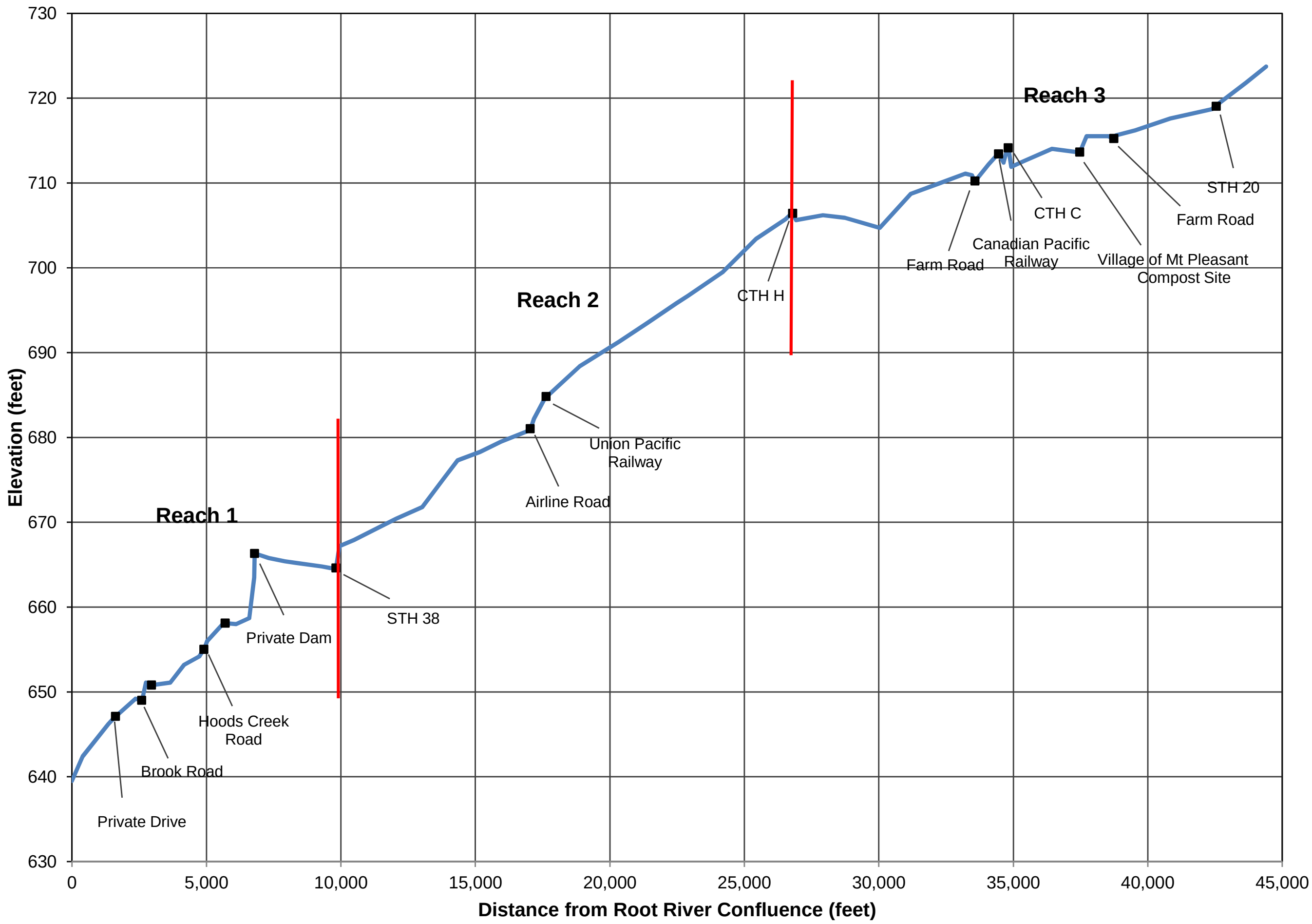
[b]*Depth measurements were spaced approximately evenly across each section.*

[c]*Based on limited relative water level measurements and observations of water level changes between high and normal flow conditions, mean water depths and maximum water depths were adjusted down 0.7 foot for pools, 0.5 foot for runs, and 0.2 foot for riffles, due to being surveyed during higher than normal flow conditions.*

Source: SEWRPC.

Figure I-3

APPROXIMATE CHANNEL BOTTOM ELEVATION PROFILE BY STREAM REACH FOR HOODS CREEK

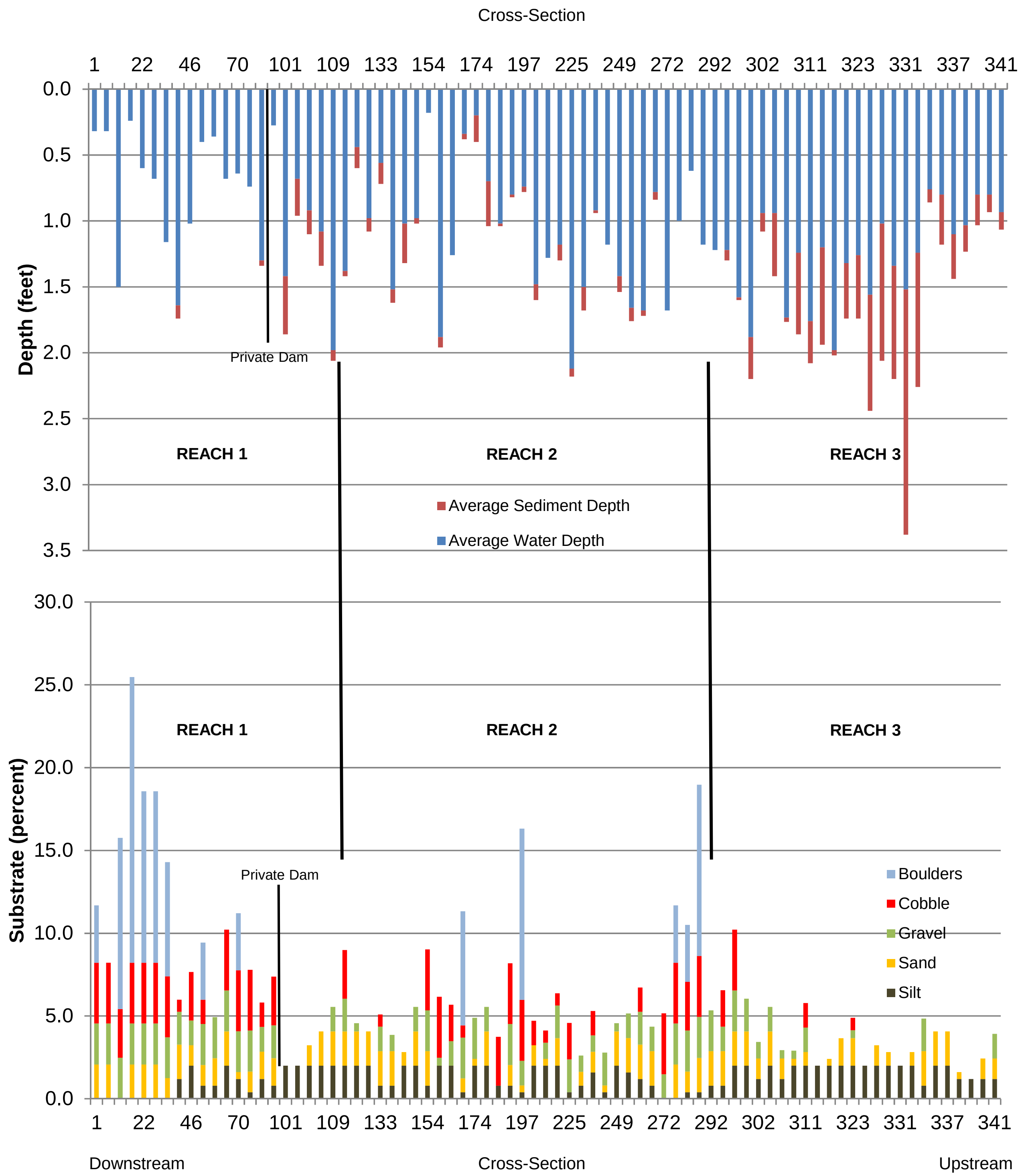


Source: SEWRPC.

Figure I-4

MEAN WATER DEPTH, SEDIMENT DEPTH, AND DOMINANT SUBSTRATE COMPOSITION AMONG CROSS-SECTIONS WITHIN HOODS CREEK IN REACH AREA 21: 2013

WATER AND SEDIMENT DEPTH



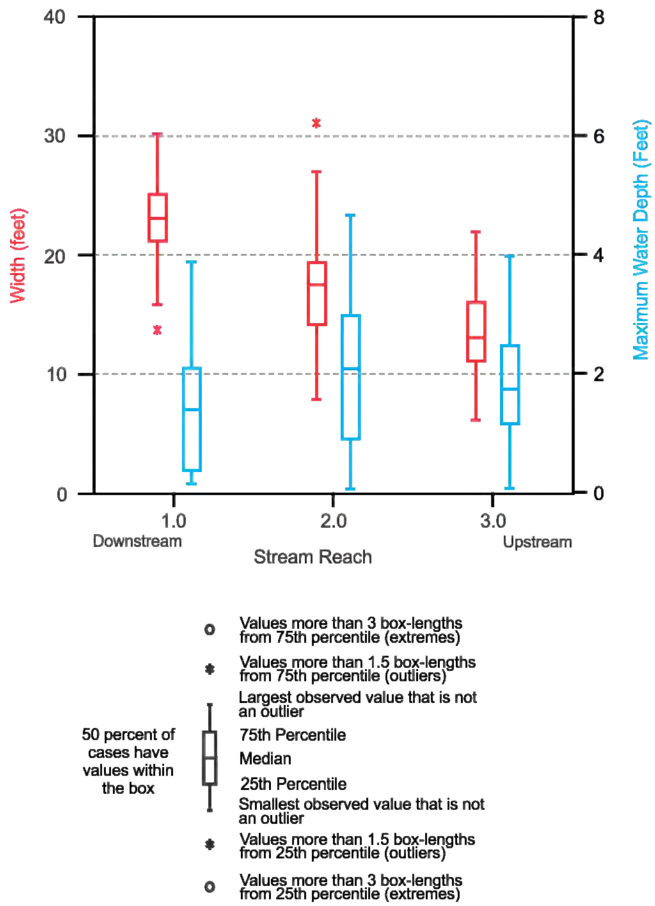
DOMINANT SUBSTRATE COMPOSITION

NOTE: See Maps I-18 through I-20 and Tables I-4 through I-6 for more details on in-stream cross-sections.

Source: SEWRPC.

Figure I-5

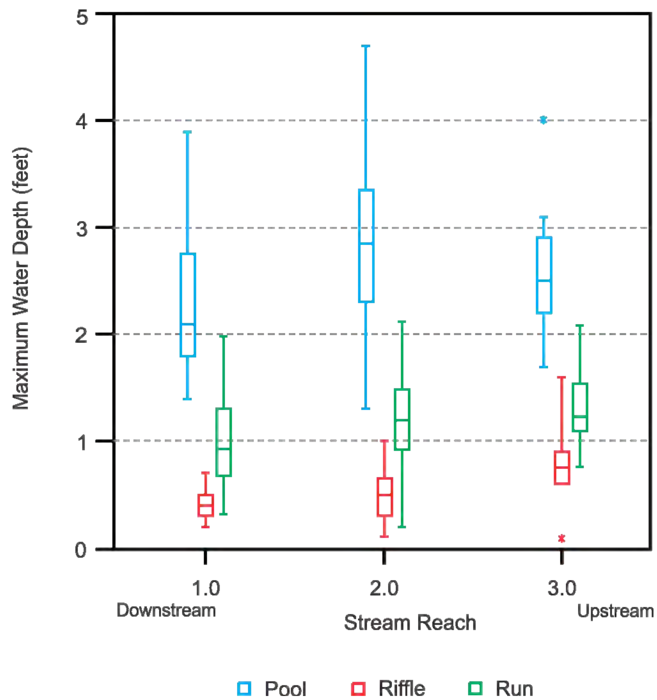
STREAM WIDTH AND MAXIMUM DEPTH AMONG REACHES IN HOODS CREEK: 2013



Source: SEWRPC.

Figure I-6

MAXIMUM WATER DEPTH AMONG HABITAT TYPE AND REACHES IN HOODS CREEK: 2013



Source: SEWRPC.

Figure I-7

STREAM CROSSINGS AND DAMS ALONG HOODS CREEK: 2013

1-PRIVATVE BRIDGE
(HOODS CREEK RM 0.31)

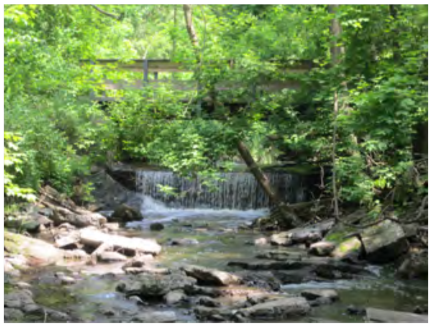
2-BROOK ROAD
(HOODS CREEK RM 0.50)

3-PRIVATE BRIDGE
(HOODS CREEK RM 0.58)

4-HOODS CREEK ROAD
HOODS CREEK (RM 0.96)

5-PRIVATE BRIDGE
HOODS CREEK (RM 1.12)

6-PRIVATE DAM
HOODS CREEK (RM 1.32)



7-PRIVATE BRIDGE
(HOODS CREEK RM 1.65)

8-PRIVATE BRIDGE
(HOODS CREEK RM 1.67)

9-STH 38
(HOODS CREEK RM 1.80)

10-PRIVATE BRIDGE
(HOODS CREEK RM 2.03)

11-AIRLINE ROAD
(HOODS CREEK RM 3.21)

12-UNION PACIFIC RAILROAD BRIDGE
(HOODS CREEK RM 3.32)

Figure I-7 (continued)

13-PRIVATE BRIDGE
(HOODS CREEK RM 4.84)

14-CTH H
(HOODS CREEK RM 5.13)

15-FARM ROAD CROSSING
(HOODS CREEK RM 6.41)

16-RAILROAD BRIDGE
(HOODS CREEK RM 6.57)

17-CTH C (SPRING STREET)
(HOODS CREEK RM 6.64)

18-VILLAGE OF MOUNT PLEASANT
COMPOST YARD ROAD CROSSING
(HOODS CREEK RM 7.14)

19-FARM ROAD CROSSING
(HOODS CREEK RM 7.38)

20-FARM ROAD CROSSING
(HOODS CREEK RM 8.07)

21-STH 20
(HOODS CREEK RM 8.10)

NOTE: See Map I-15 for locations of stream crossings and dams.

Source: SEWRPC.

Figure I-8

EXAMPLES OF IN-STREAM COVER WITHIN HOODS CREEK: 2013

Source: SEWRPC.

Appendix J

1964 HORLICK DAM ABANDONMENT DENIAL BY PSC

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PUBLIC SERVICE COMM. OF WISCONSIN 1962 MAR 16 AM 9 21

D-7673.1

March 14, 1962

Public Service Commission of Wisconsin
State Office Building
Madison 2, Wisconsin

Re: Horlick's Dam, Racine County, Wisconsin

Gentlemen:

Please consider this letter as an application for a permit to abandon Horlick's Dam across the Root River in the Town of Mount Pleasant in Racine County, Wisconsin. Ownership is presently listed under the names of Charles A. Horlick, 3620 Rapids Drive, Racine, Wisconsin, and Richard C. Horlick, 2600 Pavilion Road, Racine, Wisconsin.

This application is being made pursuant to Sec. 31.185 of the Wisconsin Statutes. It is our understanding that there are no official forms prescribed by the Commission. Other information which you may require for the purpose of enabling you to act on this application is that the Dam was originally built in 1834; it presently provides no commercial benefits; blasting operations conducted during the construction of the nearby highway may have weakened and damaged the Dam. Although the extent of damage and cost of repair and possible improvement is unknown, we are unable to restore, repair or maintain the Dam.

We have attempted to transfer the Dam to the City of Racine, Town of Mount Pleasant and the Town of Caledonia. The transfer was conditioned upon the approval of bid and payment between the parties. It provided that if the condition was not met that the agreement and conveyance be considered null and void and of no effect. Although we have not been officially advised to date that the bids have been disapproved or that payment has not been made or that the municipalities consider the conveyance null and void, information received today leads us to believe that the conveyance is null and void and therefore we hereby immediately apply for a permit to abandon.

Yours truly,

Charles A. Horlick

Richard C. Horlick

1962

1962

FILING

Racine
513

BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

Application of Charles A. Horlick and Richard C. Horlick for a Permit to Abandon Horlick's Dam in the Root River, Town of Mt. Pleasant, Racine County	2-WP-1626

FINDINGS OF FACT AND ORDER

Charles A. Horlick, 3620 Rapids Drive, and Richard C. Horlick, 2600 Pavilion Road, both in Racine, filed an application with the Commission on March 16, 1962 for a permit under section 31.185, Statutes (created by Chapter 568, Laws of 1961), to abandon Horlick's Dam in the Root River in the town of Mt. Pleasant, Racine County. Application denied.

Pursuant to due notice, hearing was held May 3, 1962 at Racine before Examiner Clarence B. Sorensen.

Appearances:

Charles A. Horlick in person and by

Harley Brown, attorney
Racine

As Interest May Appear:

Town of Mt. Pleasant, by

Harold Schink, supervisor
Racine

In Opposition:

Wisconsin Conservation Department, by

Huber Wheeler, conservation biologist
Madison

Francis Paulin, district fish manager
Waterford

Norman Wood, warden
Union Grove

Of the Commission Staff:

William Sayles, engineering department

The Commission deferred action on the application herein until this time because of the possibility that an application for a permit to transfer ownership of Horlick's Dam would be filed.

Findings of Fact

THE COMMISSION FINDS:

1. Horlick's dam in the Root River was originally constructed in 1838 for mill dam purposes. In its docket No. 2-WP-45 (dated May 24, 1932, 2 P.S.C.W. 544), the Commission fixed the minimum level of the pond created by the dam at elevation 93.8 feet (Public Service Commission datum).

2. At the present time the dam is not used for power purposes. The owner or owners have failed to maintain the structure. Part of the crest of the spillway has failed. At low flow the dam is incapable of maintaining the established minimum level of the pond.

3. The present owners of the dam, Charles A. Horlick and Richard C. Horlick, propose to abandon the dam leaving the existing structure in place. Applicants have attempted to transfer the dam to the city of Racine, the town of Mt. Pleasant, and the town of Caledonia without success.

4. The pool formed by the dam extends upstream for a distance of $3\frac{1}{2}$ miles. For the most part the pool is confined between the river banks. There is extensive residential and park development along the river in the reach of stream influenced by the dam.

5. In the notice of hearing and order for mailing and publication dated April 2, 1962 the applicants were directed by order of the Commission to mail a copy of the

notice of hearing to each person interested in any land affected by the proposed abandonment of Horlick's Dam. After review of an engineering firm's report entitled, "Backwater and Flood Conditions Upstream from Horlick's Dam on the Root River, Racine County" (item C of the record), it develops that there is a substantial number of upstream riparian owners whose land would be affected by the proposed abandonment of the dam. The affidavit of mailing submitted by applicants does not include all of them.

Conclusions of Law

THE COMMISSION CONCLUDES:

1. That proper and sufficient notice of hearing was not given to property owners affected by the proposed abandonment.

2. That an order should be issued dismissing the application herein, without prejudice.

Order

THE COMMISSION THEREFORE ORDERS:

That the application herein for a permit to abandon Horlick's Dam be and hereby is dismissed without prejudice.

Dated at Madison, Wisconsin, this 13th day of April, 1964.

By the Commission.

John D. Goetz

Acting Secretary

Appendix K

INSPECTIONS AND REPAIRS

June 11, 1915 – An inspection by the Engineering Department of the Railroad Commission of Wisconsin described the dam as being constructed of stone block masonry with a limestone block foundation, which was in good condition. The rock and concrete fishway was described as being approximately one foot deep, eight feet wide and 100 feet long. The maximum depth of the pond upstream of the dam was listed as about 12 feet.

August 28, 1939 – A Wisconsin Public Service Commission (PSC) inspection noted some leakage through the dam and water wheel, with a total combined flow of less than three to four cubic feet per second (cfs).

June 19, 1961 – A PSC inspection of the Horlick dam described the condition of the structure concrete as poor and the masonry as very poor. The inspection also indicated that the fishway was not in use.

May 8, 1974 – A Letter from WDNR Secretary Lester P. Voigt to State Senator Dorman indicated that restoration of the dam was desirable, and a fish ladder would not be required.

June 4, 1974 – The WDNR inspection noted that the tailrace had been filled and the headgates and mill had been removed. The report described a considerable loss of material from the spillway crest (a five- to six-foot reduction in the crest elevation). It noted that the then-present spillway crest had one row of flashboards. The report indicated that there was seeping and piping observed on the left end, that the fishway on the left side was overgrown, and that the right wall of the fishway was cracked and undercut.[1] At the time of the inspection, the water level was below the crest of the fishway. The report noted that the Horlick dam appeared to have had minimal or no maintenance since the late 1940s and was in need of extensive repairs.

Late 1975 – Based on information contained in the plan set, the Horlick dam was reconstructed in late 1975. The top of dam was to be restored to an elevation of 629.95 feet above NGVD 29.

August 14, 1976 – A WDNR inspection noted that the Horlick dam appeared to be structurally sound, but that there was a leak along the right abutment of about 0.5 cfs. The inspection indicated that good concrete placement practices were not used in the reconstruction of the dam. The Root River water level was lowered on the day of the inspection. The lowered River also facilitated a river clean-up of debris and trash between the dam and STH 31.

---

[1]*References to right and left are based on looking downstream.*

March 4, 1981 – A WDNR inspection noted that the concrete portions of the dam were in excellent condition and that the limestone foundation was in good condition. No seepage or leakage was observed, but warning and portage signs needed to be installed.

September 27, 1984 – A quote from Grout-Tech, Inc., suggesting right abutment grout repair was noted in the archives.

March 3, 1988 – A WDNR inspection noted the need to correct minor slumping adjacent to the right abutment, to remove trees and brush from the dam abutments, and to fill rodent burrows upstream of the right abutment. The dam concrete looked to be in fair condition (visibility was limited), but seepage was observed along the right abutment wall at its base. A grout curtain was noted at the right abutment, but there was still seepage present. The inspection report indicated the need to develop an inspection and maintenance plan, and to conduct a dam break analysis to establish the hazard rating for the dam.

June 9, 2008 – A WDNR quick assessment, made during the 2008 flood event, noted seepage at the right abutment through the railroad ties adjacent to a landscaping wall. From 4:30 p.m. to 6:30 p.m. on June 9th, the water level in the pool peaked at six inches below the top of the brick landscaping wall on the right embankment of the dam.

June 25, 2008 – A WDNR inspection recommended remedial measures including tree and brush removal on the abutments, filling of a minor slump on the right abutment bank, and facilitating large natural debris to pass downstream on an ongoing basis. Numerous additional actions were requested, including: preparation of an Emergency Action Plan, conduct of a dam failure analysis, preparation of an inspection/operation/maintenance plan, conduct of concrete and stop log condition investigations, completion of a scour study, installation of a "portage" or "take out" sign, and establishment of a benchmark. All efforts were to be completed by June 2011.

April 2011 – The wooden stop logs on the dam were replaced with aluminum stop logs. Note that only the stop logs were replaced at this time.

November 18, 2011 – Racine County staff and WDNR staff inspected the dam as a follow up to the June 25, 2008, inspection report. Minor seepage at the right abutment toe was noted. Numerous additional actions were requested, including a conduct of a dam failure analysis; preparation of an Emergency Action Plan and Inspection/Operation/Maintenance Plan; completion of a concrete investigation, scour study, and bank repairs; installation of a "Take Out" sign; and, establishment of a benchmark. Deadlines for completion of these items ranged from March 2012 to December 2013.

December 8, 2011 – The WDNR response to the November 18, 2011, Racine County Inspection Report requested two additional actions. First, plans and a condition report for the stop logs, sill plate and embedded slots were requested to be prepared by March 2012. Second, installation of a bridge operating deck and mechanism for stop log removal was required to be installed by December 2016.

Appendix L

1975 WDNR WATER AND SHORELAND MANAGEMENT INVESTIGATION FOR HORLICK DAM RECONSTRUCTION

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FORM 3500-23

Department of Natural Resources
INTRA-DEPARTMENT
MEMORANDUM

SOUTHEAST DISTRICT
Station

Date 12 SEPTEMBER 1975

IN REPLY REFER TO: 3560
3-WR-1874

TO: Water Regulation Section

FROM: P. S. HAUSMANN

SUBJECT: Water and Shoreland Management Investigation, RACINE County

Location NW 1/4, NE 1/4, Sec. 6, T 3 N, R 23 (E)(W) CITY OF RACINE

Date of Investigation 12 SEPTEMBER 1975

Name of Water ROOT RIVER ( ) Lake ( ) Flowage (✓) Stream

Applicant's Name C. & R. HORLICK / C.W. KORNDOERFER Street Address 4025 NORTHWESTERN AVE. / 3333 MICHIGAN BLVD.

City & State RACINE, WI 53406/53403

Applicant contacted during inspection: Yes ____, No X

Water Mgt.: Trout: Yes ___ No ✓ Species L. TROUT SPECIES BELOW DAM TO LAKE MICHIGAN Class 1, 2, or 3
Muskie: Yes ___ No ✓ Class A, B, or C (Circle One)
Other: (List and indicate relative abundance): FORAGE & ROUGH

Nature of Proposed Project: (Check one or more)

____ Channelization ____ Diversion
____ Dam Construction ____ Sand Blanket
____ Dredging ____ Structure
____ Dugout Pond: Pond (is)(is not) within 500' of navigable water
____ Other (describe): TRANSFER & RECONSTRUCTION OF DAM

Description of area prior to proposed alteration (adjacent to dugout pond):

LAKE ( ) FLOWAGE ( )

Surface area (acres) ________

Depth (ft.) Max. ____ Avg. ____

Depth (ft.) in area to be altered ____

Public access: (None) (Public Ramp)

(Nav. Water) (Proposed) Other: ____

If available, attach lake survey map showing area in detail to be altered.

STREAM:

Total length (miles) 32.6

Dimensions at site of proposed alteration:

Width 120 ft. Depth 2 ft. Length ____

Flow in cfs 8.4 Date 12 SEPT. 1975

Flow was: estimated - (metered) - floating chip (circle one) — U.S.G.S. STAGE RECORDER STATION 04087240

Navigable: Yes X No ____

If no, explain why: ________

10-74

FLOWAGES, LAKES AND STREAMS: (Data for area of proposed alteration)

Bottom types (%) UPSTREAM - SILT OVER ROCK OUTCROPPING DOWNSTREAM - ROCK OUTCROPPING

Vegetation (types and abundance) AQUATIC - NONE TERRESTRIAL - GRASSES, WILLOW, ELM, BOX ELDER, OAK, SHRUBS.

Present public use (hunting, boating, etc.) BOATING & FISHING.

Game values (beaver, muskrat, ducks, etc.) DUCKS

Fish spawning area (list species) N.A.

Present land use (within 300 ft. of shoreline) COMMERCIAL - WEST BANK RESIDENTIAL - EAST BANK

Bank stability (✓) stable ( ) unstable - describe:

EITHER WELL STABILIZED AND VEGETATED EARTH BANKS OR VERTICAL ROCK WALLS.

Describe spoil deposition area if applicable: N.A.

Scientific Areas Preservation Council Interest: Yes ____ No X

State Historical Society Interest: Yes ____ No X

Aesthetic Values: (Describe setting of the area, its unique attractiveness, if any, and how this may be enhanced or damaged by the proposed project.)

AREA IS ADJACENT TO MOTEL AND S.T.H. 38 ON WEST BANK, RESIDENTIAL AND ENVIRONMENTAL CORRIDOR ON EAST BANK. PROJECT WILL CREATE LARGER DAM POOL THAN NOW PRESENT BUT SHOULD DAMAGE AESTHETICS OF THE AREA.

SPECIAL ENVIRONMENTAL CONSIDERATIONS: Consider the ecological diversity of the area and the contribution this diversity makes to the health and stability of the lake or stream involved. View the site of the proposed work as a part of a complex interrelated and interdependent system of production, consumption, purification, and decomposition and decide if and how the proposed alteration would affect this system and thus damage or enhance the biological life support system of the lake or stream, in part or whole.

THE PROJECT WILL CREATE A LARGER HEAD POOL THAN HAS EXISTED IN LAST DECADE. POND ~~[illegible]~~ MAY BECOME STAGNANT DURING LOW FLOW YEARS AND WILL ACT AS A SEDIMENT TRAP. INCREASED POND ELEVATION WILL FLOOD SOME SEMI-AQUATIC VEGETATION ON FORMERLY EXPOSED RIVER BOTTOM & BANKS. PROJECT AS WHOLE SHOULD NOT GREATLY EFFECT THE TOTAL HEALTH & STABILITY OF THE ROOT RIVER.

FLOOD PLAIN AND SHORELAND ZONING CONSIDERATIONS

Zoning classification of project site Commercial-Residential - Prince Corridor

County - Town - City or Village permit (is) (is not) required.

There (is) (is not) a conflict with floodplain-shoreland development standards contained in Chapters NR 115 and NR 116, Wisconsin Administrative Code. (Explain)

FLOOD HAZARD MAPPING BASED ON DAM BEING RESTORED AS THIS PROJECT PROPOSES.

Additional Data Required:

____

____

REVIEW ORIGINAL APPLICATION FOR ACCURACY:

Name of water correct according to waters inventory report? YES

Legal description of project site correct? YES

Names of adjacent property owners complete? YES

Other errors or omissions observed in application - give details:

____

Permit required? Yes ✓ No ____

Any objection to proposal? Yes ____ No ✓

Specific objection, if any, in detail below with any other comments relevant to the proposal.

State opinions regarding impact of project as proposed on environment and adjacent property owners.

PROJECT SHOULD HAVE MINIMAL IMPACT ON ENVIRONMENT AND ADJACENT PROPERTY OWNERS. NEW LEVEL ON DAM WILL RECLAIM SOME RIVER BOTTOM AND BANKS WHICH HAVE NOT BEEN FLOWED IN YEARS.

Name of Investigator(s) S. HAUSMANN, R. RODEN, H MEIER

By:

Area Fish Manager	Date	Area Warden	Date
		[signature] Hausmann	12 September 1975
Area Game Manager	Date	Water Mgt. Inv.	Date

Note: Submit one original and two copies to District Headquarters. Keep copies as needed for your files.

Appendix M

SEWRPC MEMORANDUM REQUESTING STORMWATER AND FLOODING INFORMATION FOR RACINE COUNTY AREAS WITHIN THE ROOT RIVER AUGUST 5, 2011

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SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
W239 N1812 ROCKWOOD DRIVE • PO BOX 1607 • WAUKESHA, WI 53187-1607• TELEPHONE (262) 547-6721
FAX (262) 547-1103

Serving the Counties of: KENOSHA MILWAUKEE OZAUKEE RACINE WALWORTH WASHINGTON WAUKESHA

MEMORANDUM

TO: Mr. David Prott, Director of Public Works, Racine County
Mr. Mark H. Yehlen, Commissioner of Public Works/City Engineer, City of Racine
Mr. Michael Hayek, Village Engineer, Village of Caledonia
Ms. Kathleen Trentadue, President, Caledonia Stormwater Utility District Commission
Mr. William D. Sasse, Director of Engineering, Village of Mt. Pleasant
Mr. Mark Janiuk, Administrator, Village of Sturtevant
Mr. Mark Osmundsen, Director of Public Works, Village of Union Grove
Mr. Thomas P. Lembcke, Chair, Town of Dover
Ms. Karen Dubiel, President, Dover Stormwater Utility District Commission
Ms. Jean M. Jacobson, Chair, Town of Norway
Mr. Gary Kastenson, Chair, Town of Raymond
Mr. Paul E. Ryan, President, Raymond Stormwater Utility District Commission
Mr. James E. Moyer, Chair, Town of Yorkville
Mr. Steve Nelson, Chair, Yorkville Stormwater Utility District Commission

FROM: Southeastern Wisconsin Regional Planning Commission Staff

DATE: August 5, 2011

SUBJECT: **REQUEST FOR STORMWATER AND FLOODING INFORMATION FOR RACINE COUNTY AREAS WITHIN THE ROOT RIVER WATERSHED**

The Southeastern Wisconsin Regional Planning Commission is working with Racine County, Root River watershed municipalities, the Milwaukee Metropolitan Sewerage District, the Southeastern Wisconsin Watersheds Trust, Inc. (SWWT), and the Root-Pike Watershed Initiative Network to prepare a restoration plan for the Root River watershed. The scope of work for that plan is attached. The plan will address the entire Root River watershed, including areas in Kenosha, Racine, Milwaukee, and Waukesha Counties; however, Racine County has provided funding targeted specifically for an evaluation and characterization of the extent of flooding and stormwater drainage problems in the portion of the watershed in Racine County and for consideration of the status of Horlick dam.

The scope of flood mitigation planning activities to be undertaken for the watershed restoration plan was established based on priorities determined by Racine County, information that the County staff provided regarding the location of flooding problems, and the level of funding provided by the County. The plan will address the status of Horlick dam, will include review and mapping of identified flooding problems in Racine County, will characterize the nature of reported flooding problems to the degree possible, and will recommend priorities and levels of funding for future study of case-by-case alternatives to mitigate specific high priority flooding and stormwater management problems. A complete description of the flooding component of the plan is provided on pages 7 and 8 of the attached June 15, 2011 SEWRPC Staff Memorandum.

We have begun an inventory of flooding- and stormwater management–related information for each of the municipalities in Racine County that are within the Root River watershed (see Table 1 attached to this memo for a listing of electronic documents we have obtained and Map 1 in the enclosed June 15, 2011 SEWRPC Staff Memorandum). To assist with our inventory, and to provide a full understanding of the nature and severity of flooding and stormwater management problems that have been experienced we are requesting that you supplement that list by providing information on flood hazards to habitable structures due to the overflow of streams onto the adjoining floodplain; overtopping and flooding of roadways and railways and the resulting damages and interruption of traffic; and stormwater flooding of buildings, which occurs when rainfall and/or snowmelt runoff traveling from the land surface toward streams cannot be safely conveyed and stored by the stormwater management system.

In 2009, when we were preparing SEWRPC Community Assistance Planning Community Assistance Planning Report No. 266, *Racine County Hazard Mitigation Plan Update: 2010 - 2015*, (2nd Edition), we interviewed representatives from the City of Racine, the Villages of Caledonia, Mt. Pleasant, Sturtevant, and Union Grove; and the Towns of Norway and Raymond, regarding Countywide flooding and stormwater problems in their communities. Now, we are looking to obtain more-specific information for areas within the Root River watershed only, as listed below, including maps and reports, where available.

Information for the Root River watershed portion of your communities (Map 1) that would be useful includes:

- Locations of flooding or stormwater management problems affecting habitable buildings, and attribution of the source (either stream flooding or stormwater) and the cause (e.g., obstructions in channel, restrictive hydraulic structures, extreme rainfall). If maps showing specific flooded buildings or generalized areas of flooding are available, that information would be very helpful.

- Number of habitable buildings affected by flooding or stormwater problems,

- Depths of flooding experienced at buildings,

- Description of the nature of structure flooding (e.g., basement flooding, first floor flooding),

- Available flood damage cost determinations (by event), including flood response and cleanup costs, if available,

- Locations of flooding of roadways and railways, and descriptions of the nature of the flooding (e.g., maximum depth of flooding, approximate length of roadway or railway affected, duration of flooding, road closures),

- Dates on which flooding or stormwater problems occurred, and any local rainfall or snowmelt observations,

- Measures that are proposed, or are being implemented, to address flooding and stormwater problems,

- Copies of pertinent reports, studies, and ordinances, and
- Additional pertinent information that you may want to provide.

We understand that all of the above information may not be available for each community, but our goal is to develop as comprehensive an inventory as possible. We also note that, as shown on Map 1 in the attached June 15 Staff Memorandum, only very small portions of the Village of Sturtevant and the Town of Norway, and a relatively small headwaters portion of the Town of Dover, are included in the Root River watershed. While those municipalities may not have information to report, we wanted to be sure that they were aware of this planning effort and to offer them the opportunity to provide information.

Thank you for your past assistance in characterizing flooding and stormwater problems, and for your consideration of this request. If you have any questions or desire a meeting to discuss the requested information, please contact Michael G. Hahn, SEWRPC Chief Environmental Engineer (*mhahn@sewrpc.org*, (262) 547-6722, extension 243). Please provide available information to Mr. Hahn by September 2, 2011.

* * *

#158405.DOC
KRY/MGH/pk

Enclosure (#156234)

cc: Mr. James A. Ladwig, Racine County (w/enclosure)
Ms. Julie A. Anderson, Racine County (w/enclosure)
Mr. Christopher Magruder, MMSD (w/enclosure)
Ms. Susan S. Greenfield, Root-Pike WIN (w/enclosure)
Mr. Jeffrey Martinka, SWWT (w/enclosure)

Table 1

FLOODING AND STORMWATER MANAGEMENT DOCUMENTS FOR RACINE COUNTY ROOT RIVER WATERSHED COMMUNITIES

Community	Document
City of Racine	• Flood Response Plan, Spring Flood Control, prepared by Earth Tech, Inc. (August 2003) • Stormwater Utility Manual • Stormwater Utility Brochure • Stormwater Utility Non-Residential Customer List • Memo: Root River Flood Stage Relationship Study (2009) • Journal Article: Incorporating Education and Outreach of a Storm Water Outfall Impacting Recreational Water Quality at Public Beaches (Julie Kinzelman, Jaren Hiller)
Village of Caledonia	- -
Village of Mt. Pleasant	- -
Village of Sturtevant	• Chapter 21-Stormwater Management Services Ordinance • Chapter 15-Erosion Control and Post-Construction Storm Water Management • “Changing the Way We Manage Stormwater” Brochure • Municipal Separate Storm Sewer System (MS4) General Permit No. WI-S050075-1
Village of Union Grove	• Post- Construction Storm Water Management Zoning Ordinance (2009)
Town of Dover	• Stormwater Utility District Commission Ordinance
Town of Norway	• Land Disturbance and Erosion Control Ordinance (2011)
Town of Raymond	- -
Town of Yorkville	• Article IV Stormwater Utility District Ordinance

Source: SEWRPC.

Appendix N

ACUTE TOXICITY OF SODIUM CHLORIDE TO FRESHWATER AQUATIC ORGANISMS

Few data regarding instream concentrations of chloride and values of specific conductance are available for streams of the Root River watershed for the winter deicing seasons. A recent examination of specific conductance and chloride in the Menomonee River watershed may shed light on what these conditions in some parts of the Root River stream system may be like during winter months.

In 2012, during review of the second part of the draft SEWRPC Staff Memorandum, "Development of a Framework for a Watershed-Based Municipal Stormwater Permit for the Menomonee River Watershed," by the Menomonee River Watershed-Based Permit (WBP) Framework Group, a question arose as to what effects concentration spikes of chloride occurring during cold weather are likely to have upon aquatic biota within the Menomonee River watershed. This appendix presents the results of a literature review to address this question. Specifically, this appendix presents the results of a review of the literature regarding the acute toxicity of sodium chloride to freshwater aquatic organisms, compares the results of this review to estimates of chloride concentrations during the winter deicing season at locations within the Menomonee River watershed, and discusses whether aquatic organisms are likely to experience toxic effects in streams in the watershed.

Table N-1 presents data on the acute toxicity of sodium chloride to freshwater aquatic organisms. These results are taken from the toxicological and ecological literature. With two exceptions the tests use the LC50, the concentration at which 50 percent of the organisms die over the duration of the test, as the measure of acute toxicity.[1] A higher LC50 indicates lower toxicity to the organism, while a lower LC50 indicates greater sensitivity to the toxin. The table presents results for several exposure times; however, the majority of results listed come from 96-hour (four-day) acute toxicity tests. This is in keeping with standard toxicological procedures. The results are presented in terms of both the concentration of sodium chloride and an equivalent concentration of chloride. This was done to facilitate comparison of the toxicological data to estimates of chloride concentrations in streams and to the State's acute toxicity criterion for fish and aquatic life. In the discussion that follows, the LC50s will be expressed in terms of chloride concentrations.

Some patterns are apparent in the LC50 values presented in Table N-1. There is considerable variation in LC50 values. For 96-hour tests, they range from 425 milligrams of chloride per liter (mg Cl/l) for the mayfly,

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[1]*The two exceptions occur in six-hour toxicity tests and use LC40 and LC47 endpoints. These reflect the concentrations at which 40 percent and 47 percent, respectively, of organisms die during the course of the test. LC50 values for these organisms in six-hour acute toxicity tests would be higher than the values shown.*

Callibaetis coloradensis, to 13,085 mg Cl/l for the American eel, *Anguilla rostrata*. With the exception of the LC50 value for *C. coloradensis,* these values are all higher than the State's acute toxicity criterion for chloride of 757 milligrams per liter. LC50 values for fish species tend to be higher than those for many invertebrate species, suggesting that they are less sensitive to acute chloride toxicity. LC50 values also vary among tests for the same species. This may be due to several factors, including differences in test conditions, genetic variation within species, and differences among statistical techniques used to calculate the LC50 value from the raw toxicological data.

While it may be hypothesized that sodium chloride would be more toxic under warmer conditions, few data are available on the effects of temperature upon the acute toxicity of this salt. The one study that examined this found that the mayfly *Hexigenia limbata* was more sensitive to chloride at a higher water temperature than at a lower temperature. It is important to note that the temperatures used in this study, 28ºC and 18ºC, were both higher than what would be expected to be observed in streams of the Root River watershed during the winter deicing season.

With one exception, the most sensitive organisms listed in Table N-1 have LC50 values in 96-hour toxicity tests starting at about 1,400 mg Cl/l.[2] Based on this, it was decided to use 1,400 mg Cl/l as a threshold for acute toxicity effects in further analysis and discussion. It should be noted that this threshold is considerably higher than the State of Wisconsin's acute toxicity criterion for fish and aquatic life for chloride of 757 mg/l and represents a threshold at which substantial acute toxic effects would be expected to occur. This threshold does not represent a value that would be protective of fish and aquatic life.

The LC50 values listed in Table N-1 are for toxicity associated with sodium chloride. The toxicity of chloride can vary depending upon the cations with which it is associated. Sodium chloride-based deicers were shown to have lower toxicity to rainbow trout, the water flea *Ceriodaphnia dubia*, and the alga *Selenastrum capricornatum* than other chloride-based deicers such as calcium chloride and magnesium chloride and acetate-based deicers.[3] For example, the LC50 for sodium chloride for *C. dubia* was 6,583 mg/l. Lower LC50s were seen in tests with other chloride-based deicers for this organism with an LC50 for calcium chloride of 3,828 mg/l and LC50's for magnesium chloride ranging between 660 mg/l and 4,950 mg/l, depending on the particular deicer formulation. By comparison, LC50s for *C. dubia* for acetate-based deicers range between 660 mg/l and 4,670 mg/l.[4]

It is important to note that the LC50 values listed in Table N-1 reflect the toxicity of sodium chloride. Commercial deicers also contain trace amounts of metals and other substances. For example, one study found that sodium chloride-based deicers contained trace amounts of copper, zinc, cyanide, and sulfate.[5] Some of these substances can cause acute toxicity in aquatic organisms at low concentrations. Toxic effects related to the presence of these substances in deicers are not reflected in the LC50 values in Table N-1.

LC50 values represent a substantial toxic effect to organism populations. While the LC50 values are useful measures of acute toxicity, they do not represent thresholds below which concentrations are safe or harmless in

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[2]*The LC50 of the one exception, the mayfly* Callibaetis coloradensis, *is below the range of chloride concentrations that can be calculated from specific conductance using the regression relationship described in the next section.*

[3]*B. Mussato and T. Guthrie, "Anti-icers: Chemical Analysis and Toxicity Test Results," Prepared for Insurance Corporation of British Columbia, 2000, cited in Colorado Department of Transportation, "Evaluation of Selected Deicers Based Upon a Review of the Literature," Report No. CDOT-DTD-R-2001-15, October 30, 2001.*

[4]*An important caution in interpreting these comparisons is that they do not take into account any differences in how they are used. It is possible that a more toxic deicer may produce fewer toxic effects in nature due to less of the deicer being required to remove ice from roads.*

[5]*Mussato and Guthrie*, op. cit.

aquatic habitats. It should be kept in mind that appreciable acute toxic effects can be expected to occur at chloride concentrations that are lower than the LC50s. In addition, appreciable acute toxic effects can be expected to occur over shorter periods of time than the test period associated with a particular LC50. Because of this, it is important to recognize that evaluations of toxicity that utilize LC50s as an indicator of toxicity refer to concentrations at which substantial incidences of toxic effects are likely to be occurring, as opposed to concentrations at which toxic effects begin to appear.

AMBIENT CHLORIDE CONCENTRATIONS IN STREAMS OF THE MENOMONEE RIVER WATERSHED DURING THE WINTER DEICING SEASON

Whether toxicity resulting from road salt constitutes a water quality problem within the Menomonee River watershed depends, in part, on whether concentrations of chloride in streams of the watershed reach the toxic levels identified in Table N-1 for appreciable periods of time during the winter deicing season. A reasonable hypothesis is that much of the chloride loading to these streams consists of pulses that occur either while deicing operations are conducted during winter storms or when ice melt and snowmelt during thaws carries accumulated salt into streams. Under this sort of scenario, it might be expected that chloride concentrations would spike fairly rapidly, followed by a rapid decrease to a relatively nontoxic level. If chloride loading during winter follows this sort of pattern, aquatic organisms might be exposed to high concentrations of chloride for relatively brief periods.

Unfortunately, chloride concentrations in streams of the Menomonee River watershed are rarely directly measured during the winter deicing season. Few data exist and those that do are not collected with enough frequency to allow characterization of the sort of spikes hypothesized in the previous paragraph. Because of this, measurements of specific conductance were chosen as a surrogate for chloride concentration.

Continuously collected specific conductance data are available from six monitoring stations in the Menomonee River watershed which were established as part of a joint Milwaukee Metropolitan Sewerage District (MMSD)-U.S. Geological Survey (USGS) real-time water quality monitoring program. Under this program, real-time sensors measure specific conductance, dissolved oxygen concentration, turbidity, water temperature, flow, and river level at five-minute intervals under all weather conditions. The data are transmitted to MMSD and USGS offices. While the five-minute interval data are retained for only 120 days, summary data consisting of daily minimum, maximum, and mean values are archived and available from the USGS's NWIS database. Table N-2 lists the monitoring stations from this program that are located in the Menomonee River watershed and lists the periods of record for specific conductance monitoring at these stations. The table also identifies the extent of gaps in the records during the winter deicing season in which specific conductance data were not collected.

A regression model is available that relates specific conductance to chloride concentration in Wisconsin streams[6] The model was developed using simultaneously collected measurements of specific conductance and chloride concentration from 17 Wisconsin streams, including several in the Milwaukee area. The equation developed in this model is:

$$Cl = 0.363 X Sc - 271.$$

In this equation, Cl indicates chloride concentration in milligrams per liter (mg/l) and Sc indicates specific conductance in microSiemens per centimeter (μS/cm). Based on graphical examination of the data, it was determined that the relationship is valid for chloride concentrations greater than 230 mg/l, which is equivalent to a specific conductance of 1,380 μS/cm. The regression has an R^2 value of 0.997, indicating that this relationship accounts for over 99 percent of the variation in the data within the valid range.

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[6]*Corsi, S.R., 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.*

This regression model was used to estimate minimum, maximum, and mean daily chloride concentrations at monitoring stations in the Menomonee River watershed using the daily summary values of specific conductance collected as part of the MMSD-USGS real-time monitoring program. For all values of minimum, maximum, and mean daily specific conductance that were equal to or greater than 1,380 μS/cm, the concentration of chloride was estimated using the regression equation. For each monitoring station, the record of estimated chloride concentrations was examined to identify periods in which the daily minimum chloride concentration was equal to or greater than 1,400 mg Cl/l for four or more days. This value was chosen as the screening value because it both exceeds the State's acute toxicity criterion for fish and aquatic life for chloride and reflects the low end of the LC50 values identified for freshwater organisms in the 96-hour acute toxicity studies summarized in Table N-1.

There were two stations, one along Honey Creek and one in Underwood Creek, at which periods were detected when the daily minimum concentration of chloride exceeded 1,400 mg Cl/l for four or more days. These periods are summarized in Table N-3. At the monitoring station along Honey Creek, there were nine periods between November 2008 and March 2011 during which the daily minimum concentration of chloride exceeded 1,400 mg/l for four or more days. The lengths of these periods ranged from four to 19 days. These periods often occurred in rapid succession. For example, four periods occurred during the time between December 22, 2010 and February 28, 2011, accounting for 42 out of 69 days. The summary statistics presented in Table N-3 suggest that chloride concentrations in Honey Creek were quite variable during these periods. For example, during the period December 22-25, 2010 the daily minimum chloride concentrations at the Honey Creek monitoring station ranged between 1,566 mg/l and 5,718 mg/l. Maximum daily chloride concentrations at this station during the same period ranged between 2,226 mg/l and 7,933 mg/l. The average chloride concentrations detected in these streams during these periods ranged between 1,917 mg/l and 3,742 mg/l. At the monitoring station along Underwood Creek, one period during which the daily minimum concentration of chloride exceeded 1,400 mg/l for four or more days occurred between February 2010 and July 2011. Chloride concentrations at that station were above 1,400 mg/l for nine consecutive days.

Daily minimum chloride concentrations at three other monitoring stations—the Little Menomonee River near Freistadt, the Menomonee River at Pilgrim Road, and the Menomonee River at N. 70th Street—did not exceed 1,400 mg/l for periods of four or more days during the period of record.

Two conclusions emerge from this examination of winter deicing season chloride concentrations calculated from specific conductance. First, concentrations of chloride during the winter in Honey and Underwood Creeks, as calculated from specific conductance, achieve levels that are well within the range of chloride concentrations that were found to result in the deaths of 50 percent of test organism in 96-hour toxicity tests. In both streams, chloride concentrations during the winter deicing season appear to remain at levels that are associated with acute toxic effects for extended periods of time. Thus, for these streams, the rapid-spike model previously hypothesized does not appear to give a good description of chloride concentrations during the winter.

Second, the results suggest that chloride concentrations probably reach higher levels in smaller streams that are located in highly urbanized areas than they do in larger streams and streams located in less urbanized areas. Comparisons of discharge at streamflow monitoring gauges in the Menomonee River watershed show that on average discharge at the monitoring stations along Honey and Underwood Creek account for 6 and 14 percent, respectively, of the discharge at the gauge along the Menomonee River at N. 70th Street.[7] In addition, the subwatersheds drained by these streams are highly urbanized. By contrast, discharge at the gauge along the Menomonee River at Pilgrim Road—one of the sites where calculated chloride concentrations did not exceed 1,400 mg/l for periods of four or more days during the period of record—accounts for 29 percent of the discharge at the gauge along Menomonee River at N. 70th Street. The higher volume of discharge at this station may result

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[7]*See Map 32 in SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007.*

in greater dilution of chloride. In addition, rural land uses comprise a greater percentage of the areas upstream of this site than they do for the Honey Creek and Underwood Creek stations.

LIKELY EFFECTS OF POTENTIALLY TOXIC CONCENTRATIONS OF CHLORIDE TO ORGANISMS IN THE MENOMONEE RIVER

As described above, chloride concentrations in some streams of the Menomonee River watershed reach toxic levels during the winter deicing season for extended periods of time. The likelihood that toxic effects are occurring in these streams also depends upon what organisms are present in the streams during the winter deicing season. It should be noted that, to some extent, the organisms listed in Table N-1 for which the acute toxicity of sodium chloride has been characterized reflect species that are suitable for toxicity testing. These are organisms that are readily available, that can be maintained under laboratory conditions, and that have well-understood physiological and nutritional requirements. How much they reveal about potential toxic effects in streams of the Menomonee River watershed depends on at least two factors: 1) how representative these species are of the biota found in streams of the watershed, and 2) whether sensitive life history stages of these species are present in streams during the winter deicing season.

The species for which sodium chloride toxicity has been characterized, as listed in Table N-1, were compared to the species records reviewed as part of the analyses made for the recent update of the regional water quality management plan for the Greater Milwaukee watersheds.[8] Four fish species listed in Table N-1—bluegill, brook trout, fathead minnow, and goldfish—have been detected in fisheries surveys of the watershed. In species other than fish, one frog species—wood frog—and two macroinvertebrate species—the scud *Gammarus pseudo-limnaeus,* and the caddisfly *Hydropsyche betteni*—have also been reported as being present. In addition, organisms belonging to five additional macroinvertebrate genera—caddisflies in the genera *Hydroptila* and *Pycnopsyche*, mayflies of the genus *Callibaetis*, midges of the genus *Chironomus*, and snails of the genus *Physa*—have been collected from streams in the Menomonee River watershed. It is important to note that organisms were identified only to the level of genus in many of the macroinvertebrate surveys, so it is possible but not certain that these particular test species are also present in the watershed. At least seven to 12 of the species listed on Table N-1 have been reported as being present in streams of the Menomonee River watershed. Given this, Table N-1 can be held as including a reasonable representation of aquatic organism species typical of the Menomonee River watershed.

A brief review of available literature regarding the life histories of the species listed in Table N-1 indicates that many of the species listed would be expected to be present in streams during the winter deicing season. Three of the fish species that are listed in the table and present in streams of the watershed—bluegill, brook trout, and goldfish—have life spans that last several years.[9] While fathead minnows typically live for only one to two years, spawning occurs in the spring and eggs hatch within about a week of spawning.[10] Thus, all four of these species may be present in streams as adults during the winter deicing season. The remaining vertebrate listed in the table—the wood frog—typically would not be present in streams during the winter deicing season. These animals normally hibernate in terrestrial and wetland forest habitats.[11]

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

[9]*George Becker,* Fishes of Wisconsin, *University of Wisconsin Press, 1983.*

[10]Ibid.

[11]*A.H. Wright and A.A. Wright,* Handbook of Frogs and Toads of the United States and Canada, *3rd edition, Cornell University Press, 1949.*

Life history information was available for some of the invertebrates listed in Table N-1. Two groups of caddisflies listed in the table, the species *Hydropsyche betteni* and members of the genus *Pyconpsyche*, overwinter in waterbodies as late-instar larvae.[12] In northern areas like Wisconsin, the mayfly *Hexagenia limbata* typically completes its life cycle over two years. While some populations may overwinter as eggs during the first winter, they are typically present in waterbodies as larvae during the second.[13] The scud *Gammarus lacustris* has a 15-month lifespan with reproduction occurring in or around the month of February.[14] Thus, this species is present in streams as adults for much of the winter. The isopod *Lirceus fontinalis* overwinters as adults or large juveniles.[15] The water flea *Daphnia pulex* overwinters both as resting eggs and as adults in the water column.[16]

Some of the invertebrate species that are present in waterbodies during the winter may experience less exposure to dissolved chloride than would be indicated based on ambient concentrations either because they remove themselves from the water column or enter a diapause, or resting, stage during winter. Nymphs of mayflies in the genus *Callibaetis* are thought move to areas of deeper water and overwinter in mats of vegetation.[17] Larvae of midges of the genus *Chironomus* often overwinter in diapause.[18]

Based on the available life history information, it is likely that organisms are present in streams of the Menomonee River watershed during the winter deicing season. Given that concentrations of chloride in some streams of watershed appear to reach levels associated with substantial incidences of toxic effects as measured by LC50 concentrations for extended periods of time, it is likely that inputs of chlorides from deicers are causing some toxic effects to aquatic organisms in streams of the watershed.

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[12] *S. Alexander and L.A. Smock, "Life Histories and Production of* Cheumotopsyche analis *and* Hydropsyche betteni, *(Trichoptera: Hydropsychidae) in an Urban Virginia Stream,* Northeastern Naturalist, *Volume 12, 2005; R. J. Mackay*, The Life Cycle and Ecology of *Pycnopsyche gentilis* (McLachlan), *P. luculenta* (Betten), and *P. scabripennis* (Rambur), (Trichoptera: Limnephilidae) in West Creek, Mont. St. Hilaire, Quebec, *Ph.D. Dissertation, McGill University, Montreal, Quebec, April 1992.*

[13] *B.P. Hunt, "The Life History and Economic Importance of a Burrowing Mayfly,* Hexagenia limbata *in Southern Michigan Lakes,"* Michigan Conservation Department Bulletin of the Institute of Fisheries Research, *No.4, 1953.*

[14] *H.B.N. Hynes and F. Harper, "The Life Histories of* Gammarus lacustris *and* Gammarus psuedolimnaeus *in Southern Ontario,* Crustaceana, *Supplement No. 3: Studies on Peracarida, 1972.*

[15] *X. Zhao, M.G. Fox, D.C. Lasenby, A.C. Armit, and D.N Kuthamale, "Substrate Selection and Seasonal Variation in Abundance and Size Composition of Isopod* Lirceus fontinalis *in Ontario Streams, Canada,"* Chinese Journal of Oceanography and Limnology, *Volume 25, 2007.*

[16] *W. Lampert, K.P. Lampert, and P. Larsson, "Coexisting Overwintering Strategies in* Daphnia pulex*: A Test of Genetic Differences and Growth Responses,"* Limnology and Oceanography, *Volume 55, 2010.*

[17] *K. E. Gibbs, "Ovoviviparity and Nymphal Seasonal Movements of* Callibaetis *spp. (Ephemeroptera: Baetidae) in a Pond in Southwestern Canada,"* Canadian Entomologist, *Volume 111, 1979.*

[18] *B.R. Goddeeris, A.C. Vermeulen, E. DeGeest, H. Jacobs, B. Baert, and F. Ollevier, "Diapause Induction in the Third and Fourth Instar of* Chironomus riparius *(Diptera) from Belgian Lowland Brooks,"* Archiv fur Hydrobiolgie, *Volume 150, 2001.*

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Table N-1

ACUTE TOXICITY OF SALT (SODIUM CHLORIDE) TO FRESHWATER AQUATIC ORGANISMS

Species	Common Name	NaCl Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response[a]	Reference
Salvelinus fontinalis	Brook trout	50,000	30,330	0.25	LC50	Phillips, 1944
Lepomis macrochirus	Bluegill	20,000	12,132	6.00	LC47	Waller, *et al.*, 1996
Oncorhynchus mykiss	Rainbow trout	20,000	12,132	6.00	LC40	Waller, *et al.*, 1996
Chironomus attenuatus	Midge	9,995	6,063	6.00	LC50	Thornton and Sauer, 1972
Lepomis macrochirus	Bluegill	14,100	8,553	24.00	LC50	Doudoroff and Katz, 1953
Daphnia magna	Water flea	7,754	4,704	24.00	LC50	Cowgill and Milazzo, 1990
Cirrhinius mrigalo	Indian carp fry	7,500	4,550	24.00	LC50	Gosh and Pal, 1969
Labeo rohoto	Indian carp fry	7,500	4,550	24.00	LC50	Gosh and Pal, 1969
Catla catla	Indian carp fry	7,500	4,550	24.00	LC50	Gosh and Pal, 1969
Daphnia pulex	Water flea	2,724	1,652	24.00	LC50	Cowgill and Milazzo, 1990
Ceriodaphnia dubia	Water flea	2,724	1,652	24.00	LC50	Cowgill and Milazzo, 1990
Daphnia pulex	Water flea	2,042	1,239	48.00	LC50	Gardner and Royer, 2010
Daphnia pulex	Water flea	1,812	1,099	48.00	LC50	Gardner and Royer, 2010
Anguilla rostrata	American eel, (black eel stage)	21,571	13,085	96.00	LC50	Hinton and Eversole, 1978
Anguilla rostrata	American eel, (black eel stage)	17,969	10,900	96.00	LC50	Hinton and Eversole, 1978
Gambusia affinis	Mosquito fish	17,500	10,616	96.00	LC50	Wallen, *et al.*, 1957
Hydropsyche betteni	Caddisfly	13,308	8,073	96.00	LC50	Kundman, 1998
Lepomis macrochirus	Bluegill	12,964	7,864	96.00	LC50	Trama, 1954
Oncorhynchus mykiss	Rainbow trout	11,112	6,743	96.00	LC50	Spehar, 1987
Pimephales promelas	Fathead minnow	10,831	6,570	96.00	LC50	Birge, *et al.* 1985
Culex sp.	Mosquito	10,254	6,222	96.00	LC50	Dowden and Bennett, 1965
Lepomis macrochirus	Bluegill	9,627	5,840	96.00	LC50	Birge, *et al.* 1985
Gammarus pseudolimnaeus	Scud	7,700	4,670	96.00	LC50	Blasius and Merritt, 2002
Pimephales promelas	Fathead minnow	7,681	4,659	96.00	LC50	Wisconsin State Laboratory of Health, 1995
Pimephales promelas	Fathead minnow	7,650	4,640	96.00	LC50	Adelman, *et al.*, 1976
Carassius auratus	Goldfish	7,341	4,453	96.00	LC50	Adelman, *et al.*, 1976
Anaobolia nervosa	Caddisfly	7,014	4,255	96.00	LC50	Sutcliffe, 1961
Limnephilus stigma	Caddisfly	7,014	4,255	96.00	LC50	Sutcliffe, 1961
Daphnia magna	Water flea	6,709	4,071	96.00	LC50	Wisconsin State Laboratory of Health, 1995
Chironomus attenuatus	Midge	6,637	4,026	96.00	LC50	Thornton and Sauer, 1972
Hexagenia limbata	Mayfly	6,300	3,822	96.00	LC50 at 18ºC	Chadwick, 1997
Daphnia magna	Water flea	6,031	3,658	96.00	LC50	Cowgill and Milazzo, 1990
Lepidostoma sp.	Caddisfly	6,000	3,640	96.00	LC50	Williams, *et al.*, 2000
Hydroptila angusta	Caddisfly	5,526	3,352	96.00	LC50	Hamilton *et al.*, 1975

Table N-1 (continued)

Species	Common Name	NaCl Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response[a]	Reference
Cricotopus trifascia	Midge	5,192	3,149	96.00	LC50	Hamilton *et al.*, 1975
Rana sylvatica	Wood frog (tadpoles)	5,109	3,099	96.00	LC50	Sanzo and Hecnar, 2006
Cirrhinius mrigalo	Indian carp fry	4,980	3,021	96.00	LC50	Gosh and Pal, 1969
Labeo rohoto	Indian carp fry	4,980	3,021	96.00	LC50	Gosh and Pal, 1969
Catla catla	Indian carp fry	4,980	3,021	96.00	LC50	Gosh and Pal, 1969
Lirceus fontinalis	Isopod	4,896	2,970	96.00	LC50	Birge, *et al.*, 1985
Physa gyrina	Snail	4,088	2,480	96.00	LC50	Birge, *et al.*, 1985
Daphnia magna	Water flea	3,939	2,390	96.00	LC50	Arambasic, *et al.*, 1995
Pycnopsyche guttifer	Caddisfly	3,526	2,140	96.00	LC50	Blasius and Merritt, 2002
Pycnopsyche lepida	Caddisfly	3,526	2,140	96.00	LC50	Blasius and Merritt, 2002
Daphnia magna	Water flea	3,054	1,853	96.00	LC50	Anderson, 1948
Rana sylvatica	Wood frog (tadpoles)	2,636	1,599	96.00	LC50	Sanzo and Hecnar, 2006
Ceriodaphnia dubia	Water flea	2,630	1,596	96.00	LC50	Wisconsin State Laboratory of Health, 1995
Daphnia pulex	Water flea	2,422	1,470	96.00	LC50	Birge, *et al.*, 1985
Hexagenia limbata	Mayfly	2,400	1,456	96.00	LC50 at 28ºC	Chadwick, 1997
Ceriodaphnia dubia	Water flea	2,308	1,400	96.00	LC50	Cowgill and Milazzo, 1990
Callibaetis coloradensis	Mayfly	700	425	96.00	LC50	Wichard, 1975

[a]*LC50 is the concentration that is lethal to 50 percent of the test organisms. A higher LC50 value means lower toxicity of the chemical to the organism.*

Source: SEWRPC.

Table N-2

CONTINUOUS SPECIFIC CONDUCTANCE DATA RECORDS AVAILABLE IN THE MENOMONEE RIVER WATERSHED

Location	Period of Record	Comments
Honey Creek at Wauwatosa (Honey Creek Parkway)	12/6/2008 to 8/26/2011	Six data gaps during winter deicing seasons totaling to 37 days without data
Little Menomonee River near Friestadt (downstream of W. Donges Bay Road)	11/8/2008 to 7/26/2011	One data gap during winter deicing season totaling four days without data
Little Menomonee River at USH 41	5/7/2010 to 9/28/2010, 5/5/2011 to 7/18/2011	No data collected during the winter deicing season
Menomonee River at N. 70th Street	11/5/2008 to 9/13/2010	Three data gaps during winter deicing seasons totaling nine days without data
Menomonee River at Pilgrim Road	11/8/2008 to 7/26/2011	- -
Underwood Creek at Wauwatosa (Gravel Sholes Park downstream of Mayfair Road)	2/12/2010 to 7/26/2011	One data gap during winter deicing season totaling two days without data

Source: Milwaukee Metropolitan Sewerage District, U.S. Geological Survey, and SEWRPC.

Table N-3

PERIODS WHEN CALCULATED CHLORIDE CONCENTRATION IN STREAMS OF THE MENOMONEE RIVER WATERSHED EXCEEDED 1,400 MILLIGRAMS PER LITER FOR FOUR DAYS OR MORE: NOVEMBER 2008 TO JULY 2011

Stream	Length (days)	Calculated Chloride Concentrations (milligrams per liter)						
		Lowest Daily Minimum	Highest Daily Minimum	Lowest Daily Maximum	Highest Daily Maximum	Lowest Daily Mean	Highest Daily Mean	Average over the Period
Honey Creek at Wauwatosa								
December 6, 2008-December 13, 2008	8	1,715	3,348	2,724	6,589	1,998	4,630	3,448
January 8, 2009-January 12, 2009	5	1,417	3,087	2,223	4,230	1,882	3,577	2,613
January 18, 2009-January 22, 2009	5	1,420	1,613	1,969	2,727	1,733	2,179	1,917
February 9, 2010-February 14, 2010	6	1,504	2,266	1,972	4,775	1,734	3,021	2,519
February 17, 2010-March 2, 2010	14	1,410	3,326	1,751	6,227	1,577	4,266	2,421
December 22, 2010-December 25, 2010	4	1,566	5,718	2,226	7,933	1,842	6,590	3,742
January 11, 2011-January 21, 2011	11	1,613	3,904	2,383	7,679	2,092	6,227	3,522
January 28, 2011-February 15, 2011	19	1,456	3,504	2,001	5,573	1,725	3,904	2,542
February 21, 2011-February 28, 2011	8	1,929	2,680	2,963	4,448	2,426	3,831	3,024
Underwood Creek at Wauwatosa[b]								
February 21, 2011-March 1, 2011	9	1,413	1,940	1,649	2,869	1,507	2,383	1,833

[a]*Chloride concentrations were calculated from specific conductance using the regression equation from Corsi* et al. *(2010). The regression equation is based on data from 17 Wisconsin streams. The regression equation is* Cl = 0.363 X Sc – 271, *where Cl is the concentration of chloride in milligrams per liter and Sc is the specific conductance in microSiemens per centimeter. This equation is considered valid for chloride concentrations greater than 230 milligrams per liter, which is equivalent to a specific conductance of 1,380 in microSiemens per centimeter.*

[b]*Period of record at this site was February 12, 2010 through July 26, 2011.*

Source: SEWRPC.

Appendix O

AVERAGE ANNUAL POLLUTANT LOADS FOR THE ROOT RIVER WATERSHED

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Table O-1

AVERAGE ANNUAL TOTAL PHOSPHORUS LOADS FOR THE ROOT RIVER WATERSHED TAKEN FROM THE RWQMPU

			Point Sources (pounds)				Nonpoint Sources (pounds)[a,b]			
Subwatershed	Assessment Areas	Condition	Industrial Point Sources	SSOs	WWTPs	Subtotal	Urban	Rural[c]	Subtotal	Total (pounds)
Upper Root River	Upper Root River-Headwaters	Existing (2000)	0	<10	0	<10	6,000	170	6,170	6,170
	Upper Root River	Revised 2020 Baseline	0	20	0	20	4,450	120	4,570	4,590
		Recommended Plan (2020)	0	20	0	20	4,260	120	4,380	4,400
Whitnall Park Creek	Whitnall Park Creek	Existing (2000)	0	<10	0	<10	3,650	1,010	4,660	4,660
		Revised 2020 Baseline	0	<10	0	<10	2,940	740	3,680	3,680
		Recommended Plan (2020)	0	<10	0	<10	2,790	690	3,480	3,480
Middle Root River	Middle Root River-Dale Creek	Existing (2000)	0	0	0	0	3,780	5,130	8,910	8,910
	Middle Root River-Legend Creek	Revised 2020 Baseline	0	0	0	0	3,530	4,520	8,050	8,050
	Middle Root River-Ryan Creek	Recommended Plan (2020)	0	0	0	0	3,320	3,880	7,200	7,200
East Branch Root River	East Branch Root River	Existing (2000)	0	0	0	0	1,660	180	1,840	1,840
		Revised 2020 Baseline	0	0	0	0	1,460	50	1,510	1,510
		Recommended Plan (2020)	0	0	0	0	1,380	50	1,430	1,430
West Branch Root River Canal	Upper West Branch Root River Canal	Existing (2000)	<10	0	1,990	1,990	1,040	15,890	16,930	16,930
	Lower West Branch Root River Canal	Revised 2020 Baseline	<10	0	2,620	2,620	1,050	13,940	14,990	17,610
		Recommended Plan (2020)	<10	0	2,620	2,620	970	10,950	11,920	14,540
East Branch Root River Canal	East Branch Root River Canal	Existing (2000)	0	0	220	220	430	6,880	7,310	7,530
		Revised 2020 Baseline	0	0	220	220	500	6,010	6,510	6,730
		Recommended Plan (2020)	0	0	220	220	480	4,710	5,190	5,410
Root River Canal	Root River Canal	Existing (2000)	0	0	0	0	180	4,720	4,900	4,900
		Revised 2020 Baseline	0	0	0	0	170	4,260	4,430	4,430
		Recommended Plan (2020)	0	0	0	0	170	3,400	3,570	3,570

Table O-1 (continued)

Subwatershed	Assessment Areas	Condition	Point Sources (pounds)				Nonpoint Sources (pounds)[a,b]			Total (pounds)
			Industrial Point Sources	SSOs	WWTPs	Subtotal	Urban	Rural[c]	Subtotal	
Lower Root River	Lower Root River-Caledonia	Existing (2000)	130	10	0	140	8,750	14,670	23,420	23,560
	Lower Root River-Johnson Park	Revised 2020 Baseline	130	10	0	140	7,660	11,760	19,420	19,560
	Lower Root River-Racine	Recommended Plan (2020)	130	10	0	140	7,070	9,930	17,000	17,140
Hoods Creek	Hoods Creek	Existing (2000)	0	0	940	940	1,020	5,610	6,630	7,570
		Revised 2020 Baseline	0	0	1,350	1,350	990	4,420	5,410	6,760
		Recommended Plan (2020)	0	0	1,350	1,350	950	3,910	4,860	6,210
Watershed Total		Existing (2000)	130	10	3,150	3,290	26,510	54,260	80,770	84,060
		Revised 2020 Baseline	130	30	4,190	4,350	22,750	45,820	68,570	72,920
		Recommended Plan (2020)	130	30	4,190	4,350	21,390	37,640	59,030	63,380

[a]*Certain apparent anomalies in the relationship between urban and rural nonpoint source loads are due to the manner in which the loads were apportioned. In those cases, the loads in the nonpoint subtotal column generally exhibit the anticipated relationships between conditions.*

[b]*In certain limited cases, relatively minor anomalies in nonpoint source pollutant loads may occur among the three conditions for which the model results are presented in this table. Those anomalies might indicate a relatively slight increased load under the recommended plan condition relative to the revised 2020 baseline. In those cases, it may be assumed that no significant change in pollutant load occurs among those conditions. Since it was not always possible to explicitly represent certain components of the recommended plan condition in the water quality model, adjustments were made to model parameters that served as surrogates for the actual water pollution control measure being represented. In the sense that those modifications sometimes alter parameters established under the revised 2020 baseline model version, in limited cases, representation of a measure in the recommended plan model may have a side effect of introducing small, relatively insignificant anomalies in the comparative results.*

[c]*For reporting purposes, certain land uses such as forests and wetlands have been categorized as rural sources even though they may exist in a predominantly urban setting.*

Source: Brown and Caldwell; Tetra Tech, Inc.; and SEWRPC.

Table O-2

AVERAGE ANNUAL TOTAL SUSPENDED SOLIDS LOADS FOR THE ROOT RIVER WATERSHED TAKEN FROM THE RWQMPU

Subwatershed	Assessment Areas	Condition	Point Sources (pounds)				Nonpoint Sources (pounds)[a,b]			Total (pounds)
			Industrial Point Sources	SSOs	WWTPs	Subtotal	Urban	Rural[c]	Subtotal	
Upper Root River	Upper Root River-Headwaters	Existing (2000)	0	80	0	80	1,918,200	18,970	1,937,170	1,937,250
	Upper Root River	Revised 2020 Baseline	0	890	0	890	1,299,350	8,060	1,307,410	1,308,300
		Recommended Plan (2020)	0	890	0	890	1,305,180	8,060	1,313,240	1,314,130
Whitnall Park Creek	Whitnall Park Creek	Existing (2000)	0	240	0	240	1,112,640	636,060	1,748,700	1,748,940
		Revised 2020 Baseline	0	240	0	240	781,980	66,120	848,100	848,340
		Recommended Plan (2020)	0	240	0	240	795,850	66,280	862,130	862,370
Middle Root River	Middle Root River-Dale Creek	Existing (2000)	0	0	0	0	1,290,740	5,439,900	6,730,640	6,730,640
	Middle Root River-Legend Creek	Revised 2020 Baseline	0	0	0	0	1,037,170	2,221,250	3,258,420	3,258,420
	Middle Root River-Ryan Creek	Recommended Plan (2020)	0	0	0	0	1,077,250	1,783,570	2,860,820	2,860,820
East Branch Root River	East Branch Root River	Existing (2000)	0	0	0	0	494,130	229,360	723,490	723,490
		Revised 2020 Baseline	0	0	0	0	371,160	4,170	375,330	375,330
		Recommended Plan (2020)	0	0	0	0	378,760	4,170	382,930	382,930
West Branch Root River Canal	Upper West Branch Root River Canal	Existing (2000)	0	0	8,890	8,890	468,430	25,202,610	25,671,040	25,679,930
	Lower West Branch Root River Canal	Revised 2020 Baseline	0	0	11,730	11,730	415,390	21,557,740	21,973,130	21,984,860
		Recommended Plan (2020)	0	0	11,730	11,730	419,490	15,758,740	16,178,230	16,189,960
East Branch Root River Canal	East Branch Root River Canal	Existing (2000)	0	0	450	450	271,250	10,618,210	10,889,460	10,889,910
		Revised 2020 Baseline	0	0	450	450	296,030	9,004,670	9,300,700	9,301,150
		Recommended Plan (2020)	0	0	450	450	301,200	6,583,660	6,884,860	6,885,310
Root River Canal	Root River Canal	Existing (2000)	0	0	0	0	114,030	7,048,210	7,162,240	7,162,240
		Revised 2020 Baseline	0	0	0	0	105,770	6,051,940	6,157,710	6,157,710
		Recommended Plan (2020)	0	0	0	0	106,150	4,431,700	4,537,850	4,537,850

Table O-2 (continued)

Subwatershed	Assessment Areas	Condition	Point Sources (pounds)				Nonpoint Sources (pounds)[a,b]			Total (pounds)
			Industrial Point Sources	SSOs	WWTPs	Subtotal	Urban	Rural[c]	Subtotal	
Lower Root River	Lower Root River-Caledonia	Existing (2000)	480	710	0	1,190	2,781,990	18,169,680	20,951,670	20,952,860
	Lower Root River-Racine	Revised 2020 Baseline	480	710	0	1,190	2,052,910	11,915,640	13,968,550	13,969,740
	Lower Root River-Johnson Park	Recommended Plan (2020)	480	710	0	1,190	2,104,660	9,405,010	11,509,670	11,510,860
Hoods Creek	Hoods Creek	Existing (2000)	0	0	1,060	1,060	536,060	7,409,050	7,945,110	7,946,170
		Revised 2020 Baseline	0	0	1,520	1,520	395,060	4,980,580	5,375,640	5,377,160
		Recommended Plan (2020)	0	0	1,520	1,520	411,000	4,078,040	4,489,040	4,490,560
Watershed Total		Existing (2000)	480	1,030	10,400	11,910	8,987,740	74,772,050	83,759,520	83,771,430
		Revised 2020 Baseline	480	1,840	13,700	16,020	6,754,820	55,810,170	62,564,990	62,581,010
		Recommended Plan (2020)	480	1,840	13,700	16,020	6,899,540	37,685,870	49,018,770	49,601,430

[a]*Certain apparent anomalies in the relationship between urban and rural nonpoint source loads are due to the manner in which the loads were apportioned. In those cases, the loads in the nonpoint subtotal column generally exhibit the anticipated relationships between conditions.*

[b]*In certain limited cases, relatively minor anomalies in nonpoint source pollutant loads may occur among the three conditions for which the model results are presented in this table. Those anomalies might indicate a relatively slight increased load under the recommended plan condition relative to the revised 2020 baseline. In those cases, it may be assumed that no significant change in pollutant load occurs among those conditions. Since it was not always possible to explicitly represent certain components of the recommended plan condition in the water quality model, adjustments were made to model parameters that served as surrogates for the actual water pollution control measure being represented. In the sense that those modifications sometimes alter parameters established under the revised 2020 baseline model version, in limited cases, representation of a measure in the recommended plan model may have a side effect of introducing small, relatively insignificant anomalies in the comparative results.*

[c]*For reporting purposes, certain land uses such as forests and wetlands have been categorized as rural sources even though they may exist in a predominantly urban setting.*

Source: Brown and Caldwell; Tetra Tech, Inc.; and SEWRPC.

Table O-3

AVERAGE ANNUAL FECAL COLIFORM BACTERIA LOADS FOR THE ROOT RIVER WATERSHED TAKEN FROM THE RWQMPU

Subwatershed	Assessment Areas	Condition	Point Sources (trillions of cells)				Nonpoint Sources (trillions of cells)[a,b]			Total (trillions of cells)
			Industrial Point Sources	SSOs	WWTPs	Subtotal	Urban	Rural[c]	Subtotal	
Upper Root River	Upper Root River-Headwaters	Existing (2000)	0.00	1.55	0.00	1.55	2,202.96	0.75	2,203.71	2,205.26
	Upper Root River	Revised 2020 Baseline	0.00	16.89	0.00	16.89	1,657.14	0.28	1,657.42	1,674.31
		Recommended Plan (2020)[d]	0.00	16.89	0.00	16.89	1,032.09	0.28	1,032.37	1,049,26
Whitnall Park Creek	Whitnall Park Creek	Existing (2000)	0.00	4.52	0.00	4.52	1,309.52	100.59	1,410.11	1,414.63
		Revised 2020 Baseline	0.00	4.52	0.00	4.52	1,043.97	93.23	1,137.20	1,141.72
		Recommended Plan (2020)[d]	0.00	4.52	0.00	4.52	653.06	58.95	712.01	716.53
Middle Root River	Middle Root River-Dale Creek	Existing (2000)	0.00	0.00	0.00	0.00	1,323.10	317.14	1,640.24	1,640.24
	Middle Root River-Legend Creek	Revised 2020 Baseline	0.00	0.00	0.00	0.00	1,223.78	340.37	1,564.15	1,564.15
	Middle Root River-Ryan Cree	Recommended Plan (2020)[d]	0.00	0.00	0.00	0.00	849.20	279.53	1,128.73	1,128.73
East Branch Root River	East Branch Root River	Existing (2000)	0.00	0.00	0.00	0.00	554.63	2.49	557.12	557.12
		Revised 2020 Baseline	0.00	0.00	0.00	0.00	478.13	0.13	478.26	478.26
		Recommended Plan (2020)[d]	0.00	0.00	0.00	0.00	307.63	0.13	307.76	307.76
West Branch Root River Canal	Upper West Branch Root River Canal	Existing (2000)	0.00	0.00	2.85	2.85	451.94	560.80	1,012.74	1,015.59
	Lower West Branch Root River Canal	Revised 2020 Baseline	0.00	0.00	3.76	3.76	423.71	529.13	952.84	956.60
		Recommended Plan (2020)[d]	0.00	0.00	3.76	3.76	404.16	370.69	774.85	778.61
East Branch Root River Canal	East Branch Root River Canal	Existing (2000)	0.00	0.00	0.14	0.14	215.12	251.23	466.35	466.49
		Revised 2020 Baseline	0.00	0.00	0.14	0.14	228.91	237.03	465.94	466.08
		Recommended Plan (2020)[d]	0.00	0.00	0.14	0.14	217.11	166.12	383.23	383.23
Root River Canal	Root River Canal	Existing (2000)	0.00	0.00	0.00	0.00	96.48	180.79	277.27	277.27
		Revised 2020 Baseline	0.00	0.00	0.00	0.00	91.35	181.30	272.65	272.65
		Recommended Plan (2020)[d]	0.00	0.00	0.00	0.00	88.87	134.61	223.48	223.48

Table O-3 (continued)

			Point Sources (trillions of cells)				Nonpoint Sources (trillions of cells)[a,b]			
Subwatershed	Assessment Areas	Condition	Industrial Point Sources	SSOs	WWTPs	Subtotal	Urban	Rural[c]	Subtotal	Total (trillions of cells)
Lower Root River	Lower Root River-Caledonia	Existing (2000)	0.00	13.58	0.00	13.58	2,641.12	853.13	3,494.25	3,507.83
	Lower Root River-Johnson Park	Revised 2020 Baseline	0.00	13.58	0.00	13.58	2,133.73	737.65	2,871.38	2,884.96
	Lower Root River-Racine	Recommended Plan (2020)[d]	0.00	13.58	0.00	13.58	1,580.26	586.33	2,166.59	2,180.17
Hoods Creek	Hoods Creek	Existing (2000)	0.00	0.00	0.30	0.30	418.83	276.59	695.42	695.72
		Revised 2020 Baseline	0.00	0.00	0.43	0.43	361.82	243.26	605.08	605.51
		Recommended Plan (2020)[d]	0.00	0.00	0.43	0.43	231.09	141.43	372.52	372.95
Watershed Total		Existing (2000)	0.00	19.65	3.29	22.94	9,213.70	2,543.51	11,757.21	11,780.15
		Revised 2020 Baseline	0.00	34.99	4.33	39.32	7,642.54	2,362.38	10,004.92	10,044.24
		Recommended Plan (2020)[d]	0.00	34.99	4.33	39.32	5,363.47	1,738.17	7,101.54	7,140.86

[a]*Certain apparent anomalies in the relationship between urban and rural nonpoint source loads are due to the manner in which the loads were apportioned. In those cases, the loads in the nonpoint subtotal column generally exhibit the anticipated relationships between conditions.*

[c]*For reporting purposes, certain land uses such as forests and wetlands have been categorized as rural sources even though they may exist in a predominantly urban setting.*

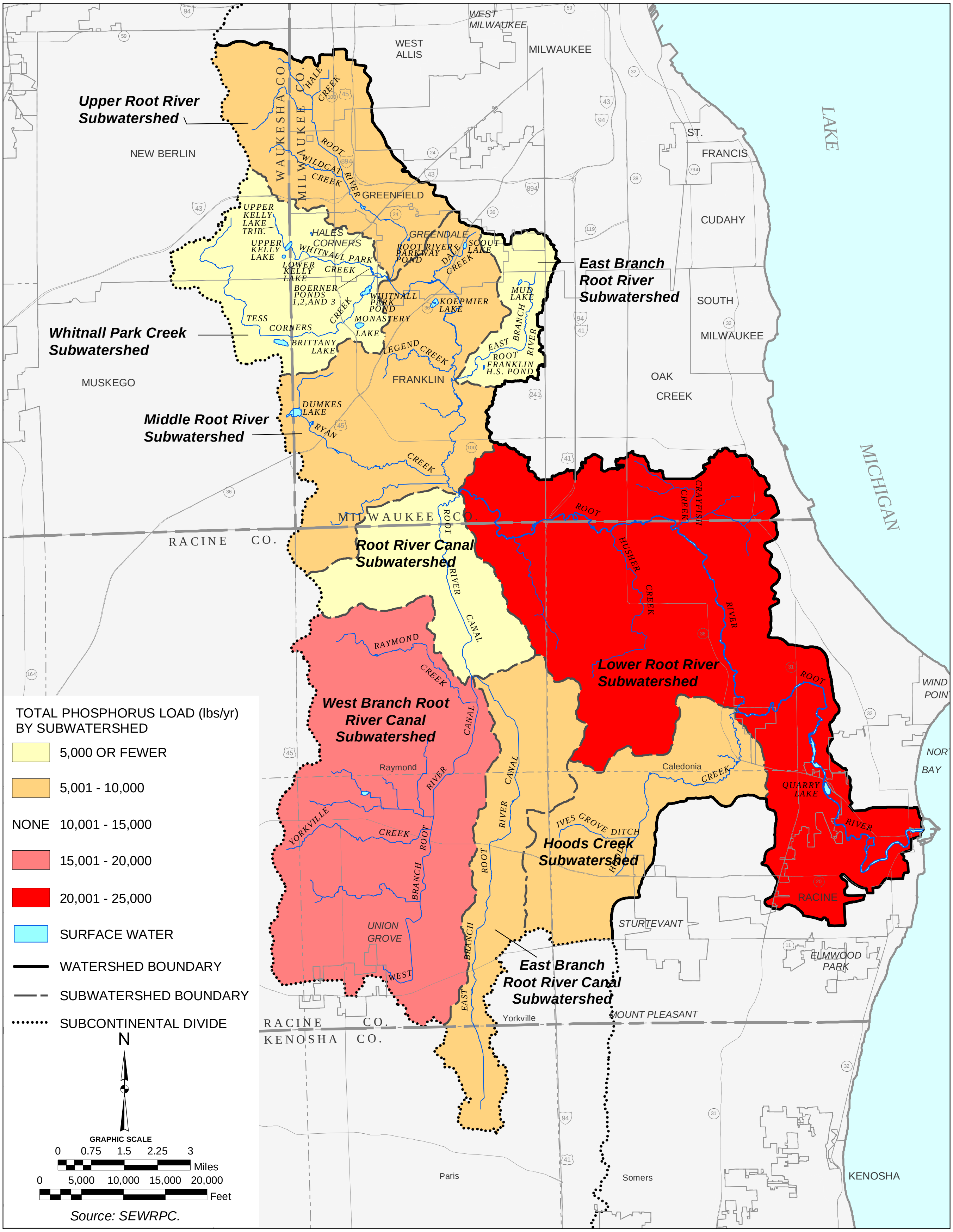
[b]*In certain limited cases, relatively minor anomalies in nonpoint source pollutant loads may occur among the three conditions for which the model results are presented in this table. Those anomalies might indicate a relatively slight increased load under the recommended plan condition relative to the revised 2020 baseline. In those cases, it may be assumed that no significant change in pollutant load occurs among those conditions. Since it was not always possible to explicitly represent certain components of the recommended plan condition in the water quality model, adjustments were made to model parameters that served as surrogates for the actual water pollution control measure being represented. In the sense that those modifications sometimes alter parameters established under the revised 2020 baseline model version, in limited cases, representation of a measure in the recommended plan model may have a side effect of introducing small, relatively insignificant anomalies in the comparative results.*

[d]*Within the water quality models for the recommended plan, 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.*

Source: Brown and Caldwell; Tetra Tech, Inc.; and SEWRPC.

Map O-1

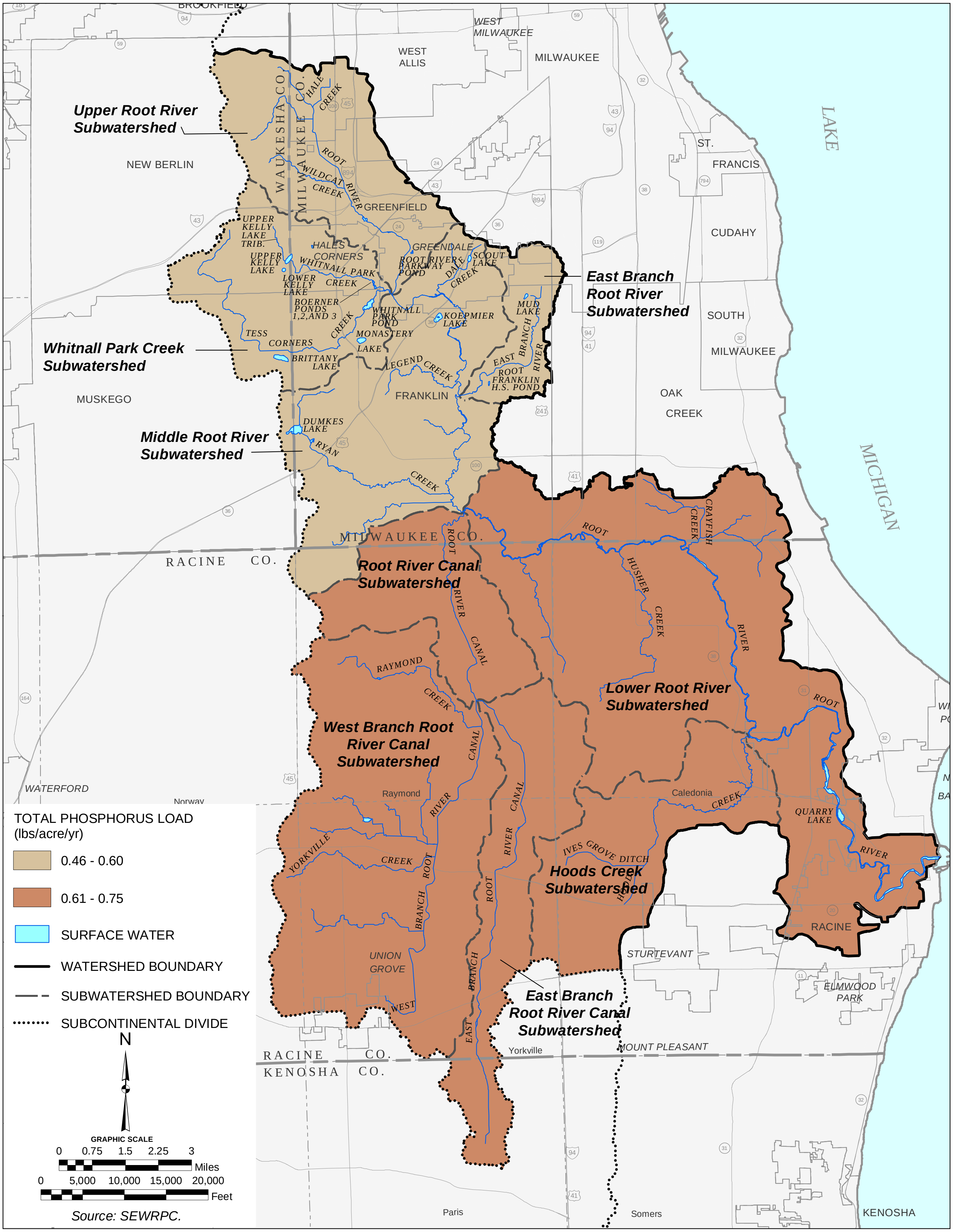
ESTIMATED AVERAGE ANNUAL NONPOINT SOURCE POLLUTION LOADS OF TOTAL PHOSPHORUS IN THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map O-2

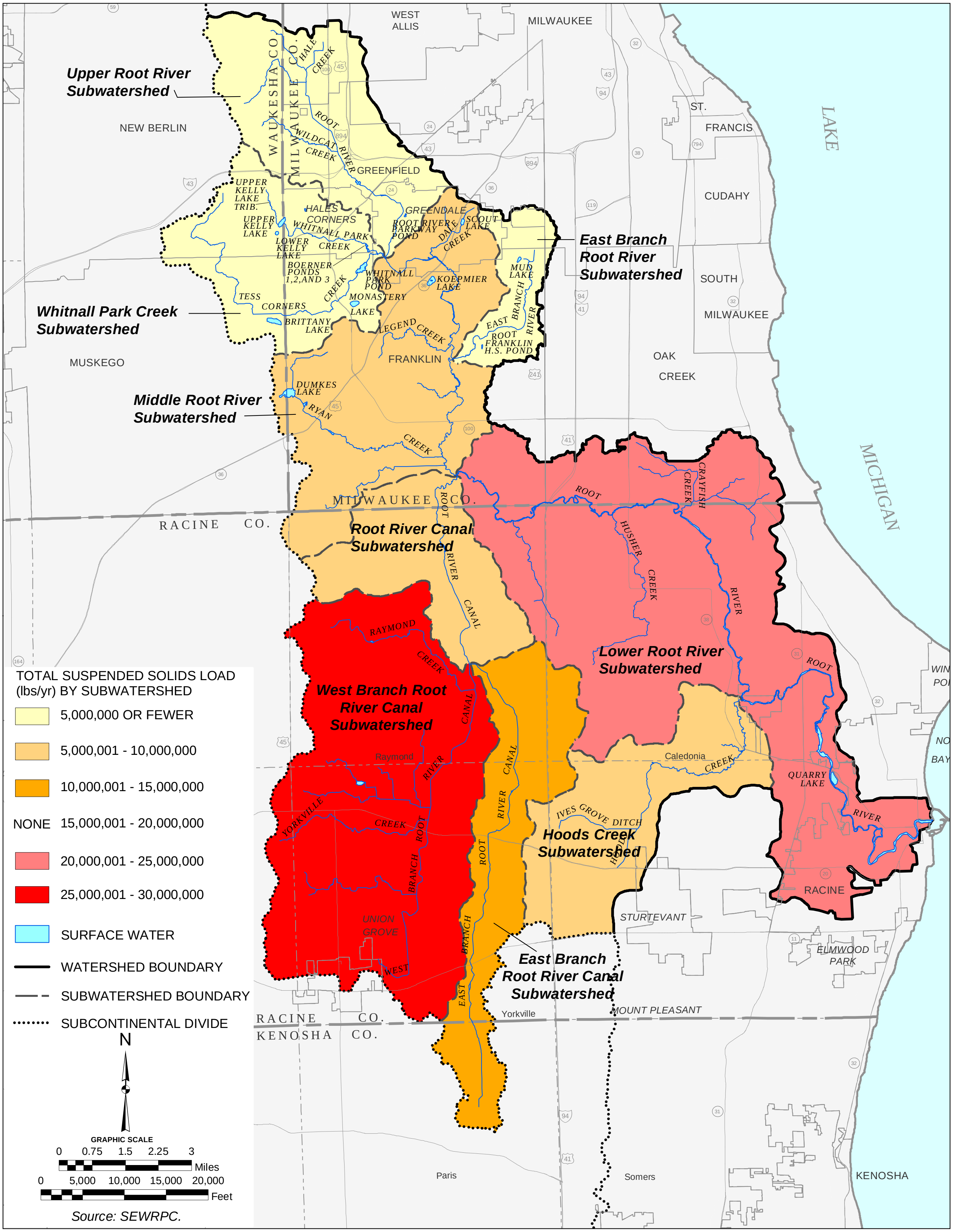
ESTIMATED AVERAGE ANNUAL PER ACRE NONPOINT SOURCE POLLUTION LOADS OF PHOSPHORUS IN THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map O-3

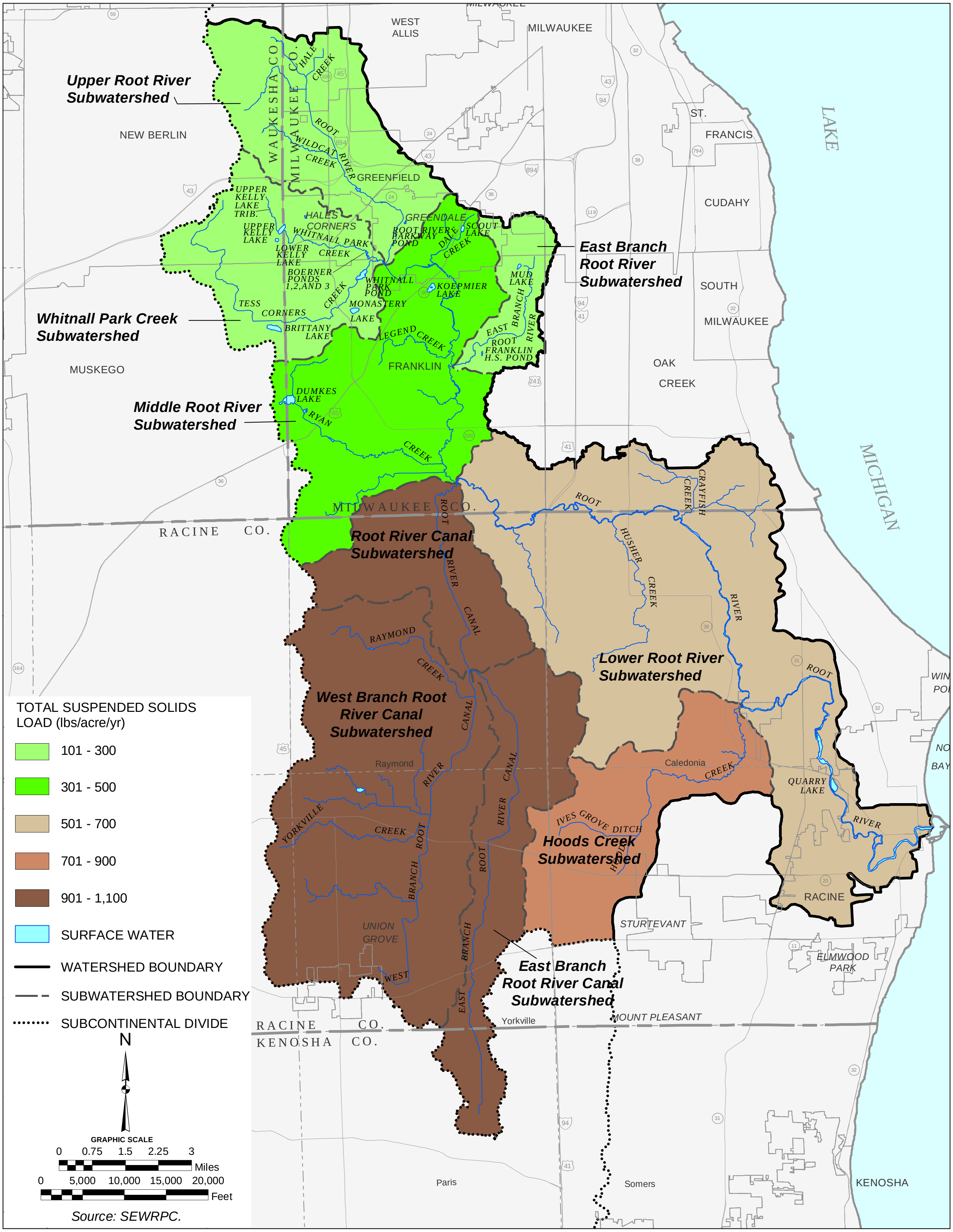
ESTIMATED AVERAGE ANNUAL NONPOINT SOURCE POLLUTION LOADS OF TOTAL SUSPENDED SOLIDS IN THE ROOT RIVER WATERSHED



Source: SEWRPC.

Map O-4

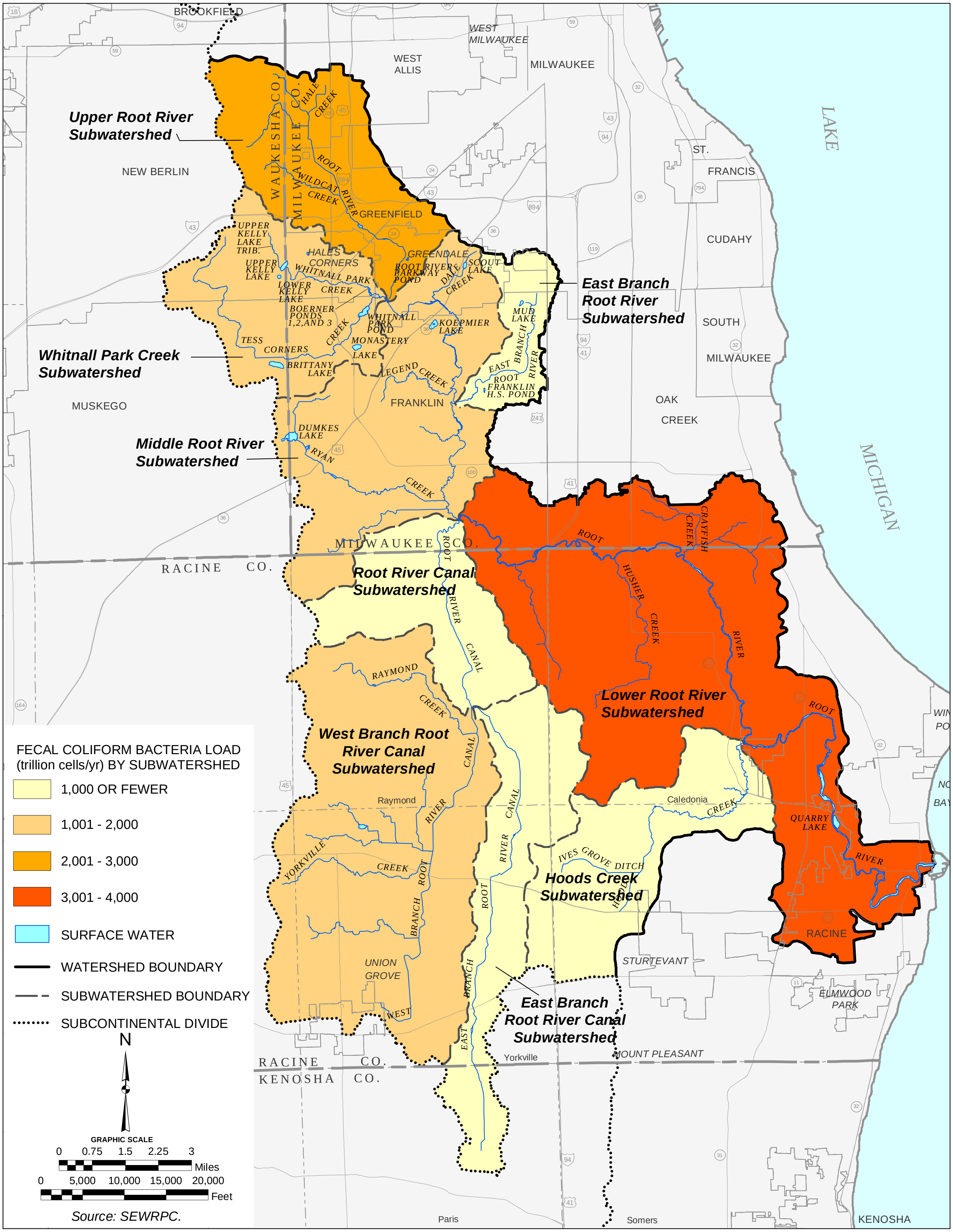
ESTIMATED AVERAGE ANNUAL PER ACRE NONPOINT SOURCE POLLUTION LOADS OF TOTAL SUSPENDED SOLIDS IN THE ROOT RIVER WATERSHED



Source: SEWRPC.

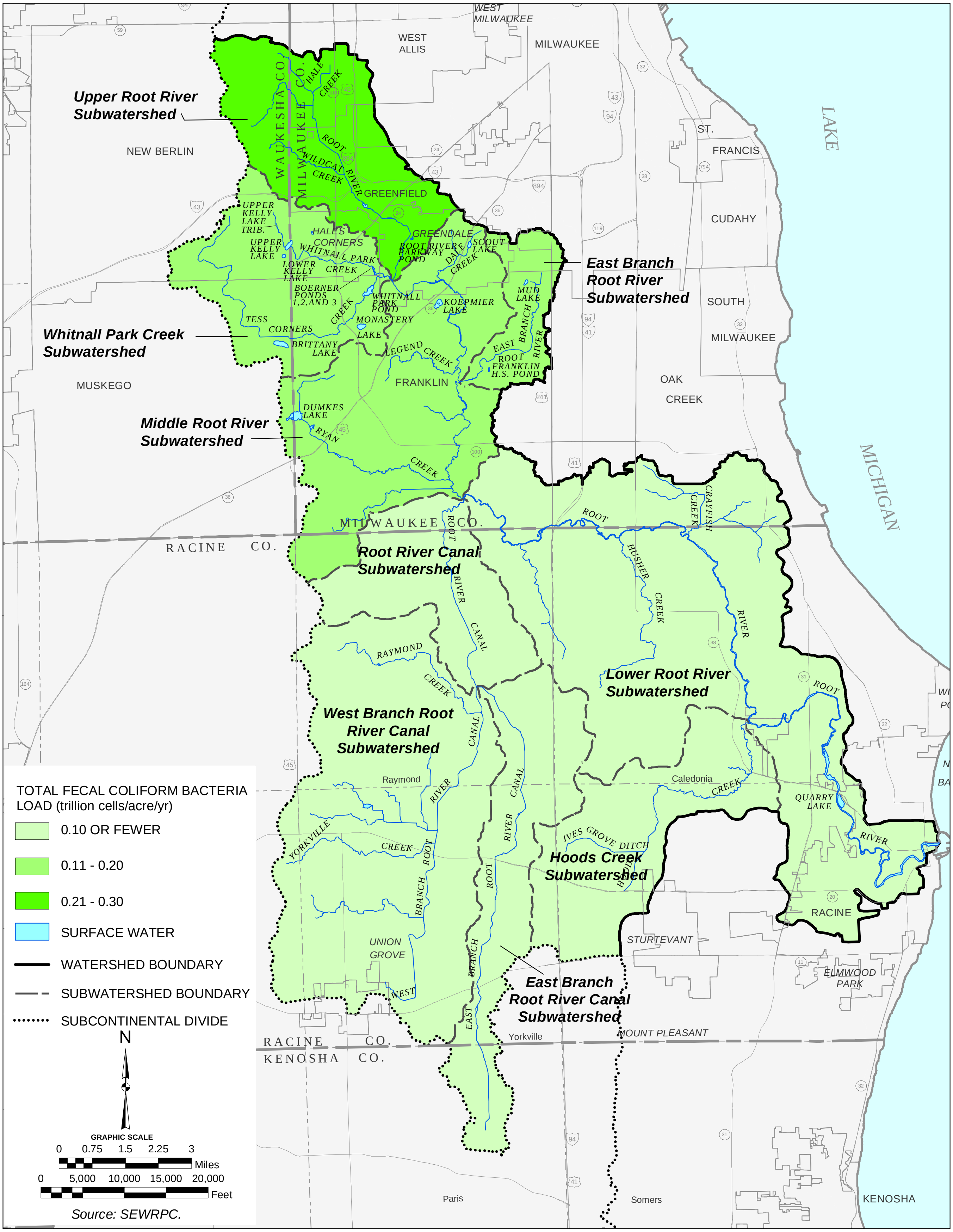
Map O-5

ESTIMATED AVERAGE ANNUAL NONPOINT SOURCE POLLUTION LOADS OF FECAL COLIFORM BACTERIA IN THE ROOT RIVER WATERSHED



Map O-6

ESTIMATED AVERAGE ANNUAL PER ACRE NONPOINT SOURCE POLLUTION LOADS OF TOTAL FECAL COLIFORM BACTERIA IN THE ROOT RIVER WATERSHED



Source: SEWRPC.

Appendix P

SEWRPC MEMORANDUM TO FILE REQUIREMENTS OF THE *WISCONSIN ADMINISTRATIVE CODE* RELATED TO EFFLUENT LIMITATIONS AND DISINFECTION REQUIREMENTS APPLICABLE TO WASTEWATER TREATMENT PLANTS IN THE ROOT RIVER WATERSHED

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MEMORANDUM TO FILE

TO: Files

FROM: Joseph E. Boxhorn

DATE: May 25, 2012, revised December 19, 2013

SUBJECT: REQUIREMENTS OF THE *WISCONSIN ADMINISTRATIVE CODE* RELATED TO EFFLUENT LIMITATIONS AND DISINFECTION REQUIREMENTS APPLICABLE TO WASTEWATER TREATMENT PLANTS IN THE ROOT RIVER WATERSHED

At the May 2, 2012 meeting of the Advisory Committee for the Root River watershed restoration plan, questions arose as to whether concentrations of phosphorus and bacteria detected in water quality samples collected from stream sites located downstream from wastewater treatment plants (WWTPs) might indicate that discharges from the plants are contributing to degraded water quality in the receiving waters. The purpose of this memorandum is to document the results of a review of the effluent limitation and disinfection requirements set forth in the *Wisconsin Administrative Code* that apply to these WWTPs.

BACKGROUND

Three WWTPs discharge into streams within the Root River watershed. Two are municipally-owned and the third is privately owned. The municipally-owned plants are the Village of Union Grove WWTP, which discharges into the West Branch of the Root River Canal, and the Yorkville Sewer Utility No. 1's plant, which discharges into Ives Grove Ditch. The privately-owned plant serves the Fonk's Mobile Home Park and discharges into the East Branch of the Root River Canal. The locations of these WWTPs are shown on Map 108 of SEWPRC Technical Report No. 39, *Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds*." The important point about the locations is that all three WWTPs discharge into upstream reaches of their respective receiving waters.

The water use objective for the stream reaches that each of these WWTPs discharge into, as codified in Chapter NR 102, "Water Quality Standards for Wisconsin Surface Waters," of the *Wisconsin Administrative Code*, is limited aquatic life. In each case, the stream flows into another stream or stream reach which has a water use objective of limited forage fish. Farther downstream, each stream flows into another stream or a stream reach that have objectives of warm water fish and aquatic life. These water use objectives are important because the codified water use objective of a waterbody is a factor in determining the water quality criteria that apply to the waterbody and the effluent limitations applicable to point sources discharging into the waterbody.

APPLICABLE WATER QUALITY CRITERIA

Chapter NR 102 also sets forth water quality criteria for surface waters of the State. The following water quality criteria apply to limited aquatic life waters:

- Dissolved oxygen concentration is not to fall below 1.0 mg/l,
- pH is to remain between 6.0 and 9.0 standard units, and

- Membrane filter fecal coliform counts may not exceed 200 colonies per 100 ml as a geometric mean or exceed 400 colonies in more than 10 percent of all samples during any month.

It is important to note that NR 102.06(6)d specifically excludes limited aquatic life waters from Wisconsin's water quality criteria for phosphorus.

The following water quality criteria apply to limited forage fish waters:

- Dissolved oxygen concentration is not to fall below 3.0 mg/l,

- pH is to remain between 6.0 and 9.0 standard units,

- Membrane filter fecal coliform counts may not exceed 200 colonies per 100 ml as a geometric mean or exceed 400 colonies in more than 10 percent of all samples during any month, and

- Total phosphorus concentration is not to exceed 0.075 mg/l.

Similar criteria apply to warm water fish and aquatic life waters, except that for these waters dissolved oxygen concentration is not to fall below 5.0 mg/l.

EFFLUENT LIMITATIONS

Effluent limitations for WWTPs are set forth in Chapters NR 210, "Sewage Treatment Works," and NR 217, "Effluent Standards and Limitations for Phosphorus." The effluent limitations set forth in the code for WWTPs discharging into limited aquatic life waters are shown in Table 1. A few explanations are in order. First, the code gives the Wisconsin Department of Natural Resources the authority to impose more stringent effluent limitations than those specified where necessary to meet water quality standards for water receiving the treated discharge.[1] Similarly, the code also gives the Department the authority to impose effluent limitations for pollutants other than those specified where necessary to meet water quality standards for water receiving the treated discharge.[2]

Second, under conditions specified in NR 210.07(4), a permitted WWTP may request that the Department substitute an effluent limitation for 5-day carbonaceous biochemical oxygen demand (CBOD5) for 5-day biochemical oxygen demand (BOD5). The conditions necessary for this substitution involve paired sampling of effluent for BOD5 and CBOD5 and, in some circumstances, sampling for ammonia nitrogen and nitrate nitrogen.

Third, NR 217.04(2) allows permitted WWTPs to seek alternative effluent limitations for total phosphorus where achieving an effluent limitation of 1.0 mg/l is not practically achievable, where operation of specific biological removal technologies will achieve a level of performance equivalent to a 1.0 mg/l effluent limitation, or where phosphorus-deficient wastewaters necessitate the addition of

---

[1]*Set forth in NR 210.05(3)f.*

[2]*Set forth in NR 210.05(4).*

phosphorus in order to assure efficient operation of the plant and to achieve compliance with other effluent standards.

Finally, NR 217.10 through NR 217.19 describe the circumstances under which, and the methodology for, the Department to impose water quality-based effluent limitations.

DISINFECTION REQUIREMENTS

Disinfection of wastewater effluent is required only in those cases where the Department has made a determination that the discharge of wastewater poses a risk to human and animal health. NR 210.06(3) specifies that the following information shall be used in identifying human and animal health risks:

- Proximity of the wastewater outfall to swimming beaches and other waters which have a high level of human contact recreational activities.
- Proximity of the wastewater outfall to public drinking water supply intakes.
- Proximity of the wastewater outfall to wetlands which support populations of waterfowl subject to disease outbreaks, which may be caused by the discharge of wastewater which has not been disinfected.
- The quality of the wastewater being discharged.
- Dilution and mixing characteristics of the wastewater with the receiving water.
- Bacterial indicator organism levels or sanitary survey results from sampling conducted in the vicinity of the wastewater outfall and near the sites used for recreational purposes.
- The classification of the receiving water and downstream waters as determined in s. NR 104.02 (1)
- The detention time of the wastewater treatment system. Except in extenuating circumstances, the discharge of wastewater to surface water from a treatment system with a detention time of 180 days or longer does not pose a risk to human and animal health.
- Other factors that are necessary to determine if there is a risk posed to human and animal health by the discharge of wastewater that has not been disinfected.

When a requirement for disinfection is imposed, the following effluent limitations apply:

- The geometric mean of fecal coliform bacteria in samples collected over 30 consecutive days is not to exceed 400 mg per 100 ml.[3]

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[3]*Presumably the units in this effluent limitation represent a typographical error in NR 210.06(2)a with the intent being that the geometric mean not exceed 400 colonies per 100 ml. If this is intended as a mass, it represents cell counts that are on the order of* 10^{11} *to* 10^{12} *cells per 100 ml (This is based on an assumption that most of the fecal coliform cells are* E. coli *and have a density of about 1.09 g/ml, a length*
(Footnote Continued on Next Page)

- Total residual chlorine in the effluent is not to exceed 0.1 mg/l.

MONITORING REQUIREMENTS

Monitoring requirements for WWTP influent and effluent are set forth in NR 210.04. Influent is required to be monitored for flow, BOD5 and suspended solids. Effluent is required to be monitored for BOD5, suspended solids, and pH. This section gives the Department the authority to adjust monitoring requirements on a case-by-case basis depending upon the characteristics of the wastewater and the potential for the wastewater to degrade water quality.

* * *

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of about 1.5 µm and a diameter of 0.9 µm. If it is assumed that the bacterial cells are from fecal coliform species other than E. coli*, this estimate may be low.).*

Table 1

EFFLUENT LIMITATIONS FOR PUBLICLY OWNED TREATMENT WORKS AND PRIVATELY OWNED SEWAGE TREATMENT PLANTS DISCHARGING INTO LIMITED AQUATIC LIFE WATERS[a]

Constituent	30-day Average (mg/l)	7-day Average (mg/l)	Minimum Removal Efficiency (percent)	Minimum Concentration (mg/l)	Range (standard units)	Code Reference
Biochemical Oxygen Demand (5-day)	20	30	85	- -	- -	NR 210.05(3)(a)
Suspended Solids	20	30	85	- -	- -	NR 210.05(3)(b)
pH	- -	- -	- -	- -	6.0-9.0	NR 210.05(3)(c)
Dissolved Oxygen	- -	- -	- -	4.0	- -	NR 210.05(3)(d)
Carbonaceous Biochemical Oxygen Demand (5-day)[b]	16	25	85	- -	- -	NR 210.05(3)(e)
Total Phosphorus[c,d]	1.0	- -	- -	- -	- -	NR 217.04(1)(a)

[a]*NR 210.05(4) gives the Department the authority to set more stringent effluent limitations for biochemical oxygen demand, suspended solids, pH, dissolved oxygen, and carbonaceous biochemical oxygen demand than those specified where necessary to meet water quality standards for the waters receiving the discharge*

[b]*Under certain circumstances specified in NR 210.07(4), a permittee may request that the Department substitute an effluent standard for carbonaceous biochemical oxygen demand for biochemical oxygen demand.*

[c]*NR 217.04(2) allows permittees to seek alternative effluent limitations where achieving an effluent limitation of 1.0 mg/l is not practically achievable, where operation of specific biological removal technologies will achieve a level of performance equivalent to a 1.0 mg/l effluent limitation, or where phosphorus-deficient wastewaters necessitate the addition of phosphorus to assure efficient operation and compliance with other effluent standards.*

[d]*NR 217.10 through NR 217.19 contains a provision and mechanism for the Department to develop water quality-based effluent limitations for total phosphorus .*

Source: Wisconsin Department of Natural Resources.

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Appendix Q

APRIL 22, 2014, WISCONSIN DEPARTMENT OF NATURAL RESOURCES HORLICK DAM FAILURE ANALYSIS AND HAZARD RATING ASSIGNMENT LETTER

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State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
101 S. Webster Street
Box 7921
Madison WI 53707-7921

Scott Walker, Governor
Cathy Stepp, Secretary
Telephone 608-266-2621
FAX 608-267-3579
TTY Access via relay - 711

Tuesday, April 22, 2014

Racine County
C/o Mr. Nathan Plunkett,
Project Engineer
14200 Washington Ave.,
Sturtevant, WI 53177

Expedited delivery via email: nathan.plunkett@goracine.org

Subject: Horlicks Dam. Field file 51.03, Key sequence # 288, dam failure analysis approval and hazard rating assignment, Racine County.

Dear Mr. Plunkett:

We are sending you this approval of the dam failure analysis and setting the hazard rating for the Horlicks Dam. The hazard rating is being set as Low Hazard. As a dam having an assigned low hazard rating, the structure must be capable of passing the 100-year flood without overtopping. The dam, as currently configured, does not have sufficient capacity to meet the requirements of chapter NR 333 Wisconsin Administrative Code, for a low hazard dam.

If you have questions about this approval, please give me a call at 608 266-1925. If you have other questions pertaining to the operation and maintenance of your dam please contact Nathan Zoch at 262 574-2188, or via email at nathan.zoch@wisconsin.gov.

Thank you for your continued cooperation.

Sincerely,

Konny Margovsky, P.E.
Dam Safety Engineer
Bureau of Watershed Management

cc. Nathan Zoch – DNR, Waukesha office, via email
Ryan Kloth, P. E. – GRAEF-USA, via email
Michael Hahn, P. E. – SEWRPC, via email

BEFORE THE
DEPARTMENT OF NATURAL RESOURCES

IN THE MATTER of the assignment of the Hazard Rating for the Horlicks Dam, located across the Root River, Racine County. Field File 51.03

FINDINGS OF FACT

1. The Department of Natural Resources (Department) has examined the dam failure analysis, for the Horlicks Dam, located in the NW ¼ of the NE ¼ of Section 6, Township 3 North, Range 23 East, Racine County, across the Root River.

2. The Horlicks Dam is owned and operated by the Racine County.

3. The dam failure analysis was performed by GRAEF-USA and the final version submitted to the Department on 04/08/2014.

4. GRAEF-USA has determined that due to convergence of the dam failure and dam nonexistent profiles immediately downstream of the dam, a rating of Low Hazard would be appropriate for the dam.

5. The current Flood Insurance Study (FIS) (FIRM Panel Numbers 55101C0114D and 55101C0227D with the effective date 05/02/2012) zoning in place downstream from the dam appears to be adequate in providing sufficient protection of life, health and property in areas below the Horlicks Dam.

6. Design flood routing completed by your consultant as part of the dam failure analysis, determined that the dam is not able to pass the 100-year flood without overtopping through its spillway as defined by NR 333, for a low hazard dam.

7. The analysis was performed in compliance with Wisconsin Administrative Codes NR 333, and NR 116.

8. The hazard rating meets the standards of Section NR 333.06, Wisconsin Administrative Code.

CONCLUSIONS OF LAW

1. The review has been conducted in accordance with Chapter 31, Wisconsin Statutes, and Chapters NR 333 and NR 116, Wisconsin Administrative Codes.

2. The Department has authority under Chapter 31, Wisconsin Statutes, and Chapter NR 333, Wisconsin Administrative Code, to assign a hazard rating.

ASSIGNMENT OF THE HAZARD RATING

1. The hazard rating of Low Hazard is hereby assigned to the dam.

2. An Emergency Action Plan (EAP) is required for your dam. Please submit an EAP to Nathan for review and approval by September 1, 2014.

3. The spillway capacity of the dam must be brought into compliance with NR 333, Wisconsin

Administrative Code within 10 years from the date this document was mailed, or otherwise served by the Department.

4. Capacity upgrade design elements will have to be incorporated into the currently approved dam failure analysis as well as any available additional and/or newly developed riverine hydrologic and hydraulic information. The analysis then will need to be re-run and submitted to the DNR for review and approval.

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that the Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed. For judicial review of a decision pursuant to sections 227.52 and 227.53, Wis. Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review must name the Department of Natural Resources as the respondent.

To request a contested case hearing pursuant to section 227.42, Wis. Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to serve a petition for hearing on the Secretary of the Department of Natural Resources. All requests for contested case hearings must be made in accordance with section NR 2.05(5), Wis. Adm. Code, and served on the Secretary in accordance with section NR 2.03, Wis. Adm. Code. The filing of a request for a contested case hearing does not extend the 30 day period for filing a petition for judicial review.

This decision was emailed on 04/22/2014.

STATE OF WISCONSIN DEPARTMENT OF NATURAL RESOURCES
For the Secretary

By ______________________________________

Konny Margovsky, P.E.
Dam Safety Engineer
Bureau of Watershed Management

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Appendix R

SUMMARY OF THE JUNE 13, 2013 MEETING BETWEEN THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES AND SEWRPC STAFFS RELATING TO FISH PASSAGE IN STREAMS AND RIVERS TRIBUTARY TO LAKE MICHIGAN

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SUMMARY OF THE JUNE 13, 2013, WISCONSIN DEPARTMENT OF NATURAL RESOURCES/SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION STAFF MEETING TO DISCUSS ISSUES RELATED TO FISH PASSAGE IN STREAMS AND RIVERS TRIBUTARY TO LAKE MICHIGAN

INTRODUCTION

The meeting was held at the request of the Southeastern Wisconsin Regional Planning Commission (SEWRPC) staff with the intent of gaining a better understanding of Wisconsin Department of Natural Resources (WDNR) criteria for assessing a dam's significance as a barrier to passage of fish and invasive species and to discuss associated issues specifically related to the Horlick dam on the Root River in the City of Racine. The Horlick dam, which is owned by Racine County, is of particular interest because SEWRPC is preparing a restoration plan for the Root River watershed that will address the status of the Horlick dam as it relates to retaining and upgrading or removing the existing dam. The meeting agenda is attached as Exhibit A. Those in attendance at the meeting are listed in Exhibit B.

BRIEF OVERVIEW OF ONGOING ROOT RIVER WATERSHED RESTORATION PLANNING PROCESS

Michael Luba, WDNR Natural Resources Basin Supervisor, opened the discussion by noting that SEWRPC is preparing the Root River watershed restoration plan (WRP), and that plan will address alternatives for the Horlick dam, which is owned by Racine County. Michael Hahn, SEWRPC Chief Environmental Engineer, said that the Root River WRP is a second level plan that builds on the 2007 SEWRPC regional water quality management plan update for the greater Milwaukee watersheds, and focuses on more-specific issues, including the Horlick dam. He added that the focus areas of the WRP are:

- Water quality,
- Habitat,
- Recreational use, and
- Flooding (in Racine County only).

Mr. Hahn said that the SEWRPC staff had developed several conceptual alternatives related to the dam, and that these would be presented to the study Advisory Group in early August 2013 and to the Root River Restoration Planning stakeholder group and other interested parties in late August. He added that the examination of alternatives related to the dam is being conducted at the request of Racine County.

ISSUES RELATED TO HORLICK DAM

Laura Kletti, SEWRPC Principal Engineer, began the discussion of Horlick dam, noting that a dam break analysis submitted by Racine County was under review by WDNR and that it was likely, but not yet certain, that the dam would be placed in the "significant hazard" category. She said that a significant hazard dam would be required to safely pass the 500-year recurrence interval flood, but that her preliminary calculations indicated that the current spillway capacity was equal to about the peak 10-year flood flow. PowerPoint slides reviewed by Ms. Kletti during this meeting are attached as Exhibit C.

Tanya Lourigan, WDNR Water Management Engineer, added that a significant hazard rating meant that failure of the dam could result in damage to structures downstream of the dam, but the maximum rise in the downstream flood stage resulting from failure would be less than two feet. She also said that generally, in a case where a dam is identified as having inadequate spillway capacity, the owner must increase that capacity within ten years, but that time frame could be shorter if WDNR determines that the condition of the dam justifies a quicker upgrade.

Mr. Hahn said that one challenge faced by the SEWRPC staff was providing Racine County with a sense of the extent of possible modifications to the dam while the WDNR review of the dam failure analysis, and determination of the adequacy of the spillway, has not yet been completed.

Ms. Kletti indicated that, during a 500-year event under current conditions, it would be expected that the tailwater elevation at the dam would be about at the elevation of the spillway crest. Brad Eggold, WDNR Natural Resources Region Team Supervisor, asked if photographs of the 2008 flood were available. Ms. Kletti said it is difficult to discern the tailwater elevation from the photos of that flood, and therefore, hard to determine whether the dam presented a barrier to fish passage under those conditions. Mr. Hahn said that preliminary analyses indicate that during very large floods the dam may not be a barrier, and that during the meeting the SEWRPC staff hoped to get clarification from WDNR on what criteria would be applied in determining whether or not a dam presents a barrier to fish passage.

Ms. Kletti said that field investigation by the SEWRPC staff indicated the existence of an apparent hard "shelf" at about elevation 620 feet above National Geodetic Vertical Datum, 1929 adjustment (NGVD 29) that extends from the upstream side of the dam to a location about 1,000 feet upstream. She noted that about four to five feet of sediment have collected in the impoundment above the top of the shelf. In response to a question from Mr. Hahn, Ms. Kletti indicated that, if the dam were removed, the shelf itself could represent somewhat of a barrier to fish passage. Craig Helker, WDNR Water Resources Management Specialist, said that test data for the sediment in the impoundment indicate slightly elevated levels of polycyclic aromatic hydrocarbons (PAHs). Ms. Kletti mentioned that the sediment sampling depths may not be deep enough to fully characterize the sediment quality, and that this needed more examination.

> [Secretary's Note: The spillway crest is at about elevation 630.0 feet above NGVD 29, or roughly 10 feet above the top of the apparent shelf.]

> [Secretary's Note: In a July 30, 2013, electronic mail message to Mr. Hahn, Mr. Helker indicated that he did not see risk to aquatic organisms since the slightly elevated PAH levels are still quite low.]

Ms. Kletti then proceeded with review of the conceptual alternatives set forth in Exhibit C. She said that the dam would have adequate hydraulic capacity to pass the 500-year flood if the entire spillway crest were lowered by about four feet, and that with such a configuration a preliminary estimate indicates that, for floods greater than a 10-year event, the tailwater elevation would be above the elevation of the lowered spillway crest.

> [Secretary's Note: The implication of that observation is that, with that degree of spillway crest lowering, fish passage might be possible during floods greater than a 10-year event.]

Ms. Lourigan noted that, if the spillway crest were lowered as called for under this alternative, the dam hazard rating might be reduced to low hazard because, if the dam were to fail, the smaller hydraulic head would result in a lower flood wave that would propagate downstream.

> [Secretary's Note: Under such a situation, it might be necessary for the designer of possible spillway modifications to perform several iterations to determine the spillway crest elevation that would both adequately pass the 100-year flood and result in a low hazard rating if the dam were to fail.]

Ms. Kletti described a second conceptual alternative under which the dam would be modified to enable fish passage by lengthening the existing, non-functioning fishway.

[Secretary's Note: This alternative was presented to highlight a possible means of enabling fish passage without removal of all, or a portion, of the dam. It does not directly address other modifications that might be needed to provide the necessary spillway capacity.]

Thomas Slawski, SEWRPC Principal Planner, noted that the need to extend a fishway further into the River arose because the land area on the east bank (left, looking downstream) upstream of the dam is a capped landfill that cannot be disturbed. In reply to a question from Ms. Lourigan, Dr. Slawski said that this alternative shows a passive fishway design.

The next conceptual alternative reviewed by Ms. Kletti calls for a complete notch of the spillway down to the current riverbed with the right (west) abutment left in place to possibly provide support for the riverbank and the adjacent hotel.

Finally, Ms. Kletti, described a conceptual alternative calling for complete removal of the dam, except for relatively small portions of the left and right abutments. With regard to the apparent shelf or ledge in the streambed, Dr. Slawski said that the dam had failed and been rebuilt just downstream several times and the observed ledge may be part of an older dam.

FISH PASSAGE ISSUES

Mr. Hahn then initiated the discussion of fish passage issues, asking the WDNR staff if there was a draft set of guidelines/criteria for evaluating the significance of a dam as a barrier to fish passage and also considering aquatic invasive species (AIS) and viral hemorrhagic septicemia (VHS). Robert Wakeman, WDNR Statewide Aquatic Invasive Species Coordinator, said that development of a WDNR policy on fish passage issues was underway. He noted that what began as a summary of WDNR's legal authority in that area had evolved to the point at which WDNR is now preparing a formal guidance document. There followed a wide-ranging discussion among those in attendance regarding the following issues:

- Identification of "pinch points" which are considered to be complete barriers to passage of aquatic organisms from downstream to upstream;
- Identification of AIS of concern;
- Preliminary identification by WDNR of pertinent criteria under which fish passage possibilities could be evaluated;
- The significance of VHS;
- Examples of how fish passage issues have been addressed by WDNR at other dams;
- The relationship between a dam that poses a threat to public health and safety and the WDNR's ability to maintain barriers to passage of fish, AIS, and VHS;
- The schedule for WDNR review of the Horlick dam failure analysis;
- Whether the WDNR Root River Steelhead Facility is a barrier to passive fish passage;
- The significance of sea lamprey for the Root River; and
- The future significance of the Lake Michigan sport fishery.

The discussion of each of those subtopics is summarized below. During the discussion, WDNR staff made it clear that any comments related to the proposed fish passage guidance and possible guidance content is currently preliminary and definitely subject to change since any guidance must go through a public review process prior to be finalized. Mr. Wakeman said that the public review process was tentatively scheduled to start around October 1, 2013. Mr. Hahn said that he would like to append the summary notes from the meeting to the Root River watershed restoration plan report, and he asked the WDNR whether that would be acceptable to them. Mr. Wakeman indicated that it would, saying that there was no information being discussed that would be considered "earth shaking."

Identification of "Pinch Points"
Mr. Wakeman characterized "pinch points" as complete barriers to passage of aquatic organisms from downstream to upstream. He noted that the U.S. Army Corps of Engineers Great Lakes and Mississippi River Interbasin Study establishes whether a hydraulic structure functions as a barrier to fish passage by evaluating the structure during a 100-year recurrence interval (one-percent-annual-probability) flood. He said that he had the impression that Horlick dam is not a complete barrier to fish passage.

Identification of AIS of Concern
Mr. Wakeman said that the U.S. Army Corps of Engineers, Chicago District, AIS interbasin transfer evaluation identified eight possible connections between the Lake Michigan and Mississippi River Basins, including one low-potential site along Jerome Creek in the Village of Pleasant Prairie. He noted that, while interbasin transfer is not an issue related to the Horlick dam, the Corps report would be a useful reference regarding AIS of potential concern.

[Secretary's Note: Mr. Wakeman distributed copies of the following paper at the meeting:

- Francis M Veraldi, Kelly Baerwaldt, Brook Herman, Shawna Herleth-King, Matthew Sanks, Len Kring, and Andrew Hannes (2011): Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study, U.S. Army Corps of Engineers.]

Preliminary Identification by WDNR of Pertinent Criteria under Which Fish Passage Possibilities Could be Evaluated for a Dam that is Not Considered to be a Barrier
Mr. Wakeman cited the following evaluation sequence that would likely be applied to each AIS:

- Make a determination if each individual AIS of concern can:
  - Reach Horlick dam,
  - Become established,
  - Pass over the dam,
  - Become established upstream of the dam, and
  - Assign a high, medium, or low risk to the specific AIS for each of the four preceding criteria.

Mr. Wakeman said that, following this evaluation sequence, WDNR would make its decision by applying a public interest test, considering ecological, economic, aesthetic, and recreational values.

Mr. Wakeman indicated that the outcome of passing native species from the downstream side of a dam to the upstream side would also be evaluated, and he noted that it could be possible that the upstream habitat and water quality would be favorable for native species, but not for AIS. He also said that WDNR supports connecting fish populations.

Mr. Eggold offered the opinion that Chinook salmon might be able to “power through” the approximately two-foot difference between the tailwater at the Horlick dam during a 100-year flood and the spillway crest.

The Significance of VHS

Mr. Wakeman stated that VHS is a major issue in Wisconsin, and that if it was found downstream, but not upstream, of a dam, no passive fish passage would be allowed. Dr. Slawski asked if the fact that the Horlick dam was designed for fish passage (as evidenced by the remains of the former fishway) would affect WDNR’s decision on allowing fish passage from downstream to upstream of the dam. Ms. Lourigan replied that there was no evidence that the fishway was functional for fish passage in the past, and Mr. Wakeman added that the WDNR interest is in keeping VHS from spreading upstream from Lake Michigan.

There was also discussion of active fish passage as it relates to VHS. Mr. Wakeman said that active fish passage can only be allowed if a fish health certificate is obtained from the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP). He noted that WDNR is reevaluating whether this procedure is necessary and will discuss that with DATCP. Lloyd Eagan, WDNR Natural Resources Manager, said that an examination by a veterinarian is required for a fish health certificate to be obtained for stocked fish. Susan Beyler, WDNR Natural Resources Region Team Supervisor, described the procedure as it relates to stocked fish. She said that stocked fish must be isolated, and a veterinarian would take from 50 to 100 individual samples and test for VHS cell lines. She said that procedure takes 30 days, during which time the fish must remain isolated. She noted that WDNR staff has not found VHS except in Lake Michigan and Lake Winnebago.

Examples of How Fish Passage Issues Have Been Addressed by WDNR at Other Dams

In response to a question from Mr. Hahn regarding where active fish passage was being considered, Mr. Wakeman mentioned a trap and sort operation is being considered at Prairie du Sac dam on the Wisconsin River and Mr. Eggold mentioned that active passage of sturgeon is being considered on the Menominee River.

The Relationship between a Dam that Poses a Threat to Public Health and Safety and the WDNR’s Ability to Maintain Barriers to Passage of Fish, AIS, and VHS

Mr. Wakeman said that, when WDNR is considering proposed actions related to dams, public safety is the primary concern. Ms. Eagan asked whether WDNR can stop abandonment in the situation of a dam that is considered to be a pinch point and where there is no identified threat to public safety, but the dam owner no longer wishes to own, operate, and maintain the dam, so the owner makes a request to WDNR for abandonment. Ms. Lourigan replied that, based on case law, WDNR could not stop such an abandonment. Mr. Wakeman agreed, but he said that WDNR could seek a new owner. Dr. Boxhorn said it appeared that it is easier to abandon a dam than to establish fish passage, and Mr. Wakeman agreed. Ms. Lourigan confirmed that public health and safety considerations related to dams would trump fishery issues. She also noted that, if Horlick dam were to be left in place, modifications should be made to the stop log gate to enable drawdown of the impoundment.

Schedule for WDNR Review of the Horlick Dam Failure Analysis

Ms. Lourigan said that WDNR review of the dam failure analysis submitted by Racine County and a WDNR decision on the dam hazard rating could take six more months, and she said she would contact Konstantin Margovsky, WDNR Water Regulation and Zoning Engineer, to verify the status of the review. Ms. Kletti inquired whether it would be appropriate for the SEWRPC staff to discuss preliminary indications regarding the dam hazard rating at the August meetings for the Root River WRP. Ms. Lourigan said she would check on that, and she noted that since preliminary indications are that the existing spillway capacity is about equal to a 10-year flood flow, doing nothing regarding the dam is not an option.

[Secretary’s Note: During a July 11, 2013, telephone conversation with Mr. Hahn, Ms. Lourigan said that Graef (Racine County’s engineering consultant who prepared the dam failure analysis) was working on revisions to the analysis.]

Whether the WDNR Root River Steelhead Facility is a Barrier to Passive Fish Passage
Ms. Beyler said that when the flashboards are fully removed and the facility is not operating, it does not restrict passage of aquatic organisms. Mr. Eggold said that the boards are in at the steelhead facility weir from March 1 through mid- to late-April and from early September through the beginning of November, and that, even with the boards in, the facility is not a barrier to fish passage.

The Significance of Sea Lamprey for the Root River
Dr. Slawski asked whether sea lamprey were considered to be an issue for the Root River. Mr. Eggold said that he did not believe there had been any detected in the Root River, but he would have to check to be sure.

[Secretary's Note: Mr. Eggold provided survey results from young-of-year sampling for sea lamprey in the Root River going back to 1959, 1976, 1977, and 2000. No sea lamprey were detected in those years. He also noted that WDNR has not done any trapping for adults in this system.]

Mr. Helker noted that round goby, smallmouth bass, and redhorse were all found below Horlick dam, but not above the dam. He also said that sea lamprey were not considered an issue related to recent dam removals on the Pike River.

[Secretary's Note: During a July 30, 2013, telephone conversation with Mr. Hahn, Mr. Helker elaborated on the preceding statement, saying that the U.S. Fish and Wildlife Service had indicated that sea lamprey were not considered an issue related to recent dam removals on the Pike River.]

Ms. Lourigan, Mr. Eggold, and Dr. Slawski indicated that sea lamprey are not good jumpers and a 1.5- to two-foot-high barrier height has been set for recent dam modifications to inhibit lamprey passage.

The Future Significance of the Lake Michigan Sport Fishery
Dr. Slawski said that the objectives of preventing invasive species from migrating upstream and promoting native species are incompatible. He cited Eurasian water milfoil, zebra mussels, and quagga mussels as species whose spread has not been successfully prevented. He stated that dams represent a barrier that could slow down, but not prevent passage of AIS. He cited the example of Chinook salmon in Lake Huron, noting that the Chinook salmon fishery in that lake has essentially collapsed, and he posed the question: If what has happened in Lake Huron were to happen in Lake Michigan, how would that affect the WDNR decision support system/guidance regarding fish passage and for what game species would WDNR plan to manage? He concluded by saying that all evidence shows that native species within Lake Michigan would benefit from increased connections to tributary streams which has been demonstrated by removal of the North Avenue dam on the Milwaukee River.

[Secretary's Note: Dr. Slawski distributed copies of the following papers at the meeting:

- Luis A. Velez-Espino, Robert L. McLaughlin, Michael J. Jones, and Thomas C. Pratt (2011): Demographic Analysis of Trade-offs With Deliberate Fragmentation of Streams: Control of Invasive Species Versus Protection of Native Species, Biological Conservation, 144, 1068-1080.

- John M. Dettmers, Christopher I. Goddard, and Kelley D. Smith (2012): Management of Alewife Using Pacific Salmon in the Great Lakes: Whether to Manage for Economics or Ecosystem?, Fisheries, 37:11, 495-501.

- S. Dale Hanson, Mark E. Holey, Ted J. Treskas, Charles R. Bronte, and Ted H. Eggebraaten (2013): Evidence of Wild Juvenile Trout

Recruitment in Western Lake Michigan, North American Journal of Fisheries Management, 33:1, 186-191.]

Mr. Wakeman replied saying that:

- The proposed WDNR guide was intended to assist managers in reaching justifiable decisions regarding whether or not to approve action on a barrier to passage;
- Such decisions would be made on a case-by-case basis;
- There are situations where dams prevent AIS transfer;
- While the WDNR staff wants to connect systems, they have to be very cognizant of the presence of VHS and AIS; and
- The proposed guidance will provide questions that will enable managers to assess specific cases.

Mr. Helker said it is important that a neutral point be selected that balances native species passage with prevention of AIS passage.

Dr. Slawski said that any design related to Horlick dam should incorporate features to enhance the northern pike and walleye communities and improve connectivity along the River. He posed the question: Do Chinook salmon have a future in Lake Michigan? Mr. Eggold replied that the loss of such non-native sport species would likely cause fishers to rally around northern pike and walleye. He indicated that the WDNR thinking had shifted regarding salmon stocking, and in 2013 WDNR was stocking 50 percent less salmon than in the past. He noted that WDNR is finding that whitefish, alewives, and Chinook salmon are generally smaller and lighter than in the past. He said that WDNR will try to maintain salmon in Lake Michigan, but that effort is at a critical juncture because of low alewife populations.

Dr. Boxhorn stated that production in the Lake may be tied up in quagga mussel and cladophora biomass. He added that if this continues, the river system tributary to the Lake may be a source for export of native fish to the Lake.

ADJOURNMENT

Mr. Luba said that the SEWRPC staff should feel free to contact WDNR staff if questions arise on these issues. In conclusion, Mr. Hahn said that the SEWRPC staff would prepare a meeting summary and distribute a draft to the participants for their review and comment.

Respectfully submitted,

Michael G. Hahn
SEWRPC Chief Environmental Engineer

SUMMARY OF 6/13/2013 WDNR/SEWRPC FISH PASSAGE MEETING (00212268).DOC
300-1106
TMS/LLK/JEB/MGH/pk
06/28/13, 07/02/13, 07/11/13, 07/12/13, 07/30/13

Exhibit A

Wisconsin Department of Natural Resources and
Southeastern Wisconsin Regional Planning Commission
Meeting to Discuss Issues Related to Fish Passage in
Streams and Rivers Tributary to Lake Michigan

Agenda

DATE: June 13, 2013

TIME: 2:00 p.m.

PLACE: Wisconsin Department of Natural Resources Southeast Region Office

AGENDA:

1. Introductions

2. Brief overview of ongoing Root River watershed restoration planning process (SEWRPC staff)

3. Issues related to Horlick dam

   a. Ongoing evaluation of hazard classification and spillway adequacy (SEWRPC staff)

   b. Information related to whether dam is a barrier to fish passage (SEWRPC staff)

   c. Conceptual alternatives being considered relative to Horlick dam (SEWRPC staff)

4. Fish passage issues (All)

   a. WDNR criteria for evaluating a dam’s significance as a barrier to fish passage, invasive species, VHS (WDNR staff)

   b. Is the WDNR Root River steelhead facility a barrier? (All)

   c. Is Horlick dam a barrier? (All)

   d. What are the aquatic species of interest?

   e. Future significance of Lake Michigan sport fishery (All)

00211757
MGH
06/07/13

Exhibit B

Wisconsin Department of Natural Resources and
Southeastern Wisconsin Regional Planning Commission
Meeting to Discuss Issues Related to Fish Passage in
Streams and Rivers Tributary to Lake Michigan

June 13, 2013

Name	Affiliation	E-Mail Address	Phone
In Attendance			
Sue Beyler	WDNR	susan.beyler@wisconsin.gov	(262) 594-6218
Jim D'Antuono	WDNR	james.dantuono@wisconsin.gov	(262) 574-2122
Lloyd Eagan	WDNR	lloyd.eagan@wisconsin.gov	(608) 275-3243
Brad Eggold	WDNR	bradley.eggold@wisconsin.gov	(414) 382-7921
Craig Helker	WDNR	craig.helker@wisconsin.gov	(262) 884-2357
Tanya Lourigan	WDNR	tanya.lourigan@wisconsin.gov	(414) 263-8641
Michael Luba	WDNR	michael.luba@wisconsin.gov	(262) 263-8514
Bob Wakeman	WDNR	robert.wakeman@wisconsin.gov	(262) 574-2149
Joseph Boxhorn	SEWRPC	jboxhorn@sewrpc.org	(262) 547-6722, ext. 244
Michael G. Hahn	SEWRPC	mhahn@sewrpc.org	(262) 547-6722, ext. 243
Laura L. Kletti	SEWRPC	lkletti@sewrpc.org	262) 547-6722, ext. 224
Aaron W. Owens	SEWRPC	aowens@sewrpc.org	262) 547-6722, ext. 293
Thomas M. Slawski	SEWRPC	tslawski@sewrpc.org	262) 547-6722, ext. 263

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MGH/pk
300-1106
07/01/13

Exhibit C

Alternatives

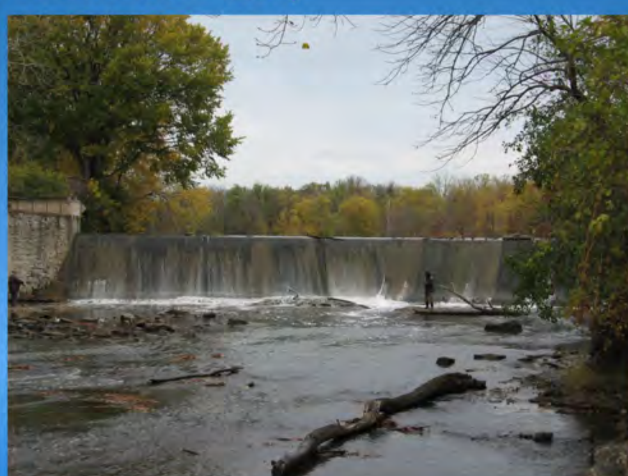
Baseline Condition - today

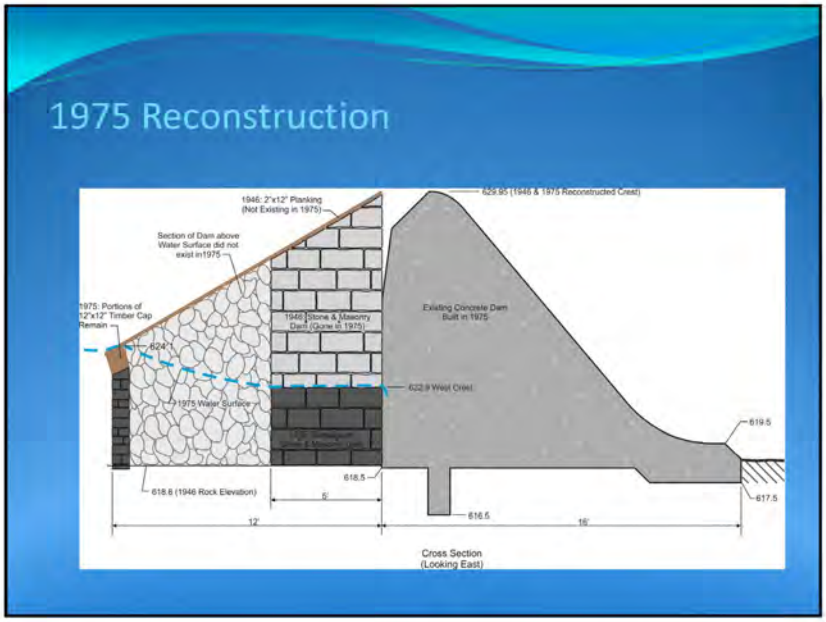
Conceptual Alternatives

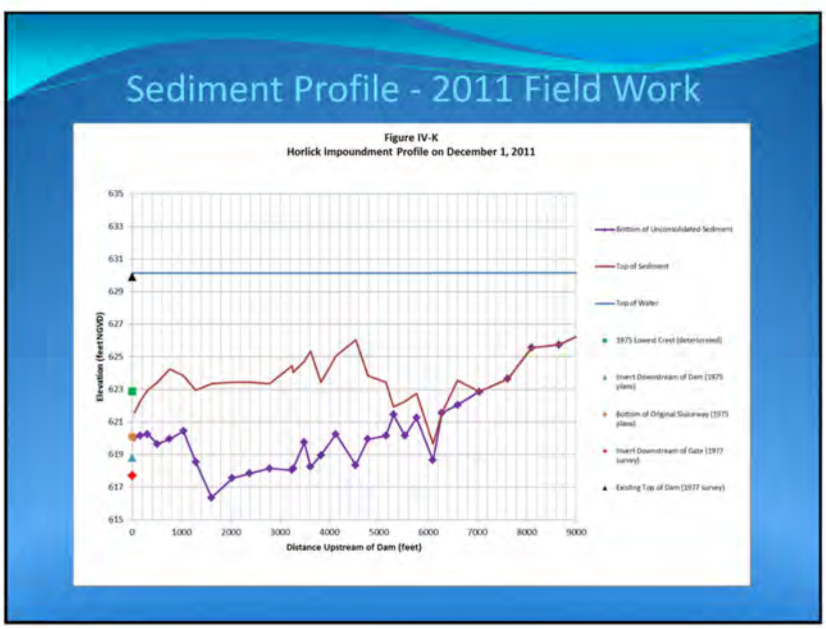
- Modify Dam to Enhance Spillway Capacity
- Modify Dam to Enable Fish Passage
- Remove Dam

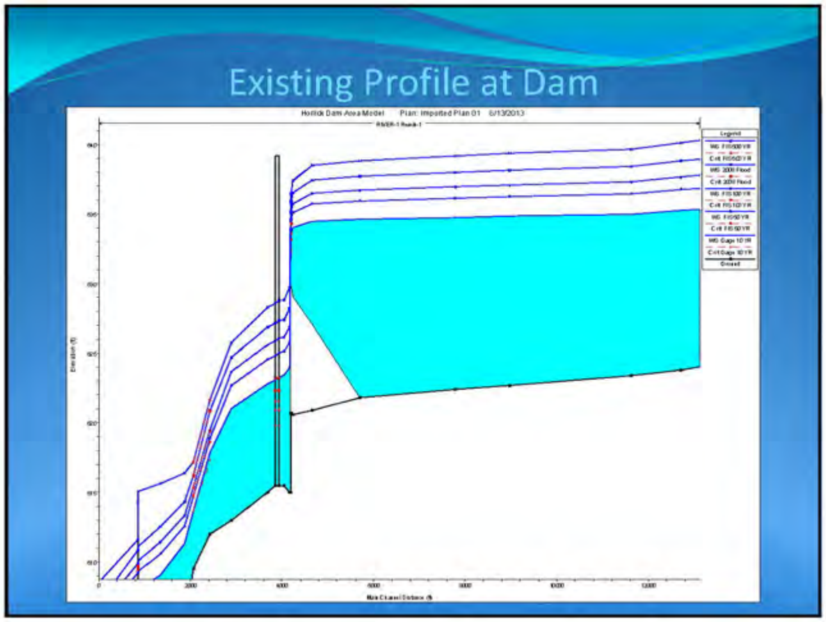
Alternatives

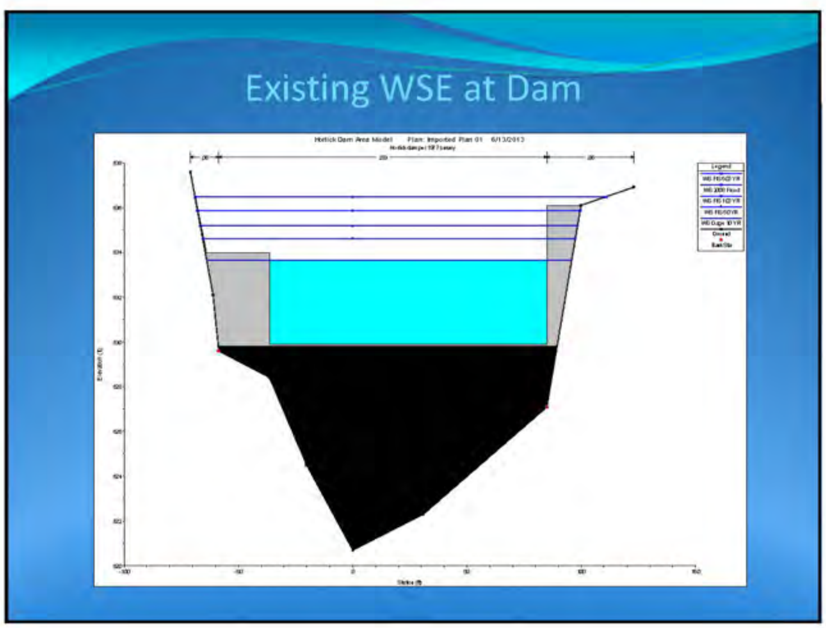
Baseline Condition - today

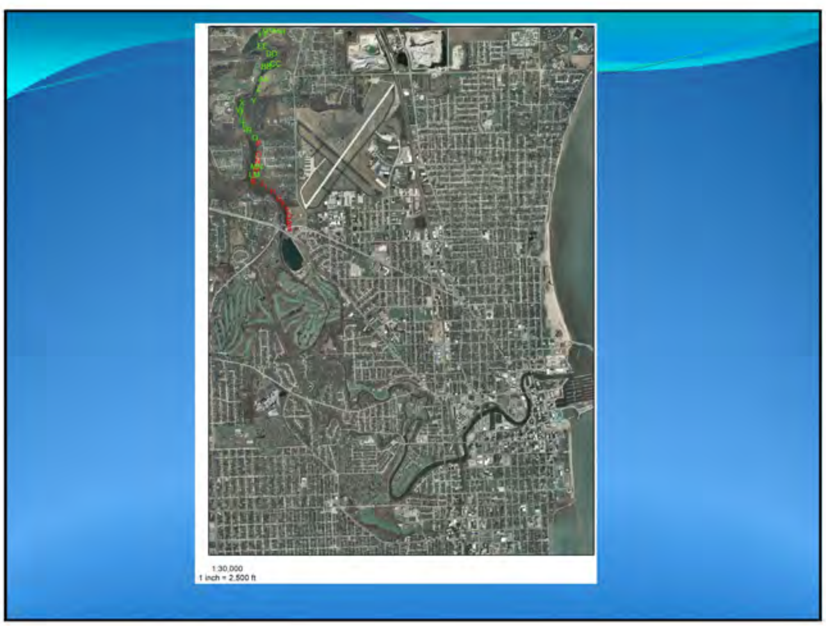


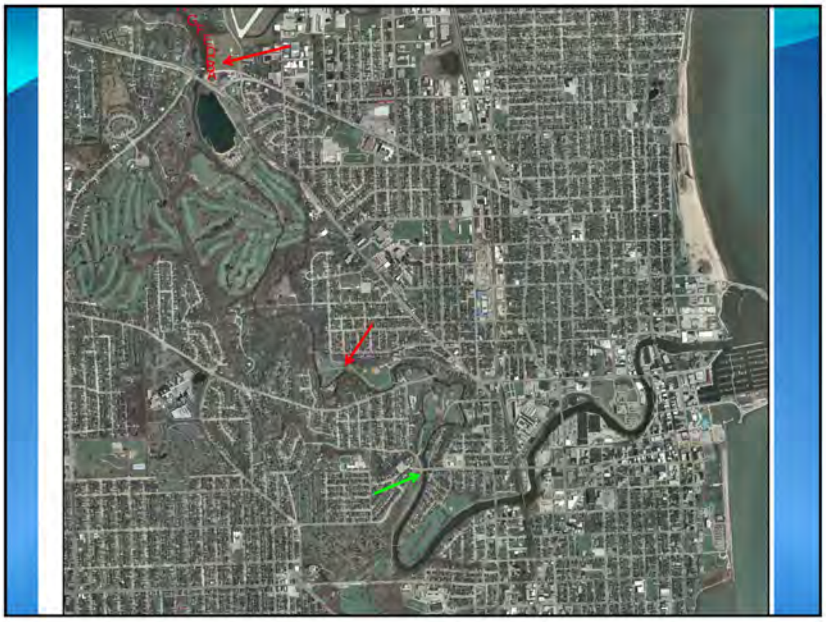

1975 Reconstruction
1946: 2"x12" Planking (Not Existing in 1975)
629.95 (1946 & 1975 Reconstructed Crest)
Section of Dam above Water Surface did not exist in1975
1975: Portions of 12"x12" Timber Cap Remain
624'
1946 Stone & Masonry Dam (Gone in 1975)
Existing Concrete Dam Built in 1975
622.9 West Crest
1975 Water Surface
619.5
618.5
618.6 (1946 Rock Elevation)
5'
617.5
616.5
12'
16'
Cross Section (Looking East)

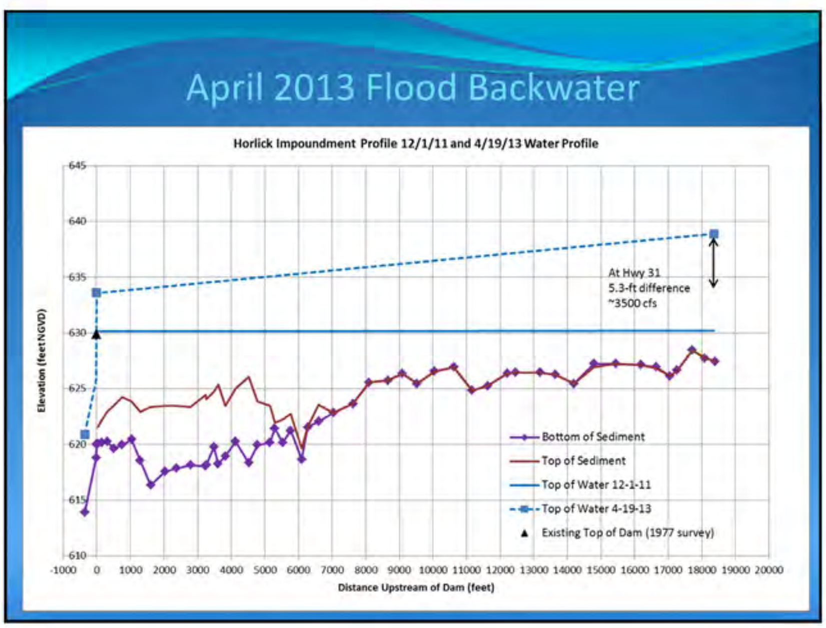

Sediment Profile - 2011 Field Work
Figure IV-K
Horlick Impoundment Profile on December 1, 2011
Elevation (feet NGVD)
Distance Upstream of Dam (feet)
635
633
631
629
627
625
623
621
619
617
615
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Bottom of Unconsolidated Sediment
Top of Sediment
Top of Water
1975 Lowest Crest (deteriorated)
Invert Downstream of Dam (1975 plans)
Bottom of Original Sluiceway (1975 plans)
Invert Downstream of Gate (1977 survey)
Existing Top of Dam (1977 survey)


Existing Profile at Dam


Existing WSE at Dam


1:30,000
1 inch = 2,500 ft

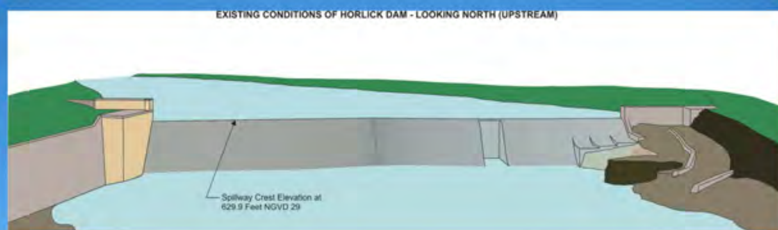




April 2013 Flood Backwater
Horlick Impoundment Profile 12/1/11 and 4/19/13 Water Profile
Elevation (feet NGVD)
645
640
635
630
625
620
615
610
-1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000
Distance Upstream of Dam (feet)
At Hwy 31
5.3-ft difference
~3500 cfs
Bottom of Sediment
Top of Sediment
Top of Water 12-1-11
Top of Water 4-19-13
Existing Top of Dam (1977 survey)

Alternatives

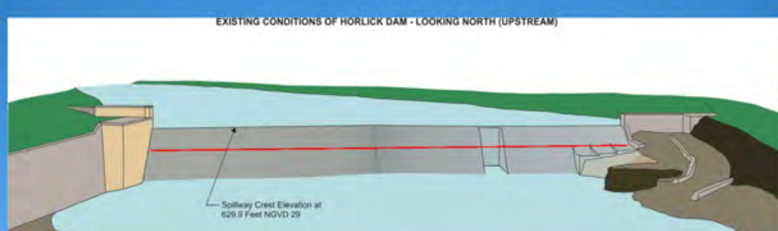
Baseline Condition - today

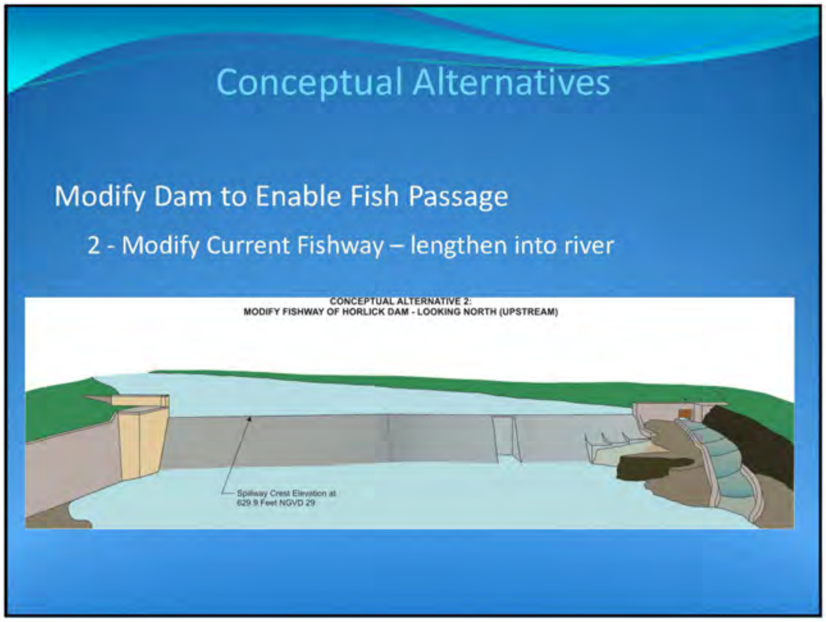


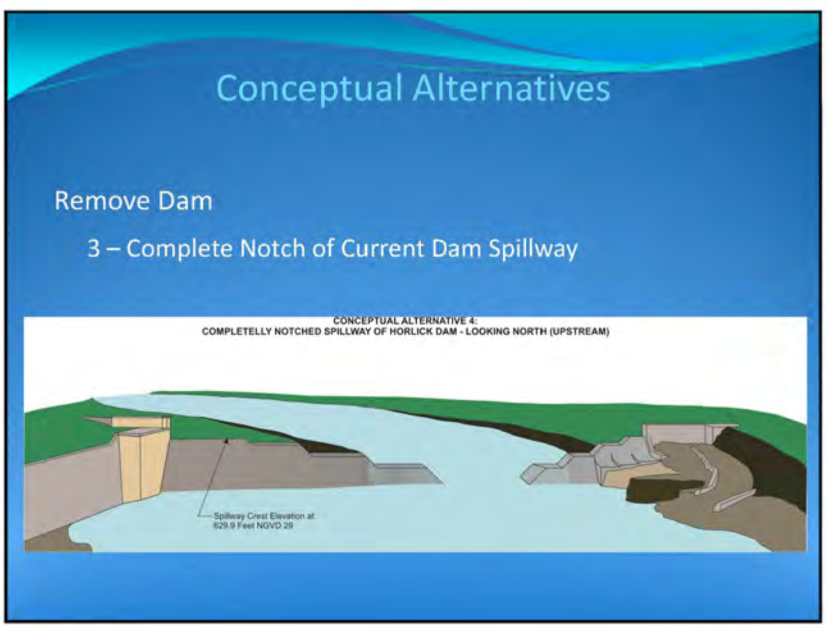
Alternatives

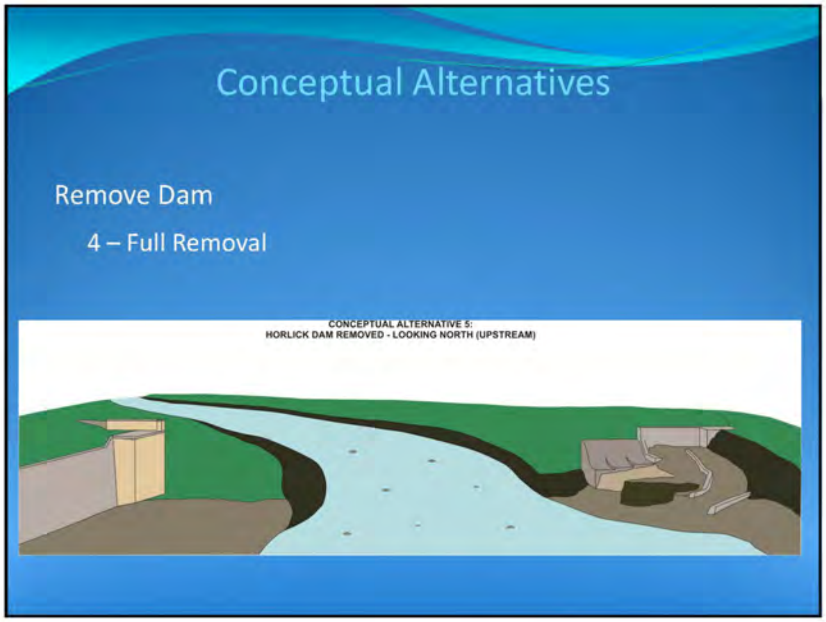
Modify Dam to Enhance Spillway Capacity

1 – Lower entire dam 3.9 feet to contain the 500 yr event




Conceptual Alternatives
Modify Dam to Enable Fish Passage
2 - Modify Current Fishway – lengthen into river
CONCEPTUAL ALTERNATIVE 2:
MODIFY FISHWAY OF HORLICK DAM - LOOKING NORTH (UPSTREAM)
Spillway Crest Elevation at
629.9 Feet NGVD 29


Conceptual Alternatives
Remove Dam
3 – Complete Notch of Current Dam Spillway
CONCEPTUAL ALTERNATIVE 4:
COMPLETELLY NOTCHED SPILLWAY OF HORLICK DAM - LOOKING NORTH (UPSTREAM)
Spillway Crest Elevation at
629.9 Feet NGVD 29


Conceptual Alternatives
Remove Dam
4 – Full Removal
CONCEPTUAL ALTERNATIVE 5:
HORLICK DAM REMOVED - LOOKING NORTH (UPSTREAM)

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Appendix S

DESKTOP ANALYSIS PROCEDURE DEVELOPED FOR ILLICIT DISCHARGE DETECTION AND ELIMINATION SCREENING

In accordance with the conditions of its watershed-based municipal stormwater discharge permit, the Menomonee River Watershed Permittees, in collaboration with Milwaukee Riverkeeper, the Wisconsin Department of Natural Resources, and Southeastern Wisconsin Regional Planning Commission (SEWRPC), developed a desktop analysis procedure to identify those stormwater outfalls most likely to be conveying water contaminated with sanitary wastewater and prioritized those outfalls for dry-weather field screening.[1] This procedure is intended to evaluate all outfalls, regardless of size.

Screening is conducted using the matrix shown in Table S-1. Each subbasin of the surface water system within a municipality's municipal separate storm sewer system (MS4) is screened for the likelihood that storm sewers are conveying water contaminated with sanitary wastewater. The subbasins are screened based upon the evaluation of a group of factors that give an indication of the likelihood of whether storm sewers within the subbasin are conveying contaminated water. For each factor, subbasins are given a rating of 1, 2, or 3, with 1 indicating a low potential for illicit discharge, 2 indicating a moderate potential for illicit discharge, and 3 indicating a high potential for illicit discharge. For a given factor, those subbasins where information is not available to assess the illicit discharge potential are given a rating or 2. The individual factor ratings are summed to yield a Human Illicit Discharge Potential (HDIP) raw score. This raw score is normalized by dividing it by the number of factors screened. The normalized HIDP scores can range between 1.0 and 3.0, with higher values indicating a greater potential for storm sewers in the subbasin to be conveying water contaminated with sanitary wastewater.

As of February 2014, the Menomonee River Watershed Permittees have proposed using the following factors for screening. The details of scoring are given in Table S-1:

- The basin's history of complaints of discharges from outfalls in the subbasin and of outfalls with discharge occurring during dry-weather screening.

- The percentage of urban development within the subbasin that is greater than 50 years old. This factor is intended to identify basins with a high proportion of older infrastructure which may be degrading.

[1]*The Menomonee River Watershed Permittees consist of the Cities of Brookfield, Greenfield, Milwaukee, West Allis, and Wauwatosa; the Villages of Butler, Elm Grove, Germantown, Menomonee Falls, and West Milwaukee; and Milwaukee County.*

It can be assessed using the SEWRPC historical urban growth mapping layer. An alternative means of assessing this would be to use the ages, if known, of sanitary and storm sewer pipes in the subbasin.

- The average condition of sanitary sewer pipes in the subbasin, based upon the National Association of Sewer Service Company's rating system for pipe inspection.

- The proximity of sanitary sewer and storm sewer pipes to one another. This would be assessed by the average density of crossings of sanitary and storm sewer pipes within the basin. In addition, each eight-foot section in which these pipes are adjacent to and within four feet of each other would be counted as a crossing. The number of crossings is divided by the area of the subbasin.

- The density of parcels in the subbasin. This serves as a surrogate for the number of sanitary sewer laterals within the subbasin. The number of parcels within the subbasin is divided by the area of the subbasin.

In addition to these factors, the matrix allows for the inclusion of an optional screening factor. This is intended to allow municipalities to take into account other factors for which data are available. Examples of factors that could potentially be used include the percent exceedences of recreational use water quality criteria in the locations in the surface water system where the subbasin discharges, presence of fecal indicator bacteria hot spots in the subbasin, or the level of fecal indicator bacteria load reductions assigned to a subbasin through a total maximum daily load (TMDL) study.

The normalized HIDP score is used to prioritize outfalls for field screening. The Menomonee River Watershed Permittees suggest that outfalls within subbasins having normalized HIDP scores greater than 2.5 be given high priority for field screening, while those in subbasins with normalized HIDP scores between 1.5 and 2.5 be given medium priority and those in subbasins with normalized HIDP scores less than 1.5 be given low priority for field screening. While they recommend that the final rank for field screening be based upon normalized HIDP scores, the ranking can also be adjusted to take into account issues such as the proximity of outfalls to current or future capital construction projects, available funding, and neighborhood concerns. They also note that, if the necessary additional data are available, a second round of desktop screen could be conducted to prioritize storm sewersheds within subbasins for screening.

It should be emphasized that this analysis procedure is intended to be used to prioritize storm sewer outfalls for field screening. It is not intended as a substitute for field screening or other in depth analyses.

Table S-1

MATRIX FOR PRIORITIZING DRAINAGE AREAS USING SCREENING FACTORS FOR ILLICIT DISCHARGE POTENTIAL OF HUMAN WASTE

SEWRPC Subbasin	Past Discharge Complaints or Flowing Outfalls During Dry Weather (rating)[a]	Age of Development (rating)[b]	Material/ Condition of Pipes (NAASCO Ratings)[c]	Proximity of Sanitary and Stormwater Pipes[d]		Subbasin Area (square miles)	Parcels per Square Mile[e]		Optional Indicator (rating)[f]	HIDP Raw Score[g]	Normalized HIDP Score[h]	Comments	Final Rank[i]
				Density of Crossings	Rating		Density	Rating					

[a]*If there have been complaints of discharges or past detections of dry-weather flow from outfalls in the subbasin, score as 3. If there have not been complaints of discharges or past detections of dry-weather flow score, score as 1. If this is not known, score as 2.*

[b]*Rate subbasins in which less than 30 percent of the area is 50 years old or older as 1. Rate subbasins in which 30 percent to 60 percent of the area is 50 years old or older as 2. Rate subbasins in which over 60 percent of the area is 50 years old or older as 3.*

[c]*Material/condition of pipes is based upon NASSCO ratings for sanitary pipe inspection. Where average pipe condition in a subbasin receives a NASSCO rank of good or excellent, rate as 1. Where average pipe condition in a subbasin receives a NASSCO rank of poor or needs immediate attention, rank as 3. Where average pipe condition in a subbasin is not known, rank as 2.*

[d]*Rating is based on the density of crossings sanitary and storm sewer pipes in the subbasin. Count all of the pipe crossings in the area. Where sanitary and sewer pipes are within four feet of each other (center to center), count each eight-foot section of pipe as a crossing. Rank all subbasins based upon the number of crossings divided by the area of the subbasins. Subbasins in the lowest 25th percentile of crossing density are rated 1, subbasins in the 25th through 75th percentile of crossing density are rated 2, subbasins in the upper 25th percentile of crossing density are rated 3.*

[e]*Rating is based upon parcel density which is calculated by dividing the number of parcels in the subbasin by the parcel areas. Subbasins in the lowest 25th percentile of parcel density are rated 1, subbasins in the 25th through 75th percentile of parcel density are rated 2, subbasins in the upper 25th percentile of parcel density are rated 3.*

[f]*The optional factor is included to prioritize basins based upon available water quality data. This could be based upon data such as percent exceedance of water quality criteria for fecal indicator bacteria, TMDL reduction priorities, or other indicators. Subbasins in the lowest 25th percentile of the indicator are rated 1, subbasins in the 25th through 75th percentile of the indicator are rated 2, subbasins in the upper 25th percentile of the indicator are rated 3.*

[g]*HIDP Raw score is the sum of the ratings for past discharge complaints, age of development, material condition of pipes, proximity of sanitary and stormwater pipes, parcels per square mile, and the optional indicator, if it is used.*

[h]*Normalize the raw HIDP scores by dividing the raw score by the number of screening factors assessed. This normalization produces scores that fall onto a standard scale of 1.0 to 3.0 for low to high illicit discharge potential, respectively. The suggested scale for prioritization for field screening is subbasins with HIDP between 1.0 and 1.5 are low priority for field screening, subbasins with HIDP greater than 1.5 to 2.5 are medium priority for field screening, subbasins with HIDP greater than 2.5 are high priority for field screening.*

[i]*The final rank will take normalized HIDP score into account, but may also include other factors such as proximity to capital construction projects, available funding, and neighborhood concerns.*

Source: Menomonee River Watershed Permitees, Milwaukee Riverkeeper, and SEWRPC.

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Appendix T

MILWAUKEE COUNTY PARKS DEPARTMENT INVASIVE PLANT SPECIES MANAGEMENT GUIDE

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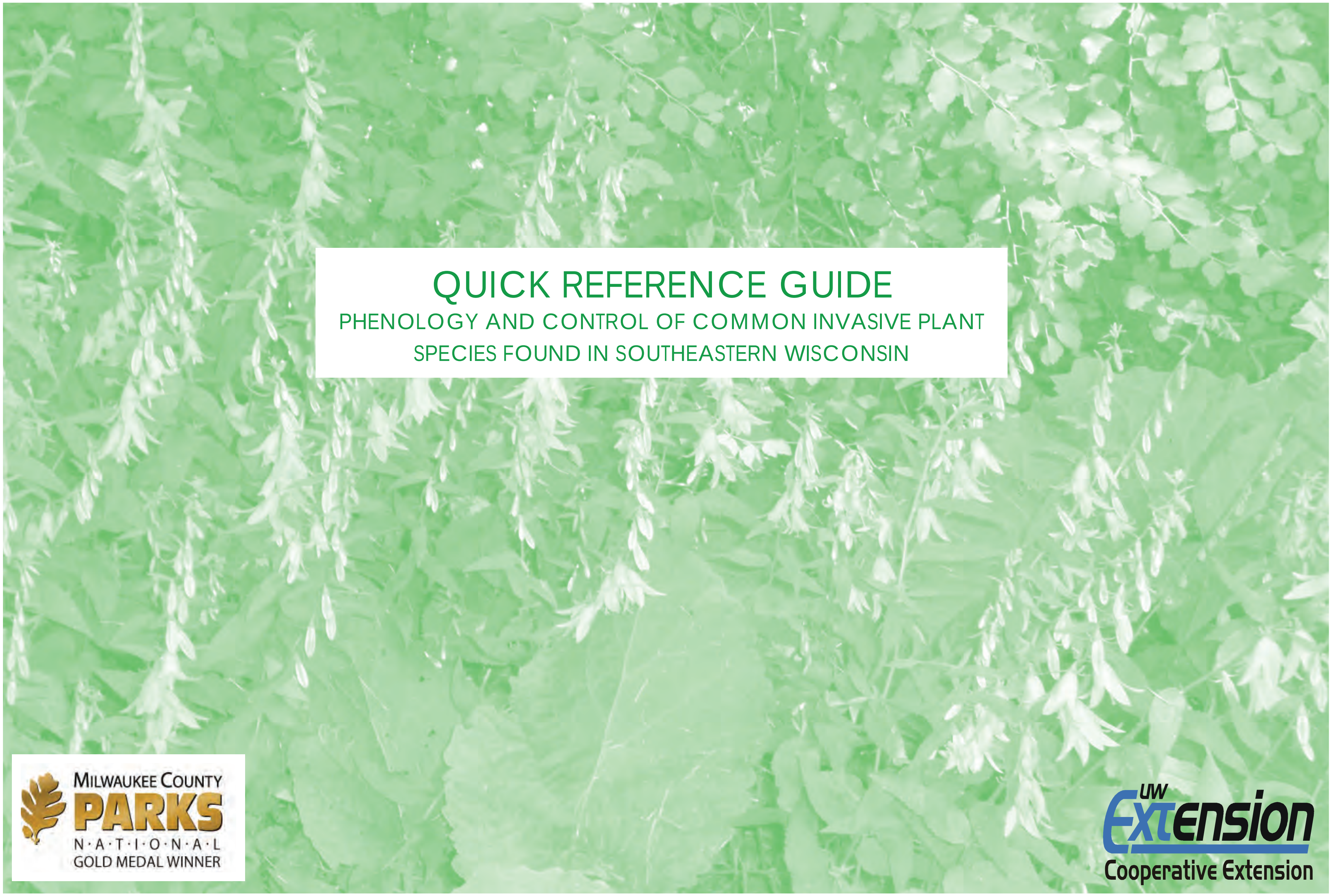


QUICK REFERENCE GUIDE

PHENOLOGY AND CONTROL OF COMMON INVASIVE PLANT SPECIES FOUND IN SOUTHEASTERN WISCONSIN

Milwaukee County Parks National Gold Medal Winner

UW Extension Cooperative Extension

1029

1030

Sources:

Milwaukee County Department of Parks, Recreation & Culture field staff experience

Wisconsin Department of Natural Resources

University of Wisconsin Stevens Point Freckmann Herbarium

Czarapata, Elizabeth. Invasive Plants of the Upper Midwest: An Illustrated Guide to Their Identification and Control

Renz Lab, University of Wisconsin Madison

Publication developed by:

Mary McQuiggin, Natural Areas Stewardship Assistant, Milwaukee County Department of Parks, Recreation & Culture

Allison Hager, Natural Areas Intern, Milwaukee County Department of Parks, Recreation & Culture

Brian Russart, Natural Areas Coordinator, Milwaukee County Department of Parks, Recreation & Culture & University of Wisconsin—Extension

Lasted updated May 2012

Table of Contents

Invasive Trees, Shrubs and Vines of Southeastern Wisconsin……………………………………………………………..3-9

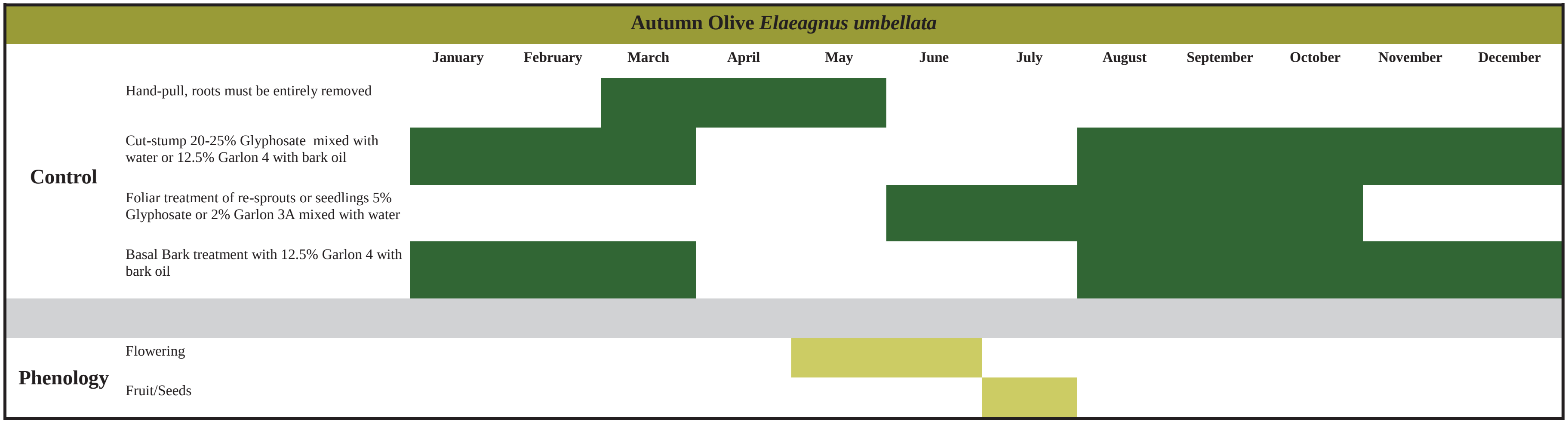
Invasive Forbs of Southeastern Wisconsin……………………………………………………………………………….10-16

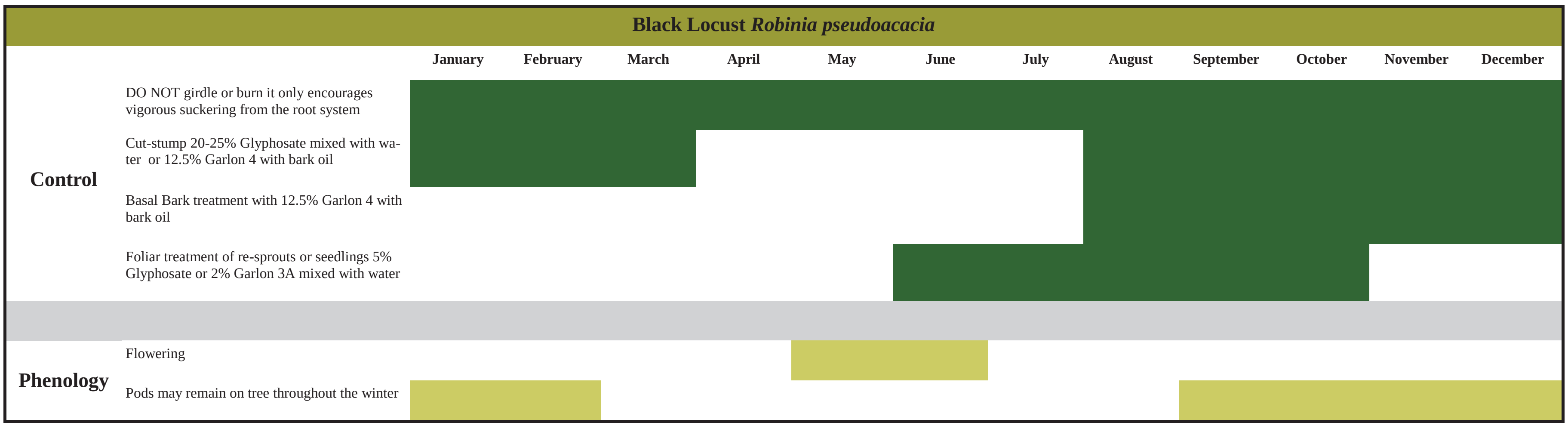
Invasive Grasses of Southeastern Wisconsin……………………………………………………………………………..17-18

Herbicide Application Methods……………………………………………………………………………………………19

Chemical Mixing Table……………………………………………………………………………………………………..20

Invasive Trees, Shrubs, and Vines of Southeastern Wisconsin

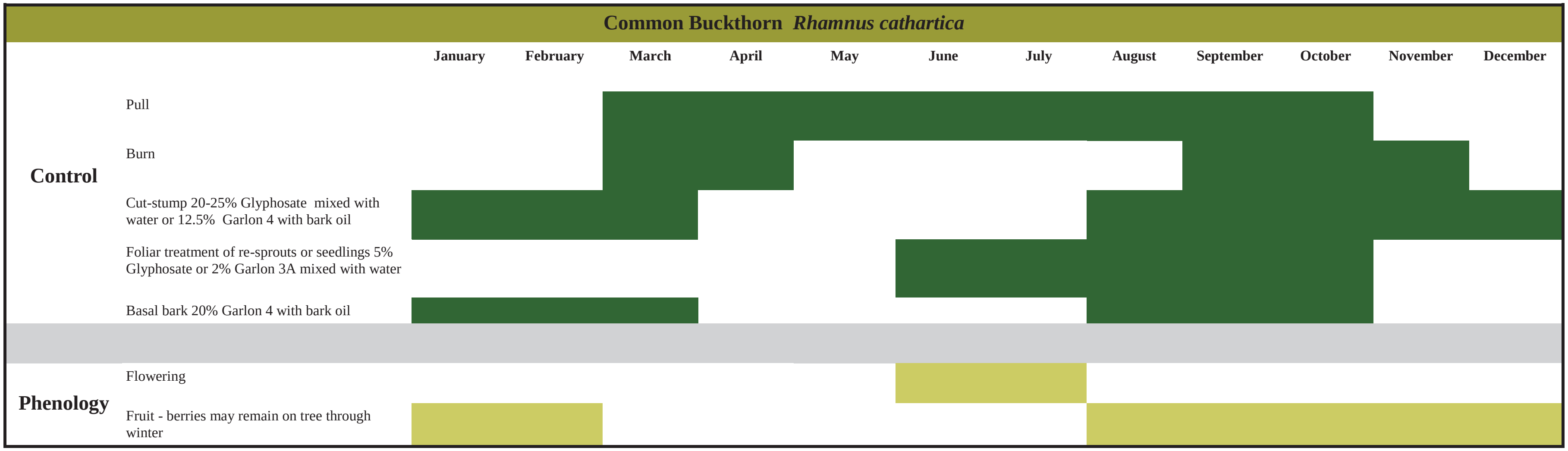


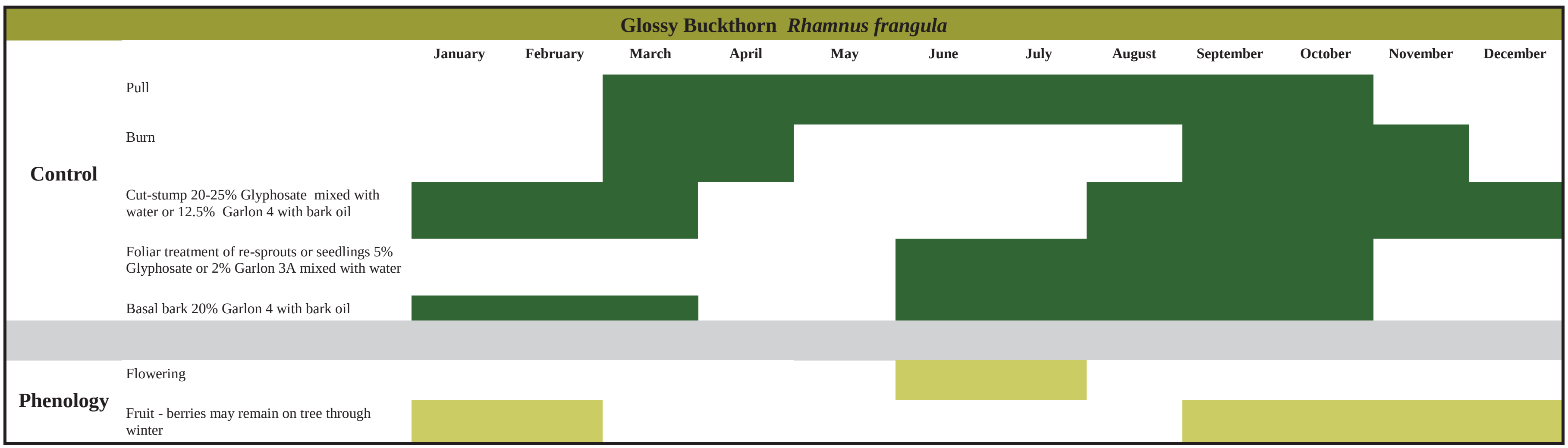


Notes:

1032

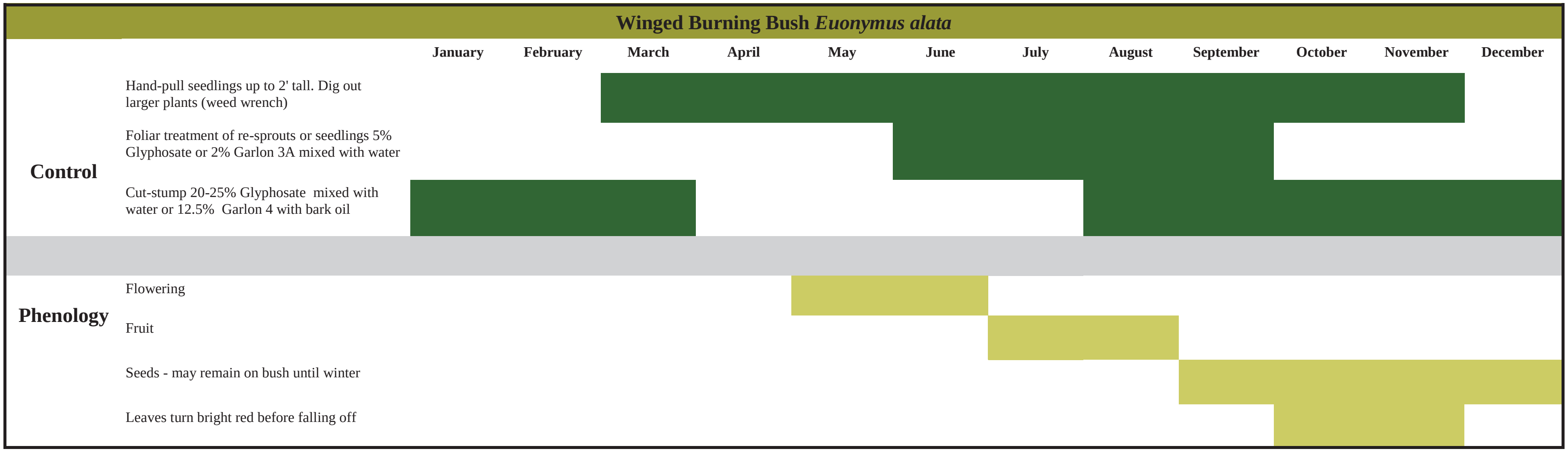
Invasive Trees, Shrubs, and Vines of Southeastern Wisconsin

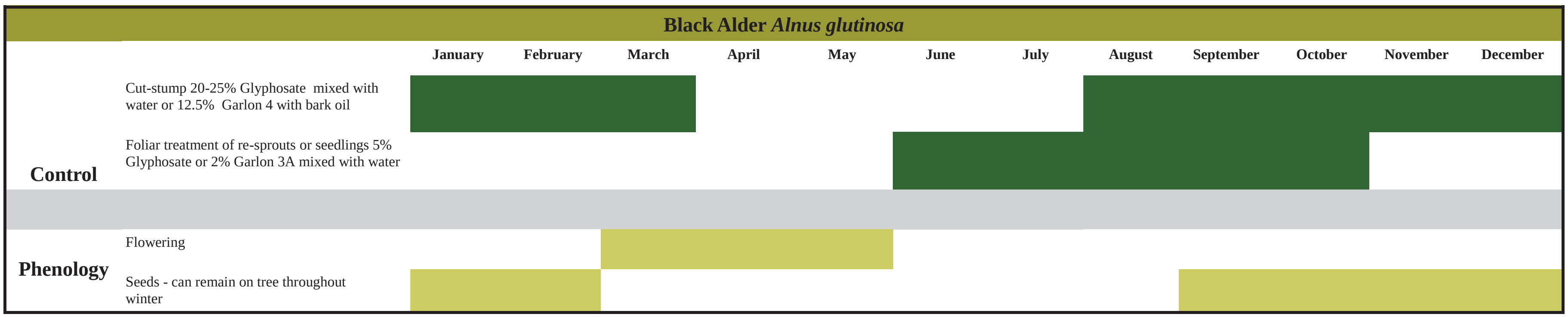




Notes: *****When controlling either species of buckthorn, priority should be given to removing mature female trees*****

Invasive Trees, Shrubs, and Vines of Southeastern Wisconsin

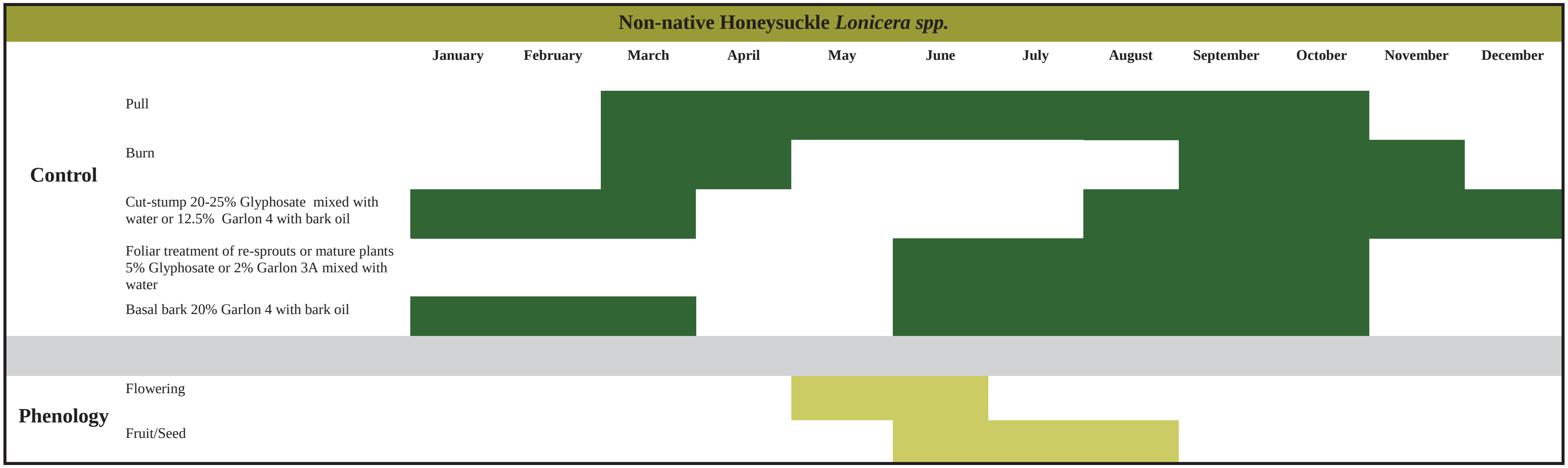


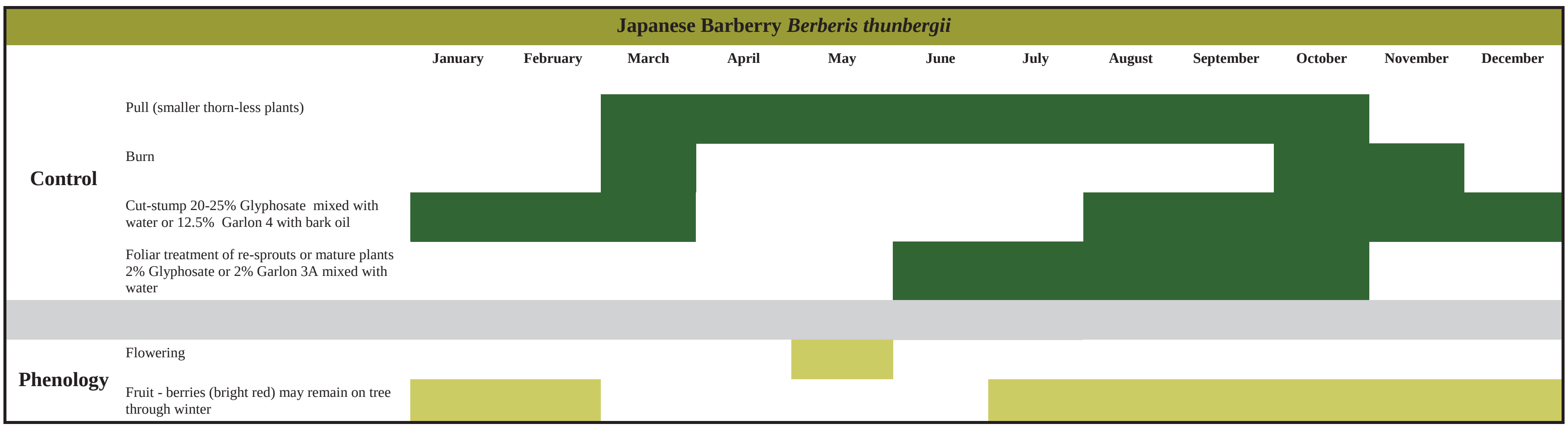


Notes:

1034

Invasive Trees, Shrubs, and Vines of Southeastern Wisconsin





Notes:

Invasive Trees, Shrubs, and Vines of Southeastern Wisconsin

Multi-flora Rose *Rosa multiflora*

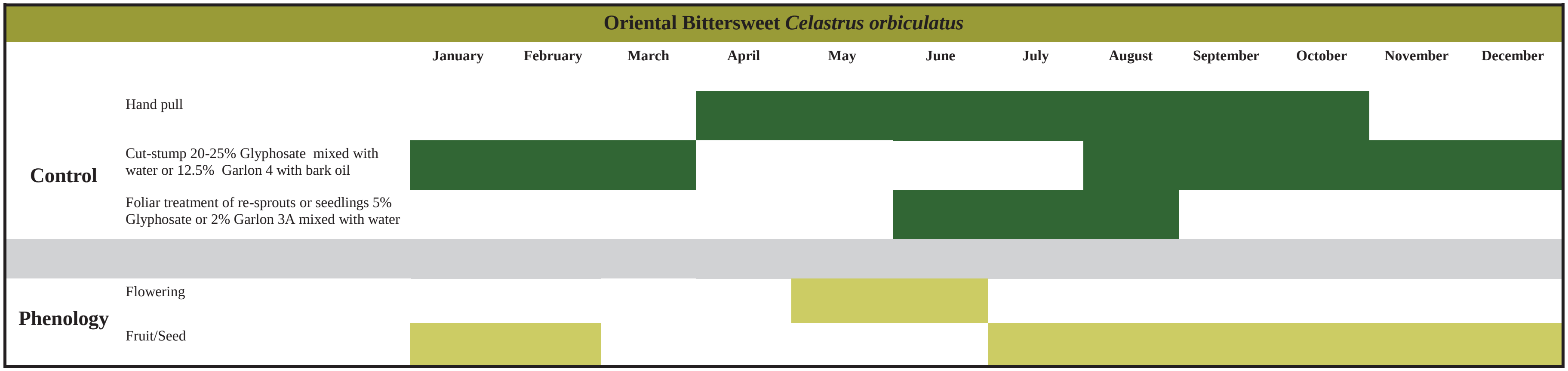
		January	February	March	April	May	June	July	August	September	October	November	December
Control	Pull (using tractor or skid steer)			X	X	X	X	X	X	X	X		
	Burn			X	X					X	X	X	
	Cut-stump 20-25% Glyphosate mixed with water or 12.5% Garlon 4 with bark oil	X	X	X					X	X	X	X	X
	Foliar treatment 2% Glyphosate or 2% Garlon 3A mixed with water						X	X	X	X	X		
Phenology	Flowering					X	X						
	Fruit - berries (maroon) may remain on shrub through winter	X	X				X	X	X	X	X	X	X

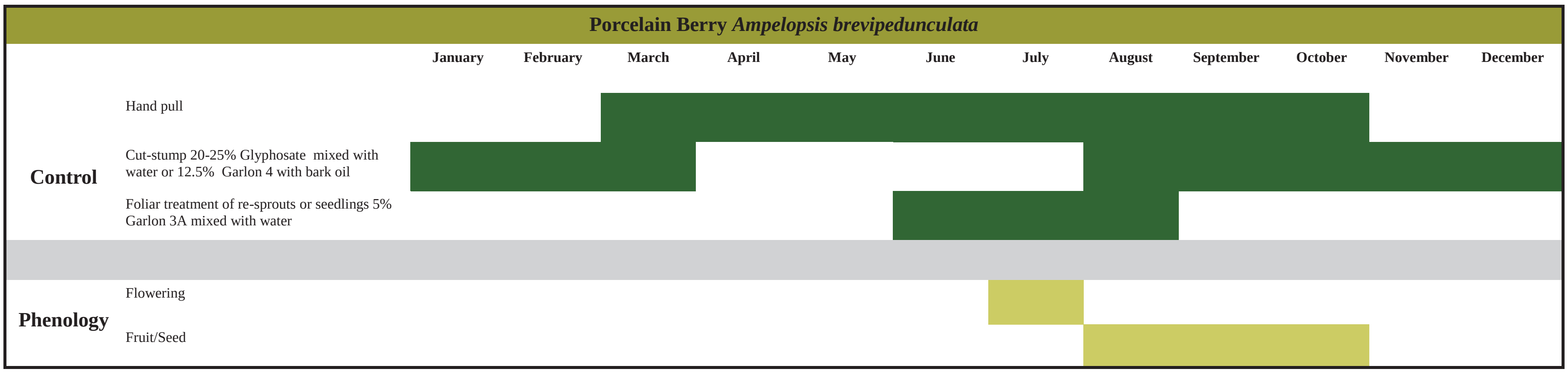
Norway Maple *Acer platanoides*

		January	February	March	April	May	June	July	August	September	October	November	December
Control	Hand pull			X	X	X							
	Burn			X	X					X	X	X	
	Cut-stump 20-25% Glyphosate mixed with water or 12.5% Garlon 4 with bark oil	X	X	X					X	X	X	X	X
	Foliar treatment of re-sprouts or seedlings 5% Glyphosate or 2% Garlon 3A mixed with water						X	X	X	X	X		
Phenology	Flowering				X	X							
	Fruit/Seed—Samaras							X	X	X			

Notes:

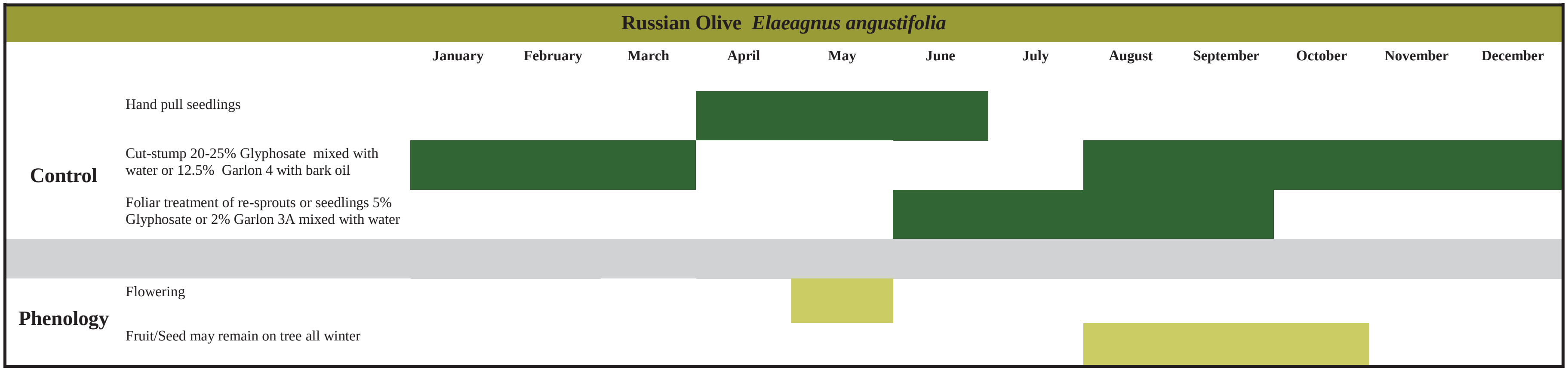
Invasive Trees, Shrubs, and Vines of Southeastern Wisconsin

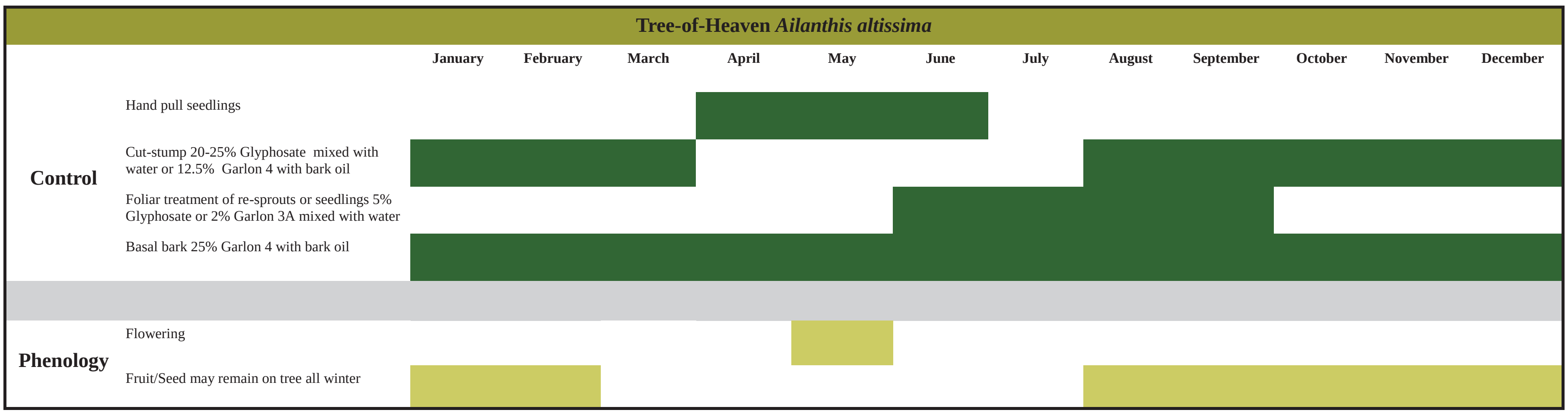




Notes:

Invasive Trees, Shrubs, and Vines of Southeastern Wisconsin





Notes:

1037

1038

Invasive Forbs of Southeastern Wisconsin

Common Burdock *Arctium minus*

		January	February	March	April	May	June	July	August	September	October	November	December
Control	Remove seed heads							■	■	■	■		
	Remove flower head at peak bloom then apply 5% Glyphosate mixed with water to cut surface						■	■					
	Taproot can be sliced through with a shovel 3-4" below soil surface before flowering				■	■	■						
	Foliar treatment on leaves of non-flowering plants with 5% Glyphosate mixed with water				■	■	■	■	■	■	■		
Phenology	Second year - stalks and flowers							■	■	■			
	Seed - bur heads remain throughout the winter	■	■	■				■	■	■	■	■	■

Canada Thistle *Cirsium arvense*

		January	February	March	April	May	June	July	August	September	October	November	December
Control	Burn late spring or early fall				■	■				■	■		
	Cut flower heads just prior to Inflorescences (i.e. before they start to turn purple)						■						
	Foliar apply 2% Glyphosate mixed with water when 6-10" tall in heavily infested areas only				■	■			■	■			
	Foliar treatment of 2% Garlon mixed with water and surfactant applied before flowering in sensitive or grassy areas												
Phenology	Flowering						■	■	■	■			
	Seed dispersal									■	■	■	

Notes:

Invasive Forbs of Southeastern Wisconsin

Non-native Cattails *Typha angustifolia & glauca*

		January	February	March	April	May	June	July	August	September	October	November	December
Control	Cut cattails 3-4' below water level one week before and 1 week after staminate spike has emerged				X	X							
	Burn to remove dead foliage and increase the effectiveness of foliar application	X	X	X							X	X	X
	Spray foliage with 5% Glyphosate mixed with water (aquatic brand if treating in standing water)							X	X				
	Treat stems using the "Bloody Glove" technique with 5% Glyphosate mixed with water (aquatic brand if treating in standing water). Small populations							X	X				
Phenology	Active Growth			X	X	X	X						
	Flowering						X	X					
	Seed								X	X	X	X	

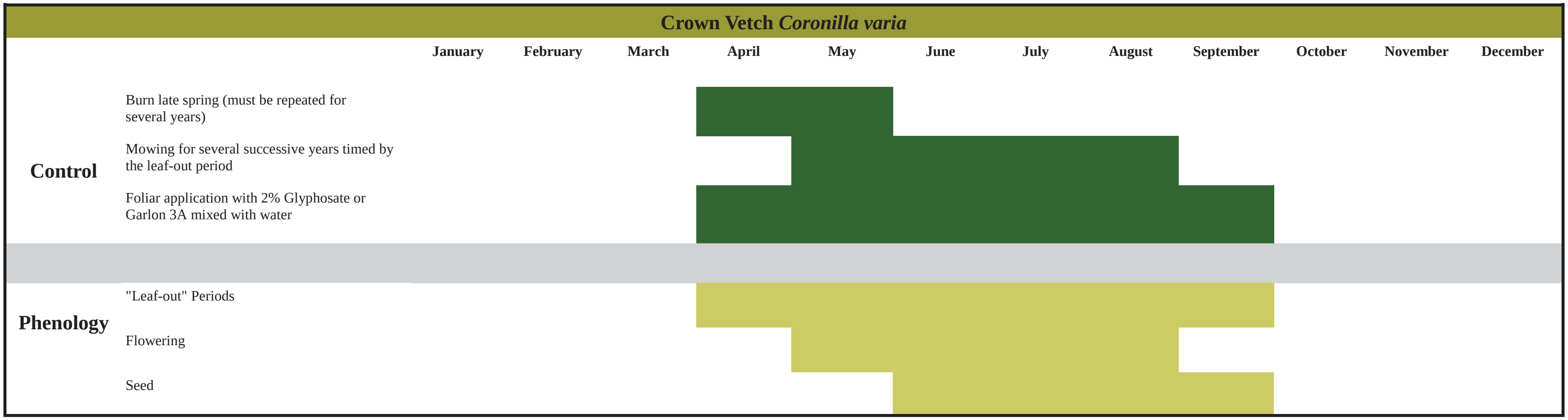
Common and Cut-leaved Teasel *Dipsacus sylvestris*

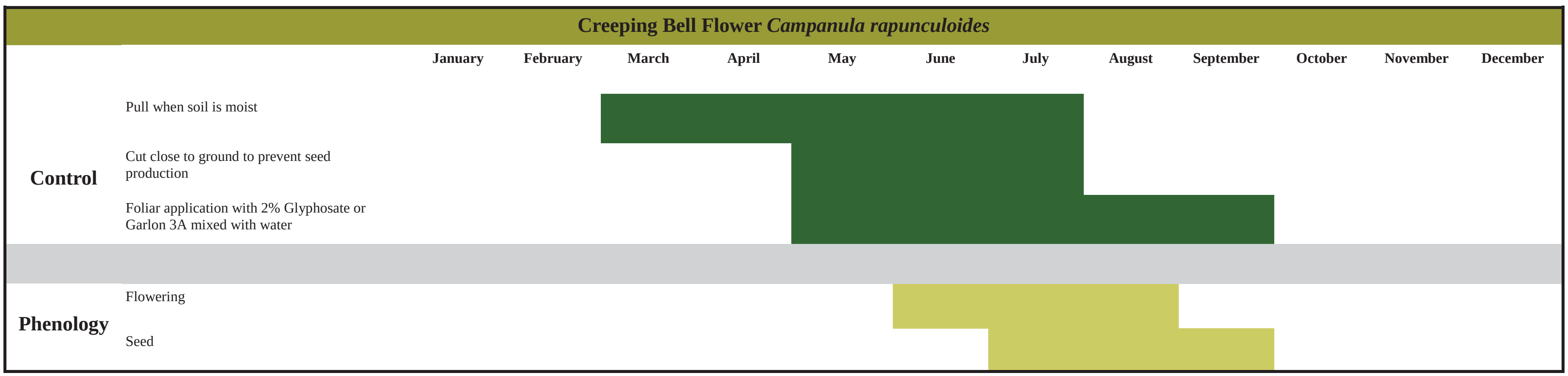
		January	February	March	April	May	June	July	August	September	October	November	December
Control	Mow				X	X	X	X					
	Do NOT mow	X	X	X					X	X	X	X	X
	Cut flower heads and bag							X	X	X	X		
	Foliar treatment of 2% Garlon 3A or Glyphosate mixed with water and applied to rosettes before flowering and/or after burning			X	X	X	X	X	X				
Phenology	First-year basal rosettes actively growing			X	X	X	X	X	X	X			
	Flowering						X	X	X	X			
	Seed	X	X	X						X	X	X	X

Notes:

1040

Invasive Forbs of Southeastern Wisconsin





Notes:

Invasive Forbs of Southeastern Wisconsin

Dame's Rocket *Hesperis matronalis*

		January	February	March	April	May	June	July	August	September	October	November	December
Control	Pull and bag when soil is moist			■	■	■	■	■					
	Foliar application with 2% Glyphosate or Garlon 3A mixed with water				■	■	■	■	■	■	■		
Phenology	Flowering					■	■						
	Seed						■	■	■				

Everlasting Pea *Lathyrus latifolius & Lathyrus sylvestris*

		January	February	March	April	May	June	July	August	September	October	November	December
Control	Mowing for several successive years timed by the leaf-out period					■	■	■	■				
	Foliar application with 2% Glyphosate or Garlon 3A mixed with water					■	■	■	■	■			
Phenology	Flowering						■	■	■				
	Seed								■	■	■		

Flowering Rush *Butomus umbellatus*

		January	February	March	April	May	June	July	August	September	October	November	December
Control	Cut below the water surface and remove all cut materials				■	■	■	■	■				
	Herbicides not effective for control												
	Hand digging to remove small populations. Care must be taken to remove all root fragments					■	■	■	■				
Phenology	Flowering						■	■	■				
	Seed-rarely germinates and mainly reproduces by rhizomes												

Notes:

Invasive Forbs of Southeastern Wisconsin

Notes:

Invasive Forbs of Southeastern Wisconsin

Lesser Celandine *Ranunculus fiscaria*

		January	February	March	April	May	June	July	August	September	October	November	December
Control	Manual control requires the removal of all bulblets and tubers			X	X	X	X						
	Spot spray rosettes with 2% Garlon 4 and bark oil			X	X	X							
Phenology	Flowering				X								
	Seed					X	X						

Purple Loosestrife *Lythrum salicaria*

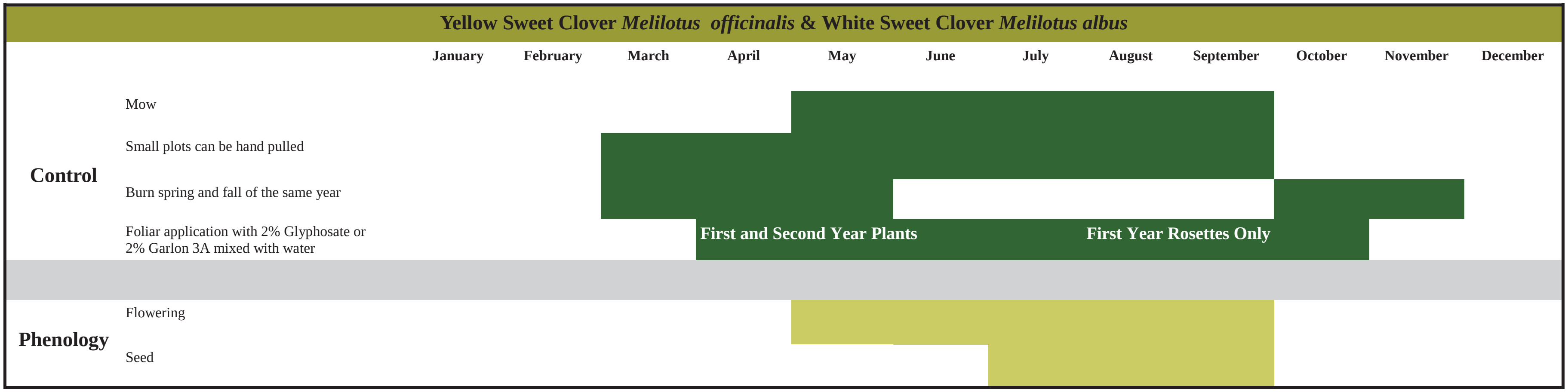
		January	February	March	April	May	June	July	August	September	October	November	December
Control	Do NOT mow	X	X	X	X	X	X	X	X	X	X	X	X
	Spray foliage with 5% Glyphosate mixed with water (aquatic brand if treating in standing water)					X	X	X	X	X			
	Treat stems using the "Bloody Glove" technique with 5% Glyphosate mixed with water (aquatic brand if treating in standing water). Small populations												
Phenology	Flowering							X	X	X			
	Seed								X	X	X		

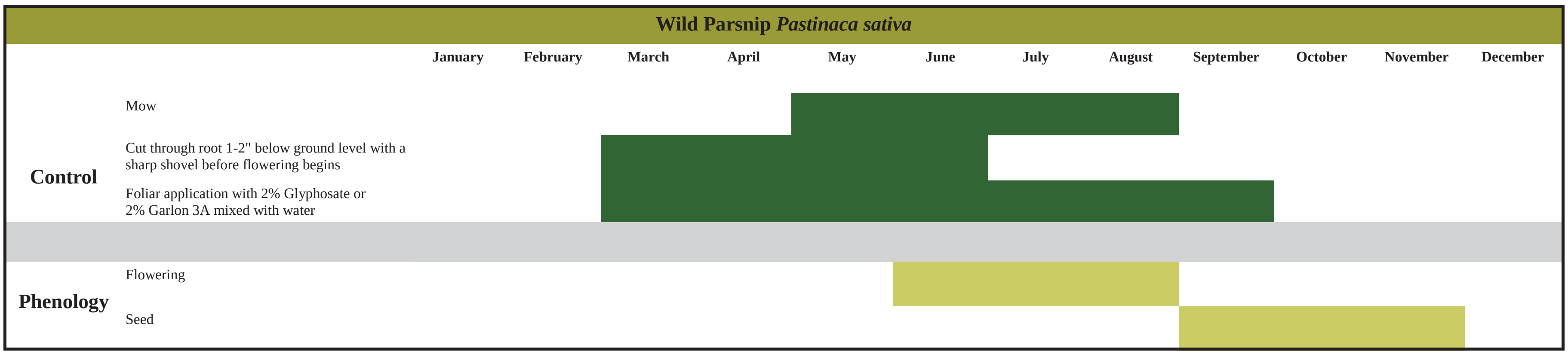
Spotted Knapweed *Centurea maculosa*

		January	February	March	April	May	June	July	August	September	October	November	December
Control	Do NOT Mow	X	X	X	X	X	X	X	X	X	X	X	X
	Small plots can be hand pulled (wear gloves - some people have an allergic reaction)			X	X	X	X	X	X	X			
	Spot spray rosettes with 2% Garlon 3A mixed with water					X	X	X	X	X			
Phenology	Flowering						X	X	X	X			
	Seed							X	X	X	X		

1044

Invasive Forbs of Southeastern Wisconsin





Notes: *********Always cover skin completely when working with this plant. Contact with sap can cause painful burns or boils*********

Invasive Grasses of Southeastern Wisconsin

Common Reed Grass *Phragmites australis*

		January	February	March	April	May	June	July	August	September	October	November	December
Control	Burn or cut to remove dead foliage and increase the effectiveness of foliar application	■	■	■							■	■	■
	Spray foliage with 5% Glyphosate mixed with water (aquatic brand if treating in standing water						■	■	■	■			
	Treat stems using the "Bloody Glove" technique with 5% Glyphosate mixed with water (aquatic brand if treating in standing water). Small populations						■	■	■	■			
	Do not mow	■	■	■						■	■	■	■
	Readily reproduces vegetatively after mowing. Equipment should be used to spot mow stands and immediately cleaned on site.					■	■	■	■				
Phenology	Flowering						■	■					
	Seeds can stay on plant through winter	■	■	■						■	■	■	■

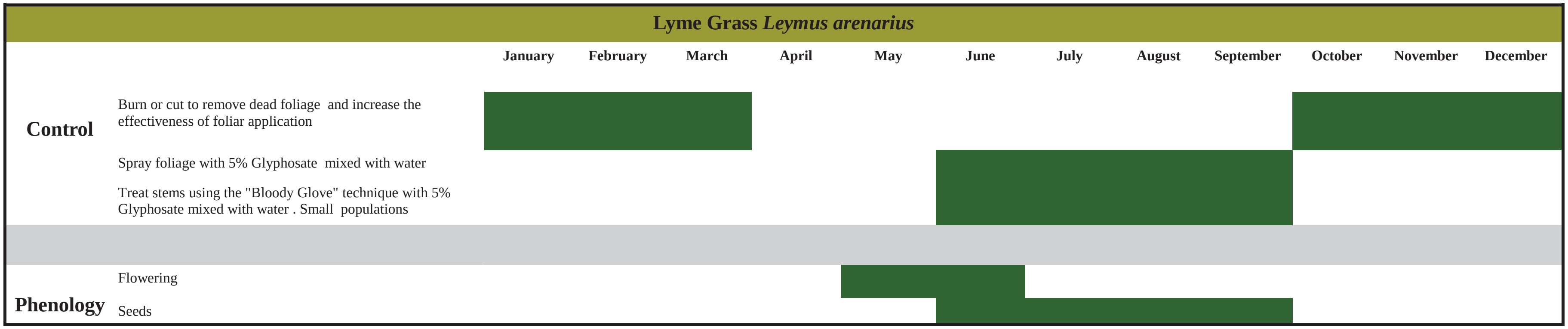
Japanese Plume Grass *Miscanthus sinensis*

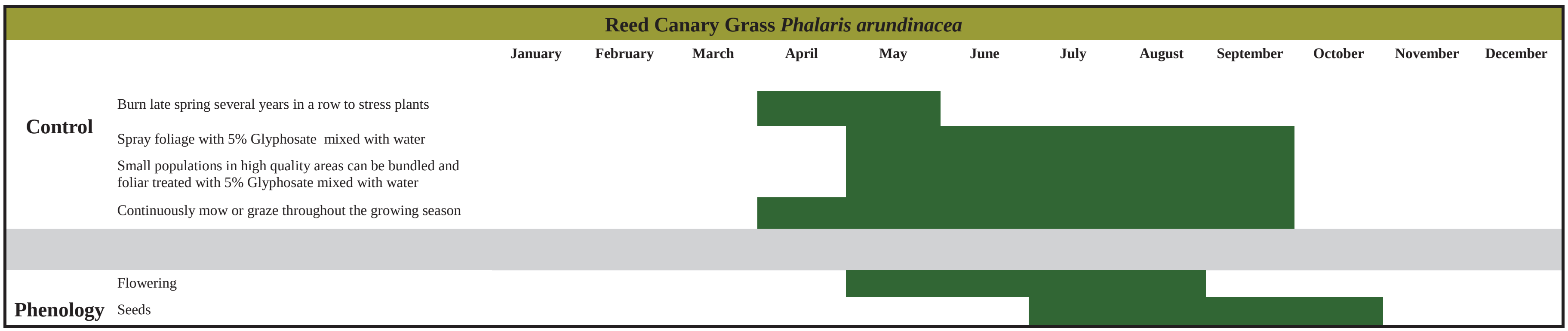
		January	February	March	April	May	June	July	August	September	October	November	December
Control	Burn or cut to remove dead foliage and increase the effectiveness of foliar application	■	■	■							■	■	■
	Spray foliage with 5% Glyphosate mixed with water						■	■	■	■			
	Treat stems using the "Bloody Glove" technique with 5% Glyphosate mixed with water. Small populations						■	■	■	■			
	Do not mow	■	■	■						■	■	■	■
Phenology	Flowering								■	■			
	Seeds can stay on plant through winter										■	■	■

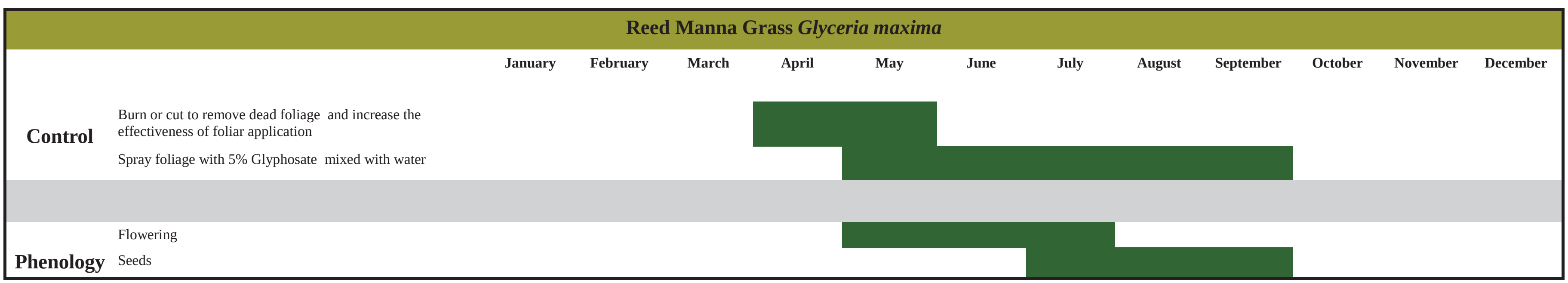
Notes:

1046

Invasive Grasses of Southeastern Wisconsin







Notes:

Common Herbicide Application Methods

Cut-stump treatment:

Applying herbicide to freshly cut stump's cambium layer. Garlon 4 should be mixed with a penetrating bark oil (year round) and Glyphosate can be mixed with just water (growing season). Glyphosate with bark only needs to be applied to the cambium layer; Garlon 4 should be applied to the cambium layer and down the sides of the cut-stump to the root crown.

Basal Bark Treatment:

Applying a mixture of Garlon 4 and bark oil in a 6-15" band around the entire trunk of a tree or the stems at the base of a shrub.

Foliar Treatment:

Apply to the green leaves of an invasive plant with a sprayer or wick applicator. Leaves should be thoroughly covered, but not have chemical dripping off of them. When foliage is either waxy or fuzzy the herbicide should be mixed with a surfactant to improve penetration. Recommended application times are early spring and late fall within high quality sites because most native plants are dormant. In ecologically degraded sites, application can occur throughout the growing season. For foliage with a waxy coating it is recommended that the solution be mixed with .5% of a surfactant such as bark oil. "Bloody Glove" technique refers to soaking a cloth glove in a chemical solution, wearing it over your rubber herbicide application gloves and wiping the glove along the blades of grass or other vegetation. This method is particularly useful in high quality sites where a broad spraying application would be ecologically degrading.

Girdling Treatment:

Girdling is cutting and removing a band (1-2" wide on smaller trees, 6-8" on larger trees) of bark around the entire trunk of the tree to interrupt the flow of sap between the roots and the crown of the tree. Cuts should be treated with herbicide prior to spring sap flow.

FAQ	**Glyphosate (Round-up, Rodeo, Razor) & Triclopyr (Garlon 3A)**	**Triclopyr (Garlon 4)**
What is it mixed with?	Water or water with surfactant (waxy or fuzzy foliage)	Penetrating Bark Oil (Cut-stump)
Where is it applied?	Cambium layer, just inside bark on cut stump, foliage	Cambium layer and down the side of cut stump to root crown
What time of year should it be applied?	Cut-stump: early fall Foliar: During growing season in heavily infested areas; early spring/late fall in sensitive areas	Cut-stump: Can be applied anytime, most effective in the fall
What are the temperature or other restrictions?	>32°F Foliar > 50 °F	< 80°F Should not be applied when snow prevents coverage to the ground line
How soon after cutting should it be applied?	As soon as possible or within 30 minutes	Anytime, shortly after cutting is recommended
What plants will be affected?	Glyphosate is non-selective and will kill anything. Triclopyr is broadleaf specific	Broadleaf specific
What percentage is used?	Cut-stump or girdling: 12.5% - 25% AI. Foliar: 2% - 5% depending on species	Cut-stump or girdling: 12.5% a..i.
Restricted Entry Interval	Keep people and pets off of sprayed area until solution has dried typically < 1 day	12 hours

Total Mix	% Concentration (Quantity of Herbicide needed) mL	% Concentration (Quantity of Herbicide needed) mL	% Concentration (Quantity of Herbicide needed) mL	% Concentration (Quantity of Herbicide needed) mL	% Concentration (Quantity of Herbicide needed) mL	% Concentration (Quantity of Herbicide needed) mL	% Concentration (Quantity of Herbicide needed) mL
Quantity (L)	**1.5**	**2**	**3**	**4**	**5**	**12.5**	**20**
1	15	20	30	40	50	125	200
3	45	60	90	120	150	375	600
5	75	100	150	200	250	625	1000
6	90	120	180	240	300	750	1200
9	135	180	270	360	450	1125	1800
10	150	200	300	400	500	1250	2000
12	180	240	360	480	600	1500	2400
15	225	300	450	600	750	1875	3000
20	300	400	600	800	1000	2500	4000
40	600	800	1200	1600	2000	5000	8000
50	750	1000	1500	2000	2500	6250	10000

*** For .5% surfactant: add 5 mL of bark oil / 1 L of mixture***
For cut stump mixtures: substitute penetrating bark oil for water

Appendix U

CRITERIA AND GUIDELINES FOR STREAM CROSSINGS TO ALLOW FISH PASSAGE AND MAINTAIN STREAM STABILITY

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CRITERIA AND GUIDELINES FOR STREAM CROSSINGS TO ALLOW FISH PASSAGE AND MAINTAIN STREAM STABILITY

TYPES OF CROSSINGS

- The number of stream crossings should be minimized.
- If a crossing is necessary, structures that maintain to the extent possible the existing streambed and bank conditions are preferable; therefore, bridges spanning streams are preferable to other structures.
- If a culvert is necessary, open bottom structures are preferable to closed bottom structures.
- If a closed bottom culvert is necessary, box culverts, elliptical, or pipe arch culverts are preferable to round pipe culverts, because round pipes generally reduce stream width to a much larger degree than the aforementioned structures, causing long-term upstream and downstream passage limitations (see physical considerations below).

BIOLOGICAL CONSIDERATIONS[1]

- Contact the area WDNR fisheries manager prior to design.[2]
- Species of fish present (coldwater, warmwater, threatened, endangered, species of special concern).
- Life stages to potentially be impacted (e.g., egg development within substrates should be avoided).
- Migration timing of affected species/ life stages (e.g., adult spawning times should be avoided).

PHYSICAL CONSIDERATIONS[3]

It is important to note that in order to achieve the minimum physical criteria outlined below, the culvert(s) will need to be oversized as part of the design to ensure adequate long-term fish passage as well as the ability to pass the design period rainfall event.

It may not be possible to achieve some of the minimum passage criteria below based upon specific on-site conditions or constraints. However, the closer the designed and completed culvert meet these criteria, the better the long-term passage and overall sustainability of the fishery will be in this region.

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[1]*British Columbia Ministry of Forests,* Fish-stream crossing guidebook, *For. Prac. Br., Min. For., http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/Guidetoc.htm, Victoria, B.C. Forest Practices Code of British Columbia guidebook, 2002.*

[2]*UW-Extension and WDNR,* Fish Friendly Culverts*, 2002.*

[3]*Washington Department of Fish and Wildlife, Habitat and Lands Program, Environmental Engineering Division,* Fish Passage Design at Road Culverts: A Design Manual for Fish Passage at Road Crossings*, Washington, March 3, 1999.*

COMPARISON OF UNDERSIZED AND ADEQUATELY SIZED AND PLACED CULVERTS

Undersized culvert.

Properly sized and placed culverts.

Source: Minnesota Department of Natural Resources.

Provide Adequate Depth

- Slope—Culvert should be installed with a slope that matches the riffle slope as measured in the thalweg[4] (see Minnesota DNR guidelines[5]).

- Water Depth—Depths should maintain the determined thalweg depth at any point within the culvert during low flow periods (see Minnesota DNR guidelines).

- Installation Below Grade—The culvert should be installed so that the bottom of the structure is buried to a depth equal to 1/6th the bankfull width of the stream (up to two feet) below the natural grade line elevation of the stream bottom (see Minnesota DNR guidelines). The culvert should then be filled to stream grade with natural substrates. The substrates should consist of a variety of gravel ranging from one to four inches in diameter and either mixed with nonuniformly laid riprap or uniformly placed alternate riprap baffles, large enough to be stable during the culvert design discharge, which will ensure stability of substrates during high-flow events.

Provide Adequate Width

- Width—Culvert width shall match the bankfull width (minimum) of the existing channel.

- Offsetting Multiple Culverts—The number of culverts used should be minimized. However, if multiple culverts are necessary, it is recommended that the culvert inverts be offset vertically and only one culvert be designed to provide passage during low-flow conditions and the additional culverts be used to pass the higher flow events (see figure above). Therefore, the low-flow culvert will be the only culvert, in a series of two or more culverts, designed to provide fish passage during low flows and shall meet the physical requirements of passage above.

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[4] *The thalweg is the lowest point of the streambed.*

[5] *Minnesota DNR, Best Practices for Meeting DNR General Public Waters Work Permit GP 2004-0001, March 2006.*

Provide Adequate Resting Areas

- Length—Culverts that exceed more than 75 feet in length need to provide additional resting areas (e.g., installation of baffles or weirs) within the culvert to facilitate passage.[6]

Inlet and Outlet Protection

- Align the culvert with the existing stream alignment (e.g., 90 degree bends at the inlet or outlet should be avoided, even though this will increase culvert length, see Minnesota DNR guidelines).

- The low-flow culvert should be centered on the thalweg of the channel to ensure adequate depths inside the culvert.

- Provide grade control where there is potential for head-cuts that could degrade the channel.

- It may be necessary to install riprap protection on the outside bank below the outlet to reduce bank erosion during high-flow events.

[6] *Thomas Slawski and Timothy Ehlinger, "Habitat Improvement in Box Culverts: Management in the Dark?,"* North American Journal of Fisheries Management, *Volume 18:676-685, 1998.*

Road/Stream Crossing Inspection Data Sheet

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

SUPERIOR WATERSHED PARTNERSHIP

Site ID: ___________

Name of Observer(s)______________________________ **Date**_____________

GPS coordinates (lat/long.) ______________________________ OR **T/R**____________ **Sec**____ ¼____

Road Name__________________________ **Road Number** _________ **Structure ID** _________

Stream Name________________________________ **Road type** State County Town Private Federal Other

Land Use In Surrounding Area: (circle all that apply)
Forest Wetland Open/Field Pasture Cultivated Urban Other

Additional comments about location (milepost, etc.):

Road Surface (circle all that apply) Paved Gravel Native **Road Width** ______ft. **with shoulders** ______ft.

Erosion of road near crossing? Y N
(if YES, also fill out Section F)

Is there a trash rack or beaver prevention structure? Y N

Evidence of crossing blow-out? Y N **Evidence of beaver activity?** Y N

Structure Type (circle one) Culvert Bridge Ford No Structure

A. Crossing Characteristics:

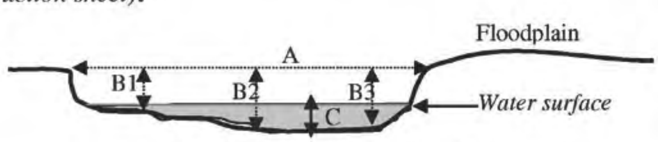
		Inlet/Upstream	Outlet/Downstream	Comments/Notes
Embankment or Side Slopes (not applicable to Fords)	Protection	vegetation armor other	vegetation armor other	
	Erosion *(if Y, fill out Section F)*	Y N	Y N	
Channel	Aligned	Y N	Y N	
	Pool present	Y N	Y N	
	Pool scour width	ft.	ft.	
	Pool water depth (max.)	ft.	ft.	
	Protection	armor other none	armor other none	
Ditch	Present	Y N	Y N	
	Protection	vegetation armor other	vegetation armor other	
	Connected to stream	Y N	Y N	
	Erosion *(if Y, fill out Section F)*	Y N	Y N	

B. Stream Measurements (*See standard procedure in instruction sheet*):

A: Bankfull Width _________feet

B: Bankfull Depth (left to right facing downstream)
B1:______feet B2:______feet B3:______feet

C: Water depth _______ feet

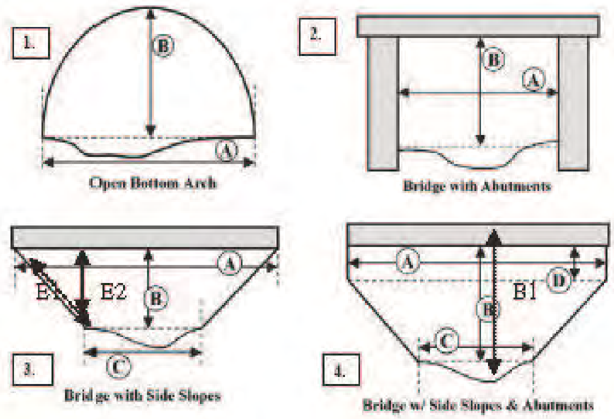


Cross-section of stream channel

Flow conditions: overbank at bankfull below bankfull very low none

Fish present? Y N

E. Bridge Characteristics (For multiple cells see below):



Bridge Type (# from diagram) _______

Bridge Surface Material:

Wood	Open decking? Y N
Concrete	Asphalt
Metal	other __________

Bridge Measurements:

A: Span ______feet Width (parallel to stream) ______feet

B: Bottom of beam to water surface _______feet

B1: Bridge Rise (bottom of beam to stream bed) _______feet

C: Stream width _______feet

D: Bottom of beam to top of embankment _______feet

E: Side Slopes (facing downstream):

Left bank: E1_______feet E2______feet **Right Bank:** E1______feet E2______feet

Present at inlet (circle all that apply): Wingwalls Apron Other _______________

Present at outlet (circle all that apply): Wingwalls Apron Other _______________

Condition of Structure: Deteriorating **Y or N**

If yes, where (check all that apply)? ☐ Abutments ☐ Decking ☐ Wingwalls ☐ Other________________

Multiple Bridge Cells

NOTE: *(number multiple bridge cells (usually separated by abutments) from left to right facing downstream. Fill in sections above for bridge cell # 1 and use this section for remaining cells)*

Bridge Cell #	A (ft.)	B (ft.)	B1 (ft.)
2			
3			
4			

F. Erosion Properties – *(fill out all that apply, add other locations in blank rows. Other locations to note may include prominent erosion along stream banks within 50' of crossing.)*

Location of Erosion	Erosion Dimensions (feet)			Material Eroded	Erosion	Comments
	Length	Width	Depth	(clay, silt, sand, gravel, loam, sandy loam, OR gravelly loam)	Reaching Stream? (Y/N)	
Road approach *(left, facing downstream)*						
Road approach *(right, facing down stream)*						
Ditch(s) *(upstream side of road)*						
Ditch(s) *(downstream side of road)*						
Road over crossing (or bridge deck)						
Culvert inlet embankment						
Culvert outlet embankment						
Bridge Side slopes *(left, facing downstream)*						
Bridge Side slopes *(right, facing down stream)*						

If erosion occurs on the approaches or in the ditches, is there opportunity (room) to install road drainage measures?
Y **N**

G. Site Sketches (Identify road crossing, stream, flow direction, issues, and location and direction of photos):

↑ N

Comments: *(Provide additional information such as invasive plants present, spillways present, etc)*

Appendix V

MAY 5, 2014, U.S. FISH AND WILDLIFE SERVICE LETTER REGARDING HORLICK DAM AS A BARRIER TO SEA LAMPREY

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Marquette Biological Station
3090 Wright Street
Marquette, Michigan 49855-9649

IN REPLY REFER TO:
FWS/MBS

May 5, 2014

Mr. Bradley Eggold
Wisconsin Department of Natural Resources
University of Wisconsin-Milwaukee Water Institute
600 East Greenfield Avenue
Milwaukee, Wisconsin 53204

Dear Mr. Eggold:

The U.S. Fish and Wildlife Service works in partnership with the Great Lakes Fishery Commission to implement the Sea Lamprey Control Program (Program) in the Great Lakes. The Program uses multiple control methods to reduce sea lamprey populations in Great Lakes tributaries including barriers and dams that block adult sea lampreys from spawning and larval habitat.

The Program has been asked to comment on an ongoing investigation to remove or modify the Horlick Dam on the Root River, tributary to Lake Michigan, in Racine County, Wisconsin. The City of Racine has contracted the Southeastern Wisconsin Regional Planning Commission to look at options for addressing spillway capacity concerns at the Horlick Dam.

Upon inspection by the Program, the Horlick Dam on the Root River was determined to be the first effective barrier to sea lamprey migration on the system. The Program 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. If 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.

Thank you for the opportunity to provide feedback on this important project and I look forward to our continued coordination. If you need any additional information, please do not hesitate to contact me at (906) 226-1241.

Sincerely,

Jessica Barber
Fish Biologist

cc: Dale Burkett, Great Lakes Fishery Commission
Nathan Zoch, Wisconsin Department of Natural Resources
Nathan Plunkett, Racine County Highway Department
Mark Holey, U.S. Fish and Wildlife Service

Reg. 3;FWS/MBS;JBarber;ckp;5 May 2014;ID 410
G:\Admin-All Supv\Correspondence\2014\Barriers\410 - Response to removal of Horlick Dam on the Root River

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cc: Dale Burkett
Great Lakes Fishery Commission
dburkett@glfc.org

Nathan Zoch
Wisconsin Department of Natural Resources
141 NW Barstow
Room 180
Waukesha, WI 53188

Nathan Plunkett
Racine County Highway Department
14200 Washington Avenue
Sturtevant, WI 53177

Mark Holey
U.S. Fish and Wildlife Service
Green Bay Fish and Wildlife Conservation Office
2661 Tower Dr
New Franken, WI 54229-9565

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Appendix W

MODEL RESOLUTION FOR ADOPTION OF THE ROOT RIVER WATERSHED RESTORATION PLAN

WHEREAS, the Southeastern Wisconsin Regional Planning Commission, which was duly created by the Governor of the State of Wisconsin in accordance with Section 66.0309(2) of the *Wisconsin Statutes* on the 8th day of August 1960, upon petition of the Counties of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha, has the function and duty of making and adopting a master plan for the physical development of the Region; and

WHEREAS, Racine County, the Milwaukee Metropolitan Sewerage District, and the Southeastern Wisconsin Watersheds Trust, Inc. executed agreements with the Regional Planning Commission on June 20, 2011 and September 30, 2011; June 17, 2011; and June 28, 2011, respectively, for the development of a watershed restoration plan for the Root River watershed leading to recommendations for the management of water resources in the watershed, including recommendation to address issues and problems related to water quality, recreational access and use, habitat conditions, in the Root River watershed and problems related to flooding in the portion of the watershed located in Racine County; and

WHEREAS, such plan has been completed and;

WHEREAS, such plan contains recommendations to address issues and problems related to water quality, recreational access and use, habitat conditions, in the Root River watershed and problems related to flooding in the portion of the watershed located in Racine County; and

WHEREAS, the aforementioned recommendations, including all studies, data, maps, figures, charts, and tables are set forth in a published report entitled SEWRPC Community Assistance Planning Report No. 316, *A Watershed Restoration Plan for the Root River Watershed*, published in July 2014; and

WHEREAS, the Commission has transmitted copies of the aforementioned SEWRPC Community Assistance Planning Report No. 316, to the local units of government; and

WHEREAS, the (Name of Local Governing Body) has supported and generally concurred in the watershed and other regional planning programs undertaken by the Southeastern Wisconsin Regional Planning Commission and believes that the watershed restoration plan for the Root River watershed prepared by the Commission is a valuable guide to the development of not only the watershed, but the community, and that the adoption of such plan by the (Name of Local Governing Body) will assure a common understanding by the several governmental levels and agencies concerned and enable these levels and agencies of government to program the necessary areawide and local plan implementation work.

NOW, THEREFORE, BE IT RESOLVED that, pursuant to Section 66.0309(12) of the *Wisconsin Statutes*, the (Name of Local Governing Body) on the _____ day of ______, 2014, hereby adopts the watershed restoration plan for the Root River watershed as set forth in SEWRPC Community Assistance Planning Report No. 316 as a guide for watershed management

BE IT FURTHER HEREBY RESOLVED that the __________ clerk transmit a certified copy of this resolution to the Southeastern Wisconsin Regional Planning Commission.

____
(President, Mayor, or Chairman
of the Local Governing Body)

ATTESTATION:

____

(Clerk of Local Governing Body)