Appendix A

WATER QUALITY DATA

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Table A-1

DESCRIPTION OF PRIMARY WATER QUALITY PARAMETERS AND THEIR REGIONAL AVERAGES

Parameter	Description	Regional Average[a]	Existing Standards
Primary Water Quality Parameters			
Chlorophyll-*a*	The major photosynthetic, "green," pigment in algae. The amount of chlorophyll-*a* present in the water is an indication of the biomass, or amount of algae, in the water. Chlorophyll-*a* levels above 0.10 mg/l generally result in a green coloration of the water that may be severe enough to impair recreational activities, such as swimming or waterskiing	43	- -
Total Phosphorus	Phosphorus, which can enter a lake from natural and manmade sources, is a fundamental building block for plant growth. However, excessive levels of phosphorus in lakes can lead to nuisance levels of plant growth, unsightly algal blooms, decreased water clarity, and oxygen depletion that can stress or kill fish and other aquatic life. Statewide standards exist for phosphorus concentrations in lakes (Rock Lake's phosphorus standard is 0.06 mg/l, meaning that if the Lake exceeded this concentration it would be considered impaired with respect to phosphorus). A concentration of less than 0.06 mg/l is the concentration considered necessary to limit algal and aquatic plant growths to levels consistent with recreational water use objectives	- -	0.06[b]
Dissolved Oxygen	Dissolved oxygen levels are one of the most critical factors affecting the living organisms of a lake ecosystem. Generally, dissolved oxygen levels are higher at the surface of a lake, where there is an interchange between the water and atmosphere, stirring by wind action, and production of oxygen by plant photosynthesis. Dissolved oxygen levels are usually lowest near the bottom of a lake, where decomposer organisms and chemical oxidation processes deplete oxygen during the decay process. A concentration of about 5.0 mg/l is considered the minimum level below which oxygen-consuming organisms, such as fish, become stressed, while fish are unlikely to survive when dissolved oxygen concentrations drop below 2.0 mg/l	10-12	- -
Water Clarity (feet)	Measured with a Secchi disk, a black-and-white, eight-inch-diameter disk, which is lowered into the water until a depth is reached at which the disk is no longer visible. It can be affected by physical factors, such as suspended particles, and by various biologic factors, including seasonal variations in planktonic algal populations living in a lake	5	- -
General Water Quality Parameters			
Alkalinity	The measure of the ability of a lake to absorb and neutralize acidic loadings, aka buffering; influenced by the soils and bedrock of the watershed due to any calcium carbonates ($CaCO_3$) – **higher levels of Ca CO_3 indicate a more alkaline lake with a higher buffering capacity**	173	- -
Calcium	Related to the growth of phytoplankton due to its reactive nature with phosphorus	36	
Chloride	Small quantities are normal in lakes due to natural weathering of bedrock and soils, while large concentrations (from road salts and effluents from wastewater treatment plants or septic systems) have an unknown impact on the ecosystem; however, **can serve as an indicator of increases in other pollutants**	19	- -
Color (Platinum units or "units")	Affects water transparency or water clarity; influenced by dissolved and suspended materials in the water, phytoplankton population levels, and various physical factors	46	
Conductivity (MicroSiemens per centimeter – μS/cm)	The measure of how much resistance to electrical flow exists in the water, thereby indirectly estimating the amount of dissolved ions in the water; **increased conductivity measurements can signal a potential pollution problem**	500-600	- -
Hardness	Measure of multivalent metallic ion concentrations such as calcium and magnesium in a lake; lakes with higher hardness levels tend to produce more fish and aquatic plants	- -	- -
Magnesium	A fundamental building block of chlorophyll and a vital nutrient to all green plants	32	- -
pH (Standard Units – S.U.)	Measures the hydrogen ion concentration on a scale from 0 (alkaline) to 14 (acidic); it influences how much nutrients (e.g., phosphorus, nitrogen) can be utilized and **can affect the solubility and toxicity of heavy metals** (e.g., lead, copper, cadmium), all of this affects the organisms living in a lake	7-8.5	- -

Table A-1 continued

Parameter	Description	Regional Average[a]	Existing Standards
General Water Quality Parameters (continued)			
pH (Standard Units – S.U.)	Measures the hydrogen ion concentration on a scale from 0 (alkaline) to 14 (acidic); it influences how much nutrients (e.g., phosphorus, nitrogen) can be utilized and **can affect the solubility and toxicity of heavy metals** (e.g., lead, copper, cadmium), all of this affects the organisms living in a lake	7-8.5	- -
Potassium	Linked to the growth of cyanobacteria (blue-green algae), which can sometimes contain toxic byproducts	- -	- -
Silica	Significant role in the production of many algae forms in freshwater lakes, especially diatoms; insufficient levels can shift algal population dominance from beneficial species (i.e., diatoms) to less desirable species (i.e., blue-green algae)	- -	- -
Sodium	Linked to the growth of cyanobacteria (i.e., blue-green algae), which can sometimes contain toxic byproducts	- -	- -
Sulfate	A form of sulfur that is an important nutrient for many aquatic organisms occurs in rocks and fertilizers, affecting the lake's eutrophication process. In high concentrations, especially in highly industrialized areas, can have a deleterious effect on some aquatic plants	20-40	- -
Total Dissolved Solids	An estimation of the total amount of inorganic solids dissolved in water due to the predominant bedrock, topography, climate, and land use in the watershed	- -	- -
Total Nitrogen	Essential to plant growth; natural sources include precipitation, nitrogen fixation in lake water and sediments, groundwater input, and surface runoff; manmade sources include livestock waste, fertilizers, and human sewage	1.43	- -
Total Suspended Solids	The soils and sands found suspended or floating within a sample of water; related to turbidity	- -	- -
Turbidity (Nephelometric Turbidity Units – N.T.U.)	Affects water transparency or water clarity due to suspended particles in the water, usually from runoff, soil erosion, and the disturbance or re-suspension of lake bottom sediments	6.7	- -

[a]*All measurements in milligrams per liter (mg/l) unless otherwise noted.*

[b]*Wisconsin Department of Natural Resources Technical Bulletin No. 138,* Limnological Characteristics of Wisconsin Lakes, *Richard A. Lillie and John W. Mason,* 1983.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table A-2

WATER QUALITY VALUES FOR HOOKER LAKE: 2004 & 2001

Water Quality Parameters	Aug. 17, 2004	Aug. 28, 2001
Depth of Sample (feet)	0-6	0-6
N, NO2 + NO3 (mg/L)	- -	0.015
N, NH3 (mg/L)	0.074	0.014
N, Kjeldahl Total (mg/L).	1.12	0.89
P, Total (mg/L)	0.031	0.020
Ca (mg/L)	42.7	39.6
Mg (mg/L)	26.8	24.8
Alkalinity (mg/L)	169	165
Conductivity (UMHOS-25ºC)	560	571

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table A-3

WATER QUALITY VALUES FOR HOOKER LAKE: 1977-1978

Water Quality Parameters	July 14, 1977		November 3, 1977		February 2, 1978		April 13, 1978	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample (feet)	0	23	0	23	0	10	0	24
N, NO2 + NO3 (mg/L)	0.056	0.049	0.040	0.476	0.167	0.133	1.073	1.200
N, NH3 (mg/L)	0.170	2.100	0.100	<0.030	0.430	0.360	0.340	0.180
N, Organic (mg/L).	1.880	1.740	0.760	0.990	1.150	0.930	1.050	1.000
N, Total (mg/L)	2.100	3.900	0.910	1.470	1.750	1.420	2.460	2.380
P, PO4 (mg/L)	0.026	0.040	0.010	0.015	0.021	0.012	0.018	0.011
P, Total (mg/L)	0.040	0.090	0.060	0.070	0.050	0.020	0.040	0.060
Ca (mg/L)	35	45	34	38	45	43	45	45
Mg (mg/L)	34	32	32	31	36	36	36	35
Na (mg/L)	21	20	17	17	23	22	19	20
K (mg/L)	2.4	3.3	3.0	3.6	2.4	3.5	3.3	3.3
Fe (mg/L)	0.18	0.29	<0.06	0.11	<0.06	<0.06	0.08	0.14
Mn (mg/L)	<0.03	0.15	<0.03	0.04	4.14	0.15	<0.03	<0.03
Conductivity (UMHOS/CM-25oC)	464	519	459	470	547	522	422	336
SO4 (mg/L)	50	68	- -	- -	- -	- -	- -	- -
Cl (mg/L)	41	38	40	41	48	47	45	49
pH	8.0	7.3	8.2	8.0	7.9	7.8	8.0	8.0
Alkalinity (mg/L)	154	205	150	154	180	178	154	154
Turbidity (mg/L)	6.4	3.0	2.8	16.0	2.6	1.5	3.2	3.0

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table A-4

WATER QUALITY VALUES FOR HOOKER LAKE: 1960

Water Quality Parameters	March 19, 1960
pH	7.4
Alkalinity (mg/L)	187
Conductivity (UMHOS-25ºC)	498

Source: Wisconsin Conservation Department

Table A-5

WATER QUALITY VALUES FOR HOOKER LAKE: 1993

Water Quality Parameters[a]	April 22, 1993		June 21, 1993	July 13, 1993	August 23, 1993
	Shallow	Deep	Shallow	Shallow	Shallow
Depth of Sample (feet)	1.5	23	1.5	1.5	1.5
Chlorophyll a (µg/L)	36.4	- -	7.82	14.9	8.66
Ca (mg/L)	51	51	- -	- -	- -
Fe (µg/L)	<50	<50	- -	- -	- -
SO4 (mg/L)	32	32	- -	- -	- -
Cl (mg/L)	61	61	- -	- -	- -

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table A-6

WATER QUALITY VALUES FOR HOOKER LAKE: 1992

Water Quality Parameters[a]	February 4		April 2		June 9		July 27		August 17	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample (feet)	1.5	23	1.5	24	1.5	23	1.5	23	1.5	23
N, NO2 + NO3 (mg/L)	- -	- -	0.012	0.012	- -	- -	- -	- -	- -	- -
N, NH3 (mg/L)	- -	- -	0.020	0.020	- -	- -	- -	- -	- -	- -
N, Organic. (mg/L)	- -	- -	0.78	0.98	- -	- -	- -	- -	- -	- -
N, Total (mg/L)	- -	- -	0.8	1.0	- -	- -	- -	- -	- -	- -
P, PO4 (mg/L)	- -	- -	0.002	0.003	- -	- -	- -	- -	- -	- -
P, Total (mg/L)	- -	- -	0.037	0.027	0.020	0.023	0.026	0.060	0.022	0.184
Ca (mg/L)	- -	- -	50	52	- -	- -	- -	- -	- -	- -
Mg (mg/L)	- -	- -	33	34	- -	- -	- -	- -	- -	- -
Na (mg/L)	- -	- -	32	32	- -	- -	- -	- -	- -	- -
K (mg/L)	- -	- -	3.0	3.0	- -	- -	- -	- -	- -	- -
Fe (mg/L)	- -	- -	<0.05	<0.05	- -	- -	- -	- -	- -	- -
Mn (mg/L)	- -	- -	<0.04	<0.04	- -	- -	- -	- -	- -	- -
Conductivity (UMHOS/CM-25ºC)	590	675	636	637	642	675	630	738	647	788
SO4 (mg/L)	- -	- -	45	45	- -	- -	- -	- -	- -	- -
Cl (mg/L)	- -	- -	72	71	- -	- -	- -	- -	- -	- -
pH	8.6	7.8	8.6	8.6	8.7	7.5	8.4	7.1	8.5	7.0
Alkalinity (mg/L)	- -	- -	180	180	- -	- -	- -	- -	- -	- -
Turbidity (mg/L)	- -	- -	1.6	1.8	- -	- -	- -	- -	- -	- -
Water Temperature (°C)	4.0	3.5	5.5	5.5	21.5	13.0	24.0	13.5	22.5	14.5
Color	- -	- -	15	15	- -	- -	- -	- -	- -	- -
Hardness, CaCO3 (mg/L)	- -	- -	260	270	- -	- -	- -	- -	- -	- -
Fluoride, Dissolved (mg/L)	- -	- -	0.1	0.1	- -	- -	- -	- -	- -	- -
Silica, Dissolved (mg/L)	- -	- -	1.1	1.1	- -	- -	- -	- -	- -	- -
Solids, Dissolved (mg/L)	- -	- -	386	386	- -	- -	- -	- -	- -	- -
Chlorophyll-*a* (*µg/L*)	- -	- -	19	- -	9	- -	12	- -	12	- -

Source: U.S. Geological Survey and SEWRPC.

Table A-7

TOTAL SUSPENDED SOLIDS CONCENTRATIONS AT INFLOW SITES TO HOOKER LAKE: 2014

(mg/l)

Date	Site 1 (north)	Site 2 (northwest)	Site 3 (west)	Site 4 (southwest)	Site 5 (south)	Site 6 (S. Oaks)
11/23/2014	7	78	23	78	5	45
10/27/2014	2	2	3	19	20	2
9/4/2014	5	4	4	8	5	5
6/11/2014	12	11	5	8	19	6
5/13/2014[a]	12	10	5	5	15	5
4/27/2014	2	2	2	2	2	7

[a]Data collected after a 3-inch rainfall on the night prior.

Source: Wisconsin Department of Natural Resources.

Table A-8

TOTAL PHOSPHORUS AT INFLOW SITES TO HOOKER LAKE: 2014

(mg/l)

Date	Site 1 (north)	Site 2 (northwest)	Site 3 (west)	Site 4 (southwest)	Site 5 (south)	Site 6 (S. Oaks)
11/23/2014	0.101	0.422	0.259	0.070	0.045	0.476
10/27/2014	0.022	0.013	0.029	0.015	0.042	0.154
9/4/2014	0.075	0.088	0.073	0.058	0.039	0.150
6/11/2014	0.063	0.104	0.025	0.112	0.181	0.332
5/13/2014[a]	0.082	0.095	0.103	0.037	0.148	0.314
4/27/2014	0.014	0.016	0.019	0.026	0.018	0.026

[a]Data collected after a 3-inch rainfall on the night prior.

Source: Wisconsin Department of Natural Resources.

Table A-9

TOTAL NITROGEN AT INFLOW SITES TO HOOKER LAKE: 2014

(mg/l)

Date	Site 1 (north)	Site 2 (northwest)	Site 3 (west)	Site 4 (southwest)	Site 5 (south)	Site 6 (S. Oaks)
11/23/2014	0.50	1.87	1.29	0.92	1.42	0.28
10/27/2014	0.10	6.30	2.40	0.50	0.20	0.10
9/4/2014	0.10	1.50	2.80	0.70	0.10	0.90
6/11/2014	8.60	17.60	3.00	3.10	0.80	0.50
5/13/2014[a]	6.50	12.30	6.10	3.00	0.70	1.00
4/27/2014	0.10	4.40	1.60	0.10	8.20	1.20

[a]Data collected after a 3-inch rainfall on the night prior.

Source: Wisconsin Department of Natural Resources.

Table A-10

TOTAL CHLORIDES AT INFLOW SITES TO HOOKER LAKE: 2014

(mg/l)

Date	Site 1 (north)	Site 2 (northwest)	Site 3 (west)	Site 4 (southwest)	Site 5 (south)	Site 6 (S. Oaks)
11/23/2014	337.0	166.0	321.0	255.0	115.0	389.0
10/27/2014	298.0	150.0	301.0	180.0	84.3	726.0
9/4/2014	156.0	76.8	144.0	175.0	77.2	329.0
6/11/2014	91.6	61.9	168.0	163.0	41.8	95.1
5/13/2014[a]	173.0	89.0	191.0	217.0	51.1	150.0
4/27/2014	448.0	654.0	304.0	97.3	309.0	473.0

[a]Data collected after a 3-inch rainfall on the night prior.

Source: Wisconsin Department of Natural Resources.

Appendix B

RIPARIAN BUFFER GUIDE
"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.

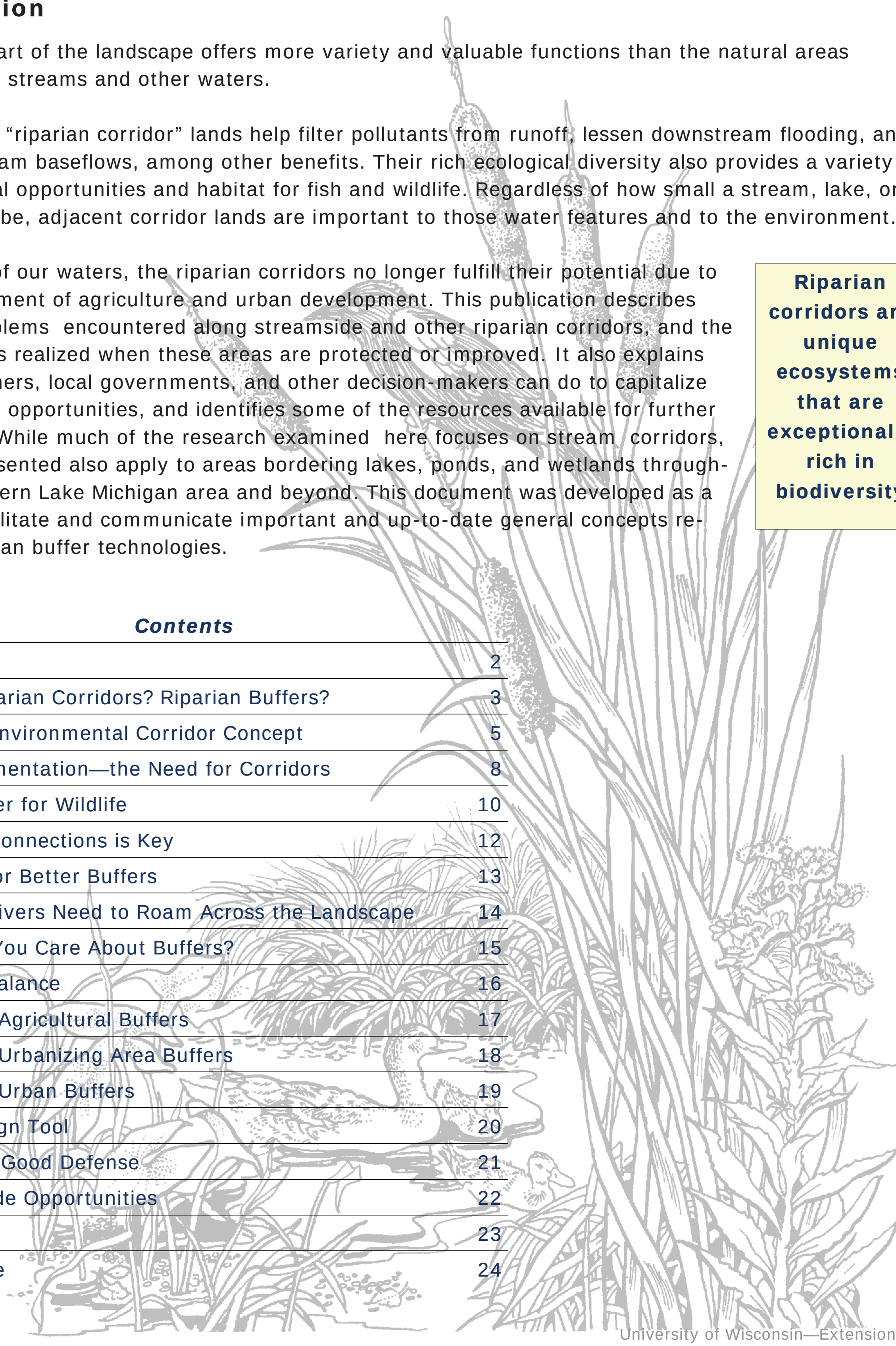
Introduction

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.

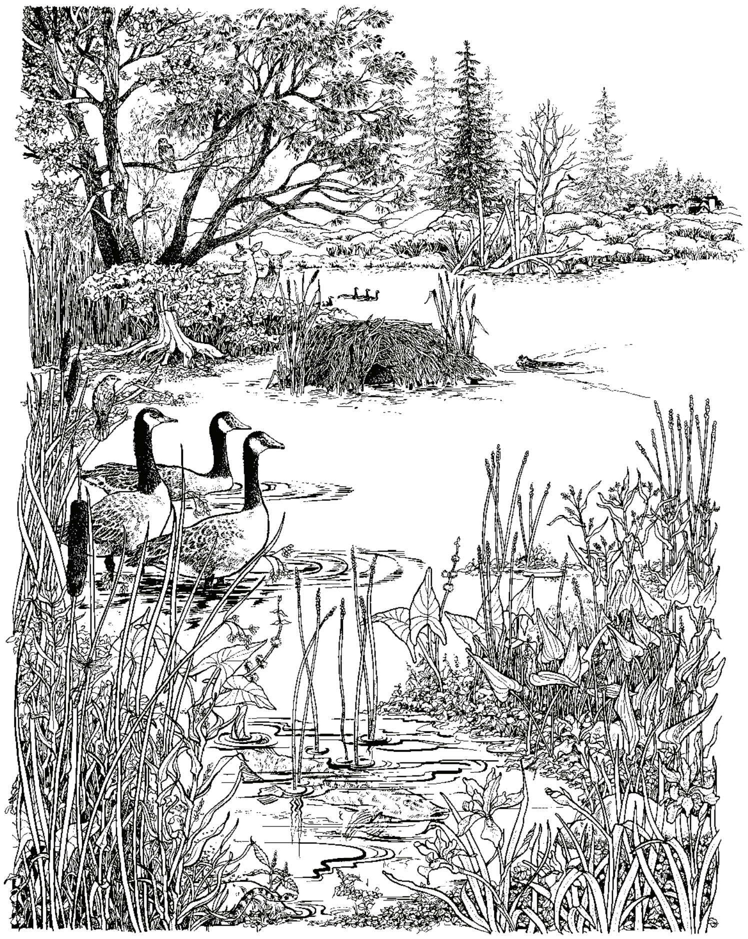
Riparian corridors are unique ecosystems that are exceptionally rich in biodiversity



Contents

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.

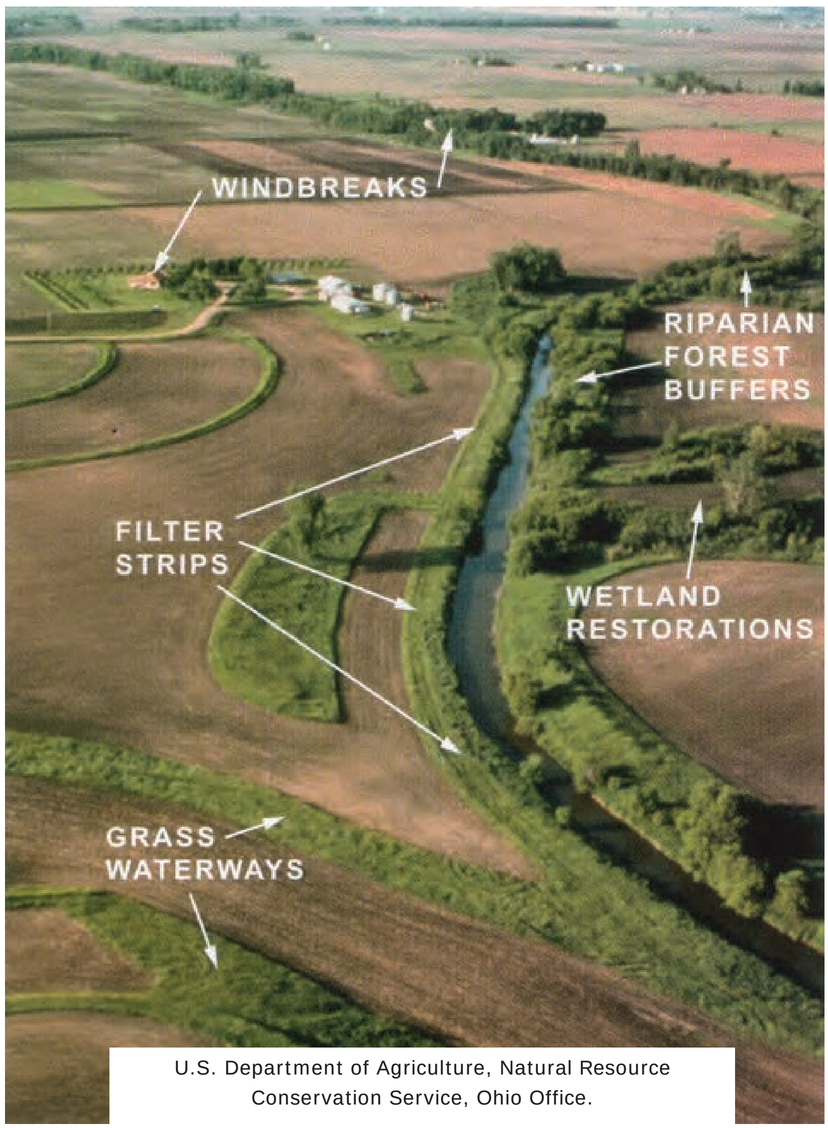
Riparian buffers are zones adjacent to waterbodies such as lakes, rivers, and wetlands that simultaneously protect water quality and wildlife, including both aquatic and terrestrial habitat. These zones minimize the impacts of human activities on the landscape and contribute to recreation, aesthetics, 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

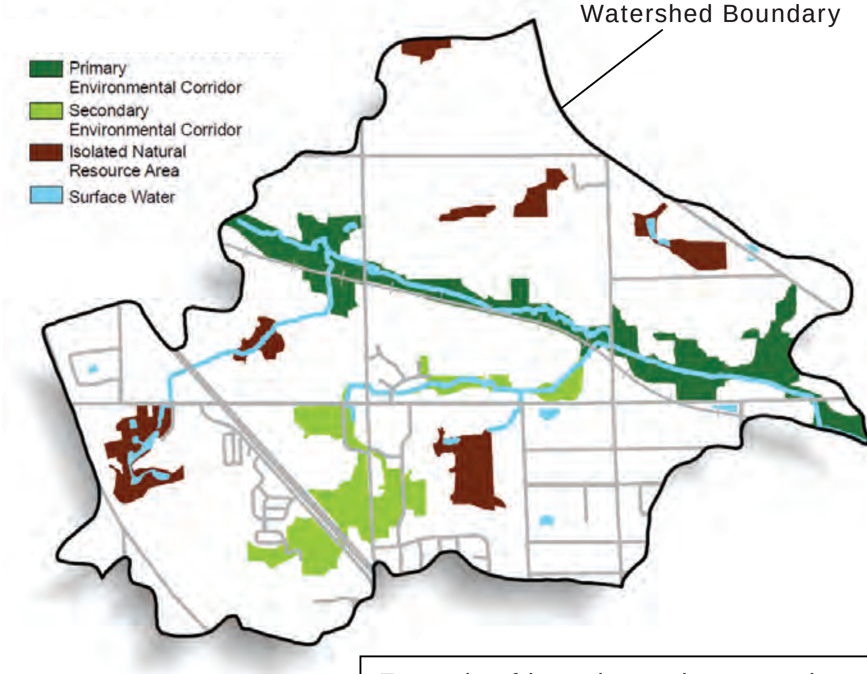
Environmental corridors are divided into the following three categories.

- **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

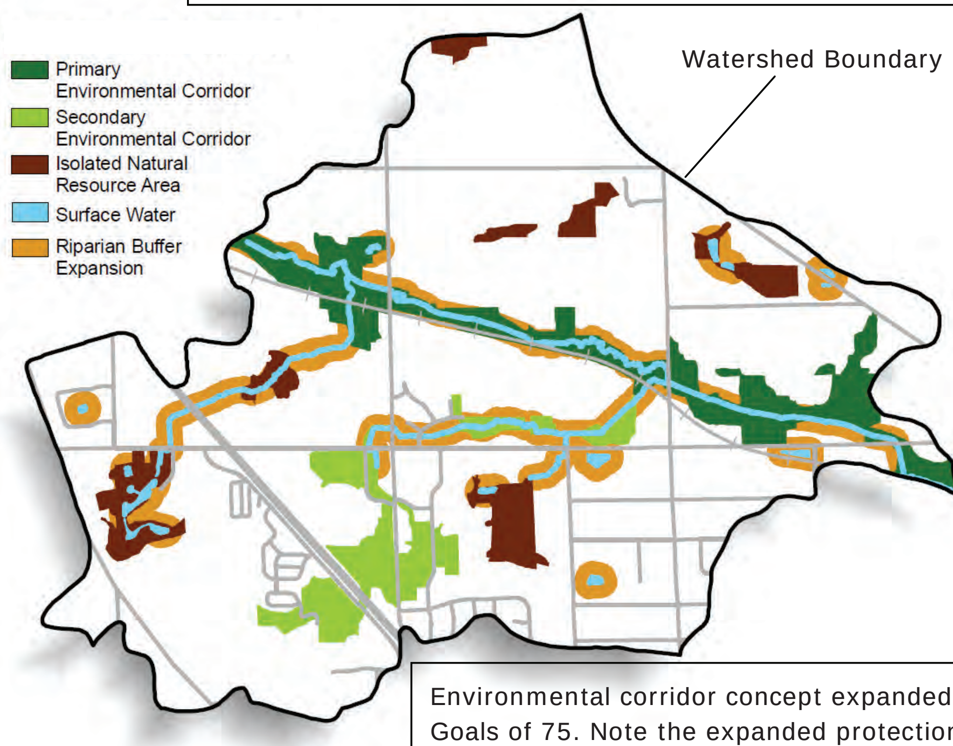


The Minimum Goals of **75** within a Watershed

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.

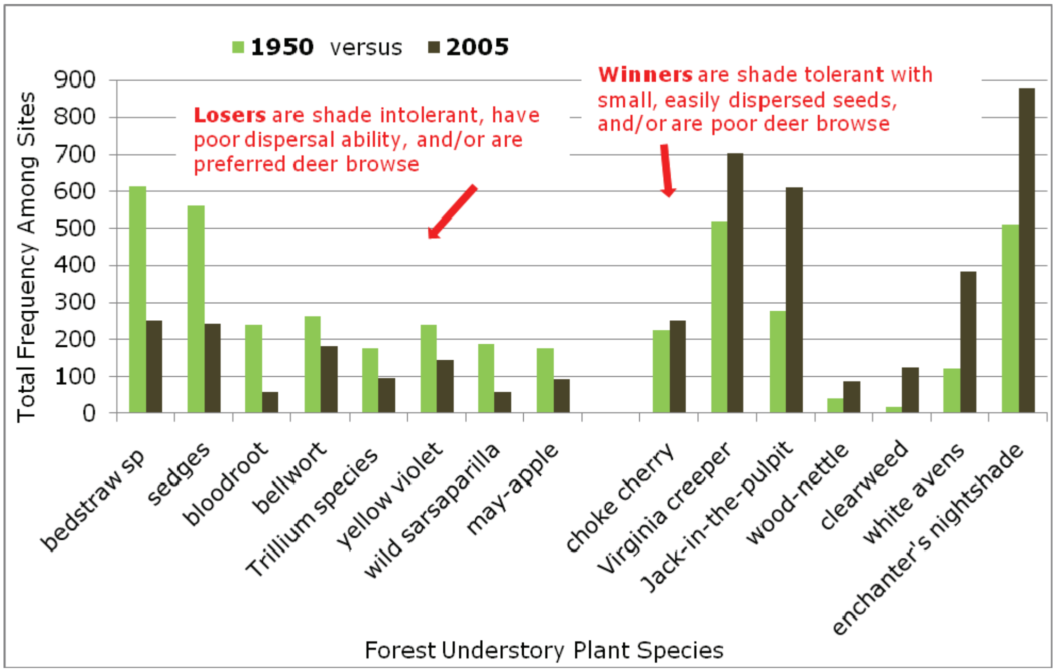
At the time of conversion of agricultural lands to urban uses, there are opportunities to re-create and expand riparian buffers and environmental corridors reconnecting uplands and waterways and restoring ecological integrity and scenic beauty locally and regionally. For example, placement of roads and 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



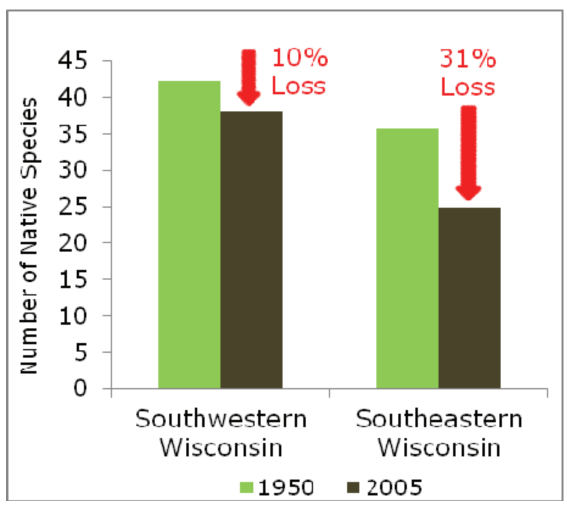
Forest fragmentation has led to significant plant species loss within Southern Wisconsin

(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

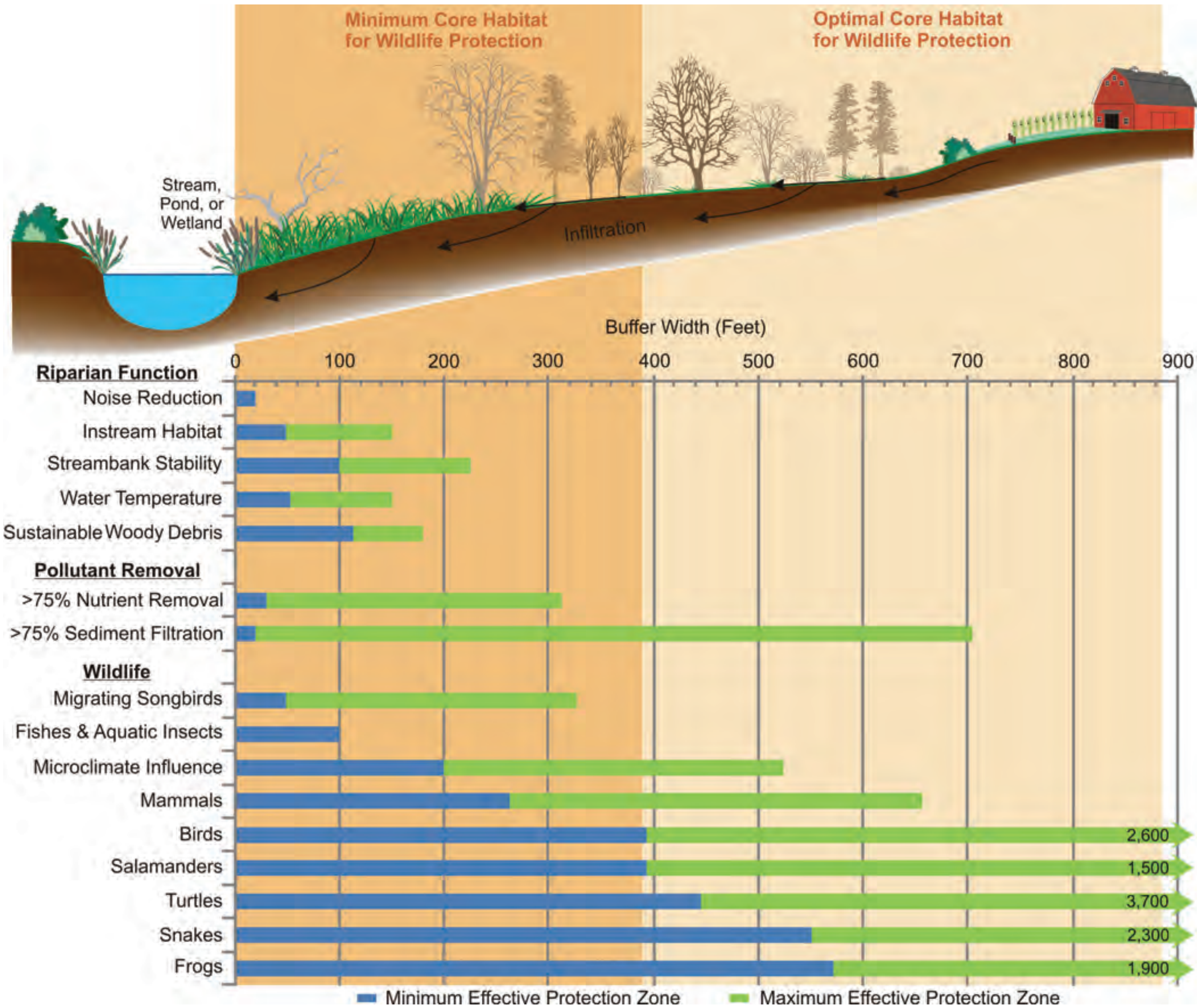
Since the 1950s, forests have increasingly become more fragmented by land development, both agricultural and urban, and associated roads and infrastructure, which have caused these forests to become isolated "islands of green" on the landscape. In particular, there has been significant loss of forest 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.

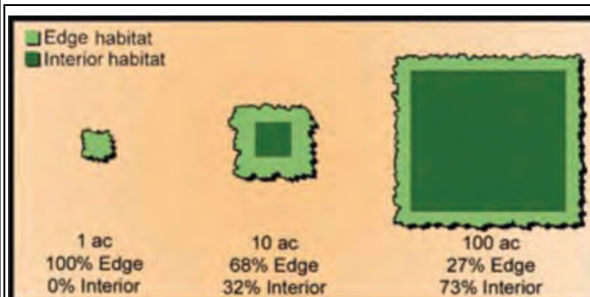
Wider is Better for Wildlife

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.*

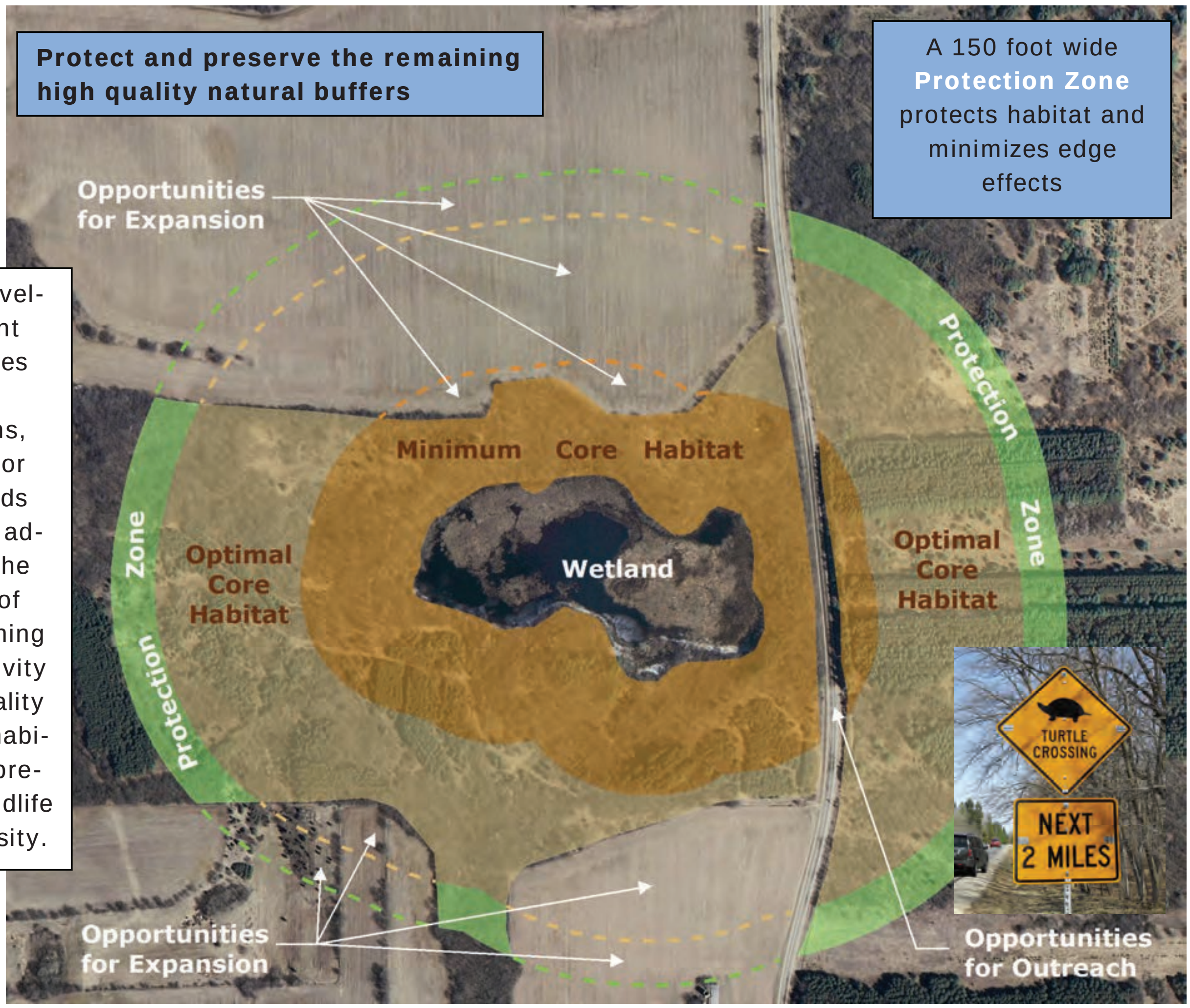


"***Large patches typically conserve a greater variety and quality of habitats, resulting in higher species diversity and abundance."*** *Larger patches contain greater amounts of interior habitat and less edge effects, which benefits interior species, by providing safety from parasitism, disease, and invasive species.*

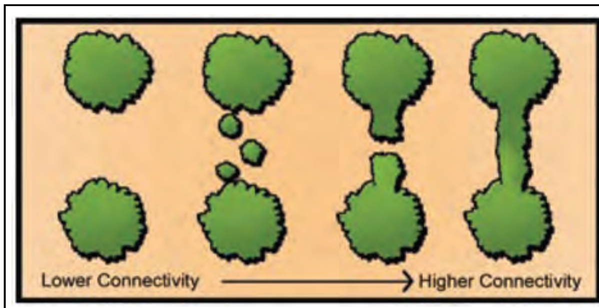
(Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station)

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.

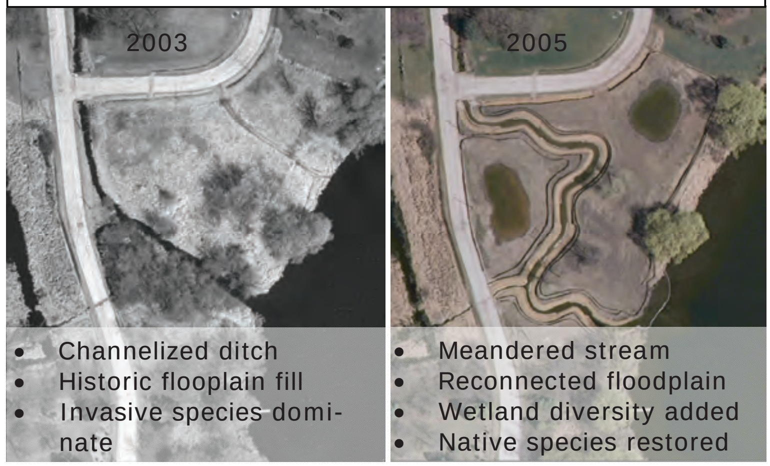


Increasing connectivity among quality natural landscapes (wetlands, woodlands, prairies) can benefit biodiversity by providing access to other areas of habitat, increasing gene flow and population viability, enabling recolonization of patches, and providing habitat (Bentrup 2008).

Basic Rules to Better Buffers

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.

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

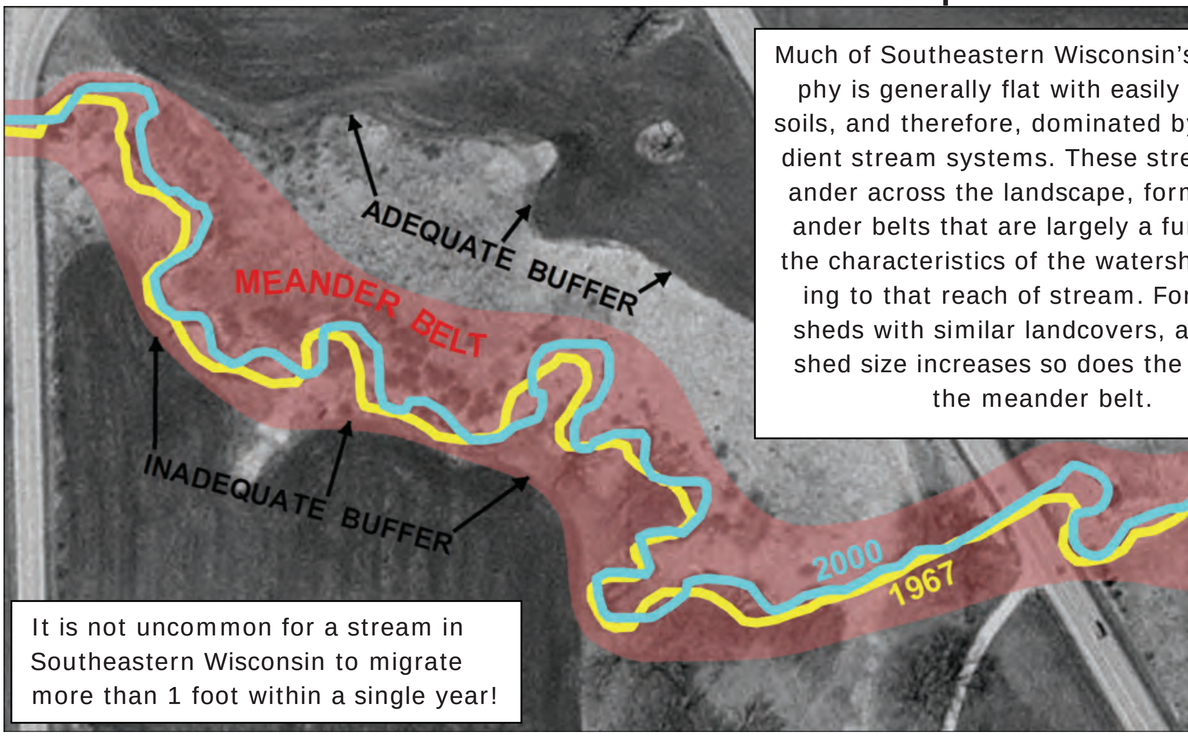


How wide should the buffer be? Unfortunately, there is no one-size-fits all buffer width adequate to protect water quality, wildlife habitat, and human needs. Therefore, the answer to this question depends upon the predetermined needs of the landowner and community objectives or goals.
As riparian corridors 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.

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:

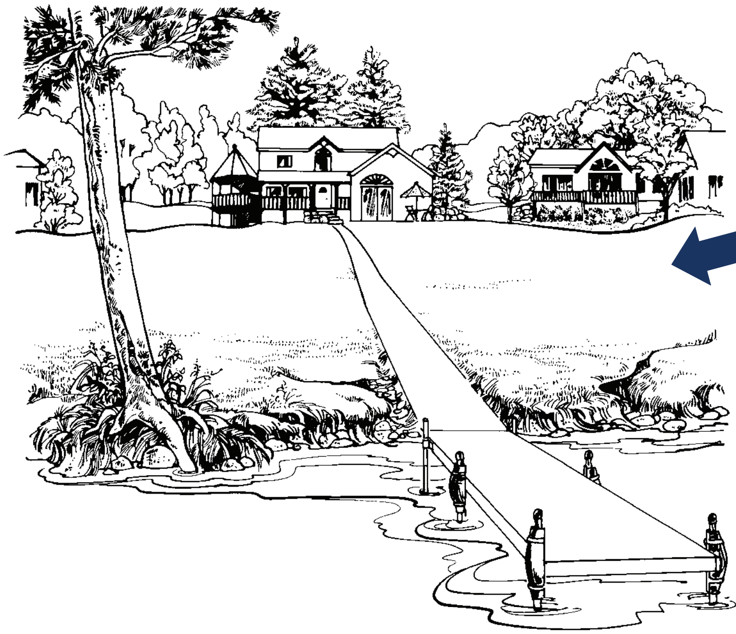
- Increased quality of the canoeing/kayaking experience
- Improved fishing and hunting quality by improving habitat
- Improved bird watching/wildlife viewing quality and opportunities
- Increased potential for expansion of trails for hiking and bicycling
- Opportunities made available for youth and others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



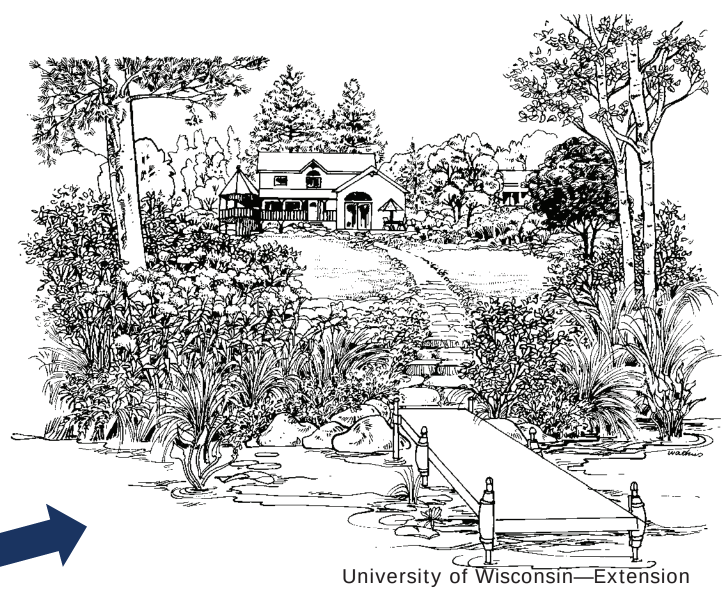
University of Wisconsin—Extension

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

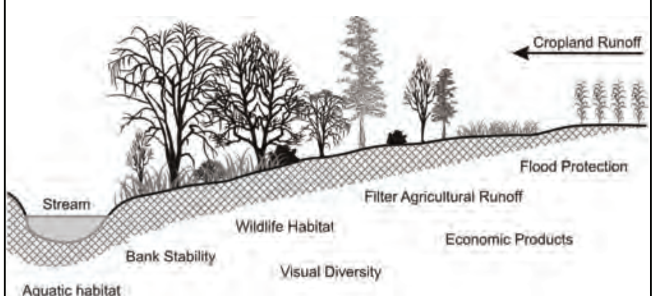
Agricultural nonpoint source pollution runoff continues to pose a threat to water quality and aquatic ecosystems within Wisconsin and elsewhere. In an effort to address this problem, the Wisconsin Buffer Initiative was formed with the goal of designing a buffer implementation program to achieve science-based, 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.



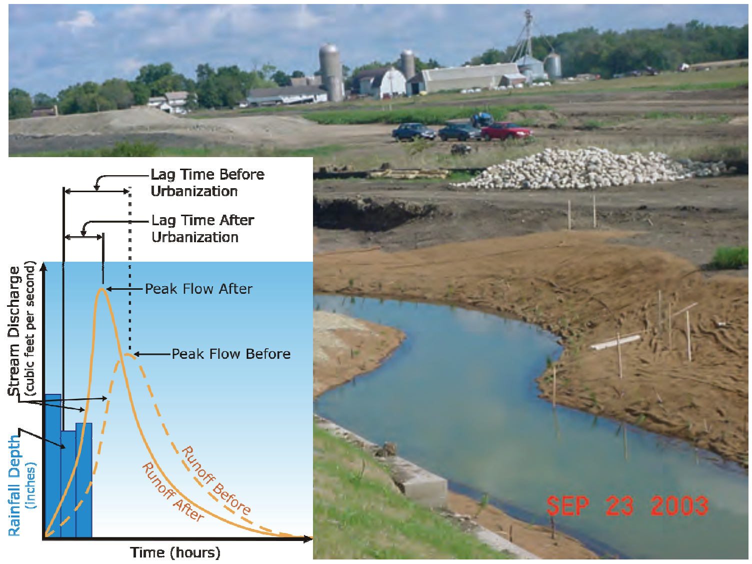
The USDA in *Agroforestry Notes* (AF Note-4, January 1997) outlines a four step process for designing riparian buffers for Agricultural lands:

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.



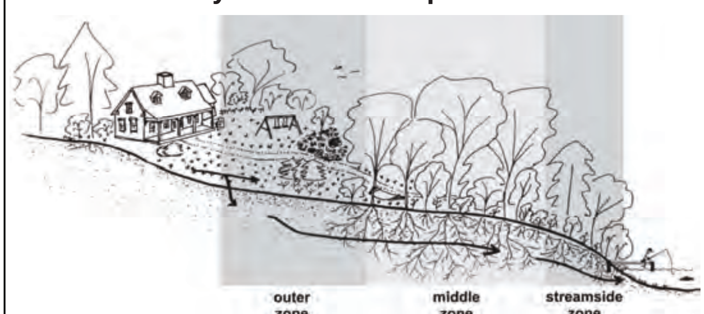
Comparison of hydrographs before and after urbanization. Note the rapid runoff and greater peak streamflow tied to watershed development. (Adapted from Federal Interagency Stream Restoration Working Group (FISRWG), Stream Corridor Restoration: Principles, Processes, and Practices, October 1998)

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.

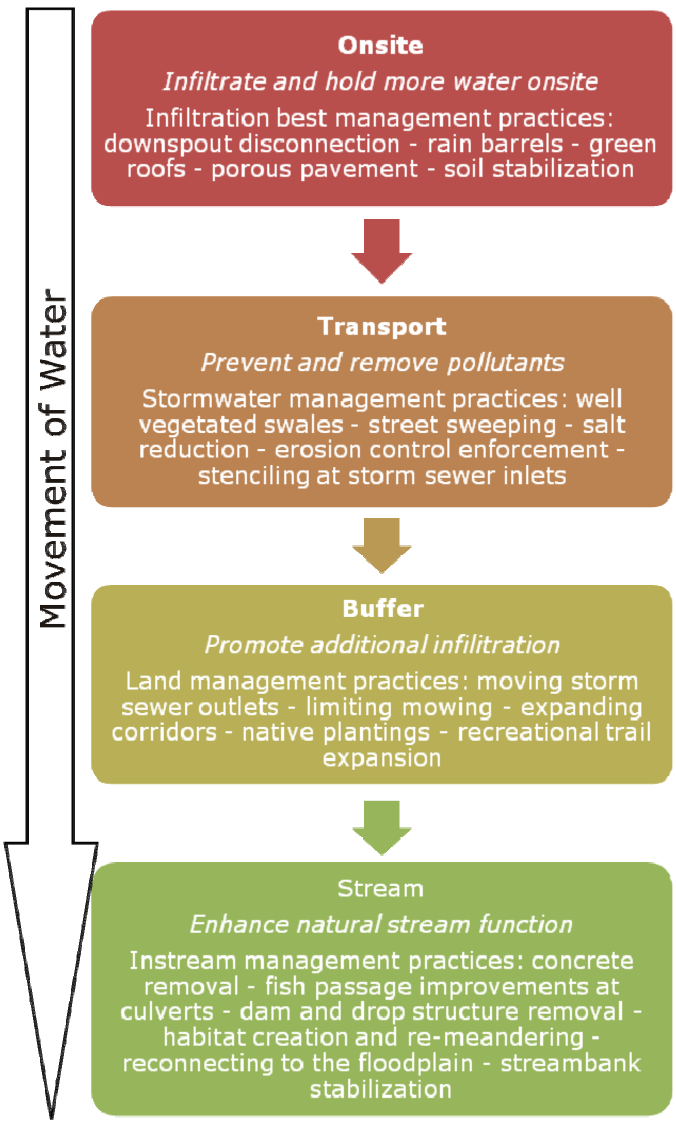
Middle Zone-Area from top of bank to edge of lawn that is composed of natural vegetation that provides wildlife habitat as well as improved filtration and infiltration of pollutants.

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.

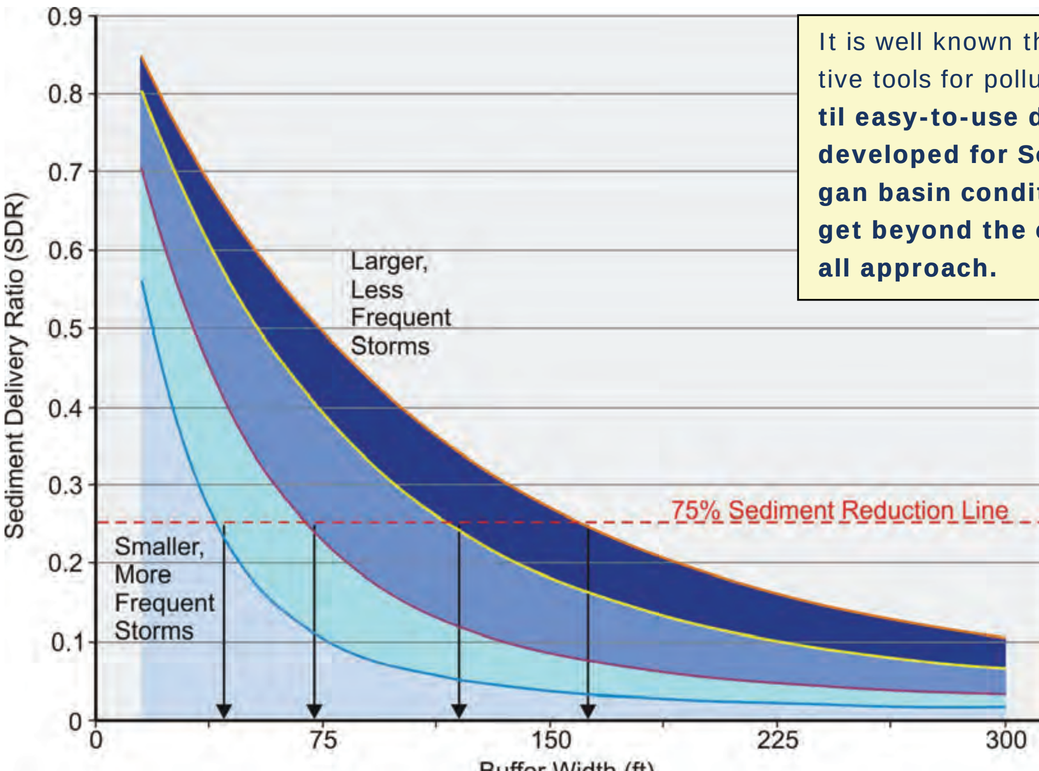
A Buffer Design Tool

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

> ***"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)*

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.

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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W239 N1812 Rockwood Drive, Waukesha, WI, 53187-1607
262-547-6721.

Staff Acknowledgements:

Principal Author: Tom Slawski, PhD, Principal Planner

Michael Hahn, P.E., P.H., Chief Environmental Engineer
Laura Kletti, P.E., Principal Engineer
Gary Korb, Regional Planning Educator, UW-Extension/SEWRPC
Ed Schmidt, GIS Planning Specialist
Mike Scott, GIS Application Specialist
Sara Teske, Research Analyst
Jeff Thornton, PhD, Principal Planner

www.sewrpc.org

May 7, 2010

Appendix C

AERIAL PHOTOS OF HOOKER LAKE 1937-2015

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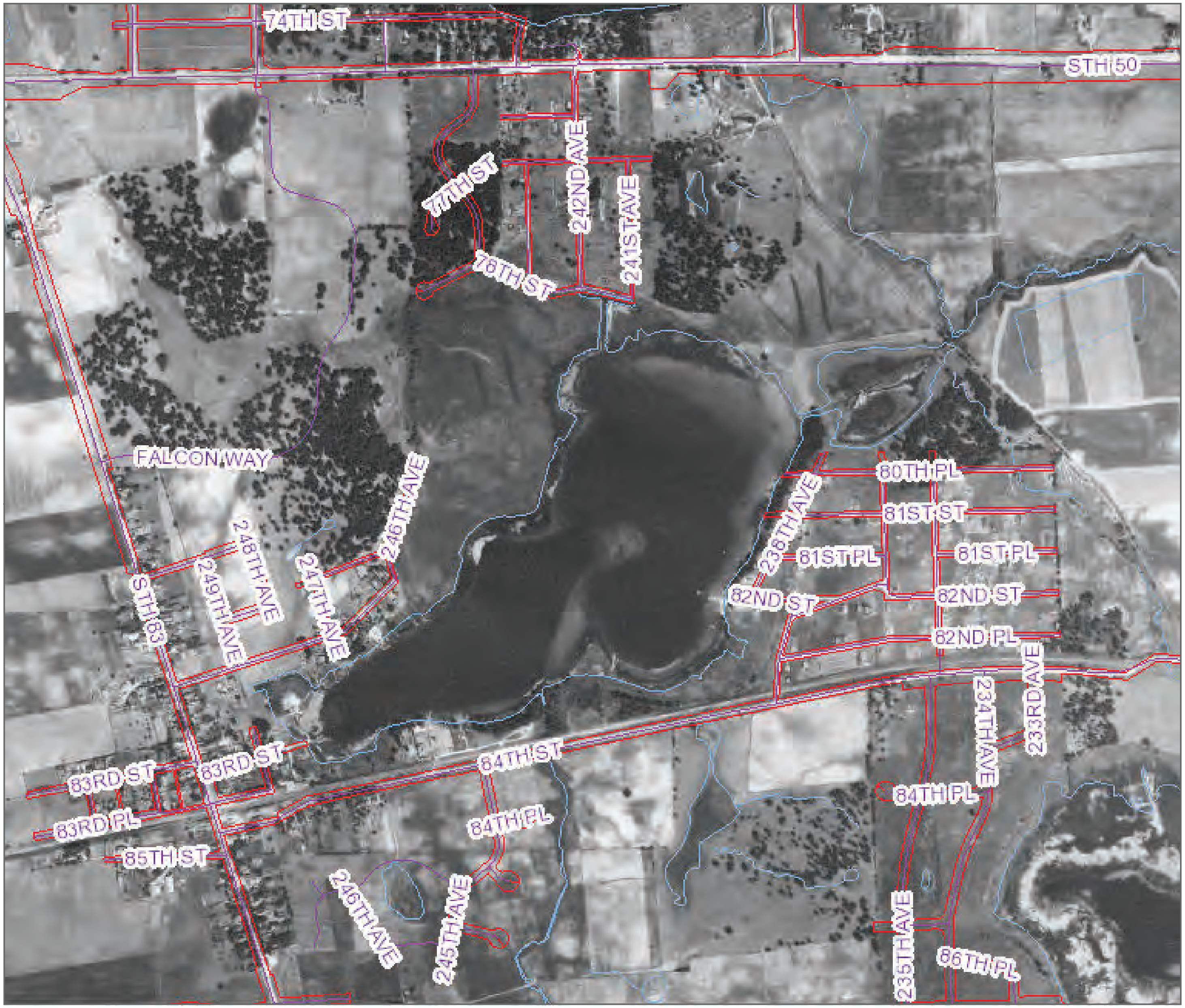
1937



KENOSHA COUNTY INTERACTIVE MAPPING

Legend

Water Features

N

S

1 inch = 1,000 feet

Date Printed: 3/31/2016

1963

KENOSHA COUNTY
INTERACTIVE MAPPING

Legend

Water Features

N
S

1 inch = 1,000 feet

Date Printed: 3/31/2016

1970

KENOSHA COUNTY INTERACTIVE MAPPING

Legend

Water Features

N
S

1 inch = 1,000 feet

Date Printed: 3/31/2016

1980

KENOSHA COUNTY INTERACTIVE MAPPING

Legend

Water Features

N

S

1 inch = 1,000 feet

DISCLAIMER This map is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, data and information located in various state, county and municipal offices and other sources affecting the area shown and is to be used for reference purposes only. Kenosha County is not responsible for any inaccuracies herein contained. If discrepancies are found, please contact Kenosha County.

Date Printed: 3/31/2016

1990

KENOSHA COUNTY INTERACTIVE MAPPING

Legend

Water Features

N
S

1 inch = 1,000 feet

Date Printed: 3/31/2016

2000

KENOSHA COUNTY
INTERACTIVE MAPPING

Legend

Water Features

N
S

1 inch = 1,000 feet

Date Printed: 3/31/2016

2010

KENOSHA COUNTY INTERACTIVE MAPPING

Legend

Water Features

N

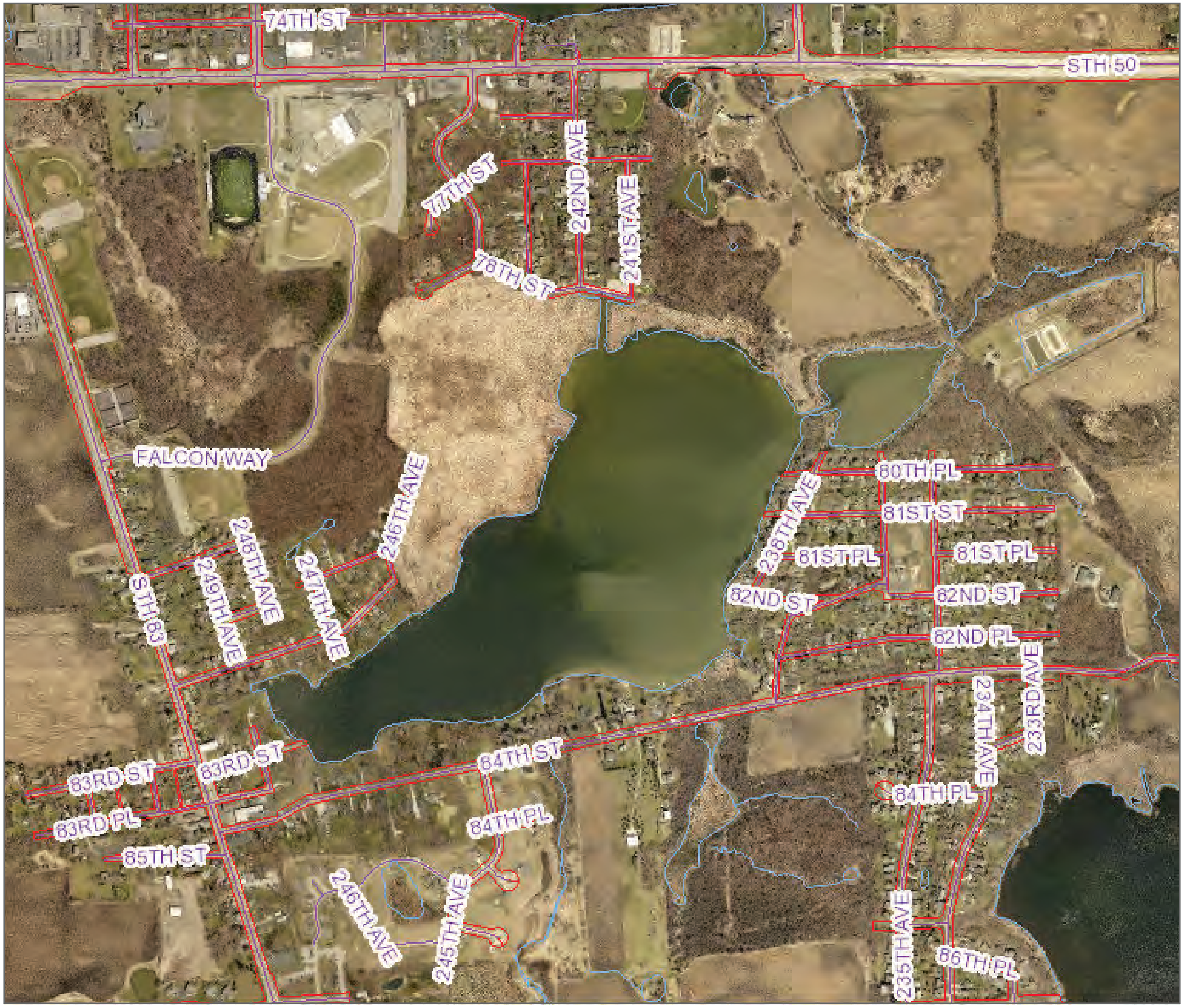
S

1 inch = 1,000 feet

<u>DISCLAIMER</u> This map is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, data and information located in various state, county and municipal offices and other sources affecting the area shown and is to be used for reference purposes only. Kenosha County is not responsible for any inaccuracies herein contained. If discrepancies are found, please contact Kenosha County.

Date Printed: 3/31/2016

2015



KENOSHA COUNTY INTERACTIVE MAPPING

Legend

Water Features

N
S

1 inch = 1,000 feet

Date Printed: 3/31/2016