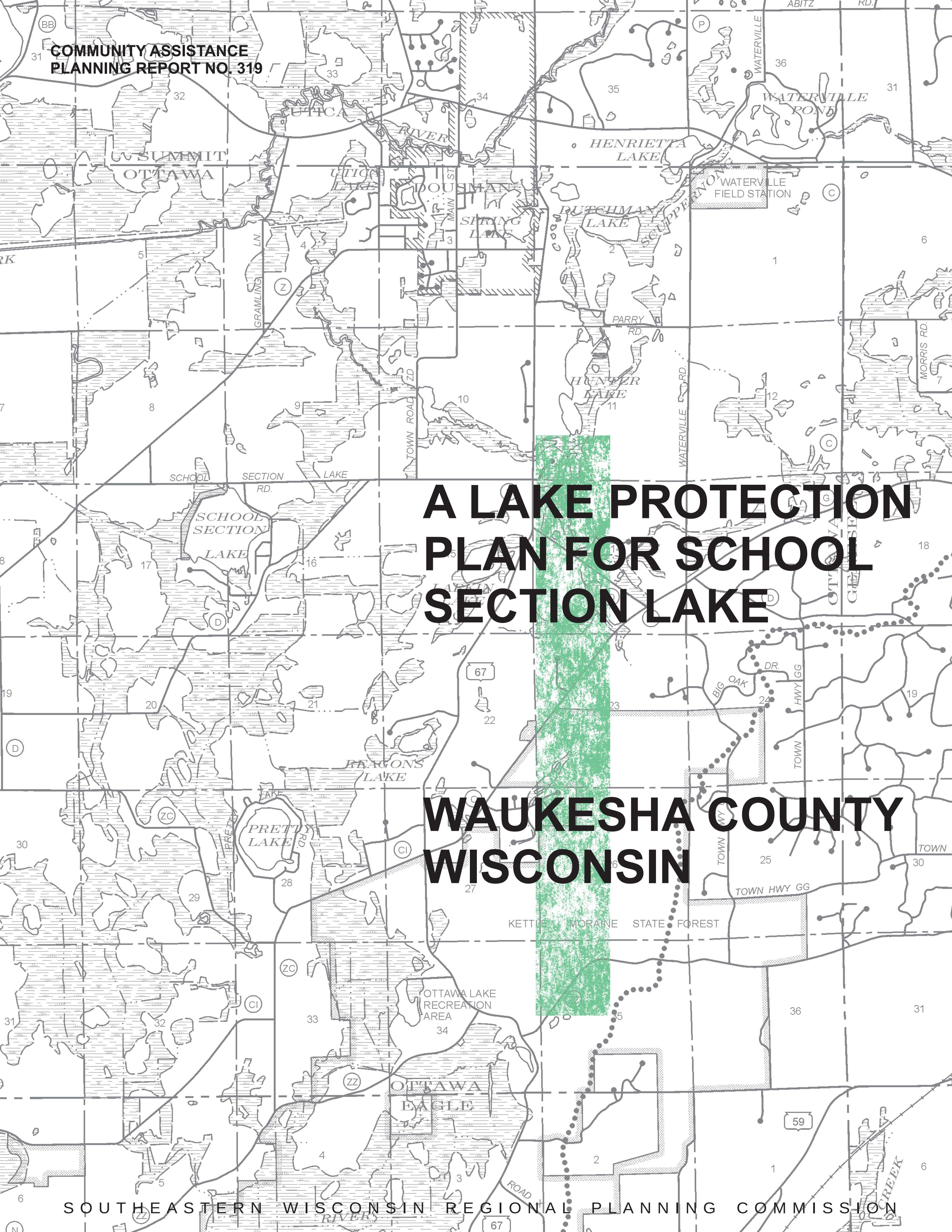
COMMUNITY ASSISTANCE
PLANNING REPORT NO. 319

A LAKE PROTECTION PLAN FOR SCHOOL SECTION LAKE

WAUKESHA COUNTY WISCONSIN



SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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NUMBER 319

A LAKE PROTECTION PLAN FOR SCHOOL SECTION LAKE

WAUKESHA COUNTY, WISCONSIN

Prepared by the

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INTRODUCTION

PURPOSE OF THE PLAN

Research shows that the health of a lake or stream is usually a direct reflection of the use and management of the land within its watershed. In fact, interventions are often necessary to maintain or improve the conditions of these resources. Located within U.S. Public Land Survey Sections 16 and 17, Township 6 North, Range 17 East, in the Town of Ottawa, Waukesha County, School Section Lake, together with its tributaries and associated wetlands, is a high-quality natural resource. The purpose of this plan is to provide a framework to protect and improve the land and water resources of School Section Lake and its watershed.

This lake protection plan focuses on what can be done to continue to *protect* this existing high-quality resource from human impacts and *prevent* future water pollution or resource degradation from occurring. This plan complements other existing programs and ongoing management actions in the School Section Lake watershed and represents the continuing commitments of government agencies, municipalities, and citizens to diligent land use planning and natural resource protection. This plan presents recommendations for appropriate and feasible watershed management measures for enhancing and preserving the water quality of School Section Lake, and for providing the public with opportunities for safe and enjoyable recreation within the Lake's watershed.

This plan is further designed to assist State and local units of government, nongovernmental organizations, businesses, and citizens in developing strategies that will benefit the natural assets of School Section Lake and protect sensitive habitats within the watershed. By using the strategies outlined in this plan, results will be achieved that enrich and preserve the natural environment. In general, this plan should serve as a practical guide for the management of water quality within the School Section Lake watershed and for the management of the land surfaces that drain directly and indirectly to the streams and lakes within the watershed.

COMMUNITY EFFORT

The Lake has a long history of efforts by the residents of the School Section Lake community to protect and improve the Lake water quality, including the formation of the School Section Lake Management District (SSLMD) as a vehicle for collecting, coordinating, and disseminating information on the Lake and its watershed; completing a dredging project in 1994 meant to improve water quality, recreational use, and wildlife habitat; completing several aquatic plant management plans; and working with Waukesha County in the upkeep of the impoundment that forms the Lake.

This report represents part of the ongoing commitment of the SSLMD to sound planning with respect to the Lake. This planning program was designed as part of an ongoing program of lake-related information gathering, evaluation and management being undertaken by the SSLMD, in cooperation with other governmental and nongovernmental organizations and agencies, including the Wisconsin Department of Natural Resources (WDNR), Waukesha County, the Town of Ottawa, and the Southeastern Wisconsin Regional Planning Commission (SEWRPC). To this end, the SSLMD maintains an ongoing program of lake management, focusing on aquatic plant management, the control of nonnative aquatic species, water quality improvement, and citizen informational programming.

LAKE PROTECTION PROGRAM GOALS AND OBJECTIVES

General lake protection goals and objectives for School Section Lake were developed in consultation with the School Section Lake Management District (SSLMD) Board of Commissioners. These goals and objectives are to:

1. Protect and maintain public health; promote public comfort, convenience, necessity, and welfare, in concert with the natural resource, through the environmentally sound management, protection, and improvement of native vegetation, fishes, and wildlife populations; and of the land, surface water, and groundwater resources in and around School Section Lake;

2. Effectively control the quantity and density of aquatic plant growths in portions of the lake basin to better facilitate the conduct of water-related recreation, improve the aesthetic value of the resource to the community, and enhance the natural resource value of the waterbody;

3. Effectively improve and maintain the water quality of School Section Lake to better facilitate the conduct of water-related recreation, improve the aesthetic value of the resource to the community, and enhance the resource value of the waterbody by controlling both nonpoint agricultural and urban runoff pollution; and

4. Promote a high-quality, water-based experience for residents and visitors to School Section Lake consistent with the policies and objectives of the WDNR as set forth in the regional water quality management plan.[1]

Specifically, this report sets forth various inventories of biota and abiotic factors currently and historically present within School Section Lake. The overall goal of this report is to produce a lake protection plan for School Section Lake designed to accomplish the following objectives:

1. To describe existing conditions in the School Section Lake watershed, including identification and quantification of potential point and nonpoint sources of pollution, nutrient and contaminant inputs, and nutrient and contaminant balances;

2. To document the aquatic plant community and fishery of School Section Lake, with emphasis on the occurrence and distribution of nonnative species;

3. To identify the extent of any existing and potential future water quality problems likely to be experienced in the Lake, including an assessment of the Lake's water quality using monitoring data being collected as part of ongoing programs and estimates of changes in these conditions in the future; and

4. To formulate appropriate lake protection programs, including public information and education strategies, and other possible actions necessary to address the identified problems and issues of concern.

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[1]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin—2000, *June 1979, as amended; see also SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995.*

This planning program was funded, in part, through a Chapter NR 190 Lake Management Planning Grant awarded to the SSLMD and administered by the WDNR. The inventory and aquatic plant management plan elements presented in this report conform to the requirements and standards set forth in the relevant *Wisconsin Administrative Codes.*[2] Implementation of the recommended actions set forth herein should continue to serve as an important step in achieving the stated lake use objectives over time.

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[2]*This plan has been prepared pursuant to the standards and requirements set forth in the following chapters of the* Wisconsin Administrative Code*: Chapter NR 1, "Public Access Policy for Waterways;" Chapter NR 40, "Invasive Species Identification, Classification and Control;" Chapter NR 103, "Water Quality Standards for Wetlands;" Chapter NR 107, "Aquatic Plant Management;" and Chapter NR 109, "Aquatic Plants Introduction, Manual Removal and Mechanical Control Regulations."*

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Chapter II

ISSUES OF CONCERN

INTRODUCTION

This chapter provides a brief background of School Section Lake as well as a detailed description of the issues and concerns addressed in this report. This chapter should be used to better understand the many facets that affect the both the "health" and recreational use of School Section Lake, as well as to better understand the recommendations made in Chapters III and IV of this report.

BACKGROUND

It is impossible to form a feasible and effective lake protection plan without first understanding the geographical, historical, and social realities that influence the Lake. Appendix A of this report details all of the information about School Section Lake that could be collected, including information about the conditions in the Lake itself as well as the watershed that drains to it, and explains the meaning and importance of this information. This section briefly summarizes the most pertinent information from Appendix A so that the issues and concerns, as well as the recommendations given in this report, can be fully understood. If there is interest in learning about any particular topic in more detail, further information can be found in Appendix A.

Lake Characteristics

School Section Lake is a full recreational use lake with a surrounding residential community. It is situated within easy reach of the greater Milwaukee metropolitan area (see Map 1). The Lake has a single basin, surrounded by marsh and wetlands, with a length of about 0.6 mile, a width of about 0.5 mile, and a shoreline length of about 2.0 miles. Additionally, the Lake levels are maintained by a four-foot head dike, built in 1938[1] and located on the outlet, resulting in the Lake having a surface area of about 122 acres (island surface area excluded), a volume of about 460 acre-feet, a maximum depth of 15.5 feet, and a mean depth of about four feet.[2] About 34 percent of the Lake is less than three feet deep.

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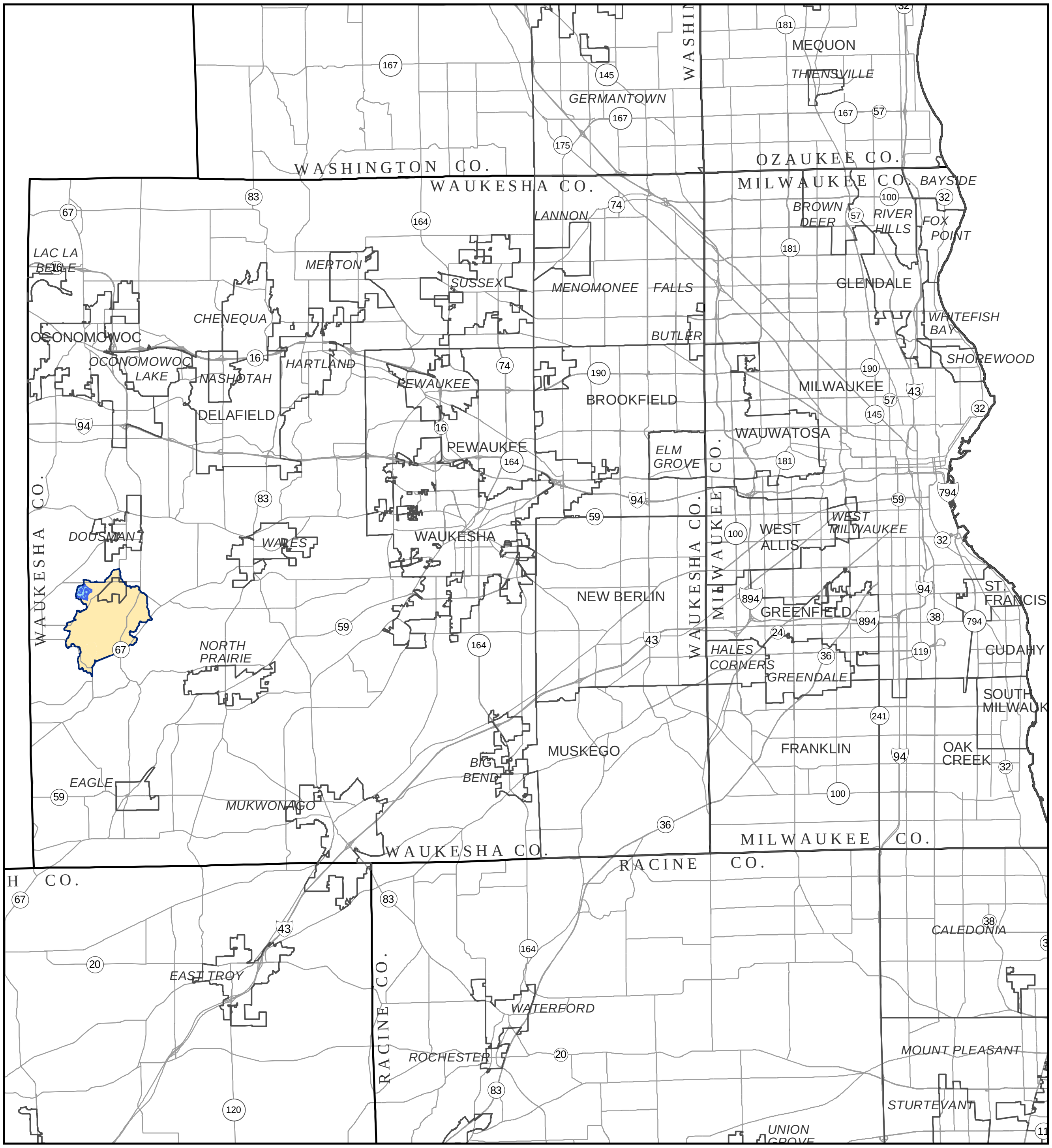
[1]*Wisconsin Department of Natural Resources,* School Section Lake, Waukesha County, Feasibility Study Results: Management Alternatives*, 1981.*

[2]*Marine Biochemists,* School Section Lake Hydro Acoustic Survey Results*, 2005.*

Map 1

LOCATION OF THE SCHOOL SECTION LAKE WATERSHED WITHIN THE REGION



SCHOOL SECTION LAKE

SCHOOL SECTION LAKE WATERSHED

N

0 0.5 1 Miles

0 2,500 5,000 Feet

Source: SEWRPC.

A hydrological budget was prepared for the Lake in 1981 which states that about 88 percent (4700 acre-feet per year) of the Lake's water supply comes from surface water sources, 6 percent (300 acre-feet per year) from groundwater sources within the Lake, and the last 6 percent from precipitation directly onto the surface of the Lake.[3] Consequently, the Wisconsin Department of Natural Resources (WDNR) has classified the Lake as a drained lake, meaning that the Lake has a defined outflow and the inflow is dependent on groundwater and surface water that drains to the Lake (i.e., its watershed). It should be noted, however, that the same report states that water being contributed to the Lake by its inlet likely comes from upstream groundwater springs located within the watershed, indicating that groundwater levels are crucial to the maintenance of the Lake levels.

A dredging project (Map 2) was undertaken in School Section Lake in 1994 that increased the maximum depth of the Lake from eight feet to about 20 feet (which filled to 15.5 feet by 2005) and greatly altered the bathymetry of the Lake (see Figure 1).[4] With these changes the Lake now stratifies[5] and has a residence time of about 52 days.[6] Additionally, the lake has been used both for high- and low-speed boating activities since the dredging activities, with a launch at the north end of the Lake being provided for public use.

In general, the water quality of the Lake is considered "poor," with the Lake being classified as eutrophic or nutrient rich.[7] Though a lake with an extensive marsh system, such as School Section Lake, may be expected to be eutrophic, the Lake's classification is likely influenced by the above-WDNR-standards, mean phosphorus concentration of 0.036 mg/l, which appears to have been greatly influenced by construction activities that occurred in the watershed between 2006 and 2009.[8] In fact, these phosphorus concentrations have resulted in the Lake being included on the Wisconsin Impaired Waters list. Additionally, the "poor" water quality can also be attributed to the high chlorophyll-*a* concentrations within the Lake, the average of which exceeds the level of impairment listed for recreational activities.[9] Despite these issues, the Lake does, however, have healthy dissolved

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[3]*Wisconsin Department of Natural Resources, Feasibility Study Results, 1981,* op. cit.

[4]*Marine Biochemists, 2005,* op. cit.

[5]*Stratification refers to lake waters forming temperature differences between deep and shallow waters which, in turn, act as a physical barrier to mixing (due to density differences). This phenomenon can cause dissolved oxygen to become depleted in deep waters. Further details about this process can be found in Appendix A in the Thermal Stratification subsection.*

[6]*Residence time, also known as* retention time *or* flushing rate, *refers to the average length of time that water remains in a lake. Further details about this process can be found in Appendix A in the Residence Time subsection.*

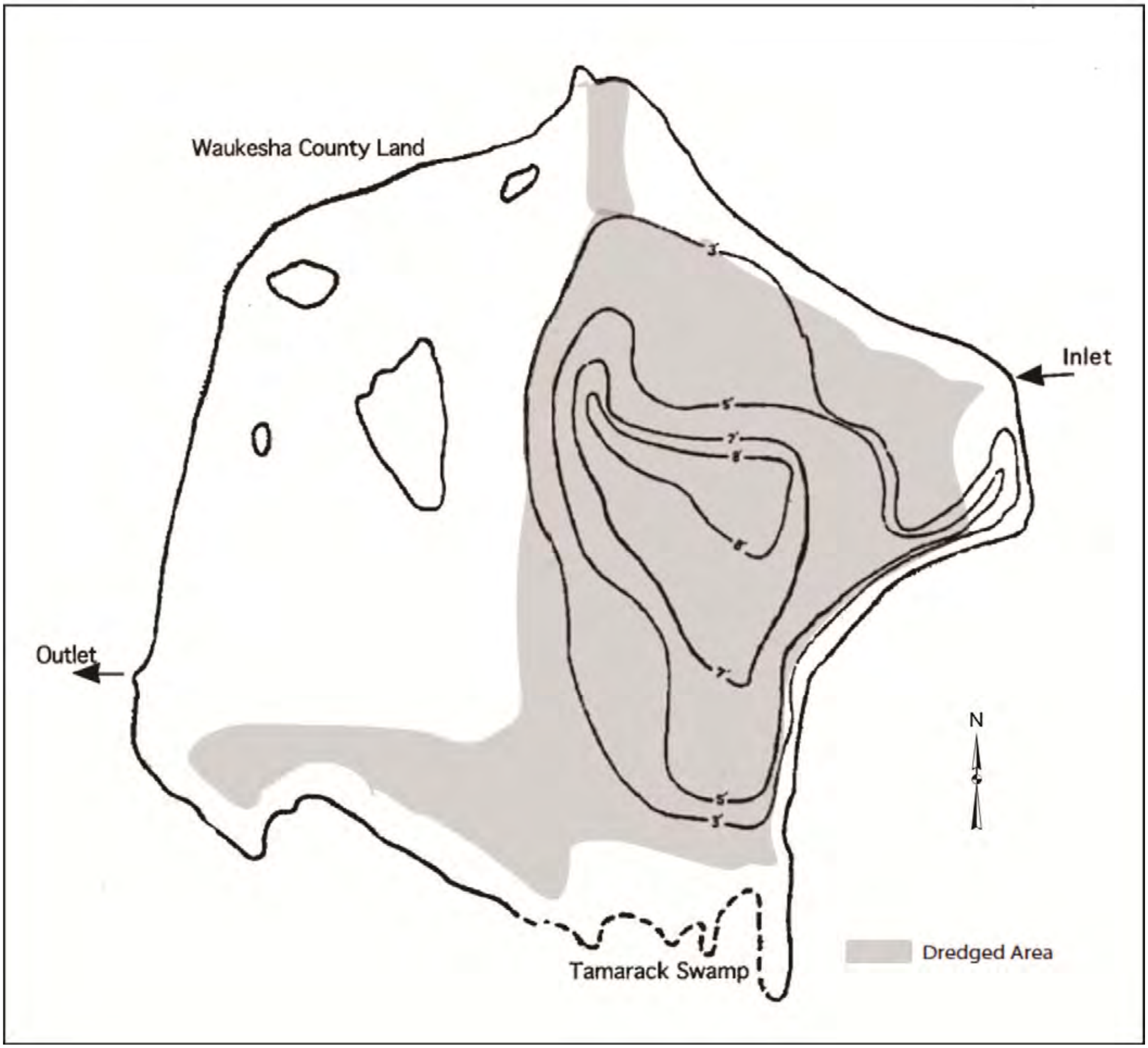
[7]*The "poor" water quality rating is based on phosphorous, water clarity, and chlorophyll-*a *measurements taken in School Section Lake between 1987 and 2013. The eutrophic standing is based on "trophic status" calculations made from that same data. Details about each of these parameters, the data used, and its relevance can be found in Appendix A in the Water Quality section and Trophic Status subsection.*

[8]*Waters are considered impaired when the phosphorus levels are above 0.03 mg/l. More information on phosphorus can be found in Appendix A in the Total Phosphorus subsection.*

[9]*Chlorophyll-*a *is a major photosynthetic pigment found in algae and this measure indicates the amount of algae, or biomass in the water. Details about chlorophyll-*a *can be found in Appendix A in the Chlorophyll-*a *subsection.*

Map 2

AREAS DREDGED IN 1994 WITHIN SCHOOL SECTION LAKE



Source: Aron & Associates.

oxygen levels at the surface,[10] which can likely be attributed to the healthy aquatic plant community found in the Lake, as discussed below.

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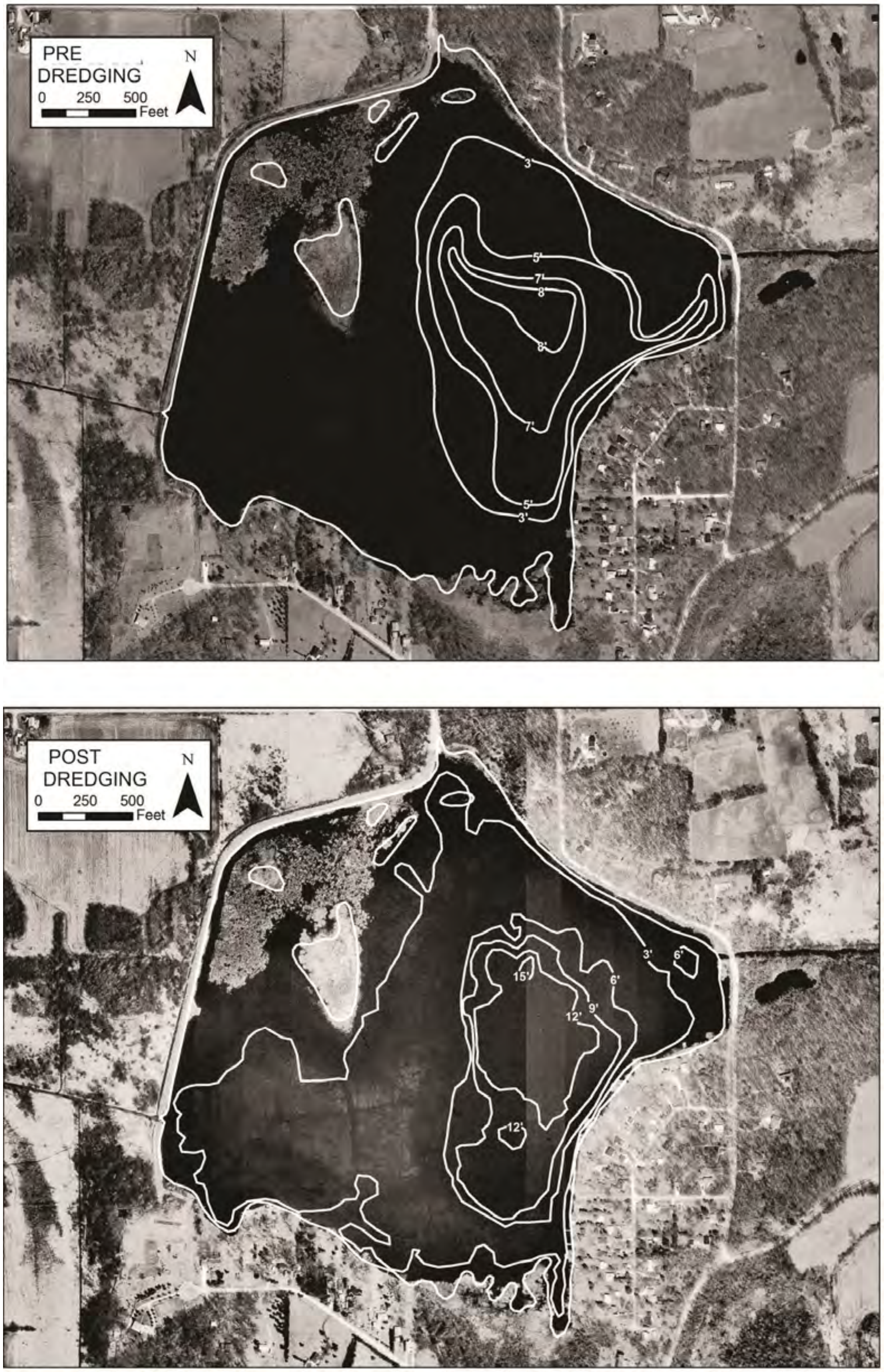
[10] *Dissolved oxygen in water, often caused by plants producing the oxygen, is a crucial need for fish. Without this oxygen fish would not be able to survive. More details on dissolved oxygen can be found in Appendix A in the Dissolved Oxygen subsection.*

Figure 1

PRE- AND POST-DREDGING BATHYMETRY IN SCHOOL SECTION LAKE ON 1990 AND 1995 AERIAL PHOTOGRAPHS



Source: Wisconsin Department of Natural Resources and SEWRPC.

Finally, School Section Lake has a very good diversity of aquatic plants, with 21 native plant species being present in the Lake, indicating a thriving wildlife population. However, two nonnative species (Eurasian water milfoil and curly-leafed pondweed) have been detected in the Lake, indicating that continued aquatic plant management activities (currently restricted to harvesting) should continue. [11] Even with these species, however, fishing surveys have indicated that the Lake supports a "very good" fishery, with good size structures.[12] Additionally, there is anecdotal evidence that the Lake, and the watershed as a whole, supports a diverse amount of wildlife including reptiles, amphibians, and waterfowl (along with other kinds of birds).[13]

Watershed Characteristics
School Section Lake's watershed is 4,069 acres, or about 6.4 square miles, with 84 percent being accounted for by rural land use. It is comprised mainly of wetlands and agricultural lands. The immediate shorelands of the Lake are developed for urban-density residential use, with urban land use accounting for 16 percent of the watershed.[14] On these developed shorelines there is limited buffering,[15] indicating that the developed shorelines may be a source of pollution that should be addressed. Additionally, planned 2035 development around the Village of Dousman area[16] also indicates that future erosion resulting from construction activities may be an issue of concern. The current population of the watershed is 813, with 316 households.

The watershed is generally very flat, with few steep slopes, which has resulted in a low amount of erosion and sediment transport to the Lake itself from the watershed.[17] Consequently, sedimentation in the Lake has been primarily restricted to in-lake processes, such as plant death. However, as mentioned above, construction activities within the watershed between 2006 and 2009 resulted in increased erosional deposition and subsequent phosphorus loading to the Lake.[18] Other than construction, the major sources of phosphorus to the Lake are likely fertilizer use and soil loss from agricultural lands and shoreline properties, and private septic system issues along the northern shoreline of the Lake.[19]

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[11] *More details about the aquatic plant diversity of the Lake can be found in Appendix A in the Aquatic Plant Diversity in School Section Lake subsection.*

[12] *Further details on fisheries surveys can be found in Appendix A in the Fish and Wildlife section.*

[13] *Further details on wildlife can be found in Appendix A in the Fish and Wildlife section.*

[14] *Further details about land use can be found in Appendix A in the Existing and Planned Land Use subsection.*

[15] *Further details about shoreline structures can be found in Appendix A in the Shoreline Protection and Erosion Control section.*

[16] *Further details about land use can be found in Appendix A in the Existing and Planned Land Use subsection.*

[17] *Further details about slopes in the Lake's watershed can be found in Appendix A in the Topography subsection.*

[18] *Legally reprimanded construction activities occurred between 2006 and 2009 in the Village of Dousman which resulted in phosphorus and sediment inputs to the Lake. Further details are provided in Appendix A in the Total Phosphorus subsection.*

[19] *Further details can be found in Appendix A in the Private Onsite Wastewater Treatment Systems and Management Implications of Loadings Calculations subsections.*

In general, groundwater flows within the School Section Lake watershed from east to west,[20] thereby indicating that groundwater recharge from within the watershed likely contributes to the water that is supplied to the Lake through springs located in the extensive wetland complex on the western side of the watershed.[21] Additionally, much of the watershed is actually located within a "high" or "very high" groundwater recharge potential area, further emphasizing this connection. Consequently, protecting these wetlands and groundwater recharge areas are crucial to the Lake's wellbeing.

Overall, School Section Lake is a valuable resource that requires further management and protection in order to ensure its continued recreational use. The rest of this Chapter will highlight the issues that should be addressed in this future management effort.

ISSUES AND CONCERNS

Though School Section Lake is a valuable resource, as highlighted above, it is subject to a number of existing and potential future problems and issues of concern. In order to better define and understand these issues, and provide for the continued recreational and residential use of the Lake, the lake residents have sought the development of a lake protection plan covering School Section Lake and its watershed. Chapter NR 190 Lake Management Planning Grant Program funds were, therefore, requested in terms of this grant application to define the issues of concern, to address the management of the root causes of community concern, and ultimately to complete a comprehensive lake management plan for the Lake.

As a part of this planning program, a complete list of the issues and concerns were identified through various means, including:

- An informal survey of School Section Lake residents conducted by the School Section Lake Management District; this survey resulted in 21 responses and provided this report with 13 specific issues of concern; and

- Consultations with School Section Lake community members and the School Section Lake Management District; these consultations provided this report with eight specific issues of concern.

Each issue of concern uncovered during the development of this report falls within seven major thematic areas: aquatic plant management, sedimentation, water quality, water quantity and resilience, wildlife enhancement, recreation, and regulation. The comprehensive list of these concerns, along with their sources and thematic area, is presented in Table 1. This chapter presents a summary of each of these identified issues of concern, organized in sections according to their thematic areas.

This chapter describes each thematic issue, includes an overview of the related issues of concern, provides a general recommendation regarding the issue and its priority for School Section Lake, and concludes with general recommendations regarding potential actions. The chapter is used to inform the management alternatives and recommendations presented in Chapter III and IV, and should be used as an opportunity to understand each issue and its potential solutions.

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[20] *Further details about groundwater flows can be found in Appendix A in the Groundwater subsection.*

[21] *Further details about the wetlands and other natural areas can be found in Appendix A in the Important Natural Areas section.*

Table 1

ISSUES OF CONCERN FOR SCHOOL SECTION LAKE

Source of Concern	Issue of Concern	Thematic Area
Informal Survey	Lake odor	Water quality
	Wildlife diversity, including birds	Wildlife enhancement
	Fish diversity	Wildlife enhancement
	Water clarity	Water quality
	Potential bacterial contamination	Water quality
	Need for improvement of swimming opportunities from shoreline	Sedimentation and water depth
	Cut aquatic plant accumulation on shoreline	Aquatic plant management
	Need for earlier harvesting time	Aquatic plant management
	More aquatic plant management in the northeast corner of the Lake	Aquatic plant management
	Pathway development from Dolmar Road to the dike	Recreation
	Development of early “slow-no-wake” regulations	Regulatory
	Installation of regulatory signs at boat launches	Recreation
	Desire for sandy lake bottom	Sedimentation and water depth
Consultations	Nuisance cattail growths	Aquatic plant management
	Toxicity and danger of chemical treatments to water supply and/or recreational contact	Aquatic plant management
	Phosphorous concentrations and associated listing on the Wisconsin impaired waters list	Water quality
	Aquatic invasive species management, specifically Eurasian water milfoil	Aquatic plant management
	Sediment accumulation threatening the dredging investment made in 1994	Sedimentation and water depth
	Future urban development and associated pollution inputs	Water quality
	Outdated ordinances	Regulatory
	Potential water quantity issues with recent droughts within Wisconsin	Water quantity

Source: SEWRPC.

AQUATIC PLANT MANAGEMENT

As is further discussed in Appendix A, aquatic plants are necessary components to maintaining a healthy lake, particularly as it relates to the introduction of dissolved oxygen to a lake and the provision of food and habitat to fish populations. In fact, as can be seen in Appendix B, each native plant plays a unique role in feeding and housing the wildlife found in lakes. However, overgrowth of aquatic plants—which is often the result of excessive phosphorous concentrations and/or decreased water depths—can cause a series of issues within a lake. These include: 1) loss of recreational ability due to nuisance plants cutting off navigation pathways; 2) the loss of native plants when the overgrowth is the result of only one species, usually Eurasian water milfoil; 3) increased sedimentation rates, as is further discussed in the Sedimentation section of this chapter; and 4) potential increases in fish kills. Consequently, management of aquatic plants is a regular occurrence in many lakes within the Southeastern Wisconsin Region, including School Section Lake.

As is further discussed in Appendix A, School Section Lake has a dominant population of Eurasian water milfoil, an invasive nonnative plant, as well as excessive growth of coontail, a nuisance native plant, and some growth of curly-leafed pondweed, another nonnative plant. These plant populations have historically resulted in dense plant communities that occur throughout the bay and pier areas, thereby impeding boat traffic. Consequently, the Lake residents and the Lake Management District have a long history of both harvesting and chemical treatment of plants within the Lake.[22]

Issues of Concern

Six issues of concern found in this planning effort are related to aquatic plant management. They include: 1) accumulation of cut aquatic plant fragments along the shorelines; 2) the need for earlier harvesting times; 3) the desire for more aquatic plant management in the northeast corner of the Lake; 4) nuisance cattail growth, which relates to the growth of a wetland plant; 5) the need for better management of Eurasian water milfoil; and 6) the potential danger associated with chemical treatment, particularly as it relates to toxicity in humans and wildlife.

The first issue of concern, the ***accumulation of cut aquatic plant fragments*** along the shorelines of the Lake, is most likely the direct result of harvesting activities within the Lake. Historically, landowners have maintained their shorelines by raking and removing floating debris. However, considering that this is an issue of concern, cleanup efforts after harvesting activities (perhaps led by voluntary efforts as well as by the School Section Lake Management District), should potentially be considered. This would not only increase the aesthetic value of the Lake, but would also decrease potential sedimentation processes.

Earlier harvesting times, as well as the need for better ***management of Eurasian water milfoil***, are largely related and, therefore, are being discussed concurrently. As mentioned above, Eurasian water milfoil (Myriophyllum spicatum), a nonnative aquatic plant currently regulated by the WDNR,[23] is one of the most dominant species in the Lake. Consequently, its presence in the Lake is considered the major issue of concern as it relates to aquatic plant management. The School Section Lake Management District has been managing exotic species and nuisance plants in the Lake since its inception in 1978; however, the continued presence of Eurasian water milfoil in the Lake suggests that efforts to target this species should be enhanced.

A possible explanation for continued populations of Eurasian water milfoil could be harvesting and chemical control activities occurring too late in the season. Since there are often native plants mixed in with Eurasian water milfoil during the peak growing season (see Map 3), efforts to reduce Eurasian water milfoil could potentially also reduce native plant populations. Loss of native plants leaves opportunities for reinfestation of Eurasian water milfoil, as this species thrives in disturbed areas.

Fortunately, there is a simple way to better target Eurasian water milfoil at lower risk to native aquatic species. This is due to the fact this species has a different growth cycle than most native aquatic species. Specifically, Eurasian water milfoil begins its growth cycle in early spring (May to June), generally a couple of months before the native species. This "early start" provides lake managers with the opportunity to target this species, using harvesting techniques or chemicals specific for milfoil such as 2,4-D or endothall,[24] when native plants are

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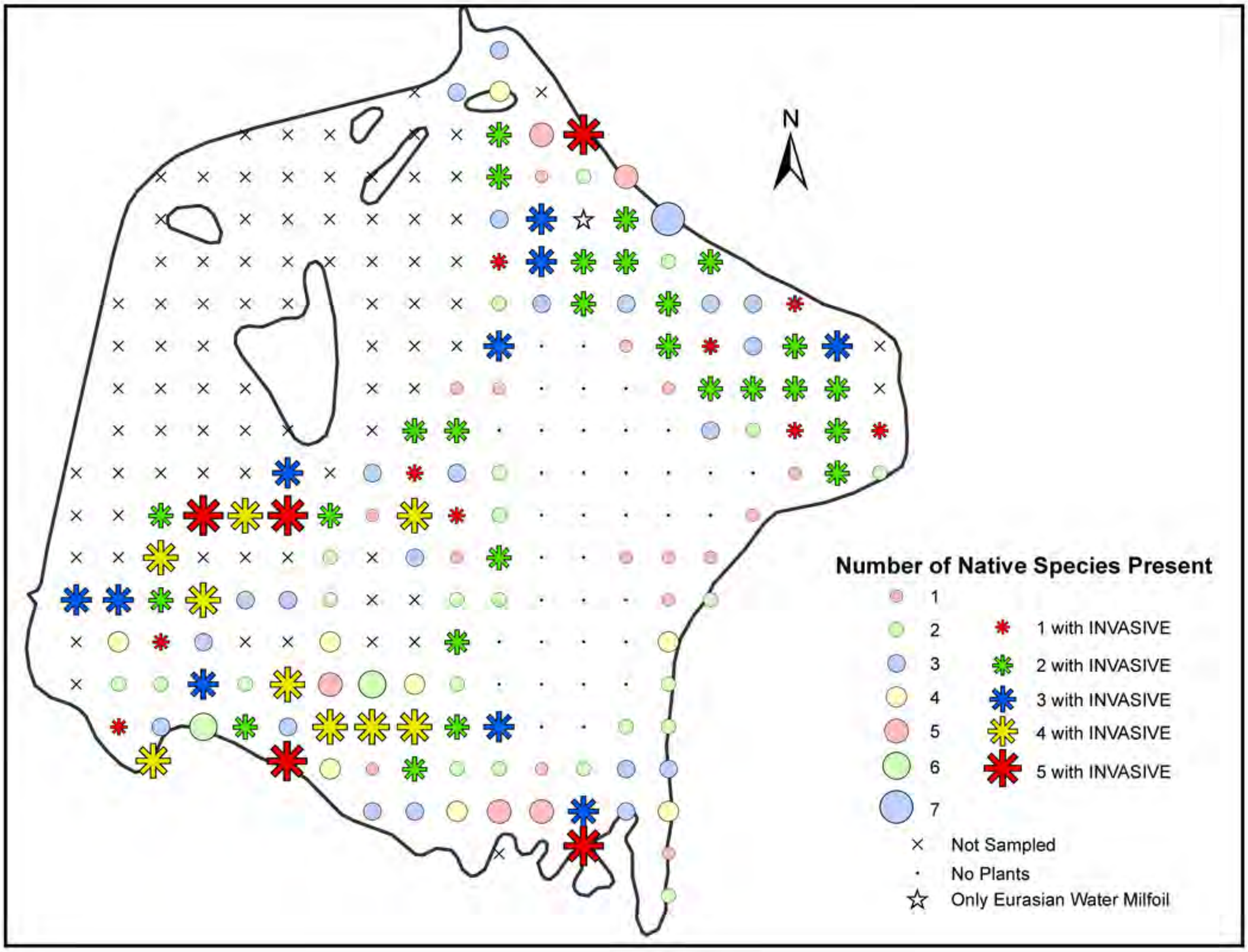
[22]*Further details about historic aquatic plant management efforts can be found in Appendix A in the Past and Present Aquatic Plant Management Practices subsection.*

[23]*See Chapter NR 109 of the* Wisconsin Administrative Code*. Section NR 109.07 (2) states that "The following aquatic plants are designated as invasive aquatic plants statewide: Eurasian water milfoil, curly leaf pondweed and purple loosestrife."*

[24]*See Wisconsin Department of Natural Resources Publication No. PUB-WT-964 2012,* 2,4-D Chemical Fact Sheet*, January 2012; see also Wisconsin Department of Natural Resources Publication No. PUB-WT-970 2012,* Endothall Chemical Fact Sheet*, January 2012.*

Map 3

COINCIDENCE OF INVASIVE SPECIES WITH NATIVE PLANT POPULATIONS WITHIN SCHOOL SECTION LAKE



Source: SEWRPC.

not yet present, thereby limiting the risk to native plant populations. Accordingly, the best option is to treat during the early spring growth season, when Eurasian water milfoil can be best targeted.[25] Additional actions which can be employed to manage this species during peak growing times without jeopardizing the native plant populations, including targeted manual extraction, rake and hand picking, and suction harvesting. More details about each of these methods are provided in Chapter III.

The perceived need for ***more aquatic plant management in the northeast corner*** is another issue of concern for School Section Lake residents. This issue relates to dense aquatic plant growth in the wetland area adjacent to the dike (see Figure 2). Though it is understandable that lake users may want to engage in recreation in this area, this area has traditionally been excluded from aquatic plant management activities, primarily due to the

[25]*J. Swearingen, WeedUS Database of Plants Invading Natural Areas in the United States: Eurasian Water Milfoil* (Myriophyllum spicatum)*, 2009.*

Figure 2

WETLAND IN NORTHEASTERN CORNER OF SCHOOL SECTION LAKE

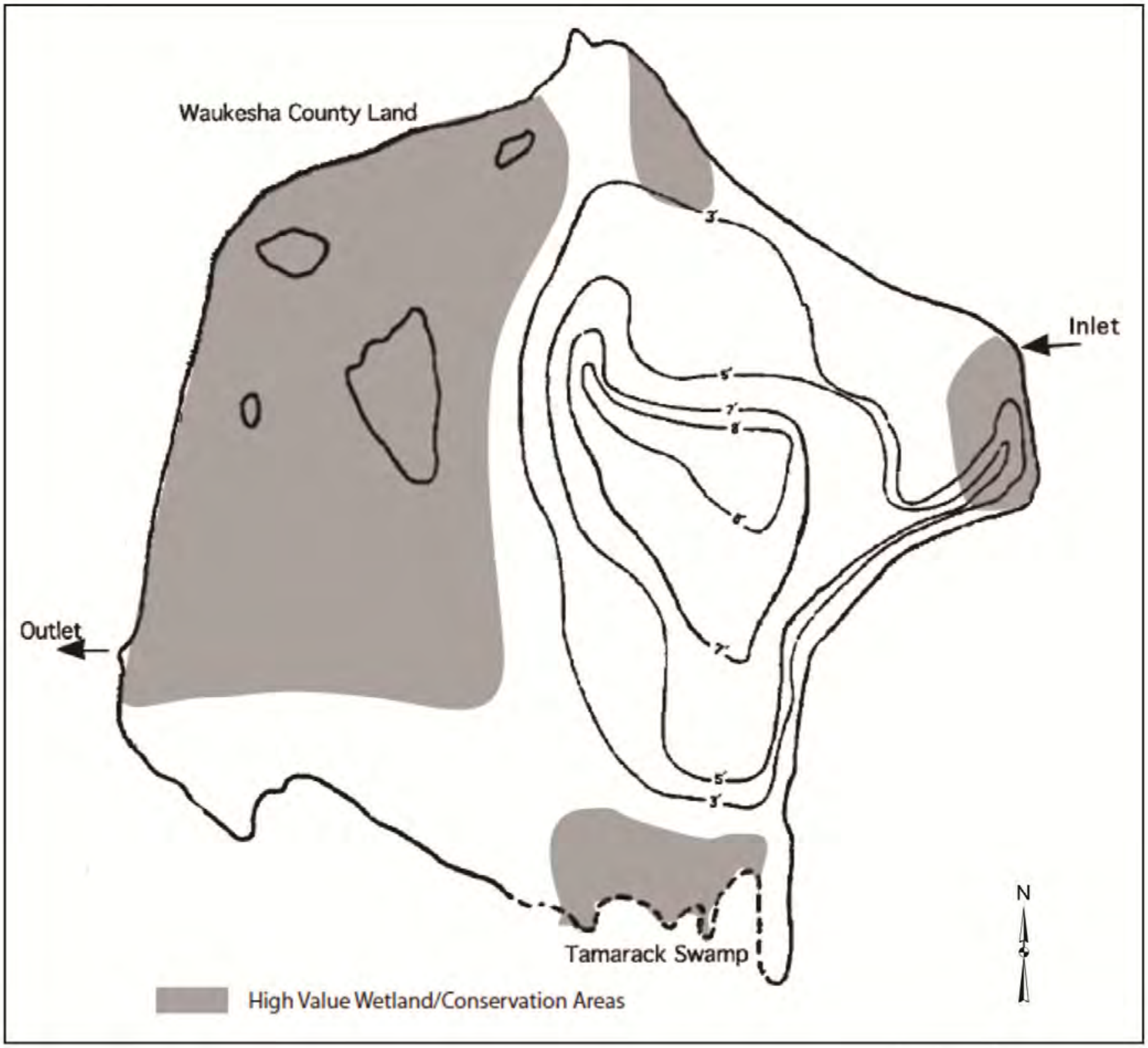
Source: SEWRPC.

presence of high-value wetland and conservation areas, as shown on Map 4. Accordingly, as this area provides high-quality fish and wildlife habitat, as well as likely plays a role in improving the water quality of the Lake, management efforts in this area are unlikely to be permitted. However, the maintenance of navigation lanes within a portion of this area may be permittable as long as native plants and fish nesting habitats are not disturbed.

The next issue of concern is related to ***nuisance growth of cattails***, a common plant in Wisconsin wetlands. The major concern related to this plant is the impairment of navigation and aesthetics within the Lake. Before control measures are considered for this plant, it is first important to note that cattails are instrumental in providing habitat for birds and mammals within wetland areas, particularly if they are native strands of cattail. Additionally, cattails provide particularly capable buffer areas that filter runoff, removing pollutants and sediments prior to them entering the Lake from the shorelines, as well as prevent shoreline erosion. However, if the cattails are found to be taking over the wetlands, controls may be desired. The type of control measure then should be determined based on the species of cattail present. Accordingly, further consultations with WDNR may need to be undertaken.

Map 4

AREAS WITHIN SCHOOL SECTION LAKE WITH HIGH ECOLOGICAL VALUE: 2004



Source: Aron & Associates.

The final issue of concern is in regard to perceived ***dangers associated with using chemical controls*** as a method for aquatic plant management. This concern is specifically related to the types of chemical used and their potential toxicity and long-term effects on both humans and wildlife alike. It is important to note that the chemicals and methods used today are very different from those used in historical applications. In the past, the half-lives (i.e. length of time the chemical persists in the water/environment) of herbicides were in the month or year range, while today many have half-lives of days and weeks. Additionally, though in the past whole lake treatments with large amounts of chemicals were quite common, today both targeted and whole lake treatments use carefully calculated, very low application rates meant to prevent loss of native plants. Finally, though all pesticides are hazardous if used improperly, chemicals used today are subject to a series of tests to determine that their effects on humans and wildlife are negligible, as well as to ensure that they have low environmental persistence. There is, however, debate on 2,4-D,[26] a common chemical used in the control of Eurasian water milfoil, as a potential carcinogen. Therefore, if this chemical is used, it should be limited to small, but necessary, areas.

SEDIMENTATION

Sedimentation in lakes is a natural process whereby particles in suspension, i.e. dissolved in the water, settle out of the water in which they are entrained and come to rest on the lake bottom. In lakes, these sediments are most likely to come from either plant matter within the lake, i.e. when a lake's aquatic plants die and their biomass accumulates on the lake bottom, or from sediment loading within the watershed (see Appendix A, Pollutant Loadings section), which enter the lake through its tributaries. Agricultural land use is a known source of large amounts of sediment loads in many lakes.

Sediment deposition can cause several issues in a lake. The mud and loose sediment that is characteristic of sedimentation can inundate or cover the sand and gravel substrates known as "parent material," resulting in: damage to boat motors; loss of aesthetic value; fear that swimmers, fishers, and boaters could become mired in unconsolidated sediment; and loss of ability to operate boat lifts at piers. Additionally, the process can also cause a loss of aquatic organisms, as parent materials are instrumental for feeding, nesting, and rearing species such as sunfish and minnows. Sedimentation, either episodic or chronic, can also eventually result in extensive loss of water depth. This phenomenon can then reduce or restrict the amount of usable area for recreational activities and lead to excessive aquatic plant growth, as aquatic plants grow in shallow areas where sunlight can penetrate the entire water column. Loss of water depth can also reduce the overall number of fish that can live in a lake, as well as cause summer fish kills if a lake becomes too shallow (see Appendix A, Anoxia section).

Sedimentation has historically been documented in School Section Lake due to investigations that preceded the aforementioned 1994 dredging project.[27] These studies, some of which included a sediment coring component, determined that—with the exception of historical loading which may have occurred during the initial installation of agricultural fields within the watershed—the majority of the sedimentation occurring in the Lake is caused by in-lake plant death and subsequent decomposition and accumulation.[28]

Given the fact that School Section Lake is a dammed marshland area, which naturally acts as a sediment catchment basin, and due to continued plant growth, it is likely that sedimentation from plant growth and death has continued to occur in the Lake since the 1994 dredging project. This conclusion is supported by an upward trend of conductivity measurements found in the Lake (see Water Quality section of Appendix A). Additionally, this conclusion is supported by the apparent water depth changes that have occurred in the 20 years since the

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[26]*2,4-D was deemed a noncarcinogen by the US Environmental Protection Agency due to lack of sufficient evidence. However, many nonprofit and advocacy agencies contest this conclusion.*

[27]*Aqua-Tech, Inc., School Section Lake, Inland Feasibility Study, 1979-1980; WDNR, School Section Lake, Waukesha County, Feasibility Study Results: Management Alternatives, 1981; and R.A. Smith and Associates Inc.,* Lake Rehabilitation Plan for School Section Lake Management District, Town of Ottawa, Waukesha County, Wisconsin, *1982.*

[28]*Wisconsin Department of Natural Resources, Feasibility Study Results, 1981,* op. cit.

dredging project, (a change of maximum water depth from 20 feet[29] to 15.5 feet[30] was detected over the 13-year period between 1994 and 2005). Though further sedimentation was expected at the inception of the project, the fact that the maximum depth of the Lake decreased 4.5 feet in 13 years indicates that sedimentation rates in School Section Lake are an important issue that must be addressed.

Issues of Concern

Three of the identified issues of concern relate to the sedimentation process occurring in the Lake, including: 1) the need to prevent the Lake from refilling to pre-dredging levels; 2) the desire to swim from the shoreline; and 3) the desire for a sandy lakeshore bottom.

The first of these issues, i.e., ***preventing the Lake from refilling***, is concerned with protecting the $125,000 dredging project investment that was made in 1994. The dredging project increased the maximum depth of the Lake from eight to 20 feet for the purpose of increasing navigability, reducing aquatic plant growth, increasing water quality, and reducing fish kills. It was estimated at inception that dredging would restore the Lake for another 50 to 100 years[31] (an average max depth increase of 0.12 to 0.24 foot per year). However, as explained above, the maximum depth of the Lake decreasing by about 4.5 feet in just 13 years (0.35 foot max depth increase per year), indicates a high rate of sedimentation.[32] Though the rate will likely slow over time,[33] it is still evident that sedimentation is occurring to an extent that future management efforts will need to be implemented if community members intend for the Lake to remain deeper than pre-dredging levels, without having to implement another large-scale dredging project in the near future.

The second and third issues, the ***desire to swim from the shorelines*** and the desire for ***sandy lakeshore bottoms***, relate to water depths along the School Section Lake shoreline and mucky material along the shoreline. It is important to note that the shallow depths and mucky sediments are naturally occurring in School Section Lake, i.e., they are the result of the natural plant growth and death which occurs in marsh lakes. Consequently, permanently dealing with these issues (i.e. creating a rocky bottom to the Lake) is not feasible. However, some mitigation measures, e.g., small scale dredging, may be possible to temporarily deal with these issues.

WATER QUALITY

Water quality deterioration can cause a host of issues in a lake, such as: 1) overgrowth of plants, potentially leading to fish kills or hindrance of boating uses; 2) water odor, which could potentially interfere with human use; and 3) potential health risks to human users such as swimmers, as in the case of *e-coli* and certain kinds of algae. Consequently, water quality monitoring and efforts to maintain "good" water quality are crucial to ensuring continued recreational use of a lake, as well as a healthy wildlife and plant community within the watershed.

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[29]*Aron & Associates,* School Section Lake Aquatic Plant Management Plan: First Reassessment 2005, *Burlington Wisconsin, 2005.*

[30]*Marine Biochemists, 2005,* op. cit.

[31]*Laurel Walker, "Cost to County Taxpayers Cut in Half for School Section Lake Dredging,"* Milwaukee Journal, *November 29, 1993.*

[32]*Sedimentation rates are assumed to be high due to the observed decreases in maximum depths. However, they cannot be calculated due to lack of adequate data.*

[33]*Increases in maximum depth occur at a higher rate than the sedimentation rate. This is due to sediments constantly moving to the deepest part of the Lake. Consequently, as the deepest part of the Lake fills in, the sediments will distribute more evenly over the entire lake bottom.*

Several factors can indicate deterioration of water quality within a lake. The most common indicators, however, are concentrations of total phosphorous and chlorophyll-*a* and water clarity measurements, primarily because these are each linked to very noticeable and impactful changes in a lake, namely, excessive plant growth, excessive algae growth, and decreased visibility in the water. There are, however, other factors to be considered in water quality, including bacterial counts, e.g., *e-coli*; dissolved oxygen levels; and the emerging issue of chloride values. These factors are important for various reasons. In the case of bacteria, *e-coli* counts can help identify the source of phosphorous pollution, (*e-coli* presence indicates fecal contamination), as well as affect the ability of a lake to provide safe recreational uses. Dissolved oxygen can be used as an indicator of the health of the fish community and the potential risk of fish kills. And, high chloride concentrations could indicate potential future issues in maintaining wildlife and plant populations in a lake. It is, therefore, important that each of these components be monitored over time and efforts to maintain their levels within acceptable ranges be made a priority.

It is important to note that sources of pollution are not confined solely to those pollutants that drain directly into a lake, but also include those which enter a lake through its tributaries, rivers, streams and springs.[34] This means that activities within the entire watershed have the potential to cause issues in a lake. Agricultural runoff, for example, can cause phosphorous loading to a lake; Private Onsite Wastewater Treatment System (POWTS or septic system) leakage can cause *e-coli* contamination; and residential runoff can bring with it pesticides from lawn treatments, and chlorides from road salt treatments. Consequently, control of nonpoint source pollution and lake water quality is an important issue to be considered.

As was discussed in the water quality section of Appendix A, School Section Lake is considered eutrophic (see Appendix A, Trophic Status section), as well as considered to have poor water quality, particularly as it relates to total phosphorous levels (the Lake has been placed on the Wisconsin Impaired Waters list for phosphorus). A phosphorus budget for the Lake developed in a 1981 WDNR study[35] indicated that 94 percent of the phosphorus loading to the Lake was entering the Lake via the inlet, while one percent of the phosphorus was entering the Lake via groundwater inputs (the rest being atmospheric contributions). Using these number, School Section Lake residents and Southeastern Wisconsin Regional Planning Commission (SEWRPC) staff attempted to identify specific current and future sources of pollution within the watershed. These include:

1. The agricultural areas throughout the watershed, which often reach the Lake through channelized pathways—This is likely the most constant source of phosphorous loads to the Lake through surface runoff, according to lading calculations presented in Appendix A (see Pollutant Loadings section);

2. Pollution deposition from past and future urban development—This is a potentially constant source of phosphorous, fertilizers, sediments, pesticides, and heavy metals, through surface runoff, as well as a likely source of episodic sediment transport which results from construction disturbances;

3. The land use and activities which occur along the shoreline of the Lake—These are potential sources of phosphorous from fertilizers; sediments from erosion; pesticides from lawn treatment; and chlorides from driveway deicing treatments, especially considering the lack of vegetative buffers on the Lake's shorelines;[36] and

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[34]*Community-Based Environmental Protection: A Resource Book for Protecting Ecosystems and Communities, U.S. Environmental Protection Agency, EPA 230-B-96-003, 1997.*

[35]*Wisconsin Department of Natural Resources, Feasibility Study Results, 1981,* op. cit.

[36]*Further details about shoreline structures can be found in Appendix A in the Shoreline Protection and Erosion Control section.*

4. Private Onsite Wastewater Treatment System (POWTS) used along the northern shoreline—This is the most likely source of groundwater pollution-caused phosphorous loading and bacterial contamination.

Considering that each of these areas could potentially be contributing to the poor water quality of School Section Lake, it is important to ensure that future management efforts seek to implement pollution reduction projects within these regions.

Issues of Concern

Five of the issues of concern identified by the Lake community were related to water quality, including: 1) lake odor; 2) water clarity; 3) potential bacterial contamination; 4) phosphorous loads and the associated enlistment on the Wisconsin Impaired Waters list; and 5) the noticeable pollutant inputs that were observed in conjunction with upstream development.

The first issue, ***lake odor***, is common in eutrophic lakes, particularly when the lakes exhibit stratification, as is the case in School Section Lake. The general process of stratification (see Appendix A, Thermal Stratification section) causes a physical barrier to gases in the deep portions of the Lake. Consequently, when dead plants and fish sink to the bottom of the Lake and then decompose, the hydrogen sulfide byproduct of decay accumulates in this deep portion of the Lake. Once mixing occurs, often in the spring or fall, although sometimes in the summer, the hydrogen sulfide is released, giving off a temporary "rotten egg" smell. This smell is often highly pronounced in eutrophic, highly productive, lakes because they contain more plants and fish in general, thereby increasing the volume of decomposing material. Smells in a lake can also be caused by large fish kills or the presence of a particular type of harmful algae; however, as neither of these have been reported in School Section Lake, it is most likely that stratification is the cause of this issue. There are measures, with varying degrees of success, such as aeration, which can be implemented to reduce the smell in a lake; however, dealing with the issue of excessive plant growth and fish kills may also be enough to prevent odors from occurring in the future.

Water clarity, the second issue of concern, is also common in eutrophic lakes, particularly those that have high organic content due to sedimentation processes, as is the case with School Section Lake. Though some of the water clarity issues in the Lake are likely caused by natural processes, e.g., the brown color of the Lake and growths of algae characteristic of a marsh area, some may also be the result of potentially high algal blooms or turbidity. High algae concentrations, or chlorophyll-*a* concentrations, have been found in the Lake, thereby indicating that algae may need to be addressed in the future. Additionally, though turbidity has not been consistently measured in the Lake, it is often a result of disturbance to the bottom of the Lake, as well as sediment deposition resulting from erosion. Considering that boating does regularly take place in the Lake, and considering that sedimentation is likely occurring in the Lake, turbidity could potentially be a major reason for the Lake's low clarity. This may be a challenging issue to deal with in School Section Lake, given the nature of the sediments in the Lake. However, increased slow-no-wake regulations may be a possible solution to this issue.

The third issue of concern, ***bacterial contamination***, has yet to be monitored in the Lake. Bacterial contamination, in particular, *e-coli*, is common in areas that have livestock within the upstream tributaries, as well as in areas where the groundwater supply is contaminated by POWT systems within the watershed. As both of these scenarios are possible within the School Section Lake watershed, further monitoring, and preventative measures, should likely be included in future management efforts.

The fourth issue of concern is ***phosphorous concentrations*** and the significance of being included on the Wisconsin Impaired Waters list. As mentioned in Appendix A, phosphorous levels in School Section Lake are well above WDNR standards of 0.03 milligrams per liter (mg/l). Consequently, the Lake has been placed on the Wisconsin Impaired Waters list. Though being on this list has benefits (in particular, eligibility for future Federal and State funding aimed at reducing phosphorous levels), being listed also indicates that something needs to be done to improve water quality in the Lake. Future actions should, therefore, seek to reduce these phosphorous concentrations to the greatest extent possible.

The fifth, and final, issue of concern is the ***pollution which entered the Lake as a result of upstream development activities*** that occurred in the Village of Dousman between 2006 and 2009, actions which resulted in a subsequent lawsuit.[37] As was described in Appendix A, this event may have been the cause of evident phosphorous concentration increases during this same time period. Additionally, visible sediment loading was present during this time, according to lake community members. This issue of concern specifically relates to the need to protect the Lake from similar future development scenarios that jeopardize water quality. Efforts to protect the Lake, such as continuing to monitor changes in the Lake, as well as implementing educational programs for developers, should, therefore, be considered a priority.

WATER QUANTITY AND RESILIENCE

Loss of water depth resulting from reduced water supply to lakes can cause several issues, including placing the affected lake at risk for: pollution accumulation due to reduced residence time; increased aquatic plant growth due to an increase in littoral zone; and increased number of fish kills.

School Section Lake has a history of efforts aimed at maintaining lake levels, as evidenced by the series of maintenance projects completed on the dike in the northwest corner of the Lake (see Figure 3), as well as permanent maintenance projects within the dam along the western shore (see Figure 4). Consequently, the continued maintenance of Lake levels should be considered a priority.

Issues of Concern

The issue of concern related to the maintenance of water levels was the ***potential for water quantity issues in face of recent droughts***, which is related to the fact that, though precipitation levels are recorded to have increased in the spring and fall seasons, there have been higher frequencies of summer droughts within Southeastern Wisconsin in the past 25 years.[38] This is an issue of concern in all the Region's lakes, as water levels and natural hydrology will inevitably be at risk with lower amounts of precipitation.

The fact that School Section Lake is dependent on surface water inputs, which come from upstream groundwater springs, puts the Lake in a unique position. Though groundwater supplies in a watershed are also affected by drought periods, as the water is not available for groundwater recharge during these times, higher precipitation levels in spring and fall provide an opportunity to maintain groundwater supplies and baseflow to the Lake even during summer drought periods, thereby leading to a level of "resilience." This process is likely the reason water supply was seemingly unaffected by the recent 2012 drought, according to Lake residents.

However, groundwater supplies can also be affected by over pumping, often caused by high-capacity wells, as well as by lowered groundwater recharge. Lowered groundwater recharge, the major issue of concern in this watershed, is often caused by an increase in impervious cover, i.e. pavement or rooftops, within high groundwater recharge areas. Therefore, actions that lower groundwater levels should be governed by best management practices and discouraged, wherever possible, in order to maintain the resiliency that groundwater recharge provides the Lake.

WILDLIFE ENHANCEMENT

Good wildlife populations present a variety of recreational opportunities, including bird watching, hunting, nature trekking, and fishing. Additionally, healthy wildlife populations, including deer, amphibians, birds, small

[37]*Wisconsin Department of Justice, Waukesha Developer Settles State Environmental Lawsuit Over Construction Site Violations For $240,000,* News Release*, February 2010.*

[38]*David S. Liebl, "An Introduction to Wisconsin's Changing Climate," UW-Cooperative Extension, Power Point Presentation, January 8, 2014.*

Figure 3

DIKE LOCATED ALONG THE EASTERN SHORELINE OF SCHOOL SECTION LAKE

Source: SEWRPC.

mammals, and fish, are the ultimate indication of a healthy watershed because wildlife require large, well-connected natural habitat areas to thrive, e.g., wetlands, buffered areas, and streams, which also serve the purpose of filtering pollutants and sediments from the system.[39] Given the fact that wildlife is so heavily correlated to the presence of well-connected aquatic and land-based habitat, the enhancement of wildlife often requires protection of the habitat within and around the Lake, and also the natural lands within the watershed.

As discussed in Appendix A of this report, School Section Lake has diverse fish and wildlife populations. In order to maintain and enhance these populations, efforts will need to be made to protect and connect wetlands; uplands; and aquatic habitat/native plants, within School Section Lake and its watershed.

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[39]*Greg Yarrow*, Habitat Requirements of Wildlife: Food, Water, Cover and Space, *Clemson Extension*, *Revised May 2009.*

Figure 4

DAM LOCATED ALONG THE EASTERN SHORELINE OF SCHOOL SECTION LAKE

Source: SEWRPC.

Issues of Concern

Two issues of concern relate to wildlife enhancement, including: 1) the need for more wildlife diversity, with birds stated as a particular issue of concern; and 2) the desire for increased fish diversity.

The first of these issues, i.e., ***bird, amphibian, and mammal enhancement***, is most largely related to the maintenance and enhancement of natural areas, such as the wetland, upland, and environmental corridors within the watershed (see Map A-24 and Map A-26 in Appendix A). Therefore, efforts to protect and potentially enhance these areas should be considered in future management efforts. Additionally, best management practices can be implemented along the shorelines, as well as in the watershed. These efforts should also be considered a priority if wildlife populations are to be enhanced in the future.

The second issue of concern, the ***desire for increased fish diversity***, relates to improving fish habitat within the Lake. This is a complicated issue, as many components affect fish habitat, including: 1) lack of "parent material" (see Sedimentation section above); 2) lack of native aquatic plant species (see Aquatic Plant Management section above); 3) poor water quality which leads to decreased dissolved oxygen and subsequent fish kills (see Water

Quality section above); and 4) overfishing. Therefore, actions to improve each of these components will serve to improve fish populations in the Lake. Best management practices also can be implemented along the shorelines to encourage fish populations and nesting. Therefore, these kinds of projects should potentially be considered in future efforts.

RECREATION

Maintenance of recreational uses of lakes is considered a crucial consideration for any lake plan. In fact, many recommendations are included in lake plans for the specific purpose of increasing the recreational usability of a lake. All of the components that have already been discussed can heavily influence recreation in a lake, including water quality, aquatic plant management, control of sedimentation, control of lake levels, and wildlife populations. However, activities such as trail maintenance and sign installation can have a positive impact on the ability of individuals to use a lake and can also reduce the risks to a lake associated with recreation, namely, the introduction of aquatic invasive species.

School Section Lake currently maintains a public access site that provides recreational opportunities according to WDNR standards. Additionally, many of the lake residents enjoy recreating along the shoreline through swimming and boating from private docks, as well as through walking along the dike located at the northwest shore. Future opportunities for recreation may, however, become evident as time continues. It is, therefore, important to continually gather feedback from Lake users in order to gather ideas about what kinds of projects would gain the most use.

Issues of Concern
Two issues of concern relate to recreation, including: 1) the desire for maintenance of a pathway from Dolmar Road to the dike; and 2) the need for the installation of regulatory and educational signs at the boat launch.

The first issue of concern, the ***maintenance of the trail between Dolmar Road and the dike***, refers to the better maintenance of this trail for the purpose of encouraging recreational use. As can be seen in Figure 5, there are several opportunities for better maintenance of the trail, including regular mowing and raking as well as potential enhancement projects, i.e., rock outlines on the trail, should the landowners provide consent. Consequently, further investigation of the logistics of this project should be investigated.

The second issue of concern, the ***installation of regulatory and educational signs***, could play a crucial role with respect to reducing the potential for overfishing, by informing users of bag limits, as well as reducing the potential for invasive species introduction. Given the fact that zebra mussels (see Figure 6), a common invasive species in Wisconsin, have yet to be detected in the Lake, educational and regulatory signs could play a crucial role in ensuring this remains the case. This concern should, therefore, be considered a priority.

REGULATIONS

Regulations can play a crucial role in preventing damage to lakes in general. Construction site erosion control ordinances, for example, can prevent erosion from entering a lake and, subsequently, harming the lake's water quality and fish populations. Consequently, the opportunity to include regulatory measures within a lake can greatly enhance the ability of a lake management agency to maintain the health of a lake. The details of regulations found within the School Section Lake watershed are included in Appendix A of this report (see Local Ordinances section).

Issues of Concern
Two issues of concern relate to regulatory issues, namely: 1) the desire for earlier slow-no-wake restrictions, and 2) the need for updated ordinances for the School Section Lake Management District.

Figure 5

TRAIL FROM DIKE TO DOLMAR ROAD

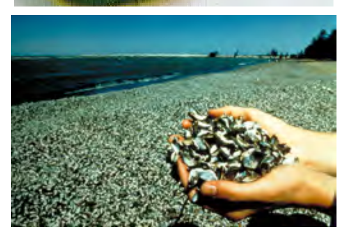
Source: SEWRPC.

Figure 6

IDENTIFICATION AND CHARACTERISTICS OF ZEBRA MUSSELS

Identifying Features and Characteristics
- Look like small clams usually identified with dark and light-colored stripes
- They can be up to two inches long, but most are under one inch
- Usually grow in clusters and are generally found in shallow (six to 30 feet), algae-rich water
- Can firmly attach to solid objects like submerged rocks, dock pilings, boat hulls, etc.
- Are about the size of peppercorns as juveniles and, when young, can feel like fine sandpaper on smooth surfaces

Preventative Measures
- Learn to recognize zebra mussels
- Ensure inspection and removal of aquatic plants, animals and mud from boats, motors and trailers
- Ensure water is drained from boat, motor, livewell, bilge, and bait containers
- Trash disposal of unwanted live bait and worms
- Rinse boat and equipment with high-pressure or hot water OR dry everything for five days
- Never introduce fish, plants, crayfish, snails, or clams from one body of water to another



Source: Minnesota Sea Grant, S. van Mechelen, and Ohio Sea Grant.

The first concern, the ***desired modification of the slow-no-wake regulations*** to earlier than the current "before 11:00 a.m. and after 5:00 p.m.," would involve the modification of the Town of Ottawa ordinances, which may be difficult in the absence of broad public support. Though this is not recommended at this time, it could be further considered if public support increases. It is, however, possible that better communicating the current rules (see Appendix C for current boating ordinances), and potentially using the signage suggestion discussed in the Recreation section above, could help solve this issue.

The second issue of concern is the ***outdated ordinances*** that currently exist for the School Section Lake Management District. The current ordinances were last revised in 1983 and contain outdated and restrictive bylaws. Measures to remove this obstacle and prevent any future issues for the School Section Lake Management District should be, therefore, considered a priority.

SUMMARY

The majority of the issues of concern, which were identified by the School Section Lake community and discussed in this chapter, were considered priority causes for action. The only two issues of concern that were not deemed a priority include: 1) the desire for plant management in the northwestern corner of the Lake, because this area has been designated as having ecological value; and 2) the desire for earlier slow-no-wake regulations, because this would be difficult to implement and potentially undesirable for many lake users. Table 2 provides a summary of the recommended actions associated with each issue of concern. Further details on the management alternatives that can be used to implement these actions, as well as the associated recommendations, are provided in Chapter III and IV of this report.

Despite the issues of concern in School Section Lake, there are also a number of opportunities. The implementation of the recommendations highlighted in Chapter III and IV of this report will capitalize on those opportunities and help ensure the sustainable use of School Section Lake and its watershed.

Table 2

RECOMMENDED ACTIONS FOR EACH ISSUE OF CONCERN IDENTIFIED IN SCHOOL SECTION LAKE

Thematic Area	Issues of Concern	Recommended Actions
Aquatic Plant Management	Cut aquatic plant accumulation on shoreline	Plant cutting collection project
	Need for earlier harvesting time and aquatic invasive species management, specifically Eurasian water milfoil	Implementation of earlier early spring harvesting and potential use manual extraction and chemical controls
	More aquatic plant management in the northeast corner of lake	*Not considered permittable*
	Nuisance cattail growths	Investigation into cattail species and potential control projects
	Toxicity and danger of chemical treatments to water supply and/or recreational contact	If 2,4-D is chosen; limit use to small secluded regions of the Lake
Sedimentation	Need for improvement of swimming opportunities from shoreline	Reduce sediment loading at the source for the long-term, while considering in lake maintenance projects for the short term
	Desire for sandy lake bottom	
	Sediment accumulation threatening the dredging investment made in 1994	
Water Quality	Lake odor	Prevent excessive biomass accumulation along lake bottom and increase dissolved oxygen when possible
	Water clarity	Reduce process of sedimentation (see above), as well as reduce boating disturbances
	Potential bacterial contamination	Engage in monitoring of *e-coli*, as well as preventative measures
	Phosphorous concentrations and associated listing on the Wisconsin impaired waters list	Engage in activities meant to reduce phosphorous loads
	Future urban development and associated pollution inputs	Encourage best management practices in new developments
Water Quantity	Potential water supply issues with recent droughts within Wisconsin	Encourage groundwater recharge wherever possible
Wildlife Enhancement	Wildlife diversity, including birds	Enhance wildlife habitat wherever possible
	Fish diversity	Enhance fish habitat and water quality wherever possible
Recreation	Pathway development from Dolmar Road to the dike	Investigate the logistics of implementing this recommendation
	Installation of regulatory signs at boat launches	Install signs which provide educational and regulatory information
Regulation	Development of early "slow-no-wake" regulations	*Not considered feasible*
	Outdated ordinances	Take actions to revise fix the ordinances

Source: SEWRPC.

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Chapter III

PLANT MANAGEMENT ALTERNATIVES AND RECOMMENDATIONS

INTRODUCTION

As discussed in Chapter II and Appendix A of this report, School Section Lake generally contains a robust and diverse aquatic plant community capable of supporting a warmwater fishery. However, excessive growth of aquatic plants, particularly Eurasian water milfoil and nuisance native plants, has led to the impairment of recreational boating opportunities and other lake-oriented activities, as well as caused issues with sedimentation. Consequently, the School Section Lake Management District engages in regular aquatic plant management activities, presently limited to mechanical harvesting, although some chemical management, as well as manual harvesting in the vicinities of piers and docks, has occurred in the past.[1]

In addition to aquatic plants, some wetland plants, namely, cattails, bulrush, and purple loosestrife, which pose a risk to navigation and the general health of the terrestrial plant community. Active management of these plants has not yet been undertaken in and around School Section Lake.

This chapter seeks to provide the necessary information and recommendations needed to manage nuisance aquatic and wetland plant growth in and around the Lake. Accordingly, it presents the range of alternatives that could potentially be used, as well as provides specific recommendations related to each of them. The recommendations made within this chapter will address the five issues of concern related to aquatic plant management deemed a priority in Chapter II of this report, namely: 1) reducing accumulation of cut aquatic plants on shorelines; 2) the need for earlier harvesting times; 3) the need for better management of Eurasian water milfoil; 4) the potential danger associated with chemical treatment; and 5) the desire to control nuisance cattail growth.

The measures discussed in this chapter are focused on those measures which can be implemented by the School Section Lake Management District in collaboration with the Wisconsin Department of Natural Resources (WDNR) and School Section Lake residents. Consequently, the aquatic plant management component presented in this chapter is limited to those recommendations that seek to monitor and control aquatic plant growth in the Lake, after the growth has already occurred. Pollution control measures, such as phosphorous loading reduction, which aid in the prevention of aquatic plant growth in general, will, therefore, be addressed in Chapter IV of this plan.

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[1]*Further details regarding past aquatic plant management is available in Appendix A in the Past and Present Aquatic Plant Management Practices subsection.*

In general, this chapter should be used to understand the particular plant management measures that should be used in and around School Section Lake, and should be used as a resource when developing future aquatic and wetland plant management efforts.

AQUATIC PLANT MANAGEMENT ALTERNATIVES

Aquatic plant management measures can be classed into five groups: 1) ***physical measures***, which include lake bottom coverings and water level management; 2) ***biological measures***, which includes the release of herbivorous insects; 3) ***manual measures***, which involve the manual removal of plants by individuals; 4) ***mechanical measures***, which include harvesting and removal of aquatic plants with mechanical tools such as a harvester or a suction device; and 5) ***chemical measures***, which include the use of aquatic herbicides. All of these control measures are stringently regulated and most of them require a State of Wisconsin permit. Chemical controls, for example, require a permit and are regulated under Chapter NR 107 of the *Wisconsin Administrative Code*; placement of bottom covers, a physical measure, require a WDNR permit under Chapter 30 of the *Wisconsin Statutes*; and all other aquatic plant management practices are regulated under Chapter NR 109 of the *Wisconsin Administrative Code*. Costs for these measures range from minimal, for manual removal of plants using rakes and hand-pulling, to up to $25,000 per year for mechanical harvesting, not including the purchase of a harvester, depending on staffing and operation policies.

The aquatic plant management elements presented in this report consider alternative management measures consistent with the provisions of Chapters NR 103, NR 107, and NR 109 of the *Wisconsin Administrative Code*. Further, the alternative aquatic plant management measures are consistent with the requirements of Chapter NR 7 of the *Wisconsin Administrative Code*, and with the public recreational boating access requirements relating to the eligibility under the State cost-share grant programs, set forth under Chapter NR 1 of the *Wisconsin Administrative Code*.

Physical Measures

Two common physical measures are used to control aquatic plants in lakes. The first measure is the use of lake bottom covers or light screens that provide limited control of rooted plants by creating a physical barrier that reduces or eliminates the sunlight available to the plants. Screens are often used to create swimming beaches on muddy shores, to improve the appearance of lakefront property and to open channels for motorboating. Various materials, with varied success rates, are available for these kinds of measures. Sand and pea gravel, for example, which are usually widely available and relatively inexpensive, are often used as cover materials despite the fact that plants readily recolonize areas where they are used. Other options include synthetic materials, such as polyethylene, polypropylene, fiberglass, and nylon, which can provide relief from rooted plants for several years. These materials, known as bottom screens or barriers, generally have to be placed and removed annually, as they are susceptible to disturbance by watercraft propellers, as well as the build-up of gasses from decaying plant biomass trapped under the barriers. In the case of School Section Lake, the need to encourage continued native aquatic plant growth, while simultaneously controlling the growth of exotic species, suggests that the placement of lake bottom covers will not be helpful as a method to control for aquatic plant growth. Thus, such measures, for the purpose of aquatic plant management,[2] are not currently considered viable for School Section Lake.

The second common physical measure involves periodic drawdown of lake levels which can be used to reduce the growth of some shoreland plants by exposing the plants to climatic extremes, while the growth of others is unaffected (in-lake plants) or enhanced (wetland plants like cattails). Both desirable (native plants) and undesirable (nonnative) plants are affected by such actions. Costs are primarily associated with loss of use of the waterbody surface area during drawdown. The effectiveness of this measure is variable, with the most significant

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[2]*Lake bottom covers for the purpose of increasing shoreline recreational use are further discussed in Chapter IV of this report.*

side effect being the potential for increased wetland and aquatic plant growth due to the shallower depths. Drawdowns can also affect the lake fisheries and wildlife populations both indirectly, by reducing the numbers of food organisms (plants), and directly, by reducing available habitat and desiccating (drying out) eggs in spawning habitats. Other adverse impacts of lake drawdown include algal blooms after reflooding, loss of use of the lake during the drawdown, changes in species composition, and a reduction in the density of benthic organisms.

Because many of the desirable, native aquatic plants exist in the near shore areas around School Section Lake (areas which are vulnerable during a drawdown), as can be seen in Appendix B, and because of the potential for increasing the spread of cattails further into the Lake (an issue of concern discussed in Chapter II), implementation of a drawdown for the purpose aquatic plant management[3] is not considered a viable option for School Section Lake.

Biological Measures

Biological controls offer an alternative approach to controlling nuisance plants. Classical biological control techniques, which use herbivorous insects to control nuisance plants, have been shown to be successful.[4] However, studies on the most commonly discussed of these methods, the utilization of *Eurhychiopsis lecontei*, an aquatic weevil species, to control Eurasian water milfoil, have resulted in variable levels of success, with little control being achieved on those lakes having extensive motorized boating traffic. Thus, the use of *Eurhychiopsis lecontei* as a means of aquatic plant management control is not considered a viable option for use on School Section Lake at this time.

Manual Measures

The manual removal of specific types of vegetation by manual harvesting provides a highly selective means of controlling the growth of nuisance aquatic plant species, including Eurasian water milfoil. There are two common manual removal methods: raking and hand-pulling.

The first of these methods, raking, is completed in nearshore areas with specially designed rakes. The use of such rakes, provides an opportunity to remove nonnative plants in shallow nearshore areas, and a safe and convenient method for controlling aquatic plants in deeper nearshore waters around piers and docks. The advantages of the rakes are that: 1) they are relatively inexpensive, costing between \$100 and \$150 each; 2) they are easy and quick to use; and 3) they immediately remove the plant material from a lake, without a waiting period, thereby preventing sedimentation processes. Should the School Section Lake Management District decide to implement this method of control, it could acquire a number of these specially designed rakes for use by the riparian owners on a trial basis.

The second manual control, hand-pulling of stems, provides an alternative means of controlling plants, such as Eurasian water milfoil, in the Lake. This method, which can be done using divers or simply by wading into the water, is particularly helpful when attempting to target nonnative plants in the high-growth season, when native and nonnative species often coexist. This is due to the fact that this method allows for higher selectivity than rakes, harvesters, and chemical treatments, and, therefore, results in fewer losses of native plants. Given this great advantage, hand-pulling-based removal of Eurasian water milfoil is considered a viable option in School Section Lake, where practicable and feasible.

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[3]*Drawdowns for the purpose of sediment compaction and wildlife enhancements are further discussed in Chapter IV of this report.*

[4]*B. Moorman, "A Battle with Purple Loosestrife: A Beginner's Experience with Biological Control,"* LakeLine*, Vol. 17, No. 3, September 1997, pp. 20-21, 34-3; see also, C.B. Huffacker, D.L. Dahlsen, D.H. Janzen, and G.G. Kennedy,* Insect Influences in the Regulation of Plant Population and Communities*, 1984, pp. 659-696; and C.B. Huffacker and R.L. Rabb, editors,* Ecological Entomology*, John Wiley, New York, New York, USA.*

Pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, both raking and hand-pulling of aquatic plants along a 100-foot length of shoreline is allowed within a 30-foot-wide corridor without a WDNR permit, provided that the harvested plant material is removed from a lake. Any other manual harvesting would require a State permit, unless employed in the control of designated nonnative invasive species, such as Eurasian water milfoil or curly-leaf pondweed. In general, all State permitting requirements for manual aquatic plant harvesting mandate that all harvested material be removed from the lake.

Mechanical Measures

Aquatic plants may also be harvested mechanically with specialized equipment. The most common mechanical technique uses what is known as a harvester. This equipment, which School Section Lake Management District currently possesses, consists of a cutting apparatus, which cuts up to about five feet below the water surface, and a conveyor system that picks up the cut plants. Mechanical harvesting can be a practical and efficient means of controlling sedimentation, as well as plant growth, as it removes the plant biomass and the associated nutrients from a lake. Mechanical harvesting is particularly effective as a measure to control large-scale growths of aquatic plants. Narrow channels can, however, be harvested to provide navigational access and “cruising lanes” for predator fish to migrate into the macrophyte beds to feed on smaller fish.

An advantage of mechanical aquatic plant harvesting is that the harvester typically leaves enough plant material in a lake to provide shelter for aquatic wildlife and to stabilize the lake bottom sediments. Aquatic plant harvesting also has been shown to facilitate the growth of native aquatic plants by allowing light penetration to the lakebed.

A disadvantage of mechanical harvesting is that the harvesting operations may cause fragmentation of plants and, thus, unintentionally facilitate the spread of Eurasian water milfoil, which utilizes fragmentation as a means of propagation. Harvesting may also disturb bottom sediments in shallow areas, thereby increasing turbidity and resulting in deleterious effects, including the smothering of fish breeding habitat and nesting sites. Disrupting the bottom sediments also could increase the risk of nonnative species recolonization, as these species tend to thrive under disturbed bottom conditions. To this end, most WDNR-issued permits do not allow harvesting in areas having a water depth of less than three feet, which would limit the utility of this alternative in some littoral areas of the Lake and, especially, at the inlet and outlet. Nevertheless, if done correctly and carefully, harvesting has been shown to be of benefit in ultimately reducing the regrowth of nuisance plants when used under conditions suitable for this method of control. Given the extent of area needing aquatic plant management, the nature of sedimentation in the Lake (i.e. caused by plant death as opposed to erosion), and the plant species composition in the Lake, mechanical harvesting with a harvester continues to be considered a viable management option, subject to permit requirements and provisions.

In addition to harvesting with a harvester, there is an emerging harvesting method called Diver Assisted Suction Harvesting (DASH). DASH, also known as suction harvesting, is a mechanical process where divers pick aquatic plants by their roots at the bottom of the lake and then insert the whole plant into a suction device which takes the plant up to the surface of the lake for disposal. The process is essentially a more efficient method for hand-pulling plants within a lake. This year (2014) is the first year this method has been widely implemented within Wisconsin. Long-term evaluation of the method will take place over time to determine the efficacy of the technique, however, intuitively there are many advantages to the method, including: 1) lower possibility of plant fragmentation in comparison to harvesting and traditional hand-pulling, thereby reducing regrowth of invasive plants like Eurasian water milfoil; 2) increased selectivity in terms of plant removal, in comparison to harvesting with a harvester, thereby reducing the loss of native plants; and 3) lower frequency of fish habitat disturbances. Given the need to control Eurasian water milfoil in the Lake while still protecting native plants, DASH is considered viable, subject to permit requirements and provisions, particularly in areas where invasive plants are located in areas with high ecological value (see Map 2 in Chapter II of this report).

Chemical Measures

Chemical treatment with herbicides is a short-term method of controlling heavy growths of nuisance aquatic plants. Chemicals are generally applied to growing plants in either a liquid or granular form. The advantages of using chemical herbicides to control aquatic plant growth are the relatively low-cost, as well as the ease, speed, and convenience of application. The disadvantages associated with chemical control include: 1) unknown long-term effects on fish, fish food sources, and humans; 2) a risk of increased algal blooms due to the eradication of macrophyte competitors; 3) an increase in rates of sedimentation (due to large-scale plant death), possibly leading to increased plant growth, as well as anoxic conditions which can cause fish kills; 4) adverse effects on desirable aquatic organisms; 5) loss of desirable fish habitat and food sources; and, finally, 6) a need to repeat the treatment the following summers due to existing seed banks and/or plant fragments.

If chemical measures are used, early spring treatments should be considered due to the fact that colder water temperatures enhance the herbicidal effects, thereby reducing the concentration and volumes of chemicals needed. Additionally, most native aquatic plants species are dormant in the early spring, therefore, early spring treatments limit the potential for collateral damage when attempting to treat for Eurasian water milfoil and curly-leaf pondweed. Whenever possible, the application of chemical controls should be limited to small areas in order to further reduce the risk of sedimentation and human exposure. Use of chemical herbicides in aquatic environments is stringently regulated and requires a WDNR permit and WDNR staff oversight during applications.

Use of early spring chemical controls, especially in the inlet and shoreline areas where water depths would prohibit mechanical harvesting, is considered a viable option for School Section Lake, subject to permits and revisions. This application should target growths of Eurasian water milfoil and other invasive nuisance aquatic plants, but should be limited to areas which are not deemed of high ecological value (see Map 2 in Chapter II of this report).

WETLAND PLANT MANAGEMENT MEASURES

As mentioned above, three terrestrial plants commonly found in wetlands should be considered for management. The first of these plants, as discussed in Chapter II of this report, are cattails, which are located throughout the wetland area in the northeastern portion of the Lake designated an area of high ecological value. The second plant is the bulrush, often confused with cattails, which were found along the western edge of the wetland area, as well as in the southeastern corner of the Lake. The final plant is purple loosestrife (see Figure 7) which was found along the southern shoreline of the Lake. The control measures of each of these plants are further discussed below.

Cattails and Bulrushes

As discussed in Chapter II, cattails are a valuable wetland plant that provide habitat for wildlife and act as buffers that stabilize soils and filter pollutants. However, it was noted that cattails were growing into the navigational lanes located on the southeastern area of the Lake. Consequently, the management of this species, particularly if it is determined to be an invasive species, i.e., *Typha angustifolia*, or a hybrid, should be considered a priority. Bulrushes, though similar to cattails, grow in deeper waters and are not as quick at establishing themselves. They do, however, provide similar benefits as cattails, as well as cause similar navigational issues.[5]

There are two accepted measures of control for cattails and bulrushes in Wisconsin, including mechanical/manual controls and chemical controls. The first of these involves cutting the stems, both green and dead, in mid to late summer or early fall. In cattails, this measure is most advantageous when water levels are maintained a minimum of three inches above the cut stems for the entire growing season wherever possible. In bulrushes, this measure is most effective when completed frequently throughout the growth season.

The second control measure is chemical control through the use of herbicides. Considering that the cattails are only an issue when they impede navigational lanes, and that chemical treatment could potentially pose a risk to native species, mechanical control of these species, while completing harvesting activities, is considered the most viable option for School Section Lake.

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[5]*T. Sons, "Bulrushes - Not to Be Confused With Cattails,"* Ezine Articles, *September 29, 2009.*

Figure 7

PHOTOGRAPH OF PURPLE LOOSESTRIFE

Source: Leslie Mehrhoff, Invasive Plant Atlas of New England.

Purple Loosestrife

Though not discussed in Chapter II as an identified issue of concern, purple loosestrife (Figure 7), an invasive nonnative wetland species, was found along the southern and northern shores of the Lake. This species has a tendency to take over wetland communities, creating monocultures that ultimately harm local wildlife, as well as wetland functions, such as pollution filtration; consequently, it should be considered a priority species to control.[6]

There are three kinds of approved controls for purple loosestrife, including manual, chemical, and biological controls. The first two are typically used on smaller infestations, as they can be very labor intensive and/or expensive on large sites. These measures may require follow-up work in subsequent years. The third option, biological controls, involves the release of a particular herbivorous insect that targets the species. Since this infestation appears to be minimal, manual removal, with careful consideration being placed on preventing seed dispersal, is likely the most viable option in School Section Lake. However, if chemical treatment is considered, a WDNR permit will be required given the proximity of the infestation to the Lake. Additionally, if dense purple loosestrife communities are detected in the wetlands surrounding the Lake, the use of biological controls may also be warranted.

PLANT MANAGEMENT RECOMMENDATIONS

The most effective plans for managing nuisance aquatic and wetland plants rely on a combination of methods and techniques. Therefore, to enhance the recreational uses of School Section Lake, while maintaining the quality and diversity of the biological communities, five recommendations are discussed within this report. These recommendations include: 1) mechanical harvesting as the primary control measure for nuisance plant growth on the Lake; 2) hand-pulling and/or raking invasive species in areas with depths less than three feet as well as in high ecological value areas; 3) consideration of suction harvesting in the high ecological value areas where Eurasian water milfoil is present; 4) consideration of early-spring chemical treatment of Eurasian water milfoil present at the inlet and along the Lake shorelines; 5) manual control of purple loosestrife along the shorelines (unless dense mats are found, in which case biological controls are recommended). Each of these recommendations, as well as details on their implementation, is presented below. Map 5 provides guidance on where each recommendation should be implemented based on 2012 observations and previous management activities.

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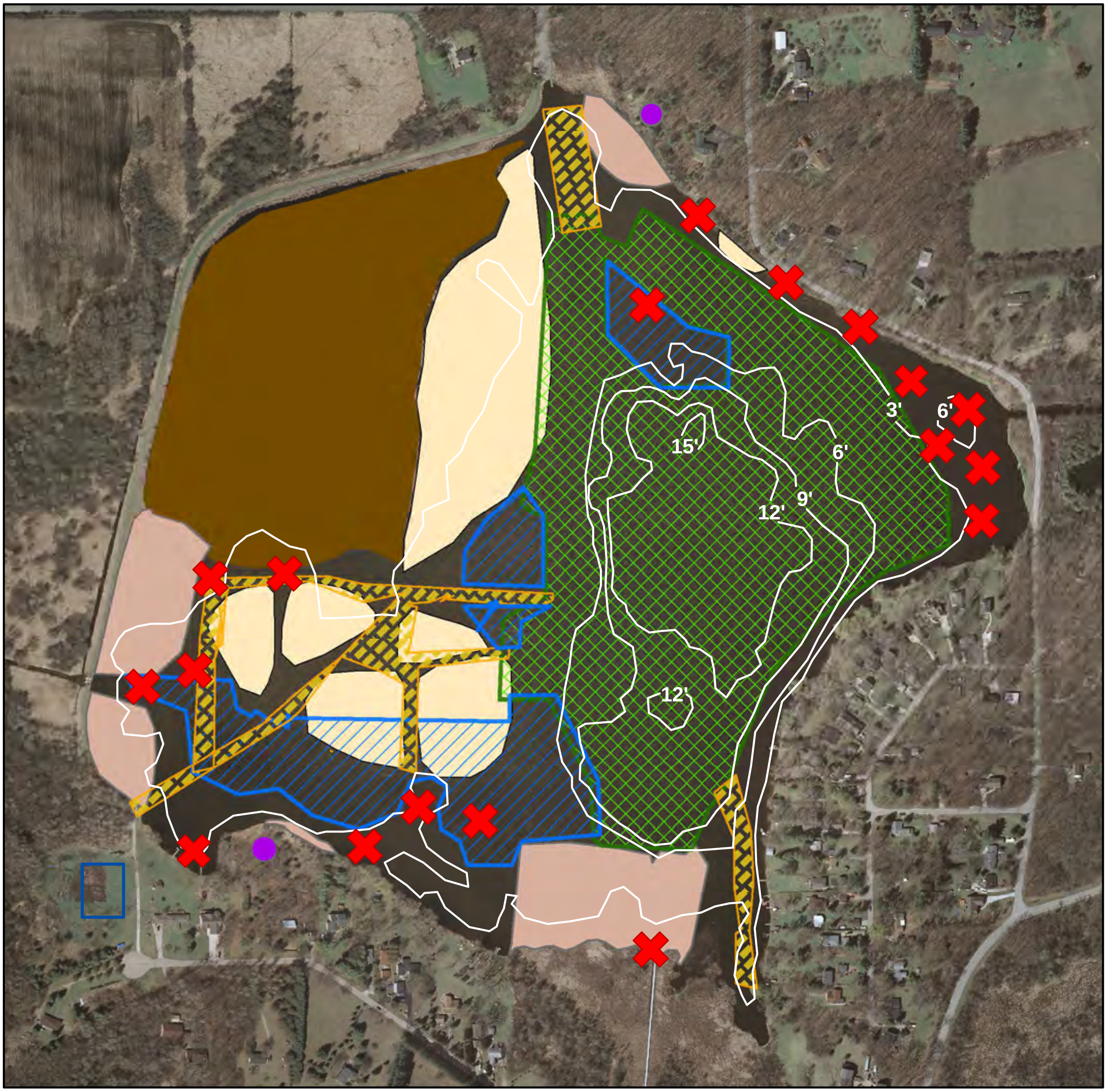
[6]*Wisconsin Department of Natural Resources and University of Wisconsin-Extension,* Purple Loosestrife: A Major Threat to Wisconsin's Wetlands and Waterways, *PUB-WT-829 2006, 2006.*

Map 5

PLANT MANAGEMENT PLAN FOR SCHOOL SECTION LAKE



AREAS TO PROTECT

- Cattails
- Water Bulrush
- Water Lilies

AREAS FOR HARVESTER

- Harvest
- Navigation (minimal damage)
- Top Cut
- Harvesting Disposal Site

OTHER RECOMMENDATIONS

- **Eurasian Water milfoil** (Areas to target Eurasian water milfoil with suction harvesting and hand-pulling or chemical treatment, subject to permitting requirements, if other two are not deemed feasible due to the presence of dense mats)
- **Purple Loosestrife** (Area to target manual removal if sparsely dispersed and chemical or insect treatments if formed in dense mats)

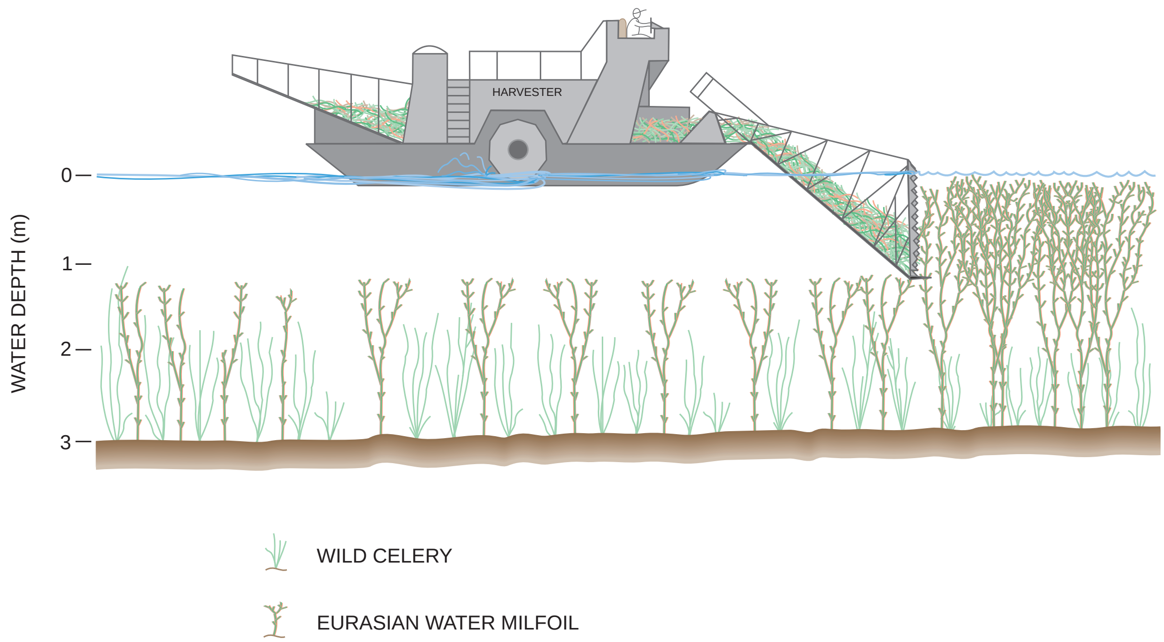
N

0 250 500 Feet

Source: SEWRPC.

Figure 8

PLANT CANOPY REMOVAL OR TOP CUTTING WITH AN AQUATIC PLANT HARVESTER



NOTE: Selective cutting or seasonal harvesting can be done by aquatic plant harvesters. Removing the canopy of Eurasian water milfoil may allow native species to reemerge.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Mechanical Harvesting

Mechanical harvesting should be implemented as the primary method of aquatic and wetland plant management in School Section Lake, so as to ensure recreational boating opportunities, as well as reduce sedimentation rates. A WDNR permit is required for these activities. Additionally, when implementing this recommendation the following elements should be taken into consideration:

1. ***Harvesting should generally begin in the late spring***, i.e., May to June, in order to target Eurasian water milfoil and curly-leaf pondweed prior to extensive native plant growth. This timing can, however, be problematic, as it coincides with the late spring, early summer spawning periods of panfish and largemouth bass, both of which are present in School Section Lake. Consequently, during these spawning periods, ***it is recommended to minimize harvesting activities to only those essential for providing boating access and/or public safety***, i.e., harvesting should only begin when access begins to be impaired.

2. All harvesting be ***limited to those areas with water depths of more than three feet*** in order to prevent sediment disturbance and, thereby, help prevent water clarity issues and colonization of invasive species. The bathymetric lines on Map 5 provide guidance on where these depths would likely occur, however, water depths can change from year to year, depending on precipitation patterns; consequently, the harvester operator will need to monitor depth throughout any harvesting activities and cease harvesting when depths are too low.

3. Harvesting activities should ***attempt to maintain native plant communities through the use of "top cutting"*** (see Figure 8) in areas with high native populations, particularly those areas which contain muskgrass as a dominant species (see Appendix B for muskgrass distributions in the Lake). This will

help maintain fish populations and natural plant communities, while still controlling invasive species. Map 5 provides guidance on where these "top cut" areas should most likely be located, based on 2012 survey data; however, as plant composition can change from year-to-year, the harvester operator will need to take stock of plant composition prior to cutting, in order to determine if a "top cut" is necessary.

4. ***In areas where coontail and Eurasian water milfoil are dominant, "deep harvesting" should be implemented***. However, ***a minimum of 12 inches or one foot of plant material should be left along the lake bottom*** in these areas in order to prevent sediment disturbance and subsequent water clarity and invasive species colonization issues. Map 5 provides guidance on where these "deep cut" areas would most likely be located, based on 2012 survey data; however, as with the "top cut" areas, the harvester operator will need to take stock of plant composition prior to cutting, in order to determine if a "deep cut" is necessary.

5. A ***50-foot-wide "access lane" and 10-foot-wide "navigation lanes" should be cut with a minimum of 12 inches or one foot of plant material being left along the lake bottom***. This will ensure boating access, navigation capabilities, and fish predation opportunities, while preventing sediment disturbance. Map 5 indicates where these lanes should likely be located, with the access lane being located at the north end of the Lake, beginning at the public access site.

6. Harvesting activities should ***avoid cutting plants in high-value ecological areas***, except in those cases where these plants impair navigation. This will prevent the loss of wildlife, while still maintaining navigational use. Map 5 indicates the areas which should be protected within the Lake, as well as the areas where these areas may impede navigation, i.e., the areas where the "harvest" and "top cut" areas overlap with the "areas to protect." Like with the other components of the map, some change is expected from year to year; consequently, the harvester operators, will need to use their best judgment when determining when plants "impede navigation."

7. All ***debris resulting from harvesting activities should be collected and disposed of at the designated disposal site***, as shown on Map 5. Special care should be taken to that assure no cut plants are deposited in the wetland portion of the lot, as is shown in the wetland delineation report provided in Appendix D. Additionally, evidenced by the fact that a complaint was made about cut plant accumulation on the shorelines, further manual collection of cut plants may also be necessary. The implementation of this recommendation could be done by lake residents or other volunteers in collaboration with the School Section Lake Management District.

8. Finally, mechanical harvesting should be guided by both official and unofficial aquatic plant surveys. Therefore, WDNR requires the ***completion of an in-lake aquatic plant survey every five years***. In addition, information on the aquatic plant control program should be recorded on an annual basis and should include descriptions of major areas of nuisance plant growth and areas to be harvested. Aquatic plant harvester operators should, therefore, be trained to identify the major aquatic plant species present in the Lake and should keep records of the most abundant species harvested.

In order to help future harvester operators in the implementation of the above guidelines and recommendations, a modified harvesting map and shortened set of guidelines are provided in Appendix E. Additionally, pictures of all the aquatic plants, including the five most abundant, as well as guidance on their identification, is provided in Appendix B. This map, the guidelines, and copies of the identification guides for coontail, Eurasian water milfoil, curly-leaf pondweed and muskgrasses, should be provided to harvesting staff to help assure that implementation of the harvesting recommendations produce ample recreational opportunities for lake residents and users, without jeopardizing native plant populations and local wildlife.

Manual Harvesting

Manual harvesting, i.e., hand-pulling and raking, is recommended in areas less than three feet deep as well as in areas with high coincidence of native plants and Eurasian water milfoil. These efforts should seek to reduce nuisance plants that impede navigation, as well as seek to control Eurasian water milfoil without jeopardizing native plants. To this end, School Section Lake Management District should consider educating Lake residents on hand-pulling, as well as consider purchasing specially designed rakes for use by the riparian owners on a trial basis. Additionally, the District should also consider a hand-pulling campaign, potentially using divers, for the purpose of removing Eurasian water milfoil in areas where deep cuts are not permitted in the Lake.

A permit is not required for these activities within 30 feet from the shoreline, as long as all plant materials are removed from the Lake. A permit is also not required if the target species are nonnative plants only. Map 5 provides indication as to where nuisance and invasive species are likely to be located along the lake shoreline and within the high ecological value areas, based on the 2012 survey; however, as mentioned above, some changes may have occurred. Consequently, educating residents about the need to prevent extensive loss of native plants, and plant identification, should be considered in order to ensure that this recommendation does not harm local wildlife and plant communities. This campaign could be implemented using pamphlets, community meetings, and other educational outlets.

Suction Harvesting (DASH)

The use of suction harvesting should be considered, upon consultation with WDNR, for controlling nuisance growths of invasive species in areas that only allow for shallow cuts with the mechanical harvester or where mechanical harvesting is not viable, like at the inlet to the Lake, in the high value ecological areas (see Map 2 in Chapter II of this report) and, potentially, along the shorelines. Map 5 indicates the areas that contained exotic species, according to the 2012 aquatic plant survey, which might be best targeted using suction harvesting if desired; however, as discussed previously, changes in communities are possible from year to year. Consequently, the abundance of Eurasian water milfoil in these areas will need to be re-evaluated annually to determine if this recommendation is viable. A WDNR permit is required to implement this alternative. In general, suction harvesting can be used for both sparse and large mats of Eurasian water milfoil; however, large mats may result in this method becoming cost-prohibitive. Consequently, if dense mats occur in these areas, it may be more viable to use chemical controls, as discussed below.

Chemical Controls

The use of chemical herbicides should be considered for controlling nuisance growths of invasive species in areas where mechanical and suction harvesting are considered not viable, particularly in areas with dense mats of invasive plants where suction harvesting can be cost-prohibitive. Only herbicides that somewhat selectively control Eurasian water milfoil and curly-leaf pondweed, such as 2,4-D and endothall,[7] should be used. If 2,4-D is used, its application should be limited to early spring and small areas, wherever possible, due to the controversy surrounding its potential effects on humans as a carcinogen, as discussed in Chapter II. A WDNR permit, as well as WDNR staff supervision, is required to implement this alternative. Map 5 indicates the areas at the inlet and around the shoreline that contained exotic species, according to the 2012 aquatic plant survey, and therefore may require chemical treatment; however, as discussed previously, changes in communities are possible from year to year. Consequently, the abundance of Eurasian water milfoil in these areas will need to be re-evaluated on an annual basis if this recommendation is implemented.

Manual Control of Purple Loosestrife

Control of purple loosestrife using manual extraction in areas where the plant is sparse or using biological controls (i.e. the raising and release of insects that eat the plant) in areas with dense population is recommended around School Section Lake. This will help prevent the spread of this species and help protect wildlife in the area. Map 5 shows where purple loosestrife was observed during the 2012 survey, however, it is possible that this species has spread in the past two years. If implemented, this recommendation could potentially be completed by

[7]*See Wisconsin Department of Natural Resources Publication No. PUB-WT-964 2012,* 2,4-D Chemical Fact Sheet*, January 2012; see also Wisconsin Department of Natural Resources Publication No. PUB-WT-970 2012,* Endothall Chemical Fact Sheet*, January 2012.*

Lake residents or other volunteers, under the supervision of School Section Lake Management District staff. If manual removal is undertaken, careful precautions, however, would need to be taken to prevent seed dispersal to the greatest extent possible, i.e., bagging the flowers immediately.

Other Recommendations

Though not discussed in depth in this report, there is a risk of new infestations of invasive species in School Section Lake. Therefore, additional periodic monitoring of the aquatic plant community is also recommended for the early detection and control of future-designated nonnative species that may occur. If new infestations do occur, funds for controlling them may be obtained through the Chapter NR 198, aquatic invasive species control grant program. Control activities should be undertaken as soon as possible once the presence of a nonnative, invasive species is observed and confirmed. This will reduce the risk of spreading these species and increase the chance of restoring native aquatic communities.

SUMMARY AND CONCLUSIONS

The recommendations contained in this report, as summarized in Table 3, should provide the basis for a set of management actions that can effectively manage the aquatic and wetland plants within School Section Lake, for the next five-year period. Additionally, this report should provide the School Section Lake Management District with all of the materials required for the permitting and implementation of the recommendations. Accordingly these recommendations are: 1) aligned with the goals and objectives set forth in Chapter I of this report, as they relate to aquatic plant management; 2) reflective of the ongoing commitment by the School Section Lake community to sound planning with respect to the Lake; and 3) sensitive to current Lake needs, as well as those in the near future.

Table 3

RECOMMENDED PLANT MANAGEMENT PLAN ELEMENTS FOR SCHOOL SECTION LAKE

Management Measures	Implementation Materials Provided/Available	Management Responsibility
Mechanically harvest, with a harvester, nuisance plants in those areas where species and water depth are conducive in order to: • Maintain boating access—Cut approximately 50-foot-wide access lane • Enhance angling opportunities—Cut 10-foot-wide "cruising lanes" • Control invasive species—Target Eurasian water milfoil and coontail with deep cutting in regions where these species dominate • Encourage native plant growth/biodiversity—Minimize treatments during fish breeding seasons to those essential for providing boating access/public safety; perform top cut in regions with high native plant diversity	Appendix B—Plant population and identification guidance Appendix D—Wetland delineation report on disposal site Appendix E—Harvesting map and shortened guidelines Map 5—Indicating areas to protect and areas to harvest	Wisconsin Department of Natural Resources (WDNR) and School Section Lake Management District (SSLMD)
Collect floating plant fragments from shoreland areas to minimize rooting of Eurasian water milfoil and deposition of organic materials into Lake	N/A	Private landowners, volunteers and SSLMD
Manually harvest in areas where harvesters are not permitted (in areas with depths less than three feet), including around piers and docks as necessary. Specifically target nuisance and nonnative plants[a]	Map 5—Indicating presence of nonnative and nuisance species along shoreline Appendix B—Plant identification guidance	Private landowners, with help from SSLMD
Consider suction harvesting for control of invasive and nuisance plants in areas where a harvester is not permitted (at depths less than three feet) or in areas where only top cuts are permitted (in areas with high species richness and high-value plants)	Map 5—Indicating presence of nonnative species in the Lake as well as areas where only top cuts are permitted Appendix B—Plant population and identification guidance	WDNR and SSLMD
Limited use of aquatic herbicides for control of nuisance nonnative aquatic plant growth where necessary (with emphasis on the inlet); specifically target Eurasian water milfoil[b]	Map 5—Indicating presence of nonnative species at the inlet Appendix B—Plant population and identification guidance	WDNR and SSLMD
Manual control of purple loosestrife	Map 5—Indicating presence purple loosestrife along the shoreline WDNR publication on purple loosestrife, PUB-WT-829 2006	Private landowners, with help from SSLMD
Continued monitoring of aquatic plant communities through aquatic plant survey every five years and annual monitoring by harvester	Appendix B—Plant population and identification guidance	School Section Lake Management District
Continued monitoring for new invasive species within the Lake	WDNR publication on aquatic invasive species, PUB-WT-960-2011	SSLMD and private landowners

NOTE: N/A indicates not applicable.

[a]*Manual harvesting beyond a 30-linear-foot width of shoreline is subject to WDNR individual permitting pursuant to Chapter NR 109 of the* Wisconsin Administrative Code*, unless the target species is a nonnative plant (e.g., Eurasian water milfoil)*

[b]*Use of aquatic herbicides requires a WDNR permit pursuant to Chapter NR 107 of the* Wisconsin Administrative Code*.*

Source: SEWRPC.

Chapter IV

LAKE PROTECTION MANAGEMENT ALTERNATIVES AND RECOMMENDATIONS

INTRODUCTION

School Section Lake is considered a valuable natural and recreational resource, to shoreline resident and lake users. Consequently, it is important to make every effort to maintain and enhance the health of the Lake in order to encourage its continued enjoyment now and in the future. This chapter, therefore, highlights alternatives and recommendations that seek to address the issues of concern deemed relevant in Chapter II, and not addressed in Chapter III. Accordingly, the chapter is organized by the thematic areas discussed in Chapter II, namely: sedimentation; water quality; water quantity; wildlife enhancement; recreation; and regulation, with the management alternatives, as well as the recommendations, for each of these thematic areas being described. These descriptions are followed by a summary of all the recommendations within this report, as well as a general description of where to focus these efforts.

As was the case with Chapter III, the measures discussed in this chapter are primarily focused on measures that can be implemented by the School Section Lake Management District in collaboration with Wisconsin Department of Natural Resources (WDNR) and School Section Lake residents. However, partnerships with municipalities, developers, and landowners within the greater watershed may be necessary to ensure the achievement of long-term ecological health in School Section Lake. Therefore, the School Section Lake Management District is encouraged to continuously seek out projects and partnerships that will further aid in achieving the recommendations in this chapter.

Though the logistics for each recommendation may not be laid out; this chapter does provide some suggestions for potential projects. It is important to know, however, that these suggestions do not necessarily constitute recommendations. Alternatively, they are meant to help generate ideas about the types of projects to implement. In short, this chapter, is intended to provide a context for understanding what needs to be done, as well as to help outline a vision what those efforts might look like.

SEDIMENTATION

Mitigation efforts meant to deal with sedimentation and protect the investment made when the Lake was dredged in 1994 may be categorized into two types of projects: 1) those that address the source of the issue; and 2) those that deal with the symptom. The first of these categories are management efforts that seek to reduce sediment loadings at their source, thereby reducing the amount of sediments entering the Lake. These projects are ideal, long-term solutions. The second category generally involves in-lake or in-stream solutions, that either attempt to remove the already deposited sediments or seek to cover them up. These kinds of projects are almost always temporary solutions that require permanent maintenance, because the problem almost always persists.

In general, management of sedimentation should seek to reduce sediment loads at the source whenever possible. In-lake solutions should be considered only when the symptoms of sedimentation (e.g., water depth loss or mucky soils), become unmanageable. This strategy will help prevent the need for constant maintenance of the symptoms of sedimentation. This section, therefore, highlights the various types of projects in both of these categories that could be implemented to address the issue of sedimentation in School Section Lake.

Sediment Reduction at the Source

As mentioned in the "Sedimentation" section of Chapter II, there are two sources of sedimentation: 1) sediments that form on the bottom of the Lake due to excessive plant death (this is the major source of sedimentation in School Section Lake); and 2) eroded sediments that enter the Lake from the surrounding watershed. Reducing each of these at the source of the problem requires different management alternatives, as discussed below.

Plant-Based Sedimentation

Plant-based sedimentation, which is the major source of sedimentation in School Section Lake, can be prevented in one of two ways: 1) through removing the dead plant biomass from the lake to prevent its accumulation at the lake bottom (through harvesting plants either mechanically or manually); or 2) through preventing the growth of plants in general. As the plant-based sedimentation process is likely natural within School Section Lake, which is essentially a dammed marsh area, the first of these measures will likely be the most effective, further emphasizing the need to continue harvesting activities and consider suction harvesting and hand-pulling when dealing with nuisance plants in shallow areas (as discussed in Chapter III). However, high phosphorus levels in the Lake[1] may also be contributing to the process by encouraging excessive plant growth. Consequently, the implementation of the recommendations included in the Water Quality section of this chapter, that seek to reduce phosphorus loads may also contribute to the reduction of the sedimentation process.

Runoff-Based Sedimentation

As discussed in Chapter II, runoff-based sedimentation historically only had a minimal effect on the sedimentation rates within the Lake, likely due to the natural ability of the watershed to filter sediments prior to entering the Lake.[2] This fact emphasizes the need to protect the wetland, woodland, and open space areas within the watershed (which likely contribute to this natural filtration process). However, as was also discussed in Chapter II, construction upstream from the Lake, which occurred between 2006 and 2009, did have a significant impact on the water quality of the Lake;[3] with Lake residents stating that the water input from the inlet during that period had visible amounts of sediments. Consequently, when development occurs in the future, stringently enforcing Construction Site Erosion Control ordinances must be considered a top priority to prevent repetition of this incidence and reduce the sedimentation that could occur from this source. Additionally, School Section Lake Management District should consider making efforts to educate upstream developers of the best management practices they are legally required to implement according to Wisconsin Law. This will help prevent future litigation, as well as prevent future pollution from entering the Lake.

Finally, though likely not a significant source of sediments, it is possible that erosion occurring along the shoreline of the Lake and on upstream channels may also be sources of more recent sedimentation. Consequently, shoreline and tributary rehabilitation may be necessary. Details about these sources are further discussed below.

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[1]*Further details on phosphorus levels in the Lake are available in Appendix A in the Water Quality section.*

[2]*Further details on the watershed characteristics that allow for the deposition of sediments in the watershed are available in Appendix A in the Topography and Important Natural Areas sections.*

[3]*Wisconsin Department of Justice,* News Release*, February 2010.*

Shoreline Rehabilitation
The shoreline assessment completed in 2012 and presented in Appendix A of this report shows that various man-made structures, such as riprap and bulkheads, are intended to reduce erosion of the shorelines. It was also noted, however, that several portions of the shoreline are occupied by lawn being mowed to the Lake's edge, as can be seen on Map A-17 in Appendix A of this report. This practice can present a problem, particularly on the eastern shoreline of the Lake where water depths are conducive to boating activities. This is because wave action caused by boaters hits the shores, causing sediments to break off the shoreline and directly enter the Lake.

An illustration of both man-made structures and natural buffers is provided in Figure 9. Though the man-made structures, like the ones already found on many of School Section Lake's shorelines, do provide some protection, natural buffers, i.e., the establishment of native plants along the shoreline, provides the most ideal solution to preventing these erosional processes. This is because buffers not only reduce erosion through plant roots holding the sediments in place, they also provide natural habitat for fish and wildlife and aesthetic beauty around the lake. Additionally, buffers also have the added benefit of filtering pollutants from runoff that enters the Lake from the adjacent property. In general, riparian buffers are a "one-stop-shop" to providing wildlife enhancement, pollution reduction, and erosion control. Consequently, outreach efforts meant to encourage natural buffer installation are recommended for School Section Lake.

Tributary Rehabilitation
The tributaries to School Section Lake, as can be seen on Map A-1 in Appendix A of this report, are heavily channelized, i.e., they are organized in straight lines rather than naturally occurring "meandering" lines, as illustrated in Figure 10. This is likely the source of some sediment loads during rain events because water can travel through those channels at high speeds, thereby producing no opportunity for sediments to settle prior to entering the Lake. To determine if this phenomenon is, in fact, occurring, a study should be done to examine these regions. This could be implemented by walking the upstream tributaries, and searching for sources of erosion, as well as by examining water in the upstream tributaries, during a rain event, to evaluate the amount of sediments being transported by the water. If tributary erosion is found to be an issue, channel blocks or other remeandering projects should be considered as a means of preventing future erosion and subsequent deposition in the Lake.

In-Lake or Instream Projects
As mentioned above, in-lake and instream projects deal with sediment loads once they have already been deposited in the Lake or its tributaries. In general, these measures use temporary "fixes" to essentially "buy time." However, they are sometimes necessary to increase lake depth, increase shoreline swim-ability, and increase sandy lake bottoms, i.e., the issues of concern highlighted in Chapter II. The three most common kinds of projects, within this category include: 1) dredging, which removes sediments from the bottom of the Lake once sedimentation has occurred; 2) in-line detention ponds, which seek to "catch" sediments prior to their entering the lake; and 3) in-lake sediment "covers," which seek to cover the mucky sediments with more desirable materials. In addition to these measures, water level manipulations such as drawdowns have also been used in the region for the purpose of sediment compaction along the shorelines. Each one of these measures is further discussed below.

Dredging
As discussed in Chapter II of this report, School Section Lake underwent a large-scale dredging project, which was completed in 1994. Since the completion of that project, the maximum depth of the Lake had decreased from over 20 feet to about 15.5 feet by 2005,[4] indicating a high rate of sedimentation. Consequently, the implementation of a new dredging project, when sediment levels begin to greatly hinder the use of the Lake, would likely extend the dredging benefits within the Lake. The completion of this management alternative could employ a "whole lake" dredging project, similar to the one completed in 1994; however, given that the Lake levels are still adequate to allow for boating activity, this seems both cost-prohibitive and currently unnecessary. This need, however, should be periodically reevaluated.

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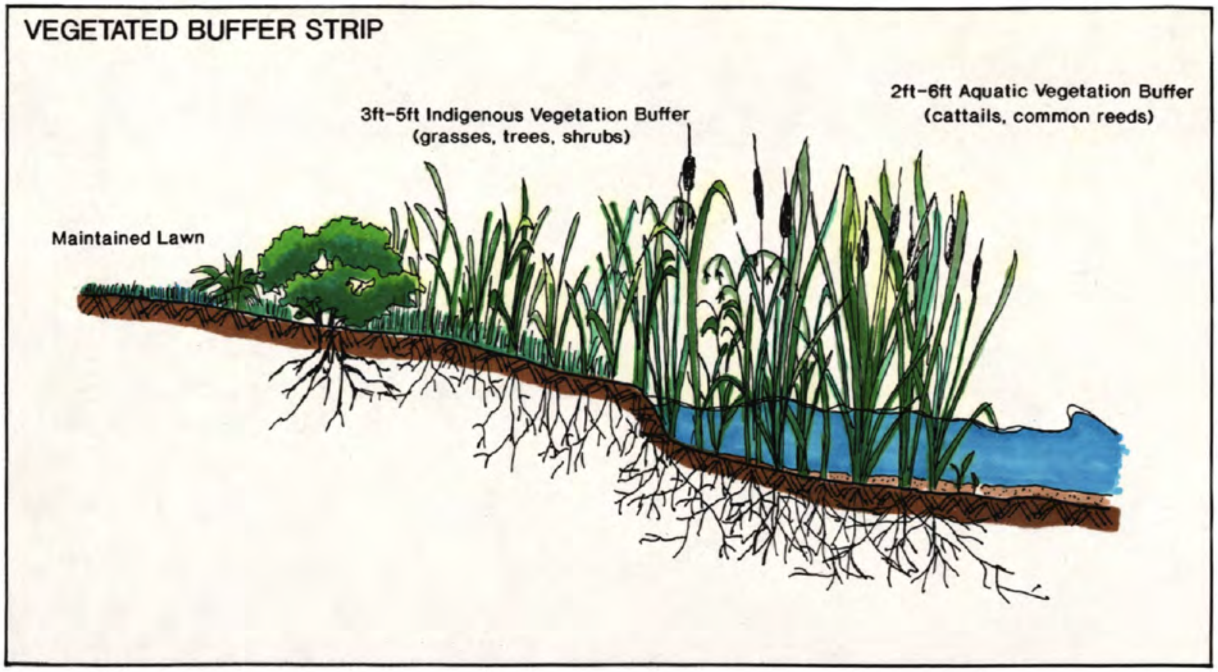
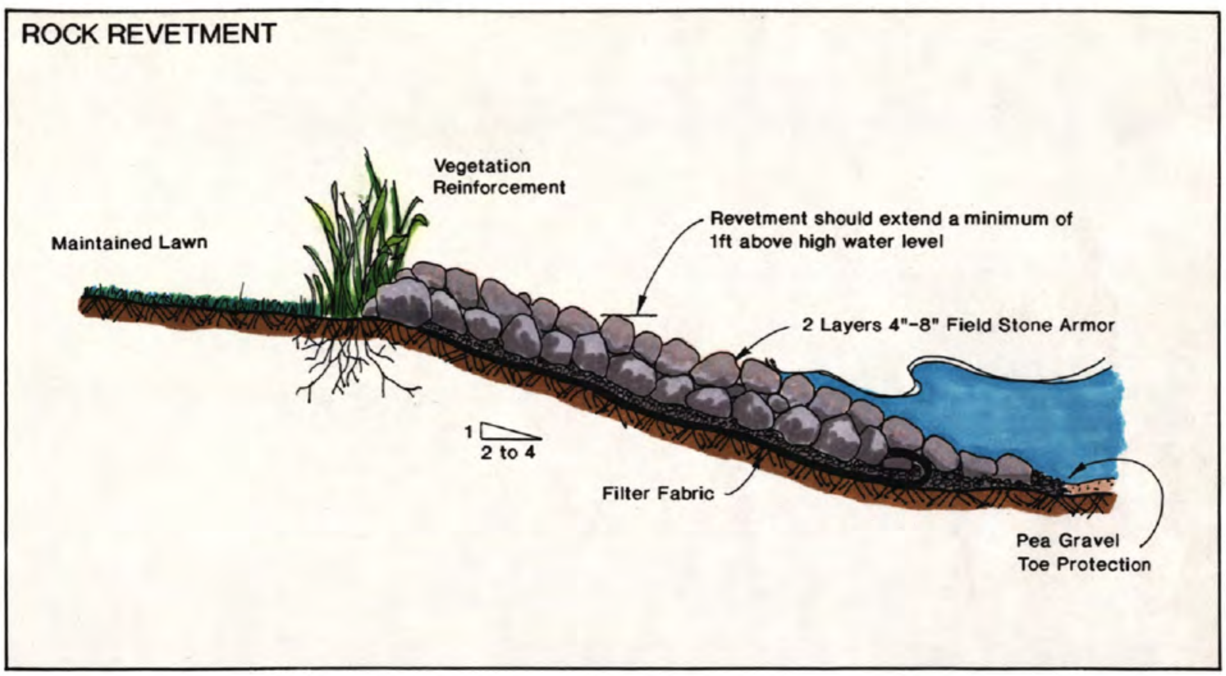
[4]*Marine Biochemists,* School Section Lake Hydro Acoustic Survey Results*, 2005.*

Figure 9

NATURAL SHORELINE BUFFERS IN COMPARISON TO MAN-MADE SHORELINE PROTECTIONS



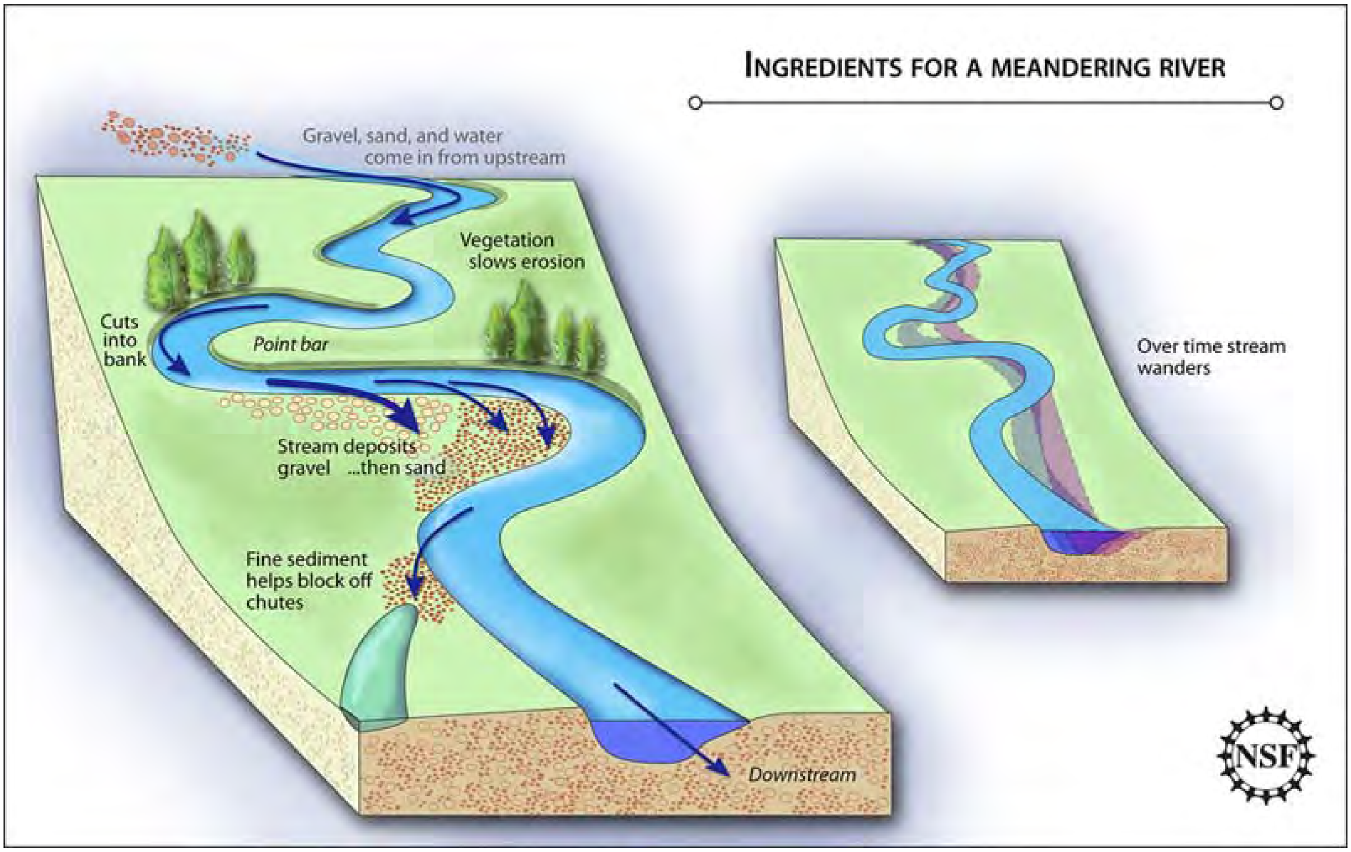


NOTE: Design specifications shown herein are for typical structures. The detailed design of shoreline protection structures must be based upon analysis of local conditions.

Source: SEWRPC.

Figure 10

SCHEMATIC OF A MEANDERING STREAM



Source: National Science Foundation.

Given two of the issues of concern related to sedimentation addressed issues along the shoreline (shoreline swimability and desire for sandy lakeshore bottoms), it may be more feasible to complete private "spot-dredging," projects that focus on particular problem areas. This kind of dredging would require the completion of a dredging feasibility study, as well as a WDNR permit. If this alternative considered a priority by the School Section Lake Management District or by private landowners, it is recommended that the School Section Lake Management District begin the process through an initial consultation with the WDNR staff to discuss next steps.

In-Line Detention Basin

This project essentially seeks to prevent the sediments from entering the Lake by essentially catching them prior to them entering the system. This is done by installing what are known as "in-line" detention ponds or basins, often built in areas adjacent to wetlands, as illustrated in Figure 11. This type of project has been implemented in some areas in southeastern Wisconsin, with success rates of 45 percent sediment reduction being shown.[5] However, these kinds of projects are often expensive and difficult to implement, due to regulatory restrictions (WDNR will rarely permit these kinds of projects within the Southeastern Wisconsin Region now because of

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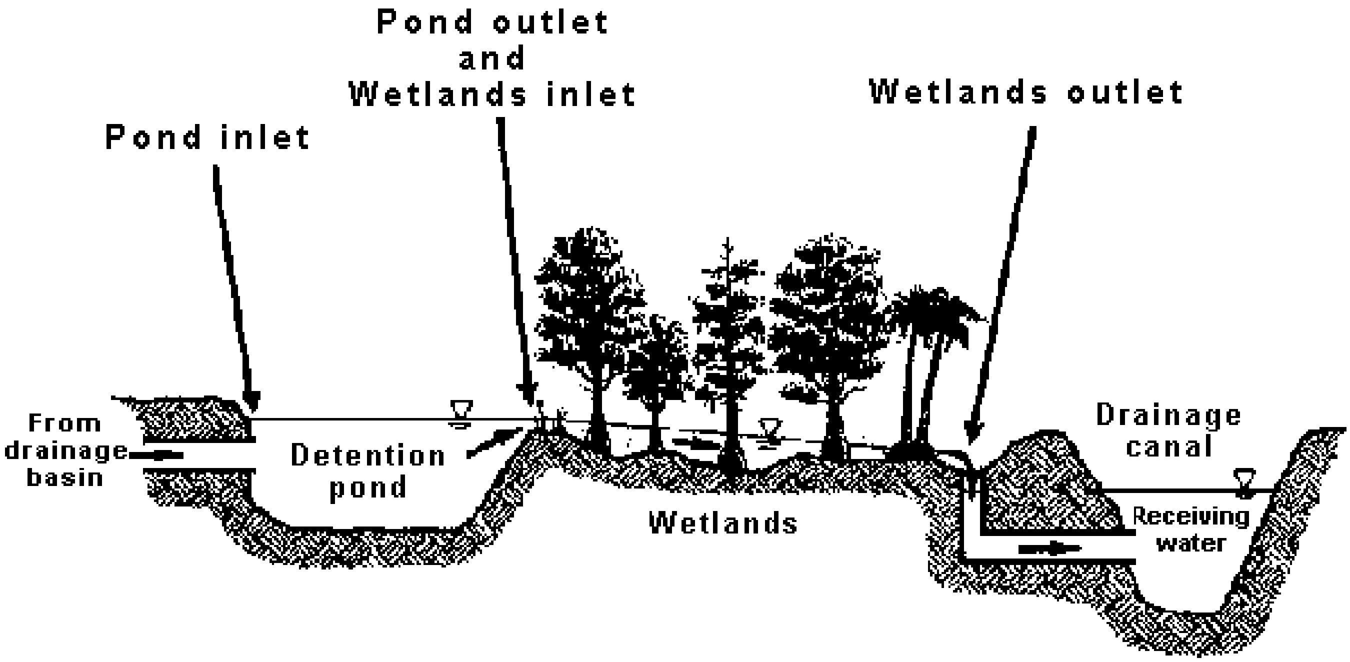
[5]*John F. Elder and Gerald L. Goddard, "Sediment and Nutrient Trapping Efficiency of a Constructed Wetland Near Delavan Lake, Wisconsin," U.S. Geological Service*, Fact Sheet FS-232-96, *1993-1995.*

Figure 11

SCHEMATIC OF A DETENTION BASIN USED IN CONJUNCTION WITH WETLANDS TO FILTER SEDIMENTS



Source: E.H. Martin and J.L. Smoot, "Constituent-load changes in urban stormwater runoff routed through a detention pond-wetlands system in central Florida: U.S. Geological Survey Water-Resources Investigations Report 85," 1986.

issues that have occurred in the past). Additionally, these projects have been shown to require permanent maintenance, as the basins require dredging on a fairly regular basis. This becomes problematic due to cost, as well as because dredging permits are required each time maintenance dredging is conducted. Given these constraints, in addition to the fact that much of the sedimentation is actually occurring from plant death and not from upstream erosion, this type of project is not considered viable in School Section Lake.

Covering Sediments
Artificially "covering" sediments is a type of project that attempts to cover up mucky bottom sediments with a pea gravel blanket, or sand, in the hopes of having a more desirable lake bottom. Unfortunately, these kinds of efforts require constant maintenance due to plant colonization as well as the process of sedimentation. However, if the need for constant maintenance is not a deterrence, then this measure may be viable to help private landowners increase their use of the Lake. In lakes, sand is not permitted because it can easily wash away; however, pea gravel is a viable option. Regardless of the material that is chosen, however, a permit, which requires a project design, is required to place the material on the beds of public waters (specifically in areas past the Ordinary High Water Mark).[6] Consequently, if this measure is desired by individual lakefront property owners, they should begin the project design and permitting process under supervision of WDNR. Instructions on how to apply for this individual permit are provided on the WDNR website.

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[6]*Ordinary High Water Mark refers to the "the point on the bank or shore up to which the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation or other easily recognized characteristic." In practice, this mark is legally defined by WDNR.*

Lake Drawdown
Sediment exposure and desiccation by means of a lake drawdown has been used in the region as a means of stabilizing bottom sediments.[7] During the period of drawdown, the exposed sediments are allowed to oxidize and consolidate, leading to the deepening of the lake by dewatering and compacting the bottom sediments. The amount of compaction depends upon the organic content of the sediment, the thickness of sediment exposed above the water table, and the timing and duration of the drawdown. This measure was suggested by the School Section Lake District as a potential method for consolidating shoreline sediments to provide relief to shoreline property owners.

Unfortunately, in order for sediment compaction to take effect, it would be necessary to draw the Lake down for a two-year period, at minimum, which would likely interfere with the recreational use of the Lake during that period as well as promote the colonization of wetland plants in the shallow areas located on the western side of the Lake (an issue of concern discussed in Chapter II). Additionally, a drawdown for that period of time could also lead to loss of native plants, loss of fish, and loss of amphibians and reptiles. Finally, the sediment compaction effect could potentially only last a short period of time once the sediments are rehydrated. Given the unpredictability of the results, the impairment of recreational uses, and the temporary nature of the beneficial effects of a drawdown, drawdown is not considered a viable option for School Section Lake.

Overall Sediment Recommendations
In order to ensure that the sedimentation issue is addressed on a long-term and sustainable basis, the following recommendations, as highlighted on Map 6, are recommended:

1. Implementation of harvesting measures described in Chapter III for the purpose of preventing plant based sedimentation.

2. Reduction of phosphorus loadings through the implementation of the recommendations included in the Water Quality section of this chapter.

3. Stringent enforcement of Construction Site Erosion Control ordinances as well as outreach to developers to ensure their knowledge of the legally mandated best management practices.

4. Implementation of sediment loading reduction measures within the watershed. These efforts should include:

    a. An investigation of sources of erosion within the watershed, with a particular focus on upstream channels. If this source of erosion is evident, efforts to reduce sediments through either channel blocking, buffer development, or other remeandering projects should be made a priority.

    b. Rehabilitation of the shorelines that exhibit signs of erosion around the Lake. To this end, educational outreach efforts and partnerships with riparian landowners should be established for the purpose of creating natural vegetative buffers along the shoreline (see Appendix F). If this is made a priority, it is recommended that the School Section Lake Management District apply for a Lake Protection Grant under the Healthy Lakes Initiative which provides funding for these kinds of projects.

5. Consideration of private "spot dredging" efforts in problem areas, to be implemented if the symptoms of sedimentation become unmanageable, and only after measures are being taken to reduce sedimentation at the source. If this alternative is deemed desirable, it is recommended that School

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[7] *City of Muskego, Big Muskego Lake and Bass Bay Management Plan, June 2004.*

Section Lake Management District begin the process by meeting with WDNR staff to discuss first steps and the completion of a feasibility study.

6. Consideration of private pea gravel blanket installation to provide increase shoreline swim-ability for shoreline property owners, subject to WDNR permit requirements.

Implementation of the recommendations related to sedimentation will require further logistical planning; however, they should be considered a priority for the continued maintenance and improvement of the Lake. Additionally, it is necessary to monitor the success of projects over time, as well as to quantify key parameters; therefore, it is also recommended that sediment depths, as well as lake depths be monitored on a regular basis. This will allow for the creation of a time series that can be evaluated to determine sedimentation rates.

WATER QUALITY

As with sedimentation, mitigation efforts meant to improve the water quality of a lake may be categorized into two types of projects: 1) those that deal with the source of the issue; and 2) those that deal with the symptoms. The first of these categories are management efforts that seek to reduce or filter pollution at their source, thereby reducing the amount of pollutants entering the lake. These kinds of projects are ideal, long-term solutions that seek to solve water quality issues. The second category generally involves in-lake solutions that either attempt to remove or suppress the already deposited pollutants or seek to deactivate them. These kinds of projects are often attractive because they are easy to understand and can be implemented within the direct drainage area of the lake, i.e., the areas within or directly adjacent to the lake; however, they are almost always temporary solutions that require permanent maintenance. This is because the problem almost always persists.

In general, management efforts seeking to improve water quality should attempt to reduce pollutant loads at the source wherever possible. In-lake solutions should only be used when the symptoms of pollution, e.g., excessive plant growth, annual fish kills, toxic algae growth, become unmanageable. This strategy will help prevent the need for constant maintenance of the symptoms of pollution. Accordingly, this section highlights the various types of projects from both of these categories that could be implemented to address the water quality issues within School Section Lake.

Pollution Reduction Measures

Projects that seek to reduce pollution at its source can either focus on preventing the pollution from occurring initially or focus on installing systems that naturally filter the pollutants prior to their entering the lake. The first of these options would focus on reducing: 1) erosion in general (which can cause the deposition of soils which contain phosphorus); 2) agricultural runoff (which often contains fertilizer contamination); 3) urban runoff (which can contain many kinds of pollutants), and 4) groundwater pollution (which can be a source of phosphorus that contaminates baseflow). The second of these would focus on installing natural buffer systems, which includes protecting currently established wetlands, uplands, and environmental corridors, for the purpose of encouraging natural filtration of pollutants prior to their entering the tributary system. Each of these measures is further discussed below.

General Erosion Control

As was discussed in Chapter II and in the Sedimentation section of this chapter, construction upstream from the Lake, which occurred between 2006 and 2009, had a significant impact on the water quality of the Lake.[8] In fact, it is suspected that the increases in phosphorus concentrations which were detected in School Section Lake, and ultimately caused the Lake to be place on the Wisconsin Impaired Waters List, were a potentially a direct result of this upstream construction activity. Consequently, the implementation of the erosion control as it relates to new developments (i.e., stringently enforcing Construction Site Erosion Control ordinance), which was discussed in the Sedimentation section of this chapter, is reiterated as a measure to maintain and improve water quality.

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[8]*Wisconsin Department of Justice,* News Release, *February 2010.*

Urban Runoff Reduction
Urban runoff, which is illustrated in Figure 12 and shown in Figure 13, is water which flows over residential and urban land, picking up pollutants such as oils, metals, *e-coli*, phosphorus, and chlorides along the way. This water then enters the lake either directly, in the case of residential runoff which occurs on riparian properties, or indirectly through the tributaries to the Lake.

The primary method of reducing pollution from residential sources involves the promotion of good urban land management and housekeeping practices. Some examples of these types of practices include: 1) fertilizer and pesticide use management efforts, preventing phosphorus and chemical pollution; 2) litter and pet waste controls, which reduce e-coli contamination and phosphorus pollution; 3) eliminating improper disposal of engine oils, as well as oil accumulation on driveways, which reduces oil and heavy metal pollution; and 4) management of leaf litter and yard waste, preventing phosphorus and sediment pollution.

In addition to best management practices that reduce *e-coli*, phosphorus, sediment, and chemical pollution, efforts to reduce chloride contamination, i.e., salt, should also be considered. This pollutant is generally the result of deicing efforts made on roads and driveways, as well as water softener discharge. Practices that could potentially reduce these pollutants could include: 1) an evaluation of existing road deicing and anti-icing programs with an emphasis on salt reduction;[9] 2) the establishment of new road deicing and anti-icing practices around the Lake, such as the use of salt brines or sand salt mixtures; and 3) the use of alternative technologies for softening potable water, such as reverse osmosis filters.

In School Section Lake the major source of residential pollution directly enters the Lake from riparian properties, though some residential property is located throughout the watershed. Consequently, the implementation of the recommendations discussed above should begin by targeting riparian landowners and then should expand to residential areas throughout the watershed once the program is established. In general, management of urban runoff should use the urban standards established under Chapter NR 151, “Runoff Management” of the *Wisconsin Administrative Code*, to inform planning efforts meant to resolve this issue.

Agricultural Runoff Reduction
As discussed in the “Pollutant Loadings” section of Appendix A, agricultural land use is the major source of phosphorus loadings to the Lake. Additionally, it can be a source of e-coli when animal manure is allowed to contaminate the waterways. Consequently, actions to reduce these loadings would likely have a high impact on the water quality of School Section Lake. The process by which this runoff occurs is also demonstrated in Figure 9.

Measures to reduce agricultural runoff are often limited to voluntary or incentive programs and partnerships. These measures generally seek to encourage and influence agricultural landowners to: 1) implement best management practices, such as reduced fertilizer and pesticide use, no tillage farming, and good manure management; and 2) install pollution reduction measures such as buffers, detention basins, and grassed waterways, as shown in Figure 14. In general, if these outreach and partnership-based measures are implemented, they should focus on forming long-term relationships with farmers. Communication regarding cost-share programs, such as: the Conservation Reserve Program (CRP); the Conservation Reserve Enhancement Program (CREP); and the Environmental Quality Improvement Program (EQIP), could potentially encourage the success of such programs.

As with urban runoff, management of agricultural runoff should apply the agricultural standards, as established under Chapter NR 151, “Runoff Management,” of the *Wisconsin Administrative Code*. Additionally, the programs should initially seek to target areas that are the likely source of the most amounts of sediments and phosphorus.

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[9] *Calcium chloride application could be reduced through implementing practices such as applying salt only at intersections, mixing salt with sand, and calibrating spreaders.*

Figure 12

ILLUSTRATIONS OF THE DYNAMIC OF COMPONENTS OF NATURAL, AGRICULTURAL, AND URBAN STREAM ECOSYSTEMS

NATURAL STREAM ECOSYSTEM

AGRICULTURAL STREAM ECOSYSTEM

URBAN STREAM ECOSYSTEM

Source: *Illustrations by Frank Ippolito* www.productionpost.com. *Modified from D.M. Carlisle and others,* The quality of our Nation's waters—Ecological health in the Nation's streams, 1993-2005: U.S. Geological Survey Circular 1391*, 120 p.,* http://pubs.usgs.gov/circ/1391/*, 2013, and SEWRPC.*

These areas are most likely located in the southern portion of the watershed, where many of the channelized tributaries are located (see Appendix A, Watershed Characteristics and Hydrology section); however, some investigation may be required to determine where the program should target first.

Groundwater Pollution Reduction

Though surface water runoff is the easiest to explain and manage in terms of pollution reduction measures, it is also important to note that groundwater pollution has been shown to affect the quality of baseflow, i.e., water that supplies the Lake year-round through groundwater springs. Though groundwater recharge through infiltration into soils does provide some level of natural pollution attenuation, high groundwater recharge areas (see Appendix A, Groundwater Recharge section)—particularly in areas that coincide with shallow depth to groundwater levels (see Appendix A, Depth to Groundwater section)—are still quite vulnerable to pollution. In the case of School Section Lake, shallow depths to groundwater exist throughout the watershed, with the exception of the far eastern edge. Consequently, areas of potentially high groundwater recharge should be targeted for groundwater pollution efforts.

Groundwater pollution reduction measures generally focus on two areas: 1) the use of best management practices throughout the watershed and 2) maintenance of private onsite wastewater treatment systems (POWTS), or septic systems (if applicable). Both of these measures are discussed below.

Best Management Practices

Within the School Section Lake watershed, there are specific areas of concern within the high groundwater recharge areas, including: 1) agricultural lands; and 2) urban and residential areas. These areas include groundwater pollution sources, as illustrated in Figure 15. Consequently, in order to reduce groundwater pollution, outreach and partnership efforts that seek to increase the implementation of best management practices in urban and agricultural areas, similar to those described in the urban and agricultural runoff sections above, should be considered a priority. These efforts should target agricultural and residential areas with high groundwater recharge potential. In addition, these efforts should also target homeowners and developers in any new residential developments that occur within high groundwater recharge areas in the watershed.

Figure 13

EXAMPLES OF URBAN RUNOFF POLLUTANTS

OIL AND GREASE

SEDIMENT

Source: Wisconsin Department of Natural Resources.

Private Onsite Wastewater Treatment System (POWTS) Maintenance

In addition to urban and agricultural sources of pollution, groundwater pollution could also be caused by mismanagement of private onsite wastewater treatment systems. Generally, when these systems are not properly maintained resulting leaks and overflows that contain phosphorus and e-coli can infiltrate the groundwater systems and subsequently contaminate the baseflow to the Lake and the source of water supply for residents of the area, as illustrated in Figure 15. This process has been confirmed as an issue, particularly as it relates to phosphorus pollution, throughout the United States.[10]

Given that most of the School Section Lake watershed is currently served primarily by POWT systems (see Appendix A, Private Onsite Wastewater Treatment Systems section), POWTS maintenance within the watershed should be considered a priority. While POWTS maintenance is normally regulated by the municipality or county, outreach efforts meant to educate and monitor POWTS users on the maintenance of their systems could potentially have a high impact on the Lake with minimal efforts. This effort, for example, could include a program in which POWTS users sign up to be automatically reminded about septic tanks maintenance.

In the School Section Lake watershed, POWTS maintenance is particularly important in the areas directly adjacent to the Lake and in high groundwater recharge areas. Consequently, outreach efforts should seek to target these areas first and then continue onto the rest of the watershed once the program has been established. This strategy will help increase the cost effectiveness and efficiency of the program to the greatest extent possible. In general, any efforts to improve POWTS maintenance should be informed by standards set under Chapter NR 113 of the *Wisconsin Administrative Code.*

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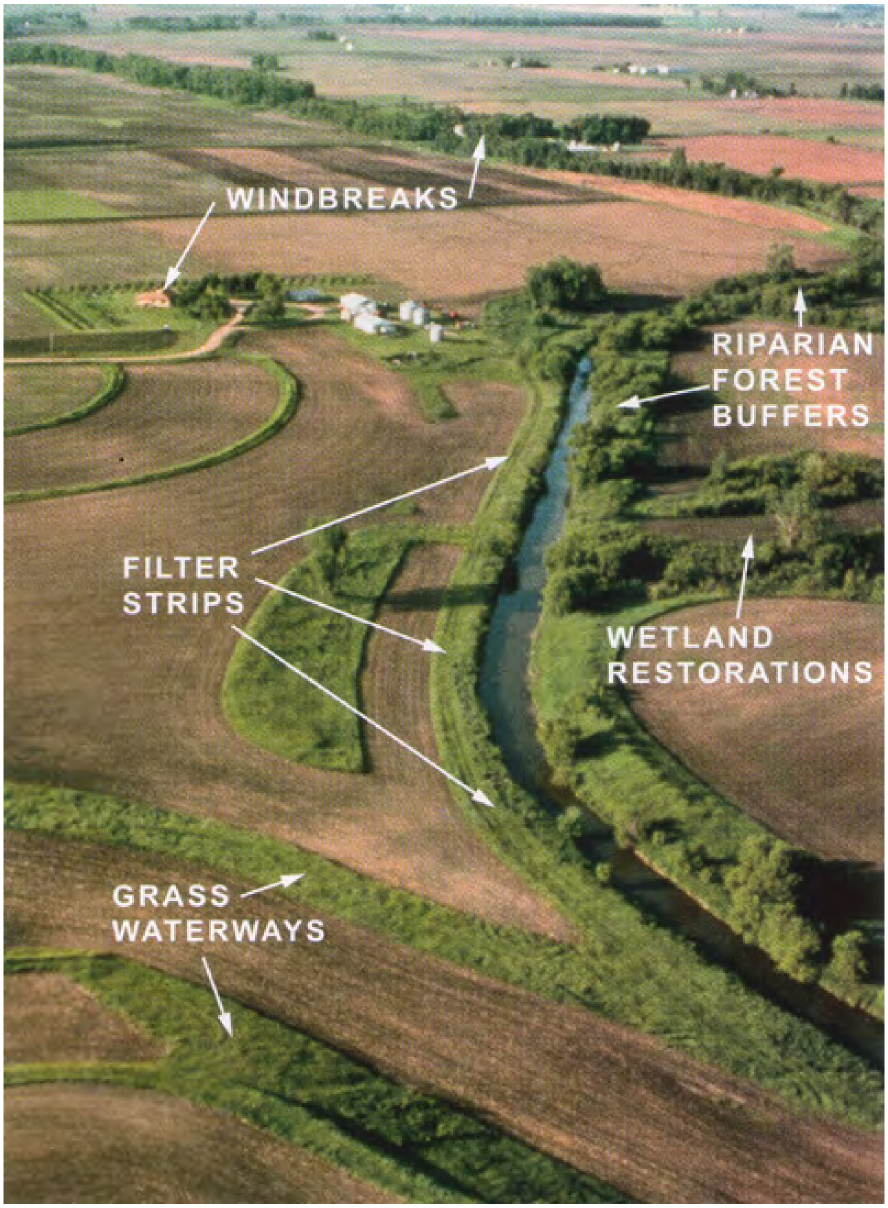
[10]*S.R. Carpenter, N.F. Caraco, D.L. Correll, R W. Howarth, A.N. Sharpley, and V.H. Smith, "Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen,"* Ecological Applications, *Vol. 8, 1998, pp. 559-568.*

Figure 14

EXAMPLES OF BUFFER TYPES AND GRASS WATERWAYS



Source: U.S. Department of Agriculture, Natural Resource Conservation Service.

Natural Pollution Filtration

Natural systems, specifically buffer areas (see Figure 14), i.e., areas of natural vegetation that separate pollution sources from waterways, may be particularly efficient at reducing pollution that would otherwise be deposited into the Lake or its tributaries. This is because these systems slow water, thereby allowing for pollutants and sediments to settle prior to entering the lake system. Additionally, they are also highly productive systems, that play a role in using and converting pollutants to nonharmful byproducts thereby further reducing the harmful effects of urban and agricultural runoff.

In fact, based upon the summary of the best available science, the preservation and development of buffers, which often include wetland and upland areas, can play a key role in reducing pollution and erosion, while enhancing

Figure 15

SCHEMATIC OF GROUNDWATER POLLUTION SOURCES

Source: Hongqi Wang, Shuyuan Liu and Shasha Du. "The Investigation and Assessment on Groundwater Organic Pollution, Organic Pollutants," 2013.

wildlife and recreational opportunities. Consequently, the protection of existing buffers, as well as the establishment of new buffers, will help address the majority of the issues of concern identified in Chapter II of this report.

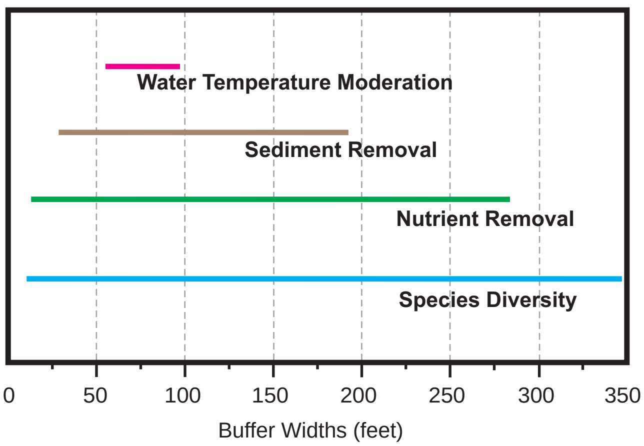
Two major factors affect the ability of buffers to filter pollutants: buffer width and buffer continuity. Both are discussed below.

Buffer Width

The size of buffers are highly related to their ability to reduce pollution and provide habitat. In general, as illustrated in Figure 16, buffer effectiveness varies depending on the conditions. However, the literature indicates that 75-foot regulatory shoreland setback widths, i.e., buffers extending 75 feet from the tributary and lake edges,

Figure 16

RANGE OF BUFFER WIDTHS FOR PROVIDING SPECIFIC BUFFER FUNCTIONS



NOTE: Site-specific evaluations are required to determine the need for buffers and specific buffer characteristics.

Source: Adapted from A. J. Castelle and others, "Wetland and Stream Buffer Size Requirements-A Review," Journal of Environmental Quality*, Vol. 23.*

can provide productive habitat and significant pollution reduction of up to 75 percent in some areas. Additionally, the literature has shown that the protection of a 400-foot minimum and 900-foot optimum riparian buffer width has significant benefits to wildlife populations.

It is important to note, however, that buffers of much shorter widths, such as five-foot buffers along lake shorelines, can also significantly reduce erosion; reduce some pollution from runoff; and provide habitat for both aquatic and terrestrial organisms. Consequently, future efforts to reduce pollution loads to the Lake should seek to protect and establish buffers along the lake shoreline and within the watershed, where possible. Further details on the studies examining buffer effectiveness at various widths are included in Appendix F.

Buffer Continuity

Another component that increases the effectiveness of buffers is continuity. In general, when buffers are continuous, i.e., have no gaps along the shoreline, this forces runoff to move through the buffers as opposed to going around them, thereby increasing their ability to remove pollutants through filtering, infiltration, and uptake by vegetation. Additionally, fragmentation of riparian buffers, even by roads, combined with encroachment by development, impacts the buffers' ability to adequately provide wildlife habitat. Therefore, it is important to reduce the fragmentation of the existing riparian buffers by: 1) establishing connections with natural plant installation, i.e., green pathways through lawns and fields between natural areas; and 2) preventing new road crossings, as well as eliminating unnecessary ones, where ever practical. It is recognized, however, that police, fire protection, and emergency medical service access is an overriding consideration that must be applied in determining whether the objective of removing a crossing is feasible.

It is important to note that the presence of a buffer is always better than the absence of one, even if only to provide some pollution reduction or to allow for better aquatic habitat. Therefore, all efforts to develop buffered areas, regardless of width or continuity, are recommended in this report. However, a focus on shoreline properties would provide a good starting point. Efforts to establish buffers should be developed in accordance with WDNR and Natural Resources Conservation Service (NRCS) technical standards for filter strips and turf management as may be applicable. The Southeastern Wisconsin Regional Planning Commission (SEWRPC) Riparian Buffer Guide No. 1, *Managing the Water's Edge*, included in Appendix F, could be used to develop any necessary education information. Additionally, the Lake Protection Grant administered by WDNR has a newly introduced Healthy Lakes Initiative that partially funds shoreline buffer development, along with other projects along shorelines. The Silver Lake Management District should consider applying for this grant if shoreline property owners are interested in buffer development.

In-Lake Pollution Control Measures

As discussed at the beginning of this section, some measures which be undertaken once pollution has already reached the Lake. However, while many in-lake pollution control measures exist, normally involving chemical additives that cause pollutants to settle to the bottom of the lake, many of these measures are not well tested in the region and are not permitted by WDNR. Consequently, this discussion focuses on the two most common in-lake projects applied in southeastern Wisconsin, i.e., aluminum sulfate treatments and aeration, as well as best management practices that can be implemented in and around the Lake.

Aluminum Sulfate
Aluminum sulfate ("alum") treatments seek to reduce phosphorus concentrations, internal phosphorus loading, and algae populations in lakes. This process works by applying the alum, which then forms a fluffy precipitate called a floc. As the floc settles to the bottom of the lake, it removes phosphorus and particulates, including algae, from the water column. The floc then forms a layer that acts as a barrier to phosphorus, thereby preventing internal loading (see Appendix A, Internal Loading section).

This process has been shown to work for up to eight years in shallow lakes such as School Section Lake (although it has been known to last only four years in some lakes within the region), and, therefore, requires continued application if phosphorus loadings are not reduced. One of the disadvantages of this alternative is that phosphorus is not actually removed from the lake; instead it accumulates at the lake bottom. This could be particularly problematic if dredging projects are ever implemented in the Lake in the future, as this would provide an opportunity for the phosphorus to re-release into the Lake

Given that internal phosphorus loading and excessive algae growth have yet to be confirmed in School Section Lake, this measure is not currently considered viable. It may, however, need to be considered in the future, if pollution symptoms become unmanageable or hazardous.

Aeration
The installation of an aerator seeks to prevent anoxic conditions and subsequent fish kills (see Appendix A, Anoxia section). As illustrated in Figure 17, this is done by pumping oxygen to the bottom of the lake and subsequently preventing the potential negative effects of thermal stratification (Appendix A, Thermal Stratification section). As fish kills have not recently been reported in the Lake, this measure does not currently seem to be warranted, and, therefore, is not currently considered necessary. This measure may, however, need to be considered if fish kills begin occurring on an annual basis.

In-Lake Best Management Practices
In addition to in-lake projects, there are also best management practices which can be implemented by lake users and managers to prevent water quality issues such as low water clarity and phosphorus accumulation. The first of these relate to motor boating activities in shallow areas. This practice disturbs the sediments in these areas, thereby causing "murky" waters or low water clarity, as well as leaves the disturbed area vulnerable to invasion of nonnative species, such as Eurasian water milfoil. Consequently, encouraging lake users to avoid such practices could quickly reduce some of the water clarity issues in School Section Lake.

Another in-lake measure is the physical removal of phosphorus from the Lake through aquatic plant harvesting. Aquatic plants use and hold phosphorus during their lifecycle, and then release that phosphorus back into the Lake once they die. Therefore, physically removing the plants is in and of itself a phosphorus reduction measure. Accordingly, implementation of the harvesting recommendations provided in Chapter III of this report should be further considered a priority.

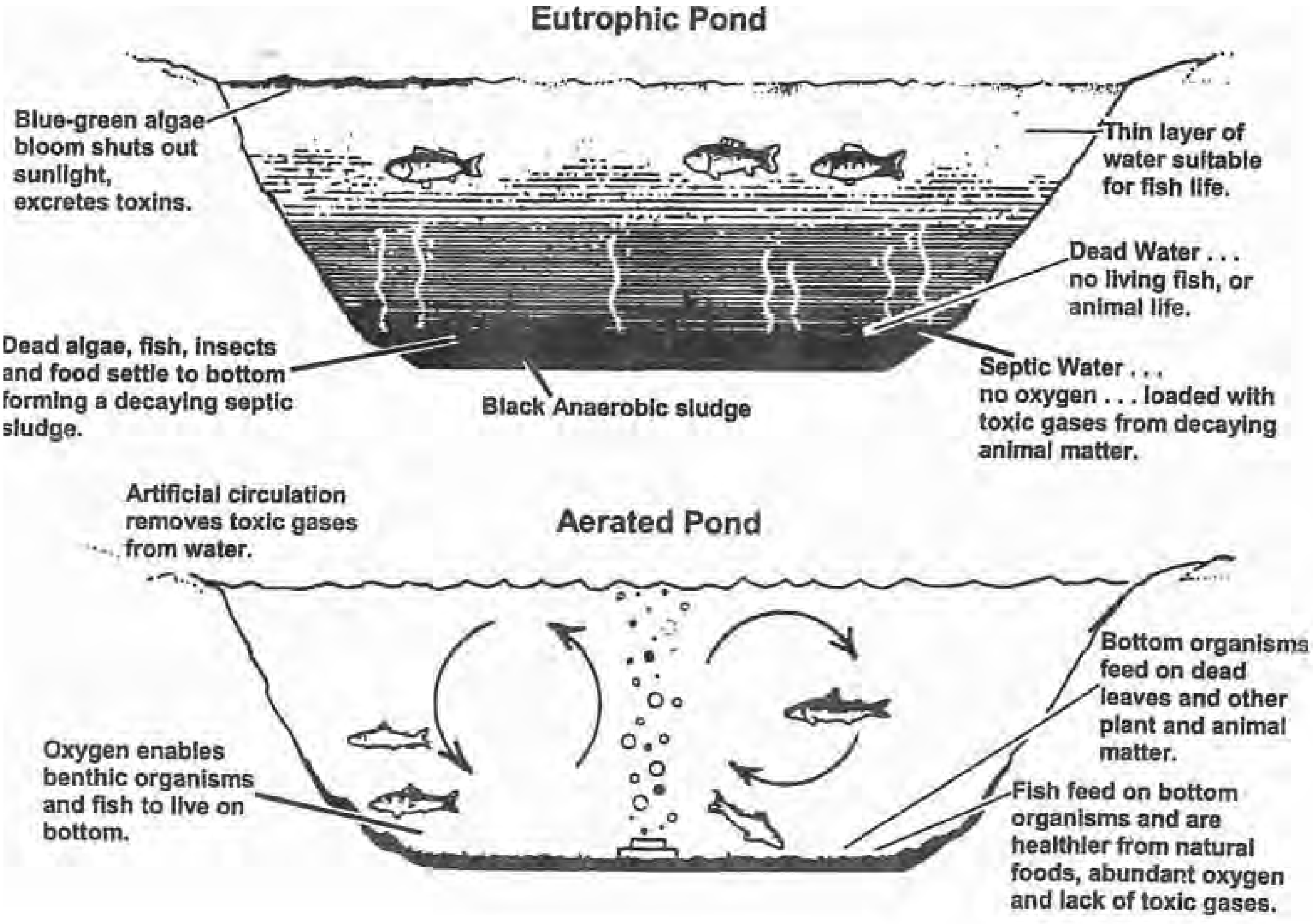
Overall Water Quality Recommendations
In order to ensure that water quality issues are addressed on a long-term and sustainable basis, the following recommendations are made:

1. Implementation of urban runoff reduction measures targeting the areas highlighted on Map 6 at the end of this chapter, i.e., along the shoreline. The implementation of this recommendation could involve educational efforts or incentive programs meant to encourage best management practices.

2. Implementation of agricultural reduction measures targeting the areas also highlighted on Map 6 at the end of this chapter. A particular emphasis should be placed on the agricultural area in the south end of the watershed. The implementation of this recommendation could use educational outreach,

Figure 17

SCHEMATIC OF AERATION PROCESS



Source: Lake Santa Fe Lake Dwellers Association.

partnerships and incentive programs meant to encourage the implementation of best management practices and the installation of buffers, grassed waterways, and naturalized detention basins.

3. Implementation of groundwater pollution reduction measures, as highlighted on Map 7. The implementation of this recommendation should seek to address the following components:

   a. Urban and agricultural groundwater pollution. This could use educational outreach and incentive programs similar to those discussed above. These efforts should focus on the urban and agricultural land uses located within high groundwater recharge areas.

   b. POWTS maintenance. This could include educational and outreach programs that seek to encourage POWTS maintenance. These efforts should first target shoreline property owners and then expand to the entire watershed, particularly in areas with high groundwater recharge.

4. Development and protection of riparian buffers where practicable. These efforts should target direct residential inflow sources, i.e., the Lake shorelines, as well as agricultural areas. To aid in the implementation of this recommendation, Map 8, at the end of this chapter, shows the existing and

potential riparian buffers, as well as "vulnerable" buffers, i.e., existing and potential buffer areas that are not currently protected from development. The implementation of this recommendation could involve:

a. Continued application of limits on development in SEWRPC-delineated primary environmental corridors. This will help protect existing natural buffer systems such as wetlands, uplands, and other natural areas.

b. Consideration of adopting and/or enforcing shoreland setback requirements in the watershed and continuation of active enforcement of construction site erosion control and stormwater management ordinances.

c. Provision of informational materials to shoreland property owners on the benefits of buffers in order to encourage their installation around the Lake. These materials could include instructions on how to proceed with their installation. Such programs would be most productive if accompanied by an incentive program.

d. Establishment of conservation easements and land purchases, particularly in areas deemed "vulnerable" followed by subsequent buffer installation and maintenance. The implementation of this recommendation should focus on agricultural lands as these are the primary sources of phosphorus and sediment loadings in the watershed.

5. Consideration of future alum treatments or aeration projects, subject to permitting requirements, to be implemented only if the symptoms of pollution become unmanageable.

6. Stringent enforcement of Construction Site Erosion Control ordinances within the watershed as well as outreach to educate developers about the legally mandated best management practices, as indicated on Maps 6 and 9.

Implementation of these recommendations will require further planning; however, if implemented, the recommendations should greatly improve water quality within School Section Lake. In order to gauge the success of these recommendations as they are implemented, it is also recommended that water quality monitoring in School Section Lake be continued, with the addition of e-coli, chloride, and periodic measurements of phosphorus at the bottom of the lake as regular measurement parameters. Additionally, monitoring of successes, such as number of acres of buffers established, or number of farmers who installed grassed waterways, should also be made a priority. These kinds of records will help evaluate the success of the implemented programs, even before they translate into water quality improvements.

WATER QUANTITY

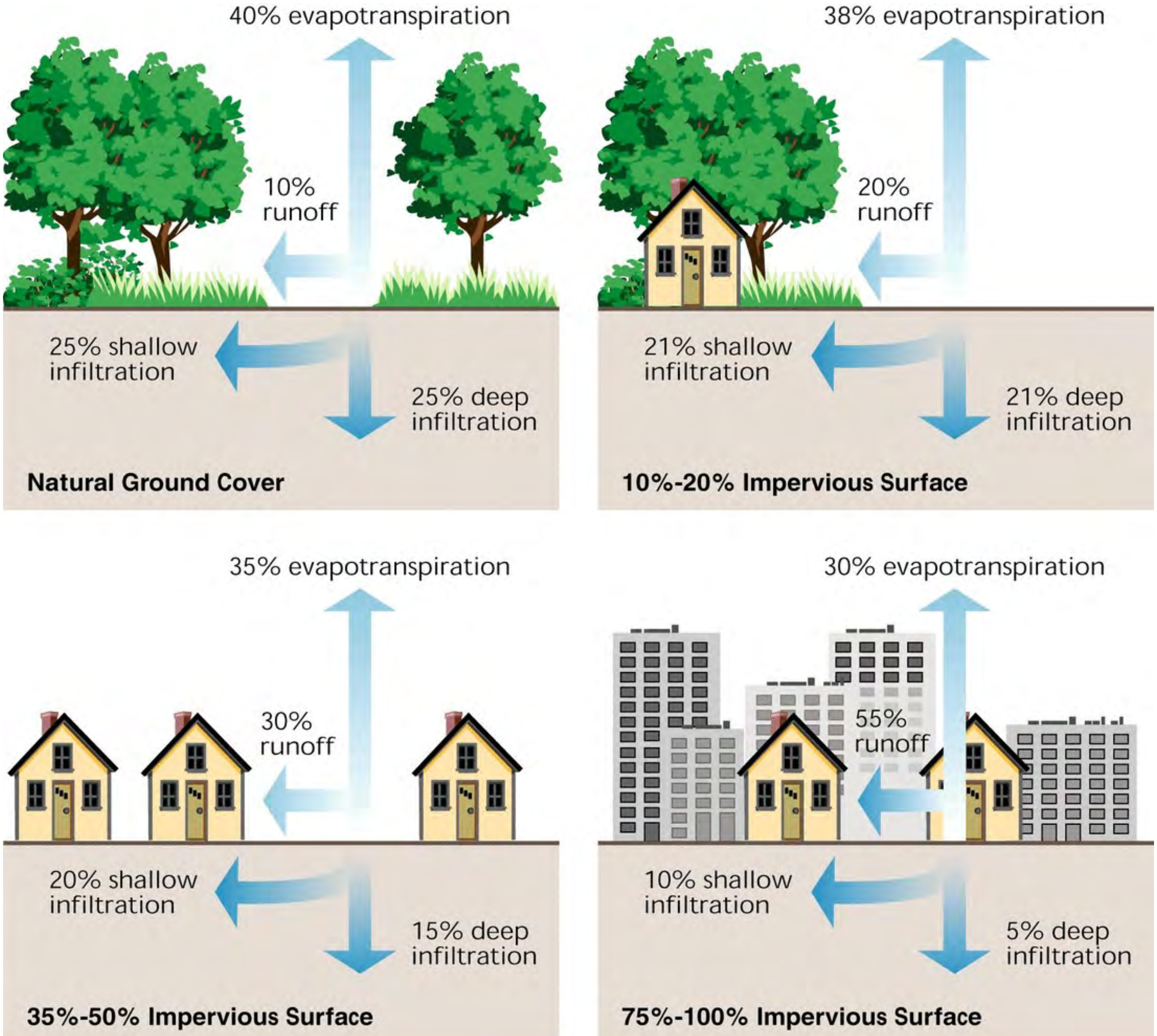
As discussed in the Water Quantity section of Chapter II, the maintenance of water levels can be crucial to the health of the Lake. Though water level fluctuations may not currently be extensive in School Section Lake, it is possible that levels may be affected as a result of climate change and the resulting changes in precipitation patterns, particularly if groundwater recharge is affected. In order to mitigate these potential issues, two major types of strategies can be implemented. The first is the implementation of projects that seek to increase the Lake's "resilience," i.e., the Lake's ability to remain constant and healthy, even with varying conditions. These kinds of projects act to prevent the need for the second strategy, namely: the introduction of water into the Lake through man-made efforts. The types of measures involved with both of these strategies are represented below.

Building Resilience

The most traditional way to increase resilience of a watershed, in terms of water quantity, is the encouragement of groundwater recharge. Such actions essentially maintain or increase the ability of the watershed to soak up the precipitation which occurs, leading to long-term supplies for baseflow and water use.

Figure 18

SCHEMATIC OF THE EFFECTS OF IMPERVIOUS SURFACES ON RUNOFF AND GROUNDWATER RECHARGE



Source: Federal Interagency Stream Restoration Working Group.

One of the major causes of the loss of groundwater recharge is impervious surfaces, i.e., surfaces in which water cannot infiltrate, such as roads, driveways, rooftops, and, to a lesser extent, lawns. This is because 1) these surfaces cover or replace soils and plants that previously would have helped contribute to groundwater recharge; and 2) these surfaces cause water to move quickly, thereby increasing the speed in which they travel over natural systems and eliminating chances for groundwater recharge. This process is further illustrated in Figure 18.

Efforts to build water quantity resilience in the Lake could focus on improving groundwater recharge rates in the watershed and/or on maintaining current levels. Projects associated with these focuses are discussed below.

Figure 19

EXAMPLE OF A RAIN GARDEN

lOTE: Special consideration goes into the construction of a rain garden. Further details are provided on Natural Resource Conservation Service and Wisconsin Department of Natural Resources websites.

Source: U.S. Department of Agriculture, Natural Resource Conservation Service.

Groundwater Recharge Improvement

Some mitigation efforts and infrastructure changes that can be implemented to increase groundwater recharge in areas with impervious surfaces. These include: 1) the implementation of infiltration best management practices in residential areas; and 2) retrofitting impervious surfaces. The first of these includes efforts such as the installation of rain gardens (see Figure 19) or infiltration basins. These could be encouraged using incentive programs, which could potentially be partially funded by the aforementioned WDNR Healthy Lakes Initiative grants or using educational efforts that provide details on rain garden benefits and installation. The second of the measures generally involves the installation of infiltration infrastructure in place of currently installed impervious surfaces. Some examples of these projects include: bioretention cells; curb and gutter elimination; green parking designs; infiltration trenches; inlet protection devices; permeable pavement; rain barrels and cisterns; rain gardens; riparian buffers; stormwater planters; tree box filters; vegetated filter strips; and vegetated roofs. Though these types of projects may be difficult to sell retroactively, they may be considered when current infrastructure needs to be replaced.

In general, implementation of these efforts should focus on residential areas within high groundwater recharge potential zones. Additionally, implementation of the recommendations should be guided by the infiltration standards set forth in Chapter NR 151 of the *Wisconsin Administrative Code*.

Groundwater Recharge Maintenance

Another consideration that relates to groundwater recharge maintenance is the prevention of the groundwater recharge losses associated with the conversion of agricultural lands and uplands to residential developments. According to the 2035 planned land use data for the School Section Lake watershed, the majority of future land use changes in the watershed will be located in areas with high and very high groundwater recharge potential (see Map 9). This indicates that the groundwater supply to the Lake could potentially be jeopardized in the future.

In order to prevent this loss of resilience, land use changes within high groundwater recharge areas should favor instead the creation of open space and buffer areas, followed by agriculture. However, as this may not be feasible because some of these areas are already zoned for development, the use of the infiltration technologies mentioned in the section above should be encouraged in all new developments. This effort will also have the added benefit of preventing future urban nonpoint source pollution.

Water Injection

Another measure of increasing or maintaining water levels in a lake is through man-made measures that inject water into the lake system. The most common water injection method is interbasin transfer, which involves taking water out of a neighboring watershed and pumping that water to the Lake. These types of measures are often used as a last resort because they: 1) are highly technical; 2) require constant maintenance; 3) are often expensive; and 4) often cause issues in the area where the source water is being tapped. Considering that School Section Lake is not yet experiencing major water level issues, and, therefore, has time to implement groundwater recharge measures, this measure is not considered necessary or viable at this time.

Overall Water Quantity Recommendations

In order to ensure that water quantity issues are addressed on a long-term and sustainable basis, the following recommendations are endorsed within this report:

1. Encourage infiltration techniques in currently installed urban development. These efforts should focus on residential areas found within high groundwater recharge areas as highlighted on Map 7 at the end of this chapter. Implementation of this recommendation could involve:

    a. Improvement of infiltration of rainfall and snowmelt through innovative best management practices (BMPs) associated with low-impact development, including bioretention and rain garden projects,[11] installation of rain barrels, etc.; and

    b. Retrofitting current urban development (e.g., disconnection of downspouts; installation of porous pavement, etc.) wherever possible.

2. Encourage the maintenance of open space, buffer areas, and agriculture in high groundwater recharge areas. Programs that seek to implement this recommendation could include:

    a. Land purchase and conservation easements in agricultural areas within high groundwater recharge areas in order to prevent their development.

    b. Promoting the consideration of groundwater conditions when locating potential building sites. This could include encourage municipalities and the County to review development proposals with groundwater recharge in mind, or could appeal to developers directly.

3. Reduce the impacts of any future urban development within groundwater recharge areas (see Map 9) by:

    a. Encouraging the review, update and/or implementation, as necessary, of local and county land use regulations to require conservation development practices in new developments.

    b. Encouraging low-impact design standards in accordance with the regional water supply plan.[12,13]

Again, the logistics related to the implementation of the above recommendations will need to be further developed; however, if even just a few of these recommendations are applied to the watershed, they could greatly contribute to future water security within the School Section Lake watershed. In order to monitor the impacts of such measures, as well as gauge the water level fluctuations in School Section Lake, monitoring of flow at the inlet and monitoring of Lake levels are also recommended.

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[11]*Roger Bannerman, WDNR and partners,* Menasha biofiltration retention research project, *Middleton, Wisconsin, 2008; N.J. LeFevre, J.D. Davidson, and G.L. Oberts, Bioretention of Simulated Snowmelt*, Cold Climate Performance and Design Criteria, *Water Environment Research Foundation (WERF), 2008; William R. Selbig and Nicholas Balster,* Evaluation of Turf Grass and Prairie Vegetated Rain Gardens in a Clay and Sand Soil, *Madison, Wisconsin, Water Years 2004-2008, In cooperation with the City of Madison and Wisconsin Department of Natural Resources, USGS Scientific Investigations Report, in draft.*

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

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

Figure 20

EXAMPLES OF COMPLETED
"FISH STICKS" PROJECTS

Source: Wisconsin Department of Natural Resources.

WILDLIFE ENHANCEMENT

Because the viability of wildlife populations is dependent on adequate water quality, water quantity, and habitat availability, the implementation of the recommendations made thus far in this chapter would each lead to the enhancement of both aquatic and terrestrial wildlife. Therefore, the implementation of the recommendations discussed thus far in this chapter is reiterated in this section. However, of these previously described recommendations, a specific emphasis should be placed on the enhancement and protection of buffers and natural areas, as discussed in the Water Quality section of this chapter. This is because, in general, the primary reason for terrestrial wildlife loss is habitat loss and fragmentation. Therefore, projects that protect and increase habitat availability will likely have the largest impact.

There are however, measures beyond the improvement of terrestrial habitat, water quality, and water quantity, which can further enhance the ability of terrestrial and aquatic wildlife to survive and reproduce. These measures include: 1) in-lake measures that relate to fish habitat and best management practices; and 2) best management practices implemented by residential and agricultural landowners. Each of these measures is discussed below.

In-Lake Measures

There are several in-lake actions that can enhance aquatic and terrestrial based wildlife. One of these measures is the improvement of aquatic habitat through aquatic plant management techniques that allow for native plant species to thrive. These measures, such as top cutting in the case of harvesting, or targeted manual removal, as discussed in Chapter III of this report, allow for fish habitat to remain in the Lake while reducing the potential for anoxic conditions in the Lake that can lead to fish kills. Consequently, the implementation of the measures recommended in Chapter III should be further considered a priority.

Three additional measures that can improve fish habitat are: 1) the introduction or maintenance of woody debris along the shorelines of the Lake; 2) the installation of natural buffer systems; and 3) periodic lake level manipulations to mimic natural lake fluctuation patterns. The first measure could take the form of allowing fallen trees to stay in the Lake, or could be implemented in the form of man-made wood structures known as "fish sticks," as shown in Figure 20. The second involves the installation of natural plants along the shoreline as a habitat source. This recommendation has the added benefit of also reducing erosion and pollution that enters the Lake, as discussed in the Water Quality section of this chapter. The third involves periodic lake drawdown and reflooding during fish spawning periods to encourage spawning in the wetland areas. The first two types of projects can be partially funded through the Healthy Lakes Initiative grant program, while the third can be implemented fairly inexpensively with a WDNR permit. In general, any efforts to improve fish habitat can greatly increase the wildlife populations in the Lake.

Finally, in addition to habitat enhancement, best management practices can be implemented in a lake that will prevent loss of fish populations. The two most feasible of these measures in School Section Lake are 1) the implementation of catch-and-release practices; and 2) ensuring that fish and animals caught during aquatic plant harvesting activities are returned to the Lake. The implementation of these measures are, therefore, recommended.

Best Management Practices

The way people manage their land and treat animals can have a significant impact on terrestrial wildlife populations. Turtles, for example, need to travel a far distance from their home lake in order to lay their eggs. If pathways to acceptable habitats are not available, or are dangerous due to pets, fences, or traffic, the turtles will not have the opportunity to increase their population. Given this affect that humans have on wildlife, many conservation organizations have developed best management practices to increase wildlife populations.

Though some of these best management practices are species or animal-type specific, e.g., spaying or neutering cats to reduce their desire to kill birds, many of these recommendations relate to general practices that can benefit all wildlife. It may, however, also be desirable to target specific animals, depending on the animals that people want to see. A lake resident who responded to the survey discussed in Chapter II, for example, expressed a desire to increase bird populations. Therefore, a campaign that seeks to do this through the implementation of bird-specific best management practices may be desirable.

In general, best management practices for wildlife enhancement can be targeted to agricultural and residential land uses. Agricultural measures tend to focus on encouraging land management that allows for habitat enhancement, such as allowing fallen trees to naturally decompose where practical or allowing for uneven landscapes. Alternatively, residential measures tend to focus on practices that landowners can install to provide habitat, such as installing a pool garden and the introduction of nonnative plants and insects. There are also recommendations which are common to both types of landowners. Killing any kind of wildlife, for example, particularly amphibians, reptiles, and birds, is generally not advised.

Communication of these best management practices may provide a means of encouraging wildlife populations without having to do extensive infrastructure changes, such as converting agricultural lands to natural areas. Consequently, the implementation of measures meant to increase the use of these practices is recommended.

Overall Wildlife Recommendations

In order to enhance wildlife within the School Section Lake watershed, the following recommendations, as highlighted on Map 10, are endorsed in this report:

1. Preserve and expand terrestrial wildlife habitat to the greatest extent possible while making efforts to ensure connectivity among natural areas. This could be achieved through the implementation of the buffer installation recommendations in the Natural Pollution Filtration section of this chapter. These recommendations are summarized on Map 8. Additionally, this recommendation should also include efforts to protect environmental corridors, wetlands, and uplands throughout the watershed through land purchases or easements.

2. Improve water quality in the Lake through the implementation of the recommendations in the Water Quality section of this chapter.

3. Ensure that water levels remain sufficient through the implementation of the water quantity recommendations made in the Water Quantity section of this chapter.

4. Improve aquatic habitat in the Lake by allowing or installing woody debris along the Lake’s edge or by installing natural shoreline buffers. Implementation of this recommendation could take the form of educational or incentive programs that seek to encourage riparian landowners to install these habitats. Healthy Lake Initiative funding should potentially be sought to aid with this recommendation.

5. Consider periodic drawdowns and reflooding, subject to WDNR permit requirements, for the purpose of encouraging fish spawning.

6. Encourage best management practices in the Lake such as catch-and-release. The need for these practices could be communicated to lake residents through outreach efforts and to lake users through proper signage.

7. Ensure proper implementation of the harvesting plan in Chapter III of this report. This includes:

   a. Using the top-cut technique where native plants dominate the plant population, thereby ensuring the survival of important fish habitat;

   b. Leaving 12 inches of plant material on the Lake bottom at all times, thereby, preventing complete habitat loss and fish catches by the harvester; and

   c. Inspecting all cut plants for fish and animals and immediately returning these organisms back into the Lake.

8. Encourage the adoption of best management practices by agricultural and residential landowners through voluntary, educational, or incentive programs, as well as directly implementing these practices on public and protected lands. If this recommendation is implemented, a complete list of best management practices should be compiled and communicated to landowners. Implementation of this recommendation in agricultural areas could also be further encouraged by:

   a. Promoting agricultural landowner enrollment in Federal agricultural incentive programs such as the Conservation Reserve Program, the Wetland Reserve Program, the Wildlife Habitat Incentives Program, or the Landowner Incentive Program, which provide financial incentives to restore habitats.

   b. Encouraging landowners to investigate and consider the establishment of a Priority Amphibian and Reptile Conservation Area (PARCA).

As with many of the other recommendations made in this chapter, the logistics related to the implementation of the above recommendations will need to be further developed; however, the implementation of any one of these recommendations could greatly enhance wildlife populations within the School Section Lake watershed now and in the future.

RECREATION

Recreation is clearly important to School Section Lake residents. This is evidenced by the fact that many of the issues of concern identified by Lake residents and the School Section Lake Management District related to recreational use, e.g., fish populations, plant growth which impedes navigation, and wildlife loss. Accordingly, two specific issues of concern that relate to recreation enhancement around the Lake were identified. 1) Poor trail maintenance on the trail from the Dike to Dolmar Park Road, and 2) the need for increased signage to communicate slow-no-wake times and prevention of the spread of invasive species. As both of these concerns were deemed relevant in Chapter II, recommendations related to both are included in this chapter, namely:

1. The implementation of a trail maintenance program. This could take the form of a volunteer group of lake residents or users who are in charge of this maintenance.

2. An evaluation of the current signage around the Lake and subsequent updating of the signage to include information that should be communicated to Lake users. WDNR signs, as well as other Lake signs, can be referenced for ideas as to what should be included on this sign. The ultimate decision could then be left to the School Section Lake Management District.

The community may want to consider additional recreational opportunities, such as extended trails or development of a nature center. The School Section Lake Management District in collaboration with Lake residents should consider further discussions on recreational needs in and around the Lake.

REGULATION

Though many regulatory measures can be used to improve the health of School Section Lake, some of which are mentioned throughout this chapter, this section is only meant to address the currently outdated School Section Lake Management District bylaws, which is the only regulatory issue deemed viable in Chapter II of this report.

The School Section Lake Management District bylaws were last updated in 1983, and primarily restated *Wisconsin Statutes* language from that time. However, the *Statutes* have since been updated, making most of the bylaws out of date. Consequently, this section provides recommendations to bring these bylaws up to date. Three relevant alternatives can be used to update the currently outdated bylaws. These include:

1. Repeal the bylaws and simply operate according to *Wisconsin Statutes*, Chapters 5 through12, 19, and 33;

2. Repeal the bylaws and create standard operating procedures covering nominations, commissioner remuneration, and committees; or

3. Amend the bylaws to contain only those clauses where the current bylaws differ in detail from the *Wisconsin Statutes* Chapter 33, specifically the nomination procedures, although these are covered in *Statutes* other than Chapter 33, commissioner remuneration, and committees.

In general, the second option is the recommended course of action; however, the first option could also be sufficient.

SUMMARY OF RECOMMENDATIONS

Table 4 provides a brief summary of all of the recommendations made in this chapter and their purpose, as well as provides guidance on which should be considered top priorities. The recommendations have been organized into short-term and long-term items. The short-term recommendations, which can be quickly implemented, should also be considered a priority, in addition to those indicated in the table, because they are simple and could potentially provide quick relief from major issues. However, it is important that management efforts in School Section Lake do not ignore the recommendations that will need to be implemented on a long-term basis. This is because these are the programs which will seek to permanently solve the issues within the Lake, and, consequently, are a good investment. In fact, the implementation of these long-term efforts will help avoid the need for the potential future projects also highlighted in Table 4. In general, management efforts should ideally include a combination of both short-term and long-term efforts.

The recommendations included in this chapter cover a wide range of programs that seek to address every aspect that influences the health and recreational use of School Section Lake. Consequently, it may not be feasible to implement every one of these recommendations in the immediate future. Priority recommendations are, therefore, indicated, and the School Section Lake Management District should begin the program of Lake improvement by implementing those recommendations. It should then also take advantage of opportunities that may arise to implement other recommendations. Eventually all of the recommendations should be addressed, subject to possible modification based on possible changed conditions and the findings of future aquatic plant surveys and water quality monitoring.

It should also be noted that, though not included in the overall recommendations, **the creation of an action plan that highlights action items and responsible parties is highly recommended**. This document, which can be created with the guidance of the SEWRPC staff, will help ensure that the recommendations made under this plan

Table 4

RECOMMENDED PROTECTION PLAN ELEMENTS FOR SCHOOL SECTION LAKE

Project Type	Recommendation	Purpose	Focus Areas	Available Resources[a]
Short Term	**Implementation of mechanical harvesting and hand-pulling recommendations within Chapter III of this report, including the provisions meant to protect wildlife**	To remove biomass from Lake to prevent sedimentation As a phosphorus control measure through the physical removal of biomass To encourage native plant growth as well as fish habitat	In the Lake	Chapter III of this report, which provides details of the aquatic plant management plan Appendix E which provides summary guidance to harvester operators
	Investigation of obvious sources of erosion within the watershed	To determine if upstream restoration is necessary	Channelized tributaries to the Lake	Map 6, which indicates the channelized tributaries
	Consider installing “fish sticks” around the shoreline of the Lake	To improve fish habitat	Shoreline areas with little woody debris in the Lake	WDNR website guidance materials WDNR Lake Protection Grant funding through the Healthy Lakes Initiative
	Consider periodic (seasonal) drawdowns and re-flooding to mimic natural conditions	To improve fish spawning	In the Lake	WDNR staff for consultation
	Consider a “trail maintenance program”	To enhance recreation	The trail from the Dike to Dolmar Park Road	N/A
	Update bylaws	To ensure up to date operating rule	N/A	Wisconsin Lakes Partnership staff for consultation
	Encourage maintenance of Private Onsite Wastewater Treatment Systems (POWTS) through a tracking program	To reduce phosphorus pollution to the groundwater which feeds the baseflow to the Lake To improve water quality in the Lake To reduce aquatic plant growth within the Lake by changing the Lake’s trophic status	Areas not serviced by sanitary sewers, with an initial focus on shoreline properties	Map A-16 in Appendix A of this report, which shows areas not serviced by sanitary sewers, i.e., areas that use POWTS
	Encourage in-lake best management practices, such as catch-and-release, invasive species prevention, and low-impact boating through signage improvements and regulation enforcement	To improve fish size structures and growth To prevent the introduction of new invasive species	In the Lake and at the public access point	WDNR staff for consultation
	Consider the installation of pea gravel blankets along shorelines, subject to WDNR permit requirements	To provide temporary relief for shoreline property owners	The shorelines of private properties	Private Pea Gravel Blanket Permit guidance on WDNR website
	Continued Citizen Lake Monitoring with the periodic addition of chlorides, e-coli, and lake bottom phosphorus	To monitor water quality and detect future issues or improvements	In the Lake	Citizen Lake Monitoring Network program
	Documentation and monitoring of progress with relation to project implementation	Keep track of progress made, even if improvements are not immediately seen within the Lake	Throughout the watershed	N/A

Table 4 (continued)

Project Type	Recommendation	Purpose	Focus Areas	Available Resources[a]
Long Term	**Stringent enforcement of Construction Site Erosion Control ordinance**	To prevent sediment and phosphorus from entering the Lake	Planned development areas	Map 9, which shows where 2035 development is planned to take place
	Shoreline buffer development and restoration using native plants	To prevent sedimentation from the shorelines To prevent pollutants from entering the Lake from the shorelines (by filtering through the buffered areas) To develop wildlife habitat in the littoral zone	Areas along the shoreline with signs of erosion as well as shoreline areas where the lawn is mowed to the water's edge	Map A-17 in Appendix A of this report, which shows current shoreline structures (further investigation of shoreline needs may be required) Appendix F, which provides information on the benefits of buffers and some guidance on their installation The WDNR Lake protection grant program under the Health Lakes Initiative
	Encourage infiltration technologies (e.g. retrofitting rooftops, pervious pavement, installing rain gardens etc.) in current and future urban areas	Ensure the maintenance and possible improvement of groundwater recharge to protect baseflow to the Lake	Current and planned urban areas located within the high groundwater recharge potential area within the watershed	Map 7, which communicates where the high groundwater recharge potential areas are located Map 9, which shows the 2035 planned development areas
	Encourage the use of wildlife best management practices through education and encouraging urban and agricultural landowners to participate in conservation programs	To enhance wildlife populations	Throughout the watershed, with an initial focus on shoreline property owners	Map 10, which communicates where to implement wildlife enhancement recommendations
	Encourage the review of local and County land use regulations to consider groundwater recharge and conservation in zoning requirements	To ensure maintenance and encourage awareness of groundwater recharge	Entire watershed	N/A
	Implementation of urban pollution reduction campaign to encourage the use of best management practices (including buffer development as discussed above)	To reduce phosphorus, chloride, and heavy metal pollutant loads that enter the Lake through surface water and groundwater pollution To improve water quality in the Lake To reduce aquatic plant growth and associated sedimentation within the Lake	Urban areas within the watershed with an initial focus on residential areas around the Lake	Map 6, which indicates where pollution and sediment control measures should be implemented Map 7, which indicates where groundwater pollution reduction measures should be implemented County Land and Water Conservation Website WDNR website on urban best management practices
	Implementation of agricultural pollution reduction campaign to encourage the use of best management practices, including green waterways and detention basins	To reduce phosphorus pollution which may enter the Lake through surface water pollution or groundwater pollution To improve water quality in the Lake To reduce aquatic plant growth and associated plant-based sedimentation within the Lake	Agricultural areas within the watershed, initially focusing on those contributing to the channelized tributaries as well as agricultural areas located in the high groundwater recharge potential areas	Map 6, which indicates where pollution and sediment control measures should be implemented Map 7, which indicates where groundwater pollution reduction measures should be implemented Natural Resource Conservation Service and other state programs

Table 4 (continued)

Project Type	Recommendation	Purpose	Focus Areas	Available Resources[a]
Long Term (continued)	**Buffer development throughout the watershed where feasible, potentially using conservation easements and land purchases to obtain land that should be developed into a buffer**	To increase the amount of pollutant filtration which occurs in the watershed To reduce aquatic plant growth and associated sedimentation within the Lake To maintain and enhance Wildlife populations	Potential Buffer Areas, with an initial focus on shoreline properties	Map 8, which communicates potential buffers within the watershed Appendix F which provides information on the benefits of buffers and some guidance on their installation WDNR Lake Protection Grant which can help fund conservation easements and land purchases
	Buffer and open space protection throughout the watershed through protection of environmental corridors, wetlands, and other important natural areas	To ensure the watershed maintains its current ability to filter pollutants and sediments To reduce aquatic plant growth and associated sedimentation within the Lake To maintain groundwater recharge To maintain and enhance wildlife populations	Vulnerable buffer areas within the watershed	Map 8, which communicates vulnerable buffers within the watershed WDNR Lake Protection Grant to help fund conservation easements and land purchases
Potential Future Projects	Consideration of "spot dredging," subject to WDNR permit requirements, on shorelines where sediments are restricting recreation	To provide temporary relief for shoreline property owners	The shorelines of private properties	WDNR staff for consultation
	Consider alum treatments or aeration if water pollution becomes unmanageable	To manage water pollution if it becomes unmanageable (i.e. excessive algal blooms or fish kills)	In the Lake	WDNR staff for consultation

NOTES: **Red Font** indicates recommendations that be considered top priority.

N/A indicates not applicable.

[a]*Resources provided in this table are limited in scope. There are many other resources available, which should be investigated when an action plan is developed.*

Source: SEWRPC.

are implemented in a timely and effective manner. Additionally, this document can help ensure that all responsible parties are held accountable for their portion of the plan's implementation.

CONCLUSIONS

As stated in the introduction, this chapter is intended to stimulate ideas and action. The recommendations provided are a starting points for addressing the issues that have been identified for School Section Lake. This path will require vigilance, cooperation, and enthusiasm from the School Section Lake Management District, State and regional agencies, Waukesha County, municipalities, and lake residents. These recommended measures will provide the water quality and habitat protection necessary to maintain conditions in the watershed suitable for the maintenance and improvement of the natural beauty and ambience of the Lake and its ecosystems, today and in the future.

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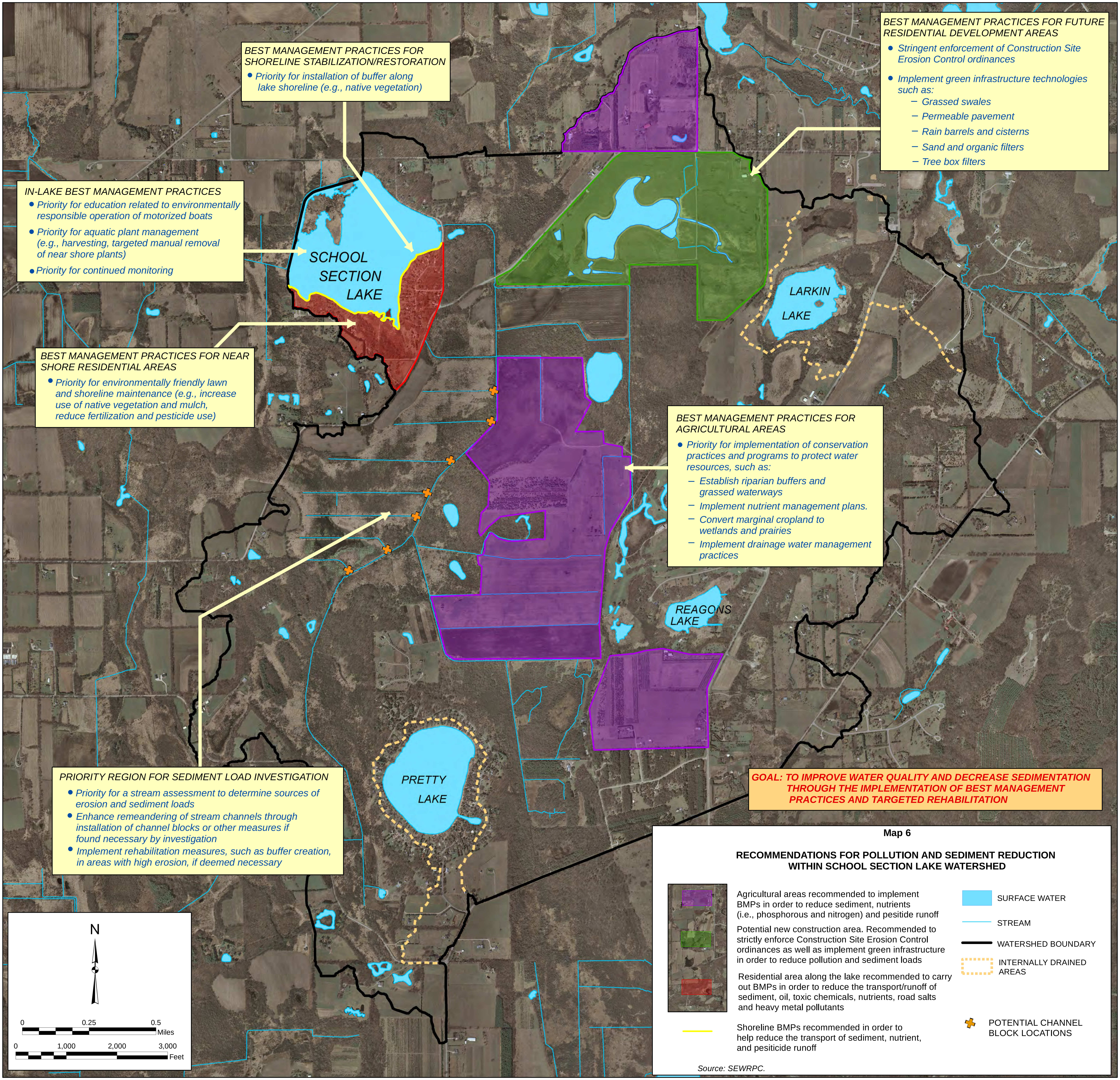
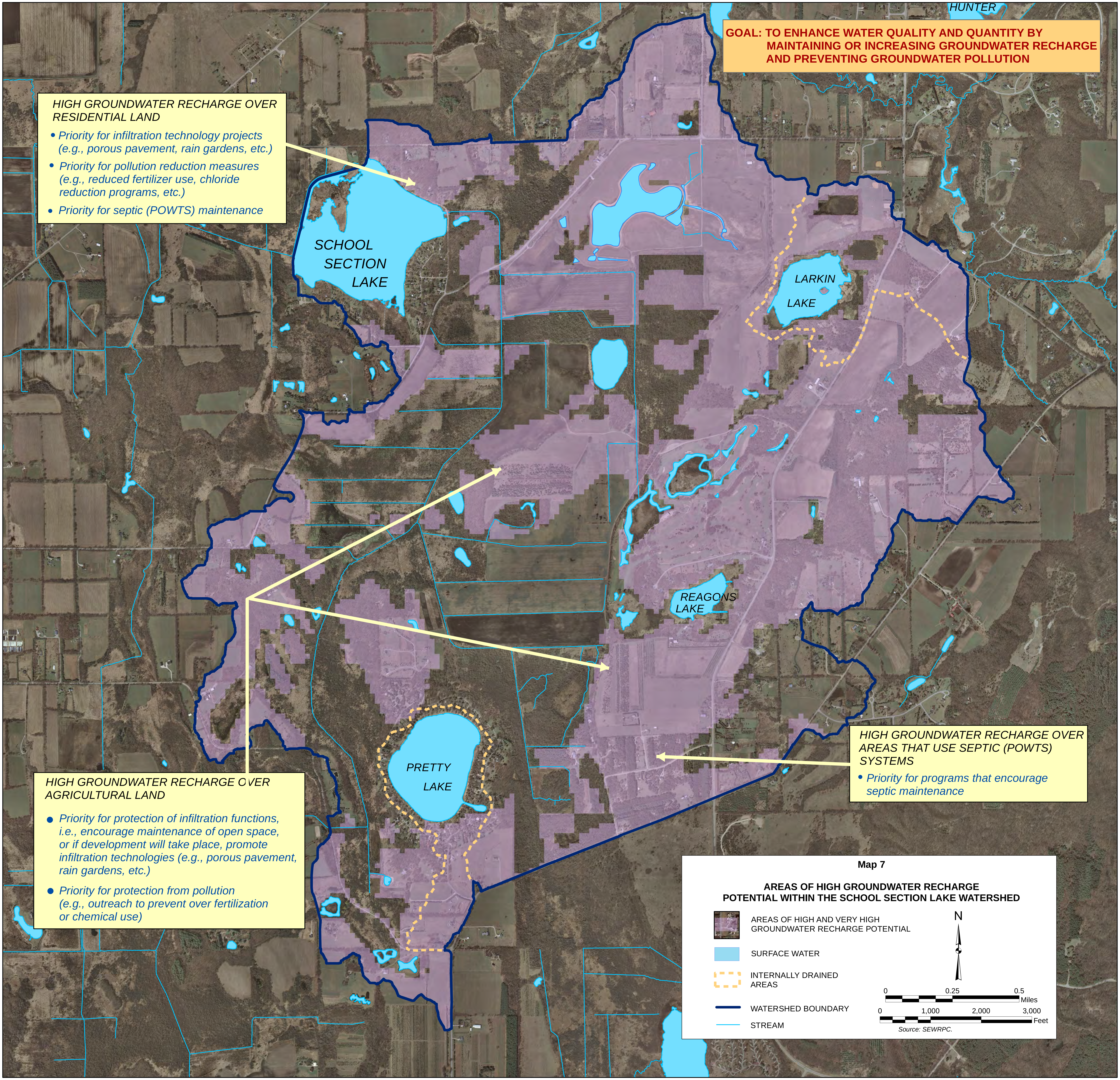
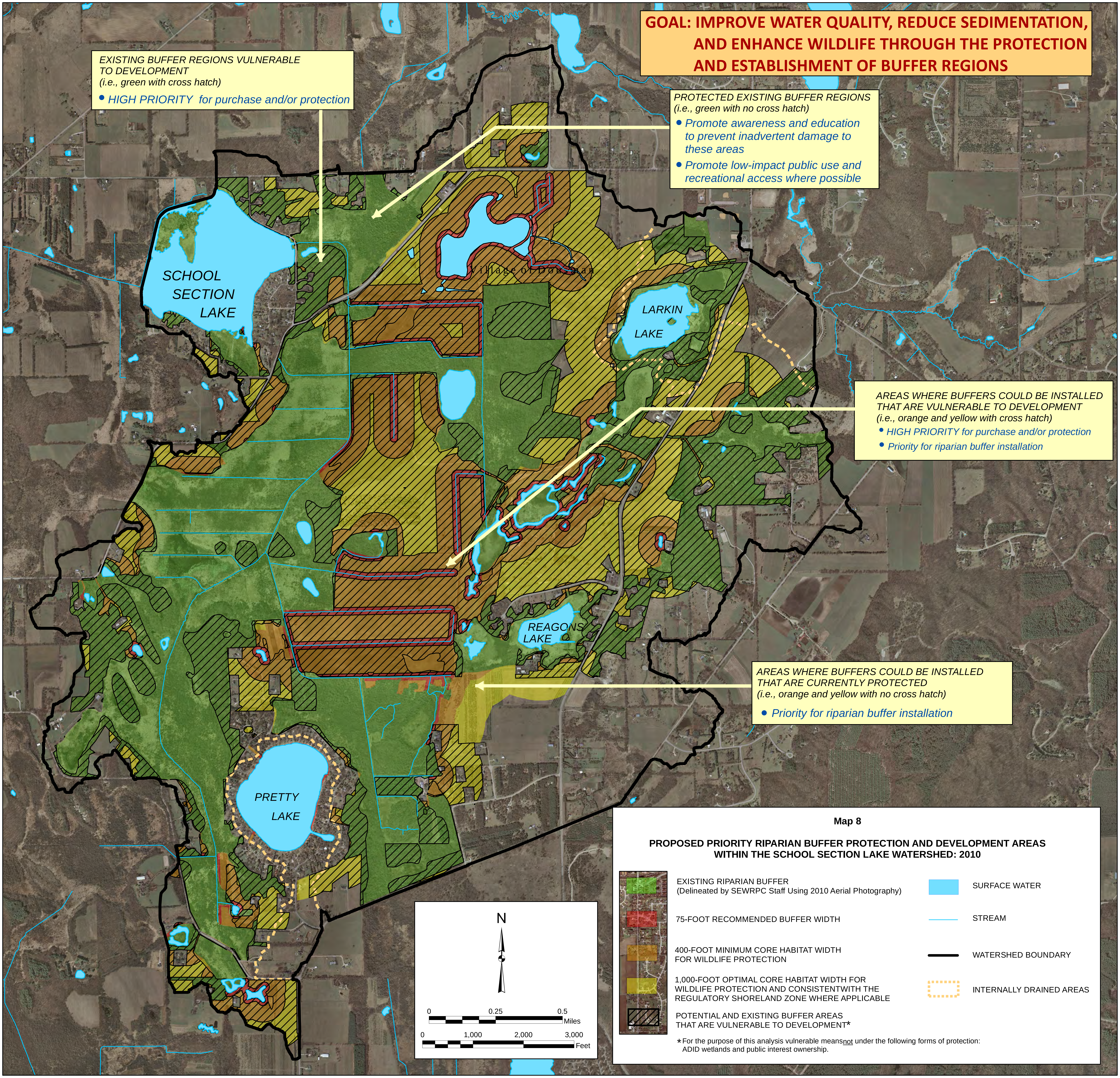

BEST MANAGEMENT PRACTICES FOR SHORELINE STABILIZATION/RESTORATION
• Priority for installation of buffer along lake shoreline (e.g., native vegetation)
BEST MANAGEMENT PRACTICES FOR FUTURE RESIDENTIAL DEVELOPMENT AREAS
• Stringent enforcement of Construction Site Erosion Control ordinances
• Implement green infrastructure technologies such as:
– Grassed swales
– Permeable pavement
– Rain barrels and cisterns
– Sand and organic filters
– Tree box filters
IN-LAKE BEST MANAGEMENT PRACTICES
• Priority for education related to environmentally responsible operation of motorized boats
• Priority for aquatic plant management (e.g., harvesting, targeted manual removal of near shore plants)
• Priority for continued monitoring
SCHOOL SECTION LAKE
LARKIN LAKE
BEST MANAGEMENT PRACTICES FOR NEAR SHORE RESIDENTIAL AREAS
• Priority for environmentally friendly lawn and shoreline maintenance (e.g., increase use of native vegetation and mulch, reduce fertilization and pesticide use)
BEST MANAGEMENT PRACTICES FOR AGRICULTURAL AREAS
• Priority for implementation of conservation practices and programs to protect water resources, such as:
– Establish riparian buffers and grassed waterways
– Implement nutrient management plans.
– Convert marginal cropland to wetlands and prairies
– Implement drainage water management practices
REAGONS LAKE
PRIORITY REGION FOR SEDIMENT LOAD INVESTIGATION
• Priority for a stream assessment to determine sources of erosion and sediment loads
• Enhance remeandering of stream channels through installation of channel blocks or other measures if found necessary by investigation
• Implement rehabilitation measures, such as buffer creation, in areas with high erosion, if deemed necessary
PRETTY LAKE
GOAL: TO IMPROVE WATER QUALITY AND DECREASE SEDIMENTATION THROUGH THE IMPLEMENTATION OF BEST MANAGEMENT PRACTICES AND TARGETED REHABILITATION
Map 6
RECOMMENDATIONS FOR POLLUTION AND SEDIMENT REDUCTION WITHIN SCHOOL SECTION LAKE WATERSHED
Agricultural areas recommended to implement BMPs in order to reduce sediment, nutrients (i.e., phosphorous and nitrogen) and pesitide runoff
Potential new construction area. Recommended to strictly enforce Construction Site Erosion Control ordinances as well as implement green infrastructure in order to reduce pollution and sediment loads
Residential area along the lake recommended to carry out BMPs in order to reduce the transport/runoff of sediment, oil, toxic chemicals, nutrients, road salts and heavy metal pollutants
Shoreline BMPs recommended in order to help reduce the transport of sediment, nutrient, and pesiticide runoff
SURFACE WATER
STREAM
WATERSHED BOUNDARY
INTERNALLY DRAINED AREAS
POTENTIAL CHANNEL BLOCK LOCATIONS
N
0 0.25 0.5 Miles
0 1,000 2,000 3,000 Feet
Source: SEWRPC.



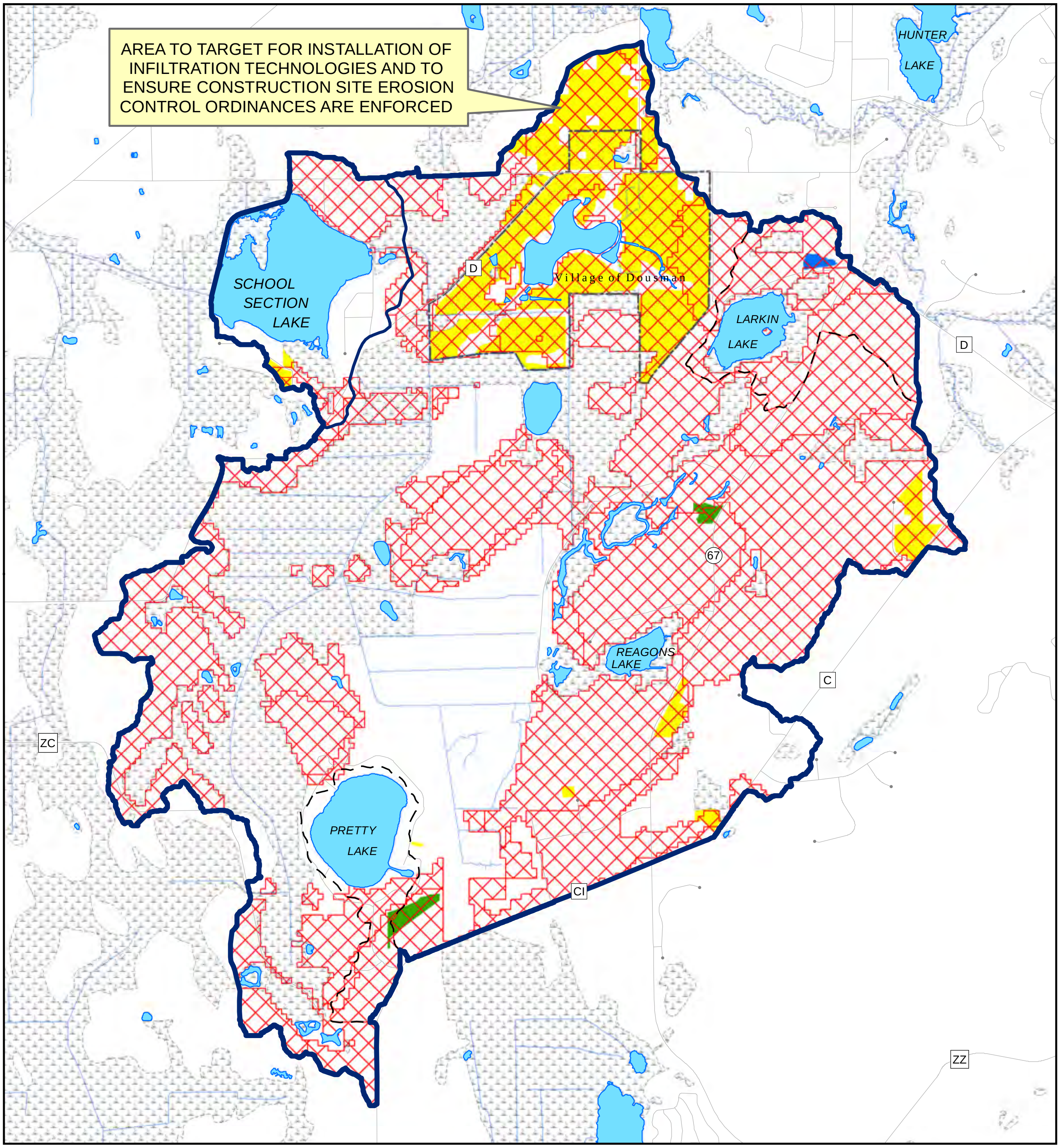
Map 7

AREAS OF HIGH GROUNDWATER RECHARGE POTENTIAL WITHIN THE SCHOOL SECTION LAKE WATERSHED


GOAL: IMPROVE WATER QUALITY, REDUCE SEDIMENTATION, AND ENHANCE WILDLIFE THROUGH THE PROTECTION AND ESTABLISHMENT OF BUFFER REGIONS
EXISTING BUFFER REGIONS VULNERABLE TO DEVELOPMENT (i.e., green with cross hatch)
• HIGH PRIORITY for purchase and/or protection
PROTECTED EXISTING BUFFER REGIONS (i.e., green with no cross hatch)
• Promote awareness and education to prevent inadvertent damage to these areas
• Promote low-impact public use and recreational access where possible
AREAS WHERE BUFFERS COULD BE INSTALLED THAT ARE VULNERABLE TO DEVELOPMENT (i.e., orange and yellow with cross hatch)
• HIGH PRIORITY for purchase and/or protection
• Priority for riparian buffer installation
AREAS WHERE BUFFERS COULD BE INSTALLED THAT ARE CURRENTLY PROTECTED (i.e., orange and yellow with no cross hatch)
• Priority for riparian buffer installation
SCHOOL SECTION LAKE
Village of Dousman
LARKIN LAKE
REAGONS LAKE
PRETTY LAKE
N
0
0.25
0.5
Miles
0
1,000
2,000
3,000
Feet
Map 8
PROPOSED PRIORITY RIPARIAN BUFFER PROTECTION AND DEVELOPMENT AREAS WITHIN THE SCHOOL SECTION LAKE WATERSHED: 2010
EXISTING RIPARIAN BUFFER (Delineated by SEWRPC Staff Using 2010 Aerial Photography)
75-FOOT RECOMMENDED BUFFER WIDTH
400-FOOT MINIMUM CORE HABITAT WIDTH FOR WILDLIFE PROTECTION
1,000-FOOT OPTIMAL CORE HABITAT WIDTH FOR WILDLIFE PROTECTION AND CONSISTENTWITH THE REGULATORY SHORELAND ZONE WHERE APPLICABLE
POTENTIAL AND EXISTING BUFFER AREAS THAT ARE VULNERABLE TO DEVELOPMENT*
SURFACE WATER
STREAM
WATERSHED BOUNDARY
INTERNALLY DRAINED AREAS
*For the purpose of this analysis vulnerable means not under the following forms of protection: ADID wetlands and public interest ownership.

Map 9

2035 PLANNED LAND USE CHANGES AND HIGH GROUNDWATER RECHARGE POTENTIAL WITHIN THE SCHOOL SECTION LAKE WATERSHED



SINGLE-FAMILY RESIDENTIAL

GOVERNMENT AND INSTITUTIONAL

RECREATION

HIGH AND VERY HIGH GROUNDWATER RECHARGE POTENTIAL

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

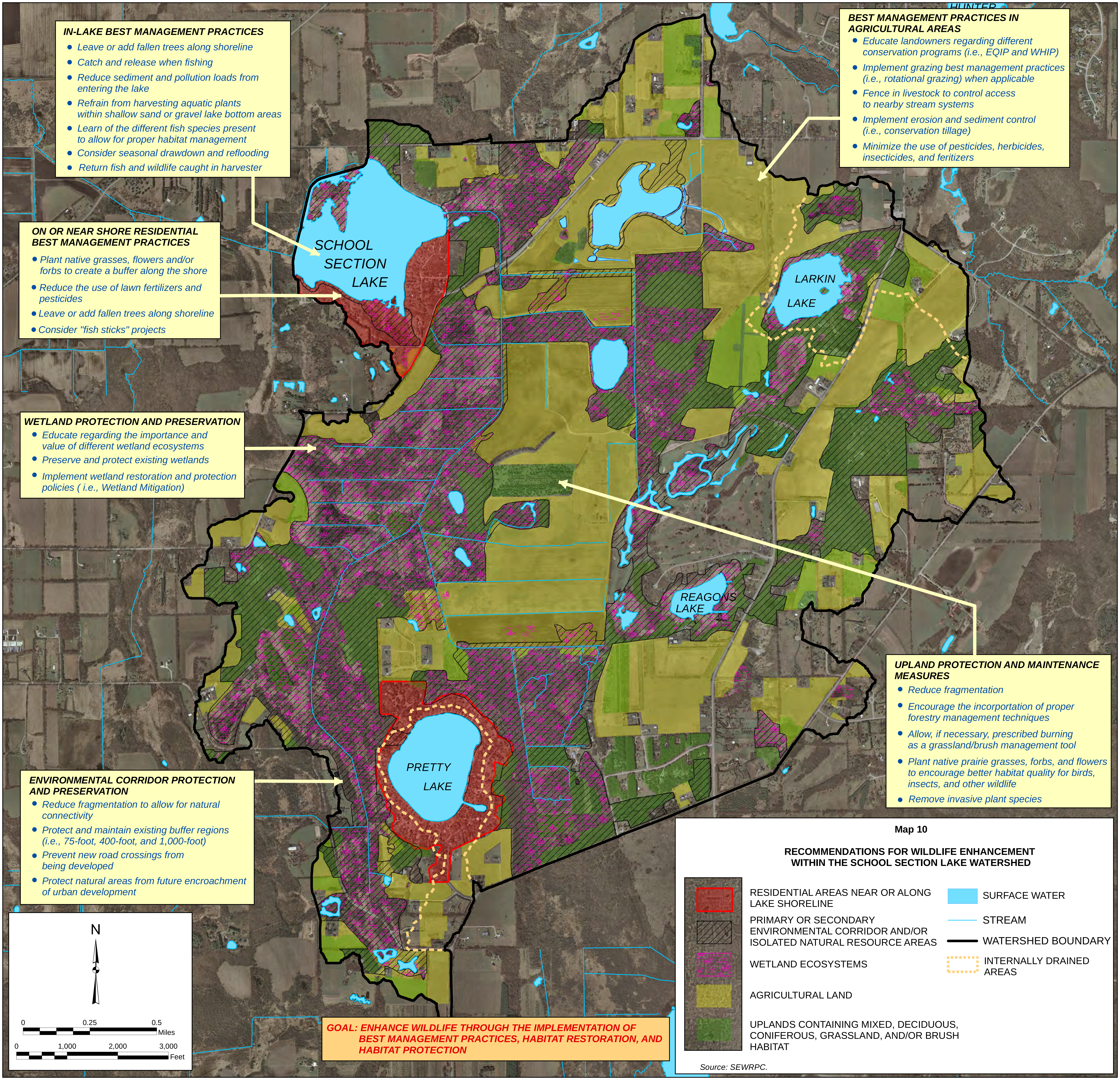
INTERNALLY DRAINED AREAS

N

0 0.5 1 Miles

0 2,500 5,000 Feet

Source: SEWRPC.



IN-LAKE BEST MANAGEMENT PRACTICES
Leave or add fallen trees along shoreline
Catch and release when fishing
Reduce sediment and pollution loads from entering the lake
Refrain from harvesting aquatic plants within shallow sand or gravel lake bottom areas
Learn of the different fish species present to allow for proper habitat management
Consider seasonal drawdown and reflooding
Return fish and wildlife caught in harvester
BEST MANAGEMENT PRACTICES IN AGRICULTURAL AREAS
Educate landowners regarding different conservation programs (i.e., EQIP and WHIP)
Implement grazing best management practices (i.e., rotational grazing) when applicable
Fence in livestock to control access to nearby stream systems
Implement erosion and sediment control (i.e., conservation tillage)
Minimize the use of pesticides, herbicides, insecticides, and feritizers
ON OR NEAR SHORE RESIDENTIAL BEST MANAGEMENT PRACTICES
Plant native grasses, flowers and/or forbs to create a buffer along the shore
Reduce the use of lawn fertilizers and pesticides
Leave or add fallen trees along shoreline
Consider "fish sticks" projects
SCHOOL SECTION LAKE
LARKIN LAKE
WETLAND PROTECTION AND PRESERVATION
Educate regarding the importance and value of different wetland ecosystems
Preserve and protect existing wetlands
Implement wetland restoration and protection policies (i.e., Wetland Mitigation)
REAGONS LAKE
UPLAND PROTECTION AND MAINTENANCE MEASURES
Reduce fragmentation
Encourage the incorporation of proper forestry management techniques
Allow, if necessary, prescribed burning as a grassland/brush management tool
Plant native prairie grasses, forbs, and flowers to encourage better habitat quality for birds, insects, and other wildlife
Remove invasive plant species
PRETTY LAKE
ENVIRONMENTAL CORRIDOR PROTECTION AND PRESERVATION
Reduce fragmentation to allow for natural connectivity
Protect and maintain existing buffer regions (i.e., 75-foot, 400-foot, and 1,000-foot)
Prevent new road crossings from being developed
Protect natural areas from future encroachment of urban development
N
0 0.25 0.5 Miles
0 1,000 2,000 3,000 Feet
GOAL: ENHANCE WILDLIFE THROUGH THE IMPLEMENTATION OF BEST MANAGEMENT PRACTICES, HABITAT RESTORATION, AND HABITAT PROTECTION
Map 10
RECOMMENDATIONS FOR WILDLIFE ENHANCEMENT WITHIN THE SCHOOL SECTION LAKE WATERSHED
RESIDENTIAL AREAS NEAR OR ALONG LAKE SHORELINE
PRIMARY OR SECONDARY ENVIRONMENTAL CORRIDOR AND/OR ISOLATED NATURAL RESOURCE AREAS
WETLAND ECOSYSTEMS
AGRICULTURAL LAND
UPLANDS CONTAINING MIXED, DECIDUOUS, CONIFEROUS, GRASSLAND, AND/OR BRUSH HABITAT
SURFACE WATER
STREAM
WATERSHED BOUNDARY
INTERNALLY DRAINED AREAS
Source: SEWRPC.

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APPENDICES

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Appendix A

INVENTORY FINDINGS

INTRODUCTION

The physical characteristics of a lake, in combination with the characteristics of the *lands that drain to the lake,* commonly referred to as a lake's "watershed," or "tributary area," are important factors in any evaluation of that lake's current and potential future issues. Characteristics, such as watershed topography, lake morphometry (external shape and dimensions) and local hydrology (water-related features), for example, ultimately influence water quality conditions and the composition of plant and fish communities within a lake. Consequentially, the characteristics of a lake and its watershed must be thoroughly evaluated in the lake protection planning process.

Accordingly, this appendix highlights all pertinent information that was available on School Section Lake and its watershed and is divided into subsections in order to help the reader navigate the large amount of information that is provided. These subsections include:

1. Waterbody Characteristics—This section provides general information about School Section Lake's hydrology and physical characteristics, and can be used to understand general conditions in the Lake, as well as the nature of water flows within the Lake, i.e., residence time.

2. Tributary Area and Land Use Characteristics—This section covers a large breadth of information about the watershed draining to School Section Lake, covering topography, groundwater, soils, existing and planned land use, urban growth, population data, and the amount of the watershed that utilizes Private Onsite Wastewater Treatment Systems (POWTS). This section should be used to: understand the conditions within the watershed; identify potential sources of pollution; and determine target areas for watershed management efforts. This section can also provide a context for understanding water quality data within the Lake.

3. Shoreline Protection and Erosion Control—This section presents a survey completed on the School Section Lake's shoreline structures and identifies potential opportunities for shoreline rehabilitation and enhanced erosion control.

4. Water Quality—This section presents and summarizes all relevant water quality data available for School Section Lake and attempts to identify trends, potential causes of issues, and monitoring gaps. This section should be used to understand the general condition of School Section Lake water quality and can be used to identify priority watershed management efforts, e.g., nonpoint source pollution reduction efforts to reduce phosphorous loads.

5. Pollutant Loadings—This section presents pollutant loads and in-lake phosphorous concentrations that were calculated using Unit Area Loading and WiLMS models. This data should be used to identify likely sources of sediment, phosphorous and heavy metal loads, as well as to guide outreach efforts seeking to reduce loadings to the Lake.

6. Aquatic Plants—This section presents the aquatic plant survey completed by Southeastern Wisconsin Regional Planning Commission (SEWRPC) staff in 2012, as well as compares the data found in this survey to previous aquatic plant surveys that were completed on the Lake. This section should be used to: understand the plant communities within the Lake; guide aquatic plant management efforts, particularly as it relates to invasive species; and to understand how the Lake's plant communities have changed over time.

7. Fish and Wildlife—This section provides a brief summary of the fish and wildlife populations within the School Section Lake watershed. This section should be used to better understand fish habitat, populations, and fish management in School Section Lake, as well as better understand the value of enhancing the wildlife population.

8. Important Natural Areas—This section presents all of the relevant natural areas located within the Lake's watershed, including wetlands, woodlands, uplands, environmental corridors, designated natural areas, and lands under legal protection. The section highlights the importance of these lands to the Lake, particularly in terms of water quality and wildlife, and should be used to understand the natural conditions within the watershed, as well as guide natural land protection and enhancement efforts.

9. Local Ordinances—This final section highlights pertinent local and regional legal structures that exist within the watershed, which affect the Lake. This section should be used to understand: the legal protections that exist for the Lake; the legal tools that can be used to maintain and enhance the Lake; and the legal and political constraints that need to be adhered to when developing watershed management efforts.

In general, this appendix covers all relevant information that could be collected on School Section Lake, as well as attempts to explain the importance and application of this information. The information presented in this appendix forms the basis upon which recommendations can be made. However, considering the breadth of data that is presented, it should be noted that this appendix should not necessarily be read in the order it is written, but, instead, should be used as a tool for understanding the many aspects that affect School Section Lake.

WATERBODY CHARACTERISTICS

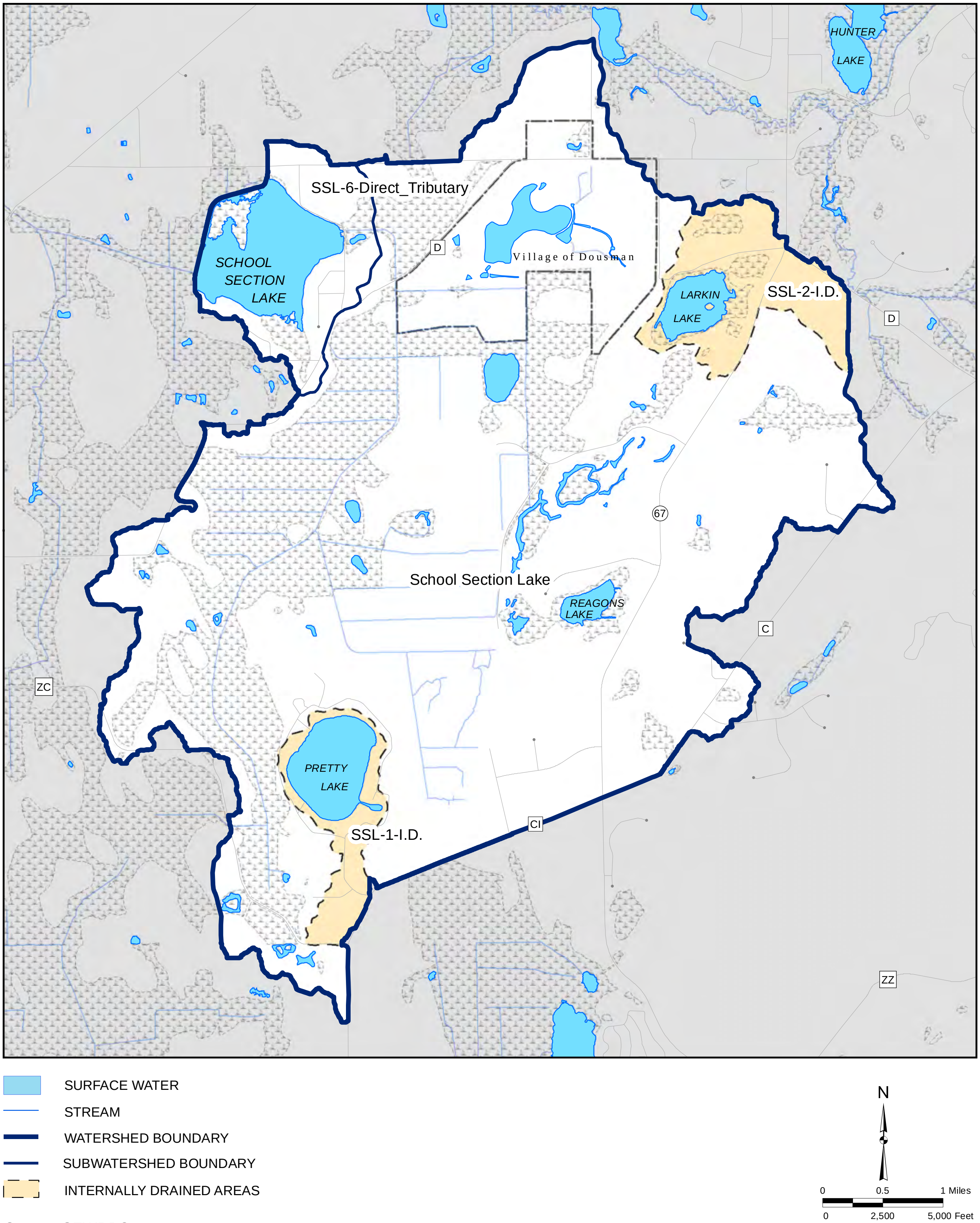
School Section Lake, shown on Map A-1, is located in the Town of Ottawa in Waukesha County, Wisconsin. The hydrographical characteristics of School Section Lake are set forth in Table A-1. School Section Lake has a single basin aligned in a slightly north-south orientation and has a length of about 0.6 mile, a width of about 0.5 mile, and a shoreline length of about 2.0 miles. Additionally, the Lake levels are maintained by a four-foot head dam located on the outlet, resulting in the Lake having a surface area of about 122 acres (island surface area excluded), a volume of about 460 acre-feet, a maximum depth of 15 feet, and a mean depth of about four feet (see Map A-2).

A dredging project was undertaken in School Section Lake in 1994 which increased the maximum depth of the Lake from eight feet to about 20 feet. This project drastically changed the bathymetry of the Lake, as can be seen in Figure 2 in Chapter II of this report, which shows the bathymetry of the Lake in 1965 before dredging and the bathymetry in 2005 after dredging.

The Wisconsin Department of Natural Resources (WDNR) has classified the Lake as a drained, or headwater, lake, which means that the Lake has a defined outflow and that the inflow to the Lake is dependent largely on

Map A-1

SURFACE WATER RESOURCES WITHIN THE SCHOOL SECTION LAKE WATERSHED: 2005



Source: SEWRPC.

Table A-1

HYDROLOGY AND MORPHOMETRY OF SCHOOL SECTION LAKE

Parameter	Measurement
Size	
Surface Area of Lake	122 acres
Total Tributary Area	4069 acres
Lake Volume	460 acre-feet
Maximum Depth	15 feet
Average Depth	4 feet
Less than Three Feet	34.4 percent
Residence Time[a]	52 days
Shape	
Length of Lake	0.6 mile
Width of Lake	0.5 mile
Length of Shoreline	2.0 miles
Shoreline Development Factor[b]	1.3
General Lake Orientation	N-S

NOTE: School Section Lake was dredged in 1994; prior to that time, the Wisconsin Department of Natural Resources listed the Lake to have a maximum depth of eight feet and an average depth of three feet; dredging increased the maximum depth to approximately 15 feet, with an estimated increase in average depth to four feet.

[a]*Residence time is estimated as the time period required for a volume of water equivalent to the volume of the lake to enter the lake during years of normal precipitation.*

[b]*Shoreline development factor is the ratio of the shoreline length to the circumference of a circular lake of the same area.*

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, and SEWRPC.

direct precipitation onto the Lake's surface, together with surface runoff from its surrounding watershed. A hydrological budget for the Lake was developed in preparation for the dredging project. This budget states that about 88 percent (4,700 acre-feet per year) of Lake's water supply comes from surface water sources, 6 percent (300 acre-feet per year) comes from groundwater sources within the Lake, and the last 6 percent comes from precipitation directly onto the surface of the Lake.[1] It should be noted, however, that this same report mentions that the water being contributed to the Lake from its inlet likely comes from upstream groundwater springs located within the watershed, given the Lake's high alkalinity levels (as discussed in the Water Quality section of this chapter). Water is lost from School Section Lake mainly through the outflow channel at the west end of the Lake.

Shoreline Development Factor and Predicted Biological Activity

Shoreline development factor is a rating scale that illustrates the irregularity of a lake's shoreline. The rating compares the shoreline length of the lake in question to the shoreline length of a lake, with the same areal size, which forms a perfect circle. This is an important factor in understanding the workings of a lake's ecosystems, due to the fact that the shoreline development factor is often related to the level of biological activity, i.e., the amount of plant and animal life, in a lake. Generally, the greater a lake's shoreline development factor, i.e., the more irregular its shoreline, the greater the likelihood that a lake will contain the shallow, nearshore areas, i.e., littoral zones, that are suitable habitat for plant and animal life. School Section Lake has a shoreline development factor of 1.3, indicating that the shoreline length is about 1.3 times greater than that of a perfectly circular lake of the same area. With a value of 1.3, School Section Lake is similar to neighboring Pretty Lake, which has a shoreline development factor of 1.1,[2] reflecting that lake's nearly circular shape; but is more circular than nearby Hunter's Lake, which has a shoreline development factor of 1.7,[3] which reflects that lake's more irregular shoreline and elongated shape.

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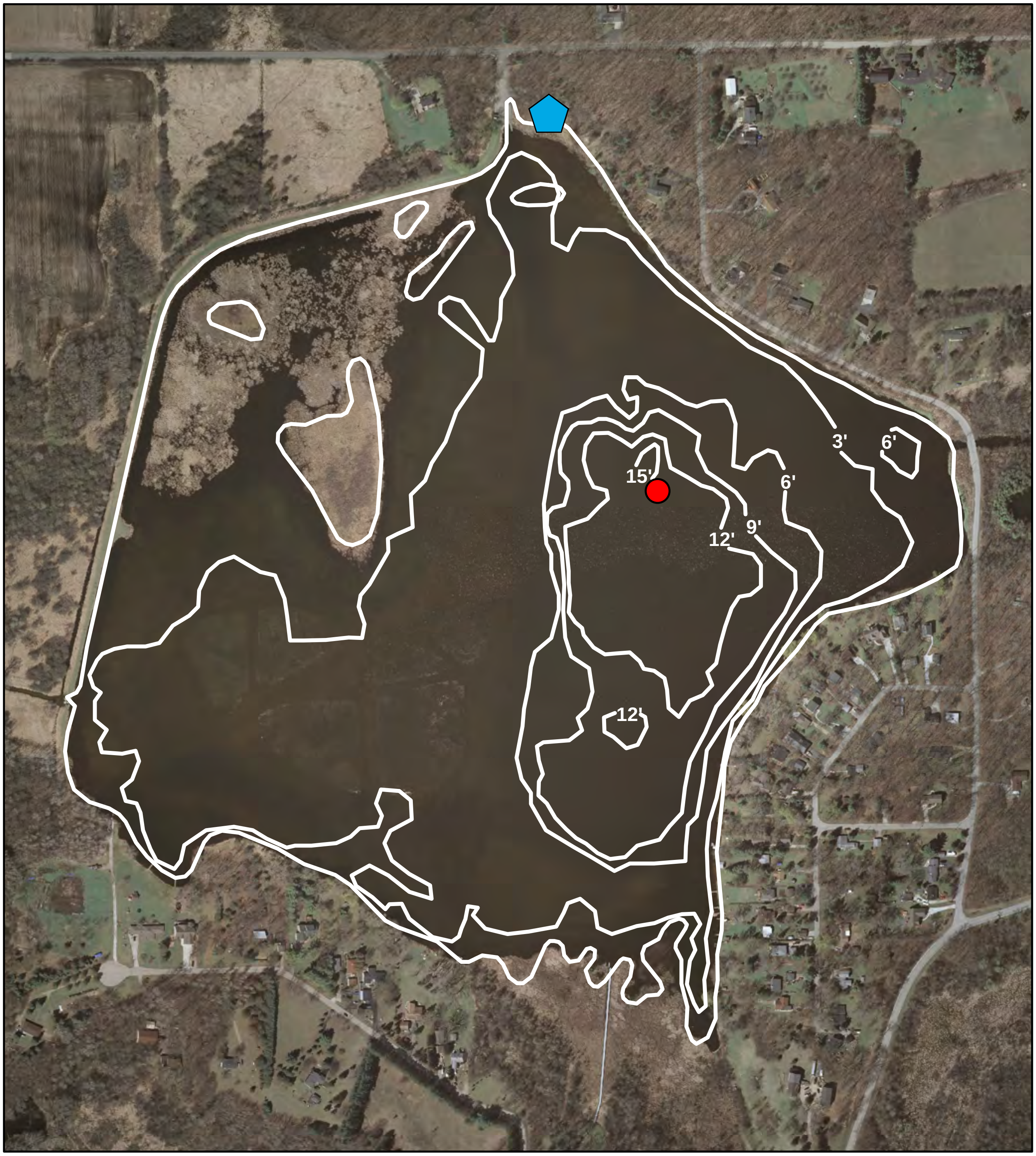
[1]*Wisconsin Department of Natural Resources,* School Section Lake, Waukesha County, Feasibility Study Results: Management Alternatives, *1981.*

[2]*SEWRPC Memorandum Report No. 122, 2nd Edition,* A Lake Protection Plan for Pretty Lake, Waukesha County, Wisconsin, *May 2006.*

[3]*SEWRPC Memorandum Report No. 120,* A Lake Protection and Recreational Use Plan for Hunters Lake, Waukesha County, Wisconsin, *May 1997.*

Map A-2

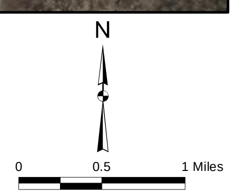
BATHYMETRIC MAP OF SCHOOL SECTION LAKE: 2005



—3'— WATER DEPTH COUNTOUR IN FEET

DEEP HOLE MONITORING SITE

PUBLIC ACCESS SITE



Source: U.S. Geological Survey, Marine Biochemists, and SEWRPC.

However, even though School Section Lake has a relatively low development factor (1.3), biological activity in a lake also can be influenced by other physical factors, such as lake-basin contour and bottom sediment composition. The combination of large shallow areas of nearly flat bottom contours, together with soft bottom sediments, generally produces conditions that support high levels of biological activity. As shown on Map A-2, School Section Lake is generally composed of large shallow water areas with low bottom contours. In addition, according to sediment surveys taken in preparation for the dredging project, most of the lake bottom is comprised of soft sediment. Given these factors, School Section Lake would be expected to have moderately high biological activity, relatively nutrient rich water and the ability to support abundant aquatic plant growth and a productive warmwater fishery.

Residence Time

Residence time, also known as *retention time* or *flushing rate*, refers to the average length of time that water remains in a lake. This can be a significant factor in determining the impact of pollutants and nutrients on a lake's water quality. Lakes with short duration retention times, such as flow-through lakes that are part of a river system, for example, will flush nutrients and pollutants out of a lake fairly quickly, while lakes with long retention times, such as seepage lakes which have no defined outflow, tend to accumulate nutrients that can eventually become concentrated in their bottom sediments. The average retention time for a lake can be as brief as a few days or as long as many years; Lake Superior, for example, has a retention time of 500 years, the longest retention time of any Wisconsin lake.

From a lake management perspective, efforts to control nutrient levels in a lake with a short retention time will usually focus on limiting nutrient inflow to a lake as the rapid flushing time will lead to apparent water quality improvement in a relatively short period of time. In contrast, lakes with slower flushing rates usually respond to watershed protection at a much slower rate, with apparent improvement in water quality sometimes taking years to occur.

Earlier reports on School Section Lake estimated the retention time to be 22 days,[4] however, the Lake has since been dredged, thereby changing the overall flow dynamics of the Lake. More recent calculations, therefore, set the retention time at approximately 52 days. With a retention time of 52 days, School Section Lake's flushing rate is moderately fast (due, in part, to the presence of a defined outflow) and, as such, would be expected to follow a pattern where the degree of nutrient inflow may hold the key to managing water quality conditions within the Lake, i.e., stopping nutrient deposition as the source would lead to quick recoveries within the Lake. The importance of this factor in the management of School Section Lake's water quality cannot be underestimated.

TRIBUTARY AREA AND LAND USE CHARACTERISTICS

Soil erosion, water pollution, recreational use conflicts and wetland losses, as well as the ultimate means for abatement of these problems, are often a function of the human activities within a lake's watershed and the ability of the underlying natural resource base to sustain those activities. This becomes especially significant in areas that are in close proximity to lakes, wetlands, and streams. It is, therefore, crucial to understand the conditions within School Section Lake's watershed in order to properly develop recommendations. This section presents all of the relevant data SEWRPC staff could collect about School Section Lake's watershed and explains how that information can be used. This information will provide a more thorough understanding of the School Section Lake watershed, and, in turn, a better understanding on how to address identified issues.

Watershed Characteristics and Hydrology

As shown on Map A-1, the School Section Lake watershed is situated within the Town of Ottawa, in the far west-central part of Waukesha County. The total land area which drains to School Section Lake is approximately 4,069

[4]*Wisconsin Department of Natural Resources,* Feasibility Study Results, *1981,* op. cit.

acres, or about 6.4 square mile, in areal extent. Large areas of the watershed contain networks of drainage canals that transport water and potential pollutants (sediments and nutrients) to School Section Lake through the inlet.

Topography

A watershed's *topographic* features, such as land elevations and slopes, play an integral role in determining a lake's water quality by influencing the amount and composition of runoff to a lake. As shown on Map A-3, topographic elevations in the School Section Lake watershed range from approximately 800 to 900 feet above National Geodetic Vertical Datum, 1929 adjustment (NGVD29) in the vast majority of the watershed, to over 1,000 feet, with these higher elevations being mostly restricted to the extreme eastern edge of the watershed. As surface waters would be expected to flow generally downhill, runoff within the School Section Lake watershed flows from the higher elevations in the eastern edge to the lower elevations in the rest of the watershed. School Section Lake itself is situated in the lower elevations, as would be expected.

Internally Drained Areas

Shown on Map A-4 are the locations of several *internally drained* areas within the School Section Lake watershed. Such areas, as a result of their surface topography, trap surface waters and prevent them from entering School Section Lake via surface runoff (although the water which enters these areas may still drain to the Lake through a groundwater connection). The size, number, and locations of such areas can have a significant impact on the quality and quantity of surface water that drains to a lake. As shown on the map, there are two such areas in the School Section Lake watershed: one located in the northeastern corner of the watershed in the area around Larkin Lake, and a second area located in the southern tip of the watershed in proximity around Pretty Lake. These two internally drained areas effectively isolate the water in Larkin Lake and Pretty Lake from directly entering School Section Lake through a surface water connection. This is particularly important as it indicates that any water quality or quantity issues that occur in these areas will not directly affect School Section Lake.

Slopes

Land slopes within a lake's watershed are an important consideration in determining amounts and types of runoff to a lake that can be expected. Poorly planned hillside development in areas of steep slopes can lead to severe construction and post-construction erosion problems, as well as high maintenance costs associated with public infrastructure. Steeply sloped agricultural lands may make the operation of agricultural equipment difficult, or even hazardous, while development or cultivation of steeply sloped lands is likely to result in erosion and sedimentation that negatively impact surface water quality. Slope maps can, therefore, guide construction and erosion control efforts in order to prevent inadvertent damage to the Lake.

As shown on Map A-5, slopes in the School Section Lake watershed range from less than 1 percent to greater than 20 percent. The majority of the watershed, especially through the central portion and including that part directly south of School Section Lake, generally sits in an area where surface slope is in the lowest, 0 to 6 percent, range. The majority of more steeply sloped lands are located in the eastern portion of the watershed between Larkin and Reagons Lakes, in the southwestern edges of the watershed, and in a few isolated areas in close proximity to School Section Lake to the east and north of the Lake.

In a study preceding the aforementioned dredging project,[5] the low occurrence of steep slopes was stated as a major reason for the high water quality within School Section Lake, given that the entire watershed, especially the

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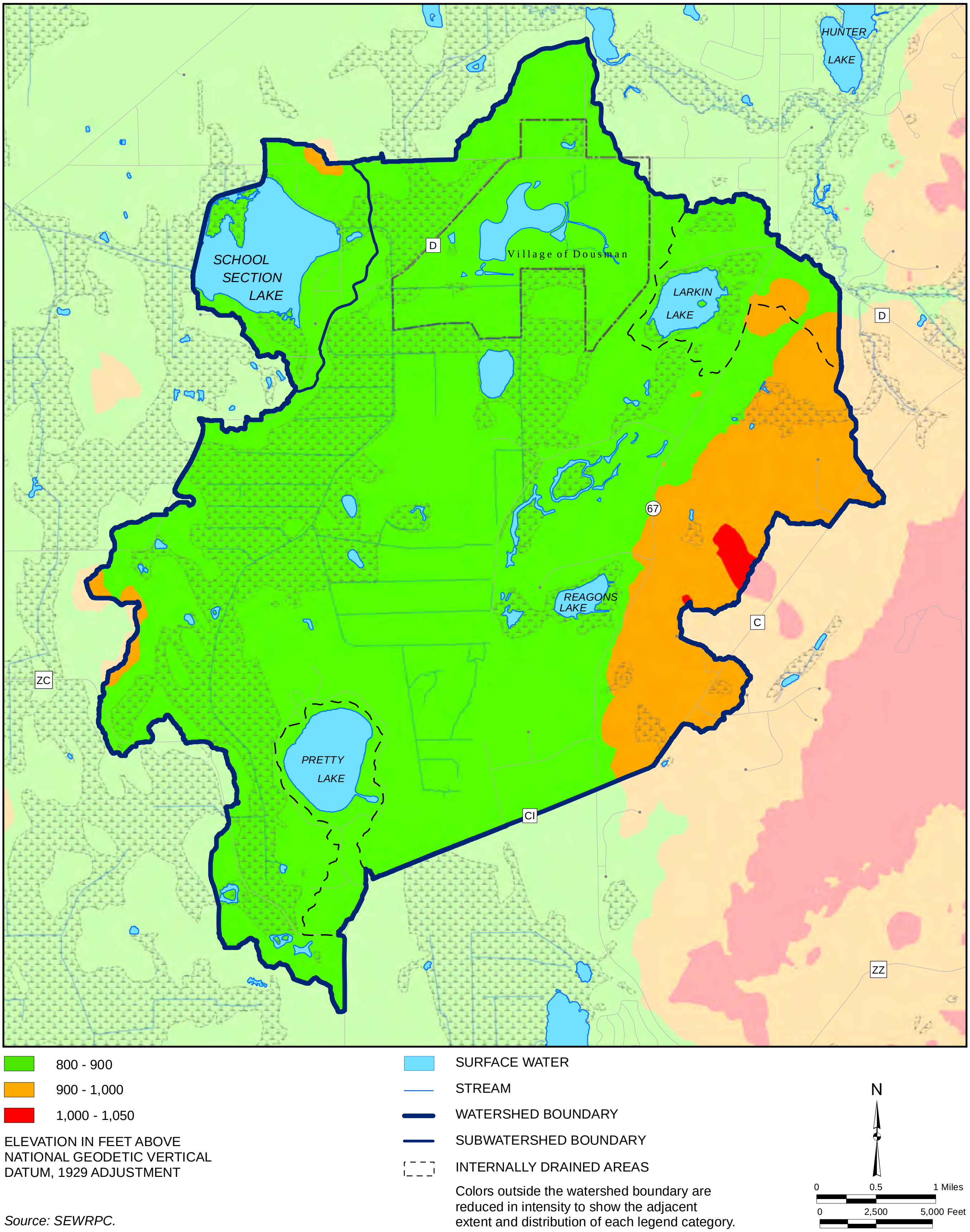
[5]Ibid.

Map A-3

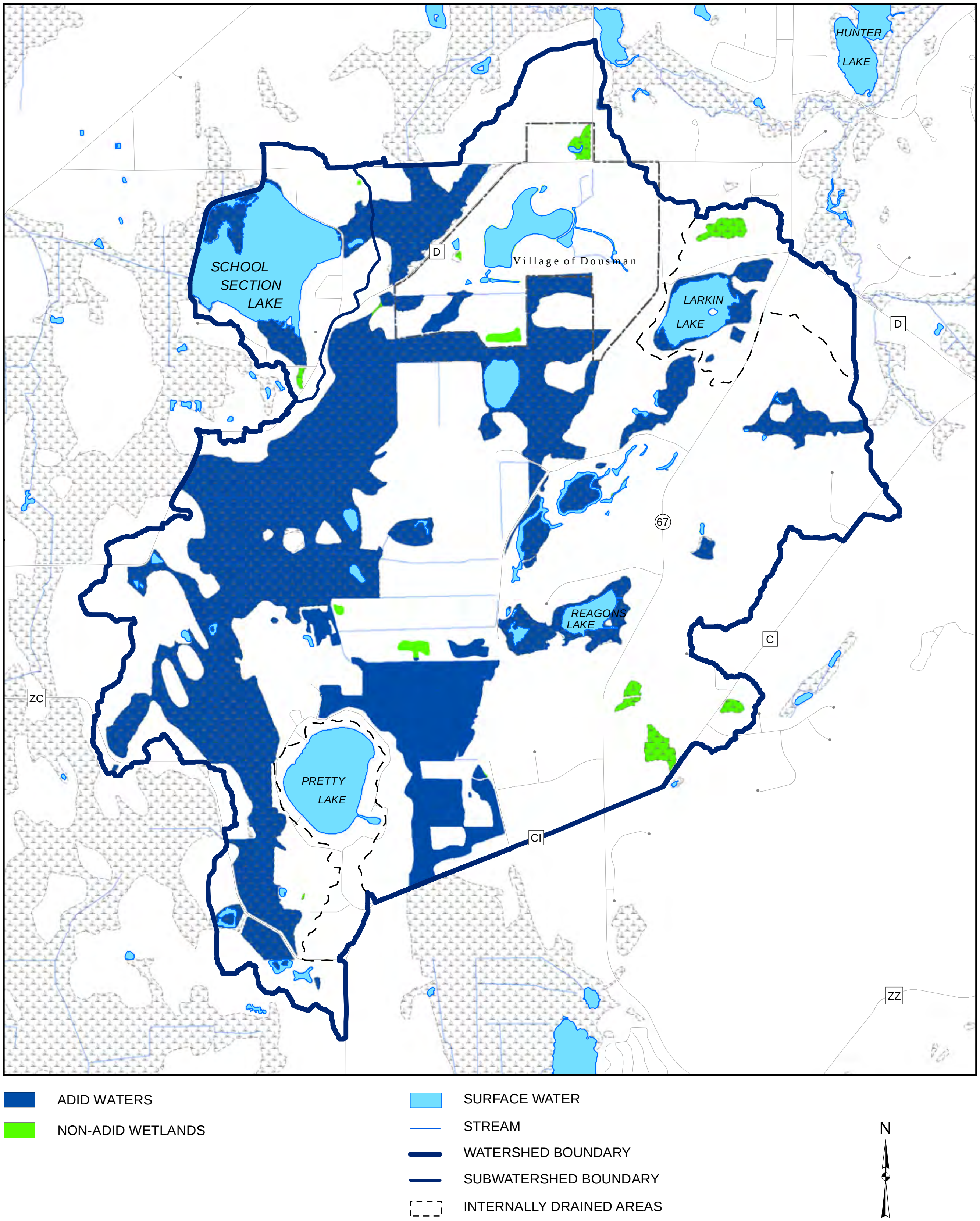
TOPOGRAPHIC AND PHYSIOGRAPHIC CHARACTERISTICS WITHIN THE SCHOOL SECTION LAKE WATERSHED



Source: SEWRPC.

Map A-4

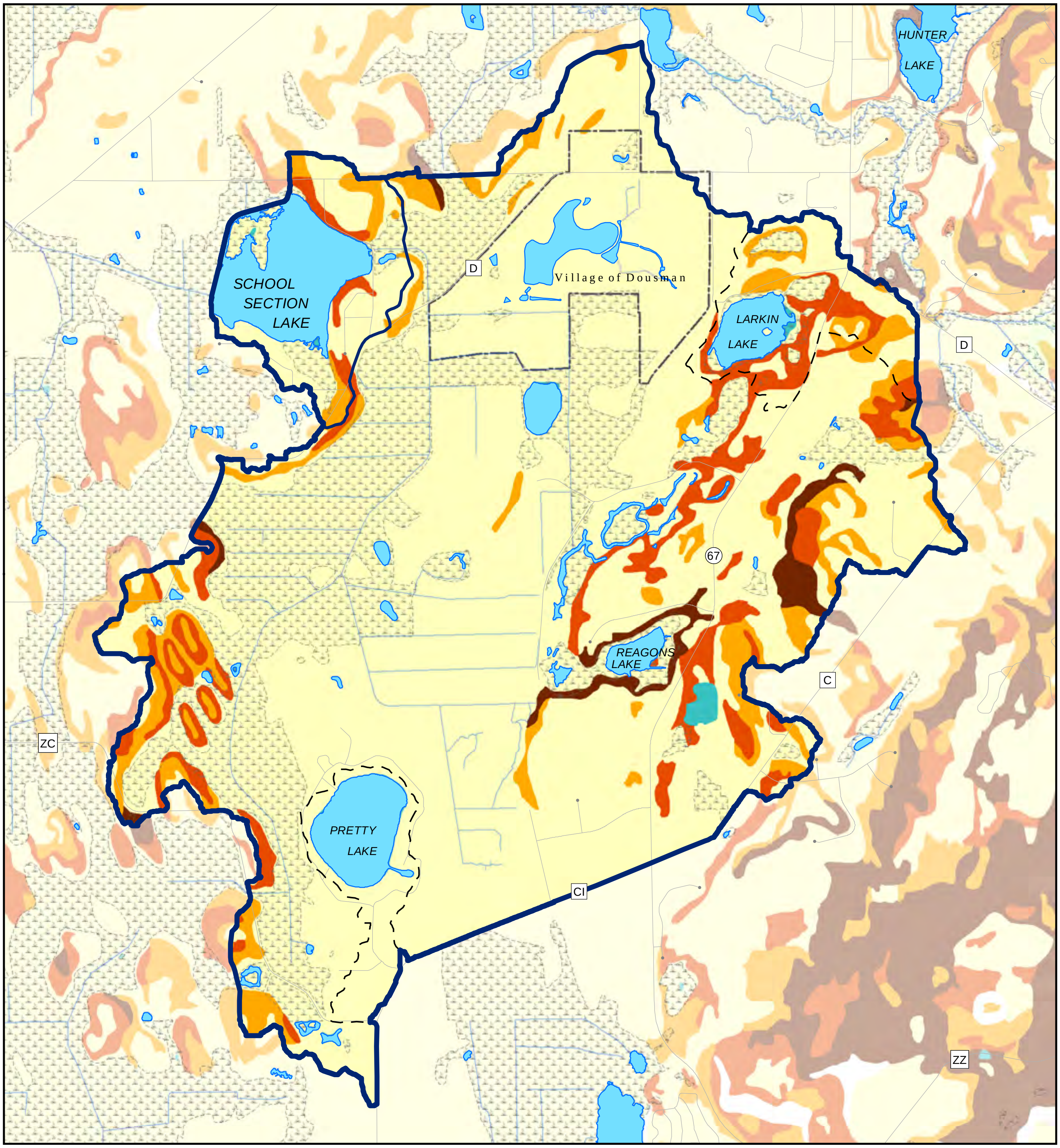
ADID WATERS AND NONADID WETLANDS WITHIN THE SCHOOL SECTION LAKE WATERSHED: 2010



Source: SEWRPC.

Map A-5

SLOPES WITHIN THE SCHOOL SECTION LAKE WATERSHED



SOILS HAVING SLOPES RANGING FROM 0 TO 5 PERCENT

SOILS HAVING SLOPES RANGING FROM 6 TO 11 PERCENT

SOILS HAVING SLOPES RANGING FROM 12 TO 19 PERCENT

SOILS HAVING SLOPES OF 20 PERCENT OR GREATER

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

INTERNALLY DRAINED AREAS

Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

N

0 0.5 1 Miles

0 2,500 5,000 Feet

Source: Natural Resources Conservation Service and SEWRPC.

wetlands located upstream from the Lake, have the ability to act as a sediment trap and prevent sediment deposition in the Lake.[6]

Groundwater

Groundwater within the School Section Lake watershed is crucial to sustaining the water supply to the upstream tributaries and wetlands, and in turn the water supply to the Lake. This is due to the fact that the groundwater provides the baseflow through spring discharge within the watershed which supplies the Lake's inlet and likely the majority of its surface water inputs through the inlet (up to 88 percent).[7] In fact, an earlier study of School Section Lake[8] attributed high alkalinity levels in the Lake and the inlet stream to the Lake receiving extensive groundwater input, most of which enters the Lake by means of inlet stream recharge. Given that School Section Lake is a headwater lake (meaning that all of its water supply comes from within its own watershed), these groundwater inputs could potentially be a major reason why School Section Lake was able to maintain fairly steady water levels during the drought period in 2012.

Additionally, groundwater is also a major source of water supply, with all of the communities within the School Section Lake watershed being dependent on groundwater for a potable water supply and for other urban and rural land uses. Groundwater resources thus constitute an extremely valuable element of the natural resource base within the School Section Lake watershed and need to be protected.

Groundwater Elevation Contours

Whereas the boundaries of surface-water watersheds, such as the School Section Lake watershed, are generally determined from topographical maps based on land elevations, the boundaries of groundwatersheds do not always coincide with their surface water counterparts. While it is true that water, whether on the surface or moving through aquifers located below the surface, does flow overall from higher to lower elevations, the movement of groundwater in below-ground aquifer systems is subject to a variety of additional factors, including geological formations that can block or redirect the flow of water.

Map A-6 shows the groundwater elevation contours in the School Section Lake watershed area. These reflect the general water table elevations, in feet above NGVD 29, based on well elevations. As indicated on the map, these groundwater contours indicate a general east to west downward slope. This indicates that the groundwater recharge within the Lake's watershed is likely contributing to the groundwater that feeds the Lake. Consequently, groundwater recharge should be considered a priority if water levels are to be maintained.

In terms of management, it is also important to monitor groundwater levels over time to detect whether any drastic changes are taking place over time. This may help determine the source of water quantity issues if they occur in the future.

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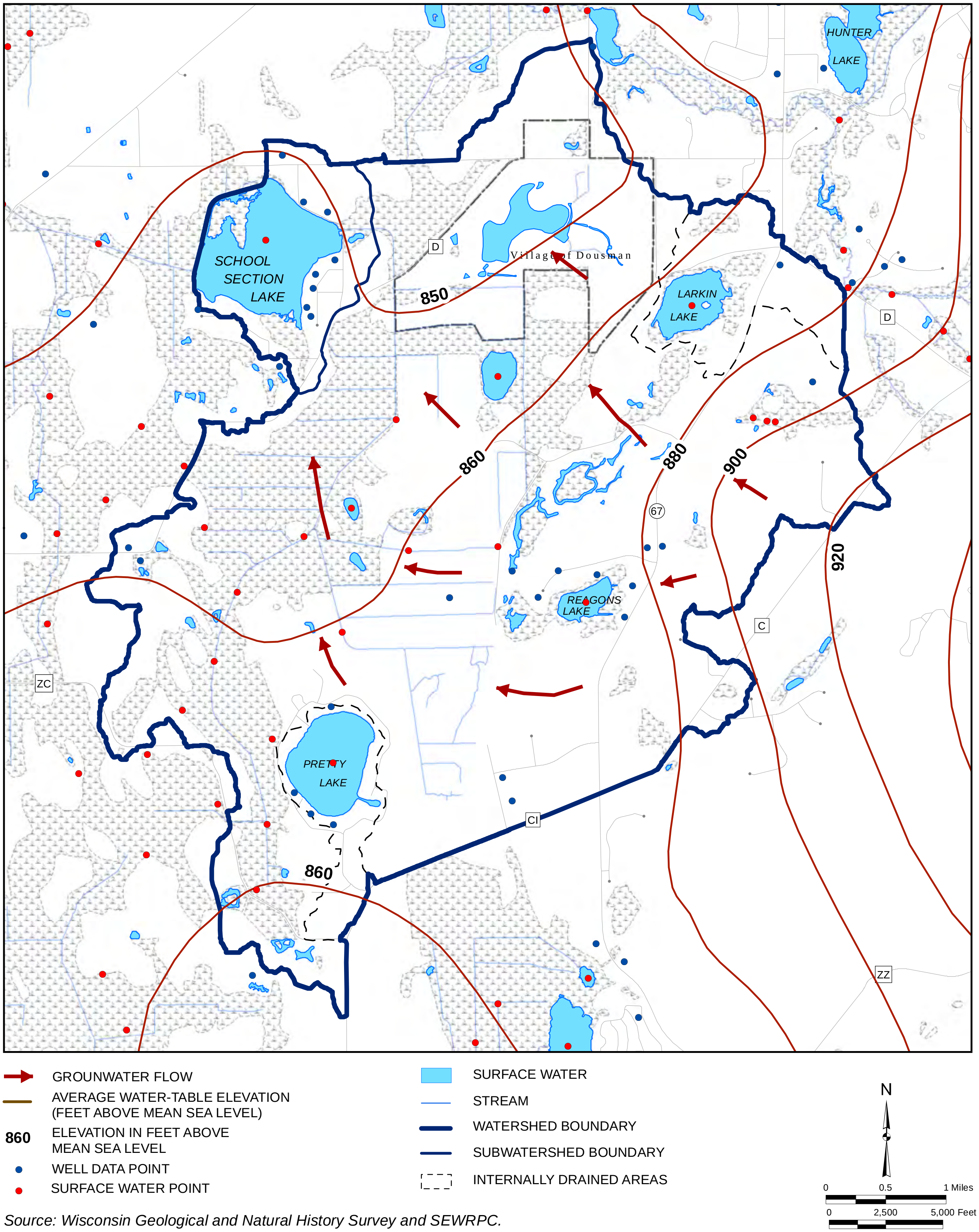
[6]*High occurrence of slopes make water move faster, thereby allowing the water to pick up sediment and transport them to an area where the water slows down and subsequently deposits the sediment (like lakes). When these slopes/high elevation differences don't exist, water moves slowly through the system and does not pick up this sediment, or deposits the sediment over a large area, rather than just in the lake. Consequently, lack of steep slopes is connected to lake water quality.*

[7]*Wisconsin Department of Natural Resources*, Feasibility Study Results, *1981,* op. cit.

[8]Ibid.

Map A-6

GROUNDWATER ELEVATION CONTOURS BASED ON WELL ELEVATIONS WITHIN THE SCHOOL SECTION LAKE WATERSHED



Source: Wisconsin Geological and Natural History Survey and SEWRPC.

Groundwater Recharge

As described above, groundwater plays an important role in sustaining lake levels and maintaining an adequate supply of potable water in School Section Lake. Groundwater recharge, i.e., precipitation and snowmelt that filters through soils and maintains aquifer levels, is, therefore, also of great importance. In general, groundwater recharge depends mainly on the permeability of the overlying soils, bedrock or other surface materials, including man-made surfaces; therefore, it is possible to determine which areas have the highest recharge potential. As shown on Map A-7, while the rates of groundwater recharge within the School Section Lake watershed range from *low* to *very high*, the majority of the watershed falls within the *high* and *very high* categories, a significantly positive feature of the School Section Lake watershed, considering the importance of groundwater to maintaining the water level in School Section Lake. It should be noted that there are also a few areas identified as having *undefined* rates of recharge, located largely in the southwestern portion of the watershed. These areas coincide with wetland areas within the watershed and were designated as undefined due to the complex interactions wetlands can have with groundwater resources. Wetlands are further discussed later in this appendix.

Knowing where the groundwater recharge takes place within the watershed is a crucial step toward protecting lake levels and water supply within the School Section Lake watershed, particularly since the groundwater moves in an east to west direction (thereby indicating the Lake’s watershed is contributing to the groundwater feeding the Lake’s inlet). This is due to the fact that there are activities and land uses that can both reduce and encourage recharge to the groundwater supply, particularly if they are undertaken within the high and very high recharge areas. If development occurs, for example, impervious surfaces may increase, thereby preventing groundwater recharge from continuing to occur in the area that was developed. However, stormwater management practices can be instituted in these areas to encourage infiltration of runoff. Such mitigating measures should, therefore, be seen as a priority in high groundwater recharge areas.

Depth to Groundwater

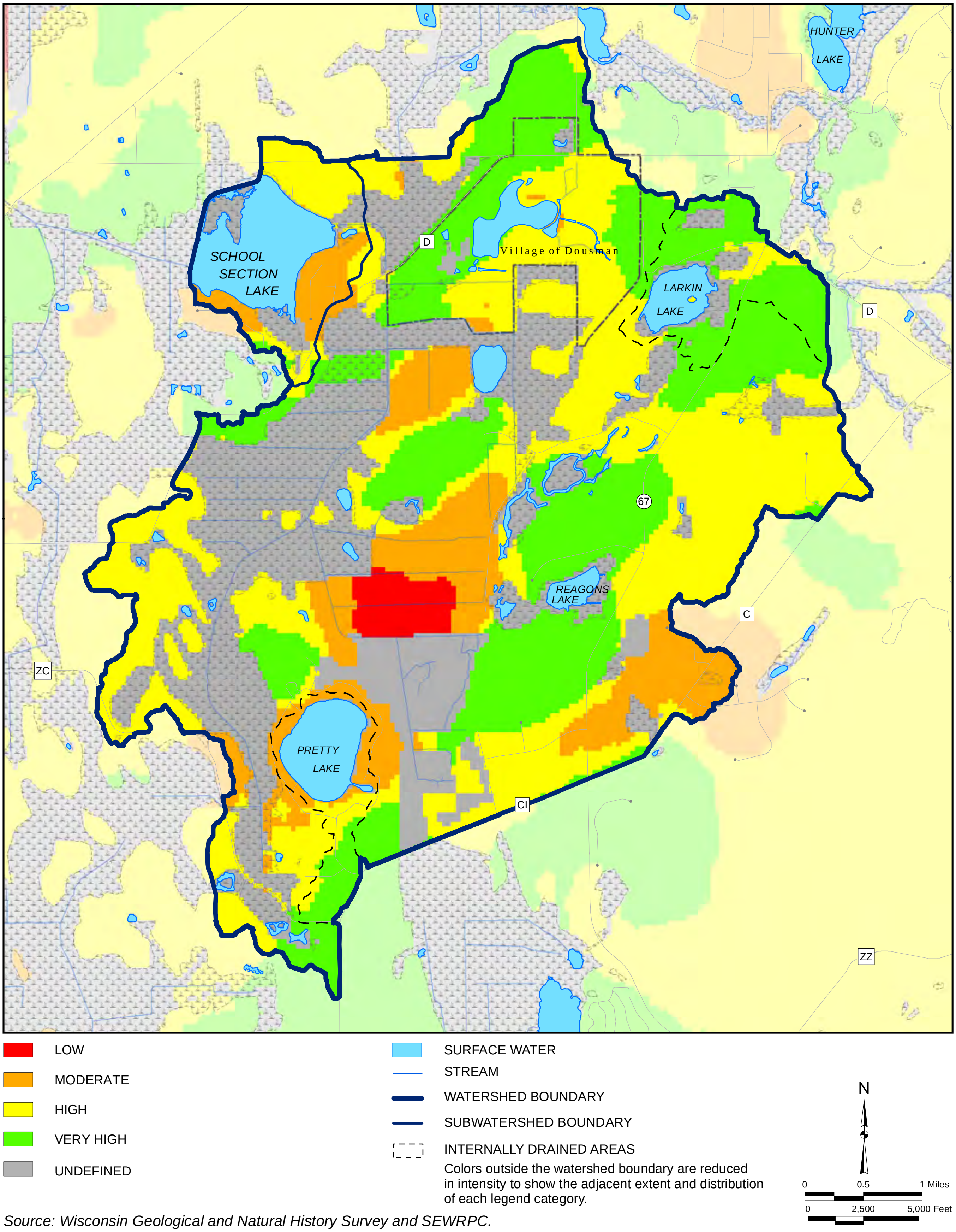
When groundwater recharge occurs, it can also bring pollution, such as pesticides and nutrients, with it. Depth to groundwater levels provide a context for understanding groundwater pollution potential, as they indicate the depth of soils that water would have to filter through in order to reach to groundwater below. In general, the higher the depth to the groundwater level, the more natural filtration groundwater recharge will have and, in turn, the lower the groundwater pollution potential will be. Depths to seasonal high groundwater levels for the School Section Lake watershed are shown on Map A-8. As expected, the levels in the School Section Lake watershed are generally consistent with the surface topography of the area, i.e., highest elevations generally coincide with the greatest depths to groundwater levels. The area with the highest depth to groundwater levels is located in the eastern portion of the watershed, which also happens to coincide with a high groundwater recharge area (see Map A-7). This coincidence indicates that this area would be ideal for infiltration efforts. On a related note, high groundwater recharge areas with lower depth to groundwater levels, like the area found in the southeastern portion of the Village of Dousman, are ideal areas to target groundwater pollution prevention efforts.

Soils

The glaciers that once covered southeastern Wisconsin deposited a wide variety of soil-forming materials and sculpted many different landforms that influence soil type and lake hydrology in the Southeastern Wisconsin Region. Soil types, along with land slope, land use and vegetative cover, are important factors for determining the rate, amount, and quality of stormwater runoff and, consequently, stream and lake water quality. Soil texture and soil particle structure, for example, can influence the permeability, infiltration rate and erodibility of soils. Additionally, the agricultural value of soils can also be useful when trying to determine agricultural areas that should be preserved and/or agricultural areas that should be priority for conversion to natural areas, i.e., valuable soils stay as agricultural while other soils get priority for conversion to natural areas.

Map A-7

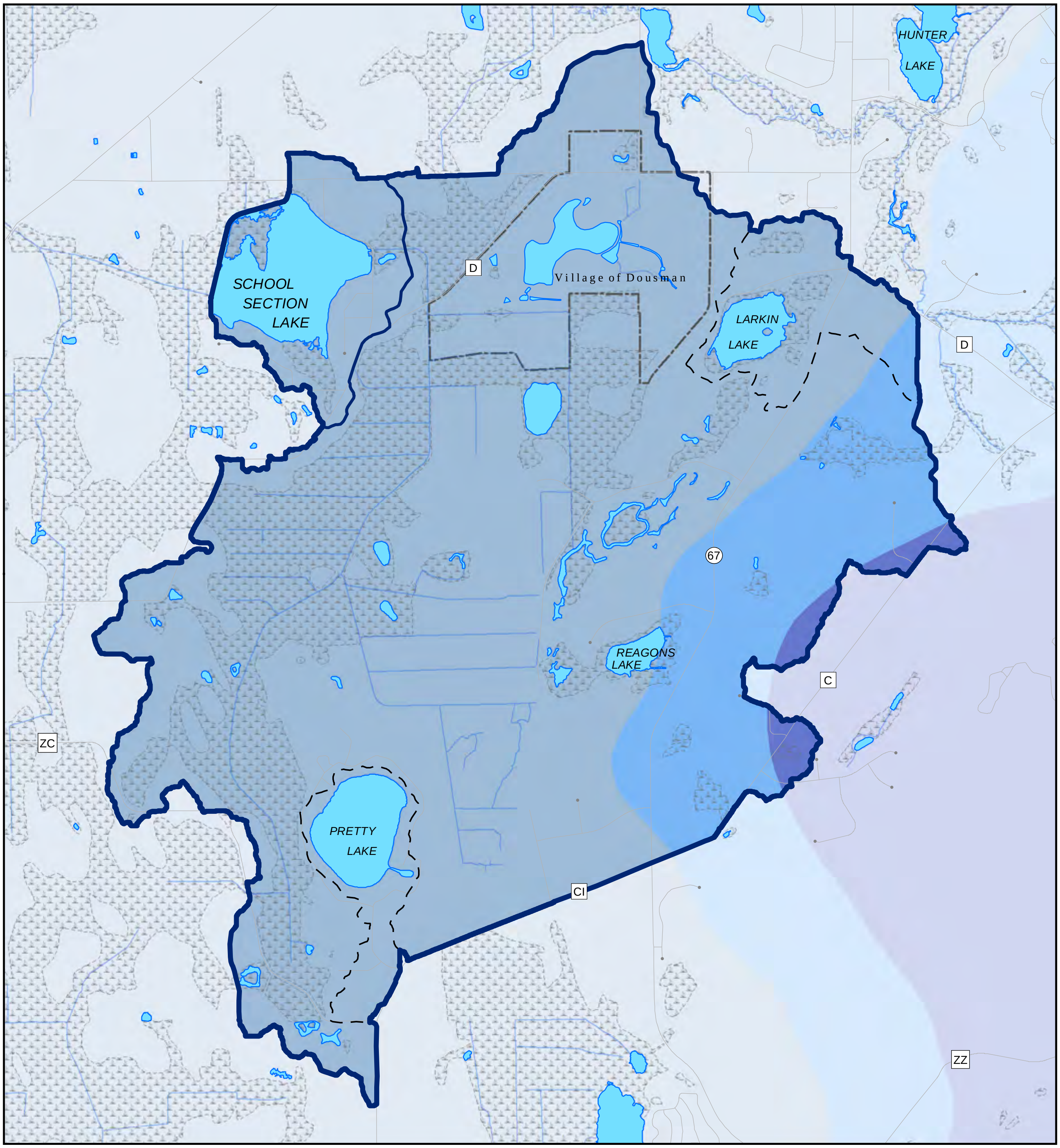
ESTIMATES ON GROUNDWATER RECHARGE WITHIN THE SCHOOL SECTION LAKE WATERSHED



Source: Wisconsin Geological and Natural History Survey and SEWRPC.

Map A-8

DEPTH TO SEASONAL HIGH GROUNDWATER LEVELS WITHIN THE SCHOOL SECTION LAKE WATERSHED



DEPTH IN FEET

0 - 25

25 - 50

GREATER THAN 50

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

INTERNALLY DRAINED AREAS

Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

N

0 0.5 1 Miles

0 2,500 5,000 Feet

Source: Wisconsin Geological and Natural History Survey and SEWRPC.

Soil Associations

The soils in the School Section Lake watershed, which are glacial in origin, are shown on Map A-9, and can be classified into three main soil associations, based upon the U.S. Department of Agriculture Natural Resources Conservation Service Soil Survey Geographic Database (SSURGO):[9]

- Hochheim-Theresa association: well-drained soils with a subsoil of clay loam and silty clay loam that was formed in thin loess and loam glacial till, on ground moraines;

- Houghton Palms Adrian: very poorly drained organic soils found in old drainageways, in old lakebeds, and in depressions and floodplains;

- Boyer-Oshtemo: well-drained, loamy sand and sandy loam soils over sandy glacial outwash and on outwash plains. The native vegetation was primarily oak and oak-hickory forests. Boyer soils are rapidly permeable to water and, thus, have low water availability; and,

- Fox-Casco: well-drained loamy soils that have formed over calcerous sand and gravel outwash. Casco soils are moderately permeable with low water availability while fox soils have moderate water availability.

These soils generally range from poorly drained organic soils to well-drained mineral soils. The Houghton Palms Adrian Association, a poorly drained soil, blankets the vast majority of the central portion of the watershed. The Boyer-Oshtemo well-drained soils cover most of the remaining central portion of the watershed. The well-drained Fox-Casco soils are found along the eastern edge of the watershed, while the well-drained Hochheim-Theresa soils are confined to one fairly small area in the extreme southeastern tip of the watershed.

Using the SSURGO data, these soils can be further subdivided into four main hydrologic groups; well-drained soils, moderately drained soils, poorly drained soils, and very poorly drained soils, as shown on Map A-10. A large proportion of the School Section Lake watershed is comprised of the well-drained Hochheim-Theresa and Boyer-Oshtemo soil associations. This result is consistent with the high- to very-high permeability, along with moderate to high groundwater recharge potential rankings of soils within that portion of the watershed.[10]

Agricultural and Open Lands within Federal and State Soil Classifications

The NRCS, formerly the U.S. Soil Conservation Service, has classified soil groups on the basis of their agricultural qualities and value. Map A-11 shows the locations of NRCS prime agricultural soil groups, as well as other soils of statewide importance (not in the NRCS prime group) and agricultural lands not meeting State or Federal categories, that are found within the School Section Lake watershed. As shown on this map, although NRCS prime agricultural lands are generally found scattered over the entire watershed area, the largest single concentration is located in the area within the jurisdiction of the Village of Dousman, between School Section Lake and Larkin Lake. It is noteworthy that the majority of wetlands in the School Section Lake watershed contain significant concentrations of soils of statewide importance in the watershed, thereby further emphasizing the importance of these wetlands to the School Section Lake watershed.

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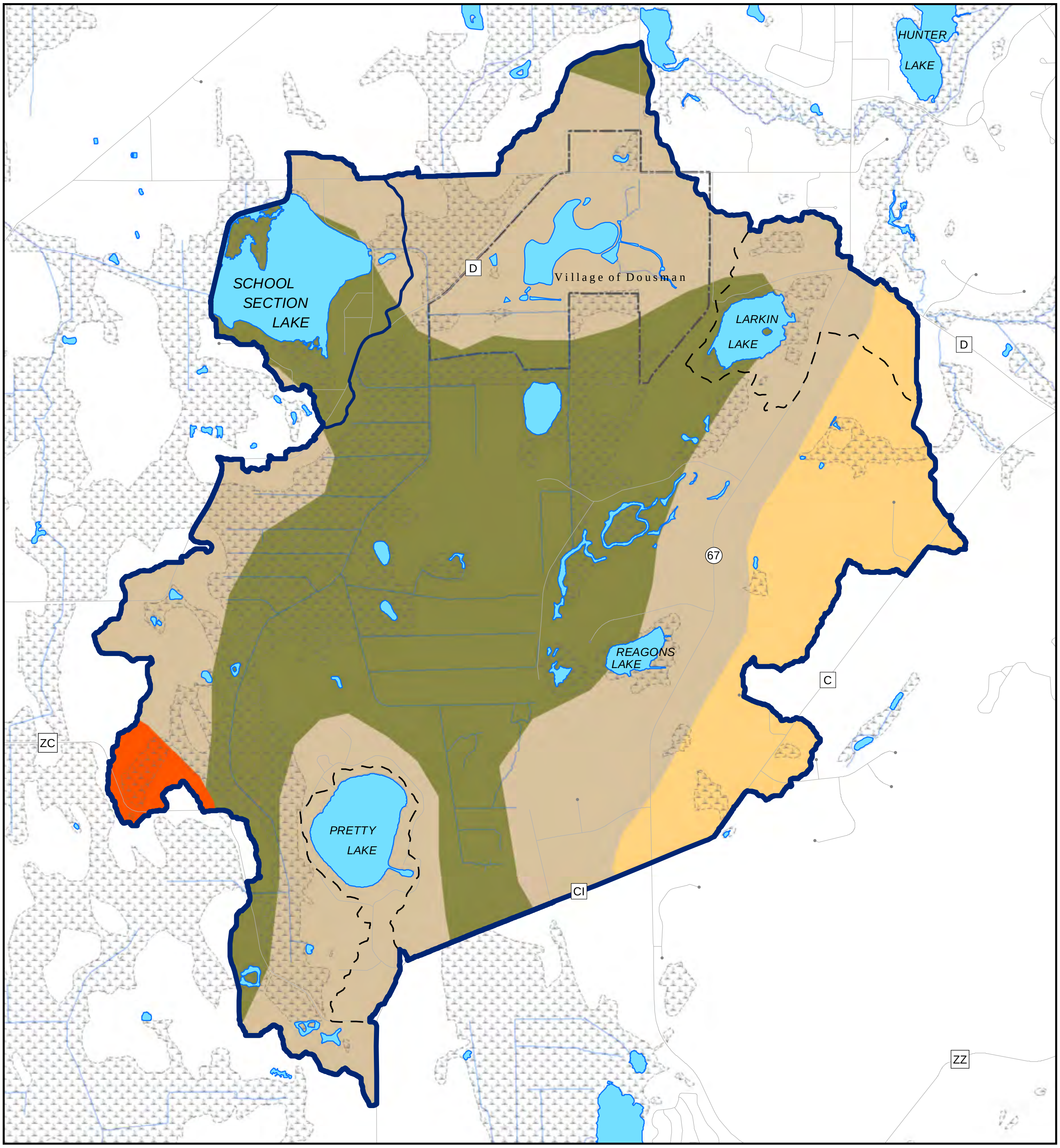
[9]*SEWRPC Planning Report No. 8*, Soils of Southeastern Wisconsin, *June 1966; see also U.S. Department of Agriculture Soil Conservation Service*, Soil Survey of Milwaukee and Waukesha Counties, Wisconsin, *July 1971.*

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

Map A-9

SOIL ASSOCIATIONS WITHIN THE SCHOOL SECTION LAKE WATERSHED



BOYER - OSHTEMO

FOX - CASCO

HOCHHEIM - THERESA

HOUGHTON - PALMS - ADRIAN

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

INTERNALLY DRAINED AREAS

N

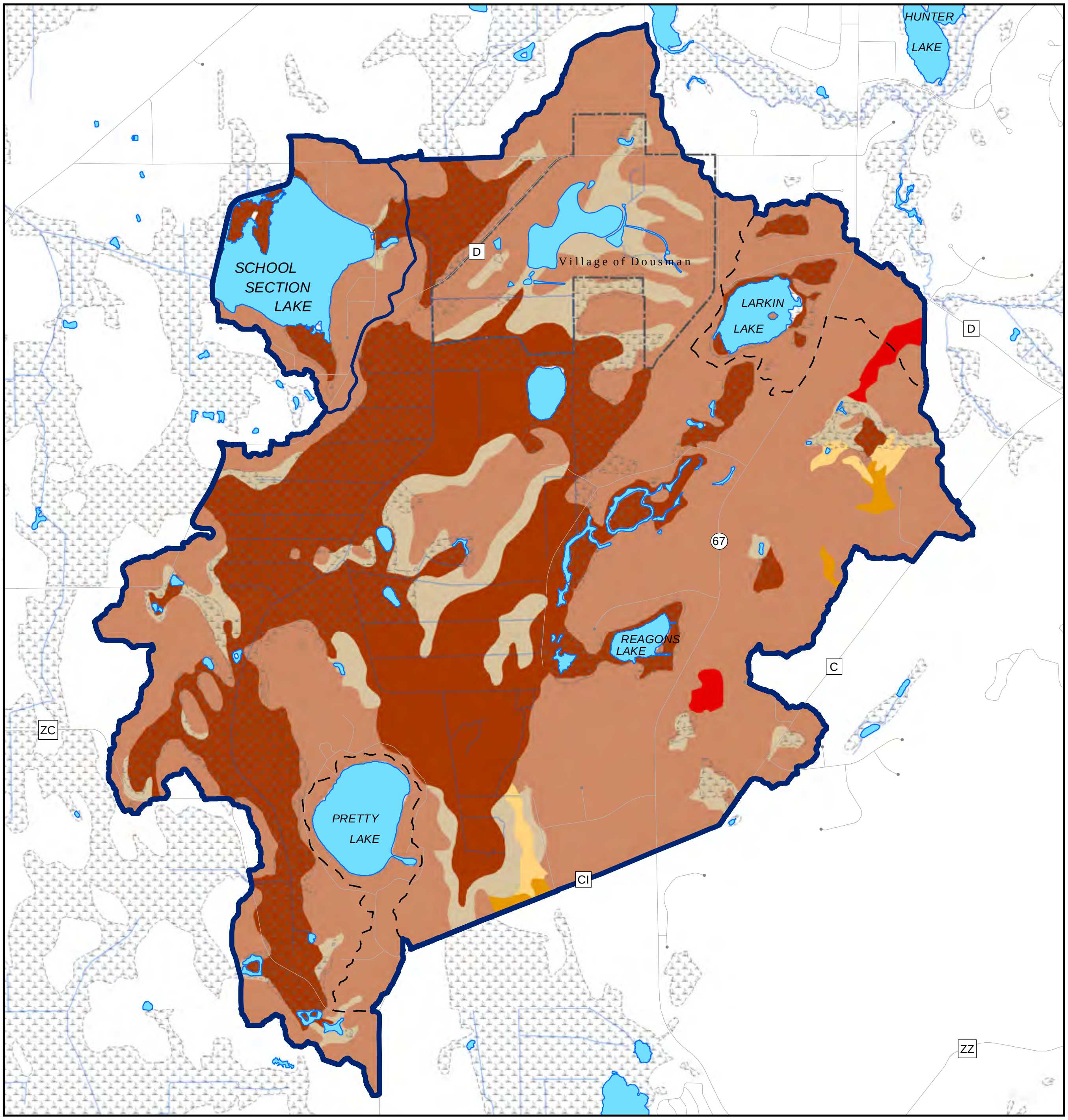
0 0.5 1 Miles

0 2,500 5,000 Feet

Source: Natural Resources Conservation Service and SEWRPC.

Map A-10

HYDROLOGIC SOIL GROUPS WITHIN THE SCHOOL SECTION LAKE WATERSHED



GROUP A:
WELL-DRAINED SOILS

GROUP A/D:
WELL-DRAINED SOIL/VERY POORLY DRAINED SOIL (WELL-DRAINED IF WATER TABLE IS LOWERED THROUGH PROVISION OF A DRAINAGE SYSTEM. VERY POORLY DRAINED IF WATER TABLE IS NOT LOWERED.)

GROUP B:
MODERATELY DRAINED SOILS

GROUP C:
MODERATELY-DRAINED SOILS

GROUP B/D:
MODERATELY DRAINED SOIL/VERY POORLY DRAINED SOIL (MODERATELY DRAINED IF WATER TABLE IS LOWERED THROUGH PROVISION OF A DRAINAGE SYSTEM. VERY POORLY DRAINED IF WATER TABLE IS NOT LOWERED.)

GROUP D:
VERY POORLY DRAINED SOIL/ POORLY DRAINED SOIL (POORLY DRAINED IF WATER IS LOWERED THROUGH PROVISION OF A DRAINAGE SYSTEM. VERY POORLY DRAINED IF WATER TABLE IS NOT LOWERED.)

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

INTERNALLY DRAINED AREAS

Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

N

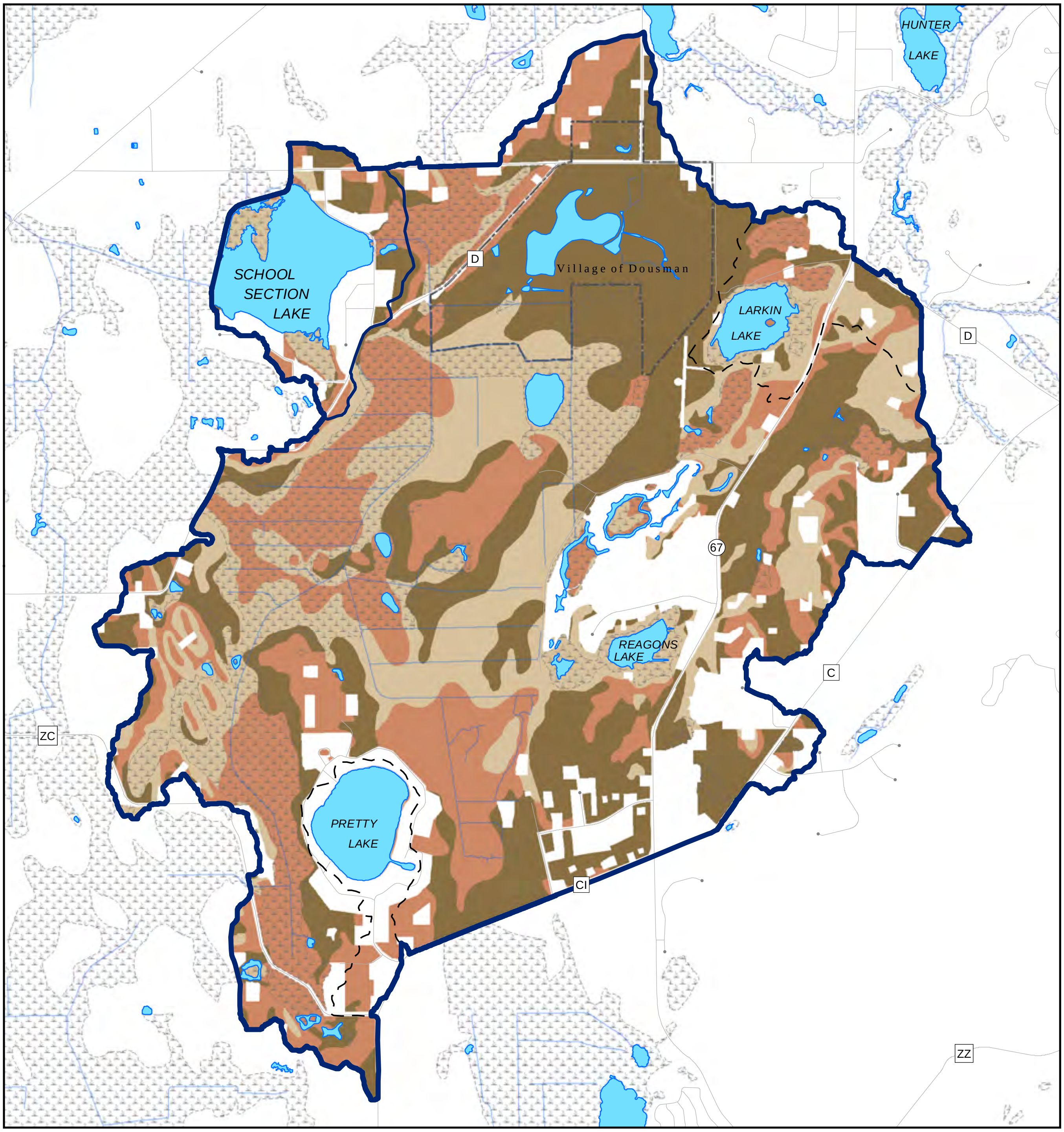
0 0.5 1 Miles

0 2,500 5,000 Feet

Source: Natural Resources Conservation Service and SEWRPC.

Map A-11

AGRICULTURAL AND OPEN LANDS WITHIN FEDERAL AND STATE SOILS CLASSIFICATIONS FOR AGRICULTURAL USES WITHIN THE SCHOOL SECTION LAKE WATERSHED: 2010



- NRCS PRIME AGRICULTURAL SOILS GROUP (INCLUDES PRIME IF DRAINED OR PROTECTED FROM FLOODING)
- SOILS OF STATEWIDE IMPORTANCE (NOT IN NRCS PRIME GROUP)
- OTHER AGRICULTURAL LANDS (NOT MEETING STATE OR FEDERAL CATEGORIES)
- SURFACE WATER
- STREAM
- WATERSHED BOUNDARY
- SUBWATERSHED BOUNDARY
- INTERNALLY DRAINED AREAS

N

0 0.5 1 Miles

0 2,500 5,000 Feet

Source: Natural Resources Conservation Service and SEWRPC.

Table A-2

EXISTING AND PLANNED LAND USE WITHIN THE TOTAL AREA TRIBUTARY TO SCHOOL SECTION LAKE: 2010 AND 2035

Land Use Categories[a]	2010 Acres	2010 Percent of Total Drainage Area	2035 Acres	2035 Percent of Total Drainage Area
Urban				
Residential				
Single-Family, Suburban-Density	155	3.8	188	4.6
Single-Family, Low-Density	157	3.9	398	9.8
Single-Family, Medium-Density	77	1.9	77	1.9
Single-Family, High-Density	- -	- -	- -	- -
Multi-Family	- -	- -	- -	- -
Commercial	4	0.1	4	0.1
Industrial	- -	- -	- -	- -
Governmental and Institutional	2	<0.1	5	0.1
Transportation, Communication, and Utilities	123	3.0	183	4.5
Recreational	146	3.6	156	3.8
Subtotal	664	16.3	1,011	24.8
Rural				
Agricultural and Other Open Lands	1,483	36.5	1,136	28.0
Wetlands	1,080	26.5	1,080	26.5
Woodlands	553	13.6	553	13.6
Water	277	6.8	277	6.8
Extractive	12	0.3	12	0.3
Landfill	- -	- -	- -	- -
Subtotal	3,405	83.7	3,058	75.2
Total	4,069	100.0	4,069	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

Existing and Planned Land Use

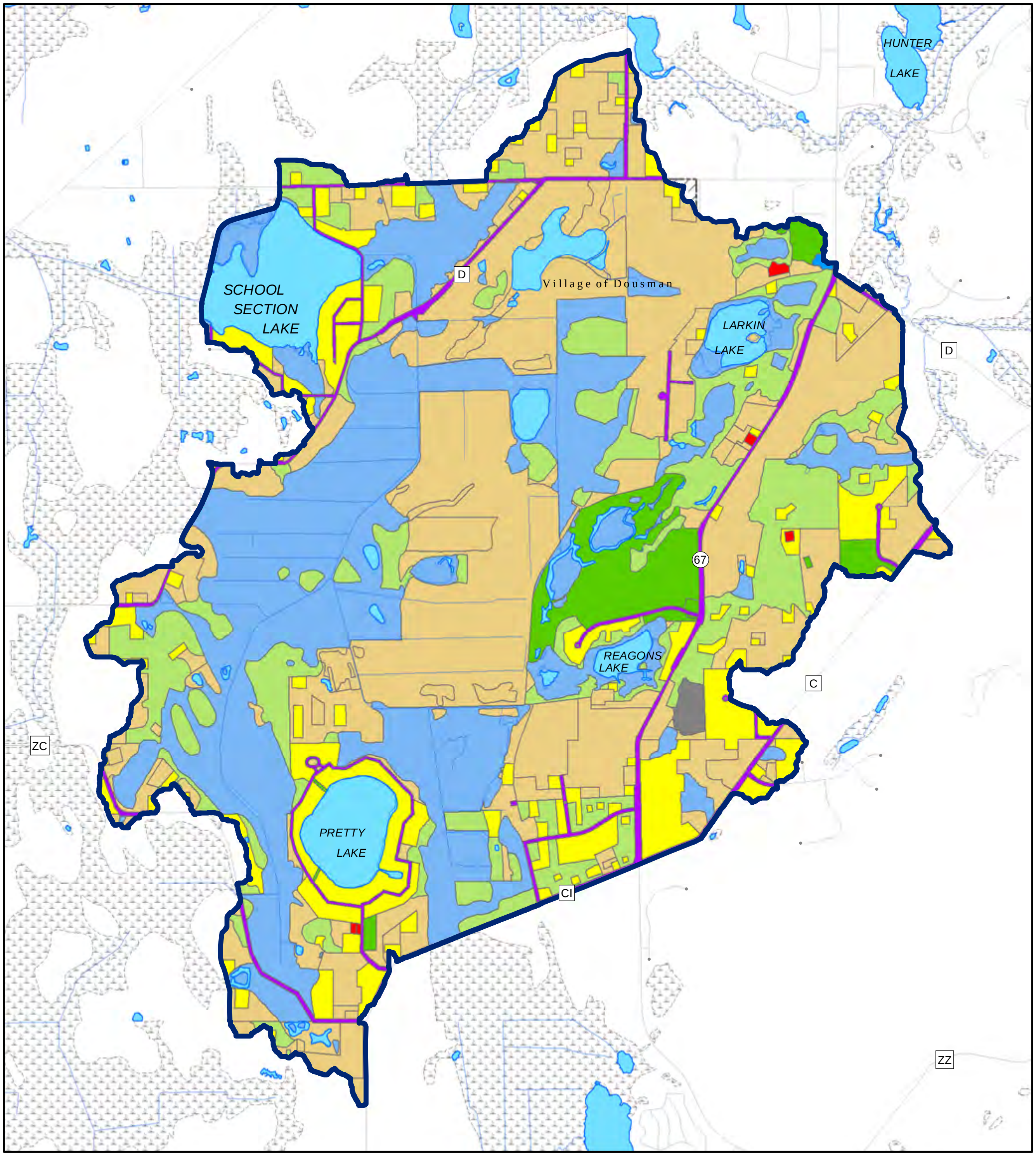
The types, intensity, and spatial distribution of land uses within the School Section Lake watershed are important elements in natural resource management. Land uses can generally be divided into urban uses and rural uses. Table A-2 compares existing year 2010 and planned year 2035 land use in the School Section Lake watershed. Map A-12 shows the distribution of those various land uses, as they existed in 2010. Map A-13 indicates the planned distribution of those land uses anticipated in 2035.

Urban Land Uses

Urban land uses include residential; commercial; industrial; governmental and institutional; transportation, communication, utilities; and recreational lands. As indicated in Table A-2 and displayed on Map A-12, the various urban land uses together accounted for about 16 percent of the total School Section Lake watershed area in 2010. Single-family, low-density and suburban-density residential land use comprised the two largest urban land uses, covering about 362 acres combined, or about 8 percent, of the total watershed. Recreational uses ranked nearly as high, covering about 146 acres, or about 4 percent of the watershed.

Map A-12

EXISTING 2010 LAND USES WITHIN THE SCHOOL SECTION LAKE WATERSHED



SINGLE-FAMILY RESIDENTIAL
MULTI-FAMILY RESIDENTIAL
COMMERCIAL
INDUSTRIAL
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
GOVERNMENT AND INSTITUTIONAL
RECREATION
WETLANDS
WOODLANDS
SURFACE WATER
AGRICULTURAL, UNUSED, AND OTHER OPEN LANDS
EXTRACTIVE AND LANDFILL
STREAM
WATERSHED BOUNDARY
SUBWATERSHED BOUNDARY

N

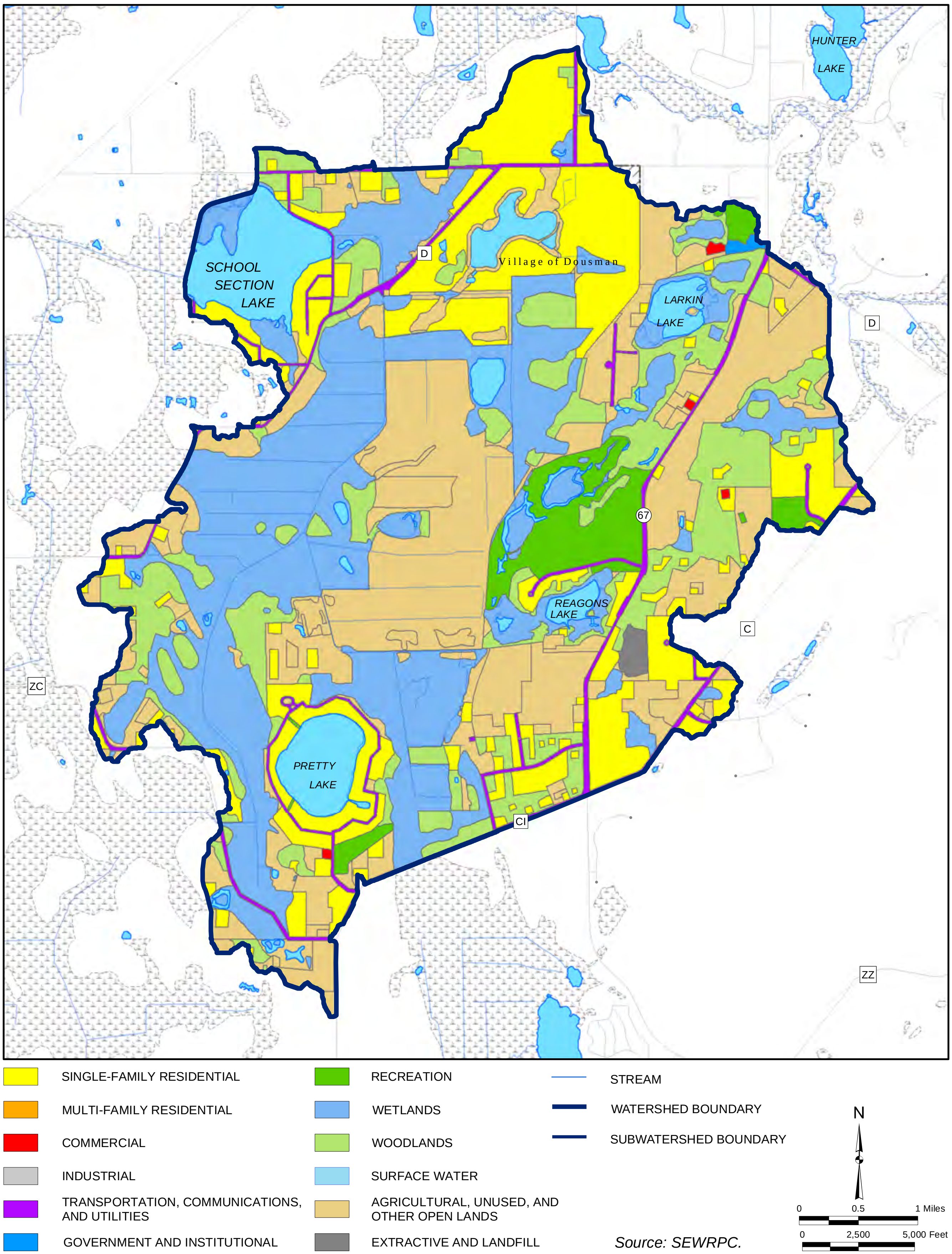
0 0.5 1 Miles

0 2,500 5,000 Feet

Source: SEWRPC.

Map A-13

PLANNED 2035 LAND USES WITHIN THE SCHOOL SECTION LAKE WATERSHED



Source: SEWRPC.

Planned changes in land use within the area tributary to the Lake's watershed may include further urban development, infilling of already plotted lots, and possible redevelopment of existing properties. Under proposed year 2035 conditions,[11] as shown on Map A-13 and summarized in Table A-2, urban land uses are expected to increase significantly to about 25 percent of the land area in 2035. The area developed in residential uses alone is predicted to increase from about 10 percent of the watershed in 2010, to about 17 percent of the area in 2035. Such land use changes have the potential to significantly modify the nature and delivery of nonpoint source contaminants to the Lake, with concomitant impacts on the aquatic plant communities and aquatic organisms.

Rural Land Use

Rural lands in the watershed are comprised of woodlands, wetlands, surface water, agricultural lands, other open lands, and extractive uses. As shown on Map A-12 and Table A-2, these various rural land uses together accounted for about 84 percent of the total land area of the School Section Lake watershed in 2010. Agricultural and wetland uses were the largest rural land uses in the watershed, encompassing about 63 percent of the total land area. Agricultural land use is divided between active cropland and other open lands, which includes farm buildings, pastures, grasslands that have not succeeded to wetland or woodland communities, and lands adjacent to cropland, such as tree lines and hedgerows.

Under proposed year 2035 conditions,[12] as shown on Map A-13 and summarized in Table A-2, rural land uses, especially agricultural use, are expected to decrease from about 37 percent of the land area in 2010, to about 28 percent of the land area in 2035. Most of this land will be converted to residential use. These changes could greatly effect groundwater recharge potential in any areas where agriculture is lost to residential land use. Maintenance of infiltration function should, therefore, be considered a priority in areas where this change occurs.

Historical Urban Growth

The current and planned land use patterns, placed in the context of the historical development of the area, can help the School Section Lake community evaluate what has taken place within the watershed throughout the past 100 years and provide context to historical water quality data that is obtained on School Section Lake. Historical urban growth within the School Section Lake watershed is presented in Table A-3. As shown in the table, the greatest increases in urban land use in the School Section Lake watershed occurred between 1975 and 1980.

Pre- and post-1990 growth is summarized on Map A-14. This map shows the lands around the shoreline of School Section Lake were developed prior to 1990. Most of the rest of the pre-1990 development in the watershed took place in around Pretty Lake and Reagons Lake and in two areas along the northern and southeastern edges of the watershed boundary.

Map A-15 reveals the pattern of historic urban growth in the School Section Lake watershed in more detail over the past century. During the period from 1950 to 1970, development in the watershed occurred primarily in the lakeshore areas on the eastern shore of School Section Lake and in the shoreline areas around Pretty Lake. The decade from 1970 to 1980 witnessed some modest expansion of development along the south shoreline of School Section Lake and along the eastern boundary of the watershed. Then, during the period from 1980 to 1990, the rate of development in the watershed expanded more robustly along the eastern and northern boundaries of the watershed. The decade from 1990 to 2000 saw a relatively small amount of development confined to several small areas: one to the south of Pretty Lake and two other small areas along the eastern boundary of the watershed.

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[11]*See SEWRPC Planning Report No. 48,* A Regional Land Use Plan for Southeastern Wisconsin: 2035, *June 2006; see also SEWRPC Community Assistance Planning Report No. 299,* A Multi-Jurisdictional Comprehensive Plan for Washington County: 2035, *April 2010.*

[12]Ibid.

Table A-3

HISTORIC URBAN GROWTH IN THE SCHOOL SECTION LAKE WATERSHED

Year	Land in Urban Use (acres)
1950	62
1963	24
1970	9
1975	21
1980	318
1985	12
1990	7
1995	19

Source: SEWRPC.

Population and Households

Changes in the population and numbers of households from 1960 to 2010 in the School Section Lake watershed are shown in Table A-4. Population and the number of households within the area tributary to School Section Lake have generally shown an increase since 1960, although there was one period when population actually decreased a small amount (1990 to 2000). The largest increase in population occurred during the decade from 1970 to 1980, when the number of people increased by about 47 percent. The greatest increase in the number of households also occurred during that period, when the number of households increased by about 68 percent. Under anticipated conditions for 2035, the population and the number of households in the School Section Lake watershed are both expected to increase by about 22 percent from 2010 levels.

Private Onsite Wastewater Treatment Systems

The presence or absence of private onsite wastewater treatment systems (POWTS), or onsite septic systems, can greatly influence the water quality of a Lake and its tributaries, particularly if septic tanks are not being properly maintained. Leaking onsite septic systems can lead to raw sewage and associated bacteria and nutrients draining into the Lake and its tributaries. Public sanitary sewer systems can sometimes mitigate these issues by treating waste offsite. In the School Section Lake watershed, both kinds of systems, private septic and public sanitary, are in use. Map A-16 indicates those areas served by public sanitary sewer systems; the rest of the watershed area is served by onsite septic systems.

In the aforereferenced 1981 WDNR Feasibility Study, which preceded dredging, a phosphorus budget was made indicating that septic pollution accounted for only one percent of the phosphorus pollution to the watershed. However, a Lake Rehabilitation Plan,[13] created for the Lake in 1982, still placed septic maintenance as a priority because of the proximity of onsite septic systems to the Lake. Given the inevitable increasing age of these systems within the nearshore areas (thereby increasing chances of malfunctioning systems), septic maintenance should further be considered a priority. Consequently, extra caution will need to be placed on monitoring and maintaining these onsite septic systems, particularly in areas with shallow depth to groundwater levels (see Map A-8) and high groundwater recharge (see Map A-7).

SHORELINE PROTECTION AND EROSION CONTROL

Erosion of shorelines results in the loss of land, damage to shoreline infrastructure, interference with lake access and use, and increased phosphorus loading to the Lake. Wind-wave action, ice movement and wave action produced by motorized boat traffic, as well as activities along the shoreline such as walking on unprotected or under-protected shoreline, are usually the primary causes of such erosion.

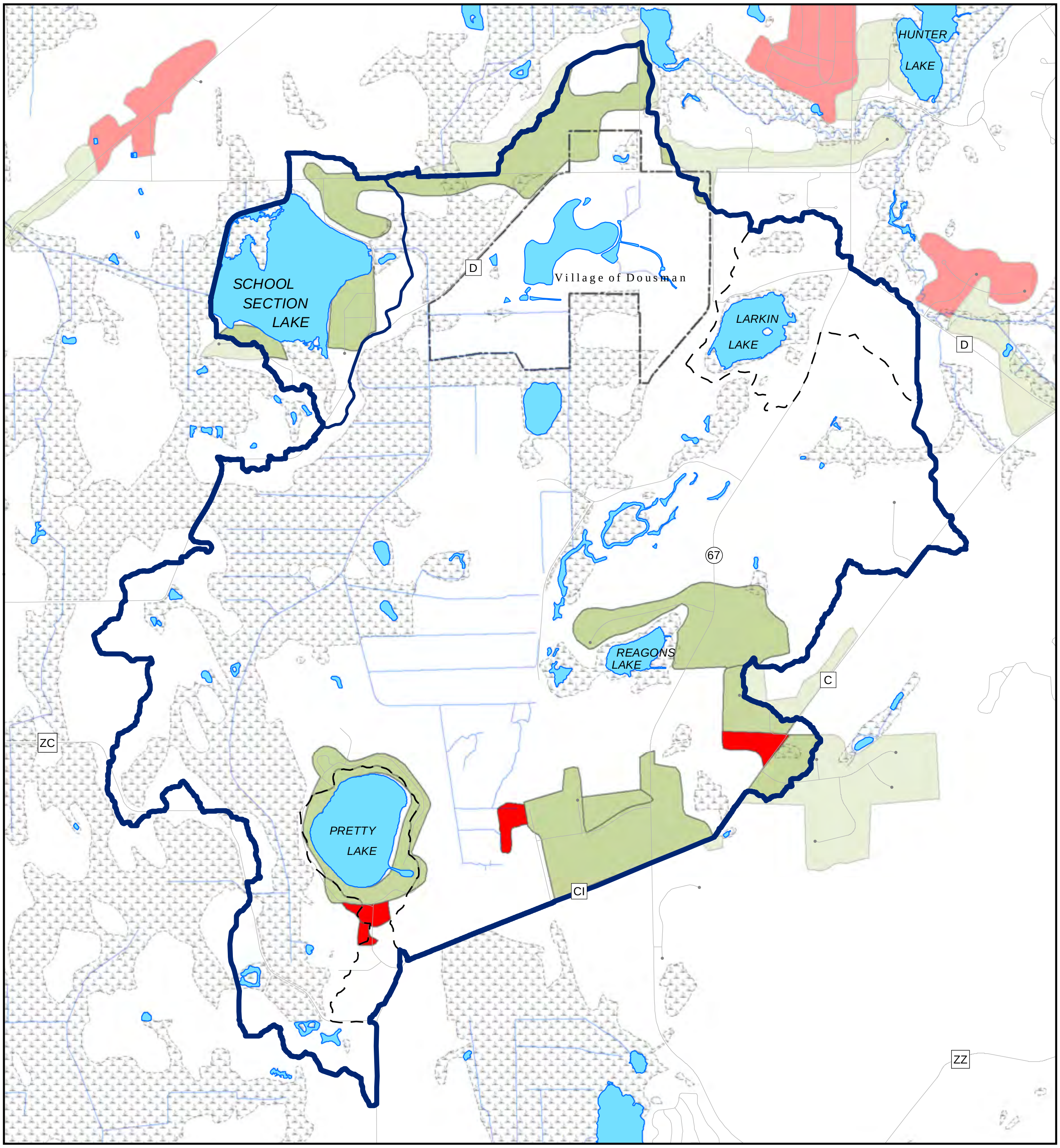
Constructed and Natural Shoreline Protection

Most riparian owners recognize the value of protecting their shorelines from erosion. In many cases some kind of man-made structure or material has been installed in an attempt to provide protection from erosive forces. Figure

[13]*R.A. Smith and Associates, Inc.*, Lake Rehabilitation Plan for School Section Lake Management District, Town of Ottawa, Waukesha County, Wisconsin*, 1982.*

Map A-14

HISTORICAL URBAN GROWTH WITHIN THE SCHOOL SECTION LAKE WATERSHED: PRE- AND POST-1990



1990 AND EARLIER URBAN GROWTH

POST - 1990 URBAN GROWTH

Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

INTERNALLY DRAINED AREAS

N

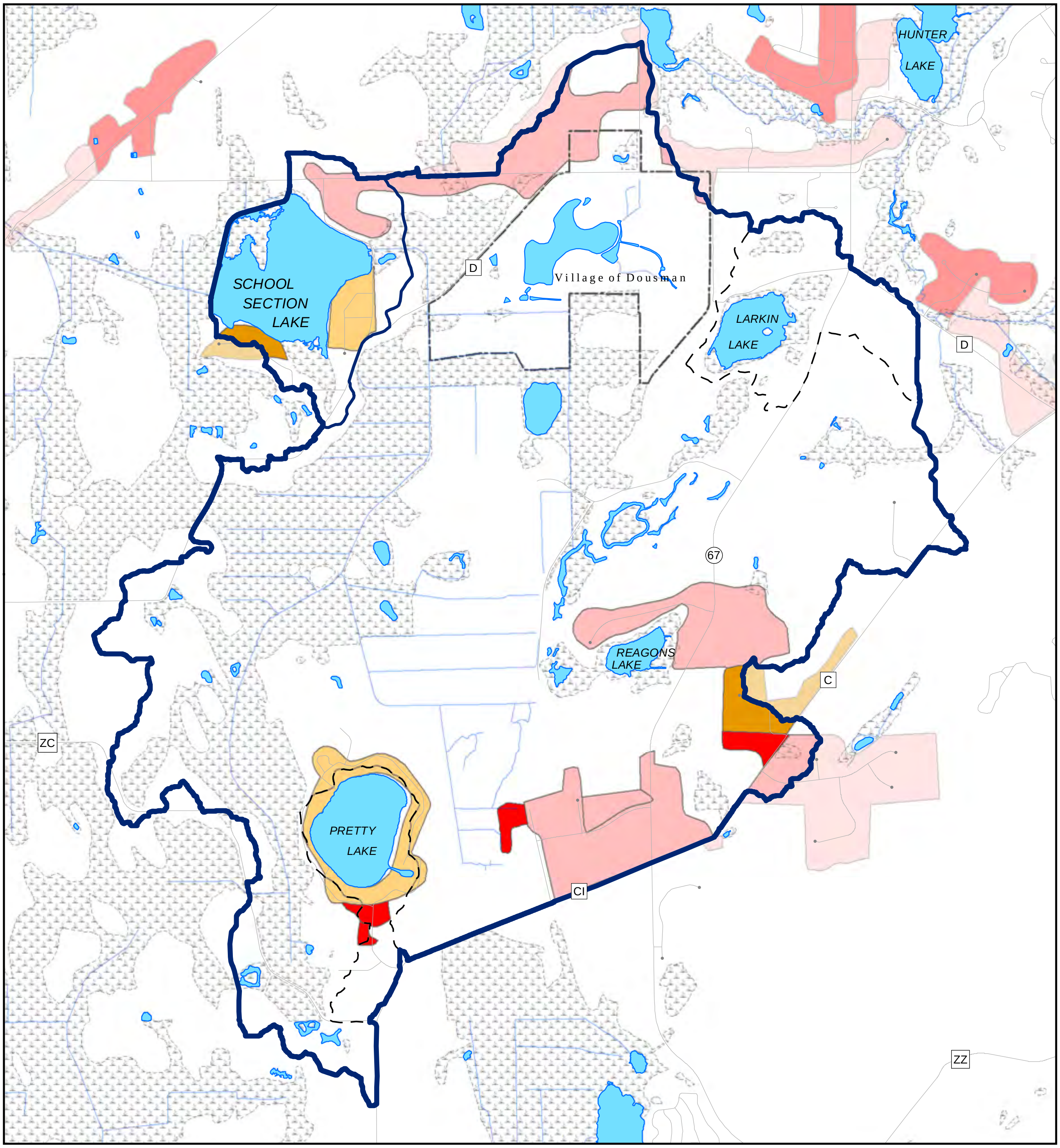
0 0.5 1 Miles

0 2,500 5,000 Feet

Source: SEWRPC.

Map A-15

HISTORICAL URBAN GROWTH WITHIN THE SCHOOL SECTION LAKE WATERSHED: 1950-2010



1950 - 1970

1970 - 1980

1980 - 1990

1990 - 2010

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

INTERNALLY DRAINED AREAS

Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

N

0 0.5 1 Miles

0 2,500 5,000 Feet

Source: SEWRPC.

Table A-4

POPULATION AND HOUSEHOLDS IN THE SCHOOL SECTION LAKE TRIBUTARY AREA: 1960-2010

Year	Population	Change from Previous Decade		Households	Change from Previous Decade	
		Number	Percent		Number	Percent
1960	397	- -	- -	121	- -	- -
1970	525	128	32	134	13	11
1980	773	248	47	225	91	68
1990	796	23	3	271	46	20
2000	732	-64	-8	271	No change	No change
2010	813	81	11	316	45	17
Planned 2035	990	177[a]	22[a]	384	68[a]	22[a]

[a] *Change relative to 2010.*

Source: U.S. Bureau of Census and SEWRPC.

A-1 shows typical installation of the various types of shoreline protection observed on lakes in southeastern Wisconsin. Most such structures generally fall into one of three categories, including: 1) “bulkhead,” where a solid, *vertical* wall of some material, such as poured concrete, steel, or timber, is erected; 2) “revetment,” where a solid, *sloping* wall, usually asphalt, as in the case of a roadway, or poured concrete, is used; and 3) “riprap,” where a barrier of rocks and/or stones is placed along the shoreline. However, shoreline protection does not always depend on the installation of man-made structures. Many different kinds of natural shorelines offer substantial protection against erosive forces. The rock boulders and cliffs found along Lake Superior, for example, are natural barriers that serve to protect against shoreline erosion. Additionally, marshlands, such as those found on the west side of School Section Lake, with large areas of exposed cattail stalks are a very effective mitigator of shoreline erosive forces, as they act to disperse and dampen waves by dissipating their energy against the plant rather than the shoreline.

In fact, the “hard” man-made seawalls of stone, riprap, concrete, timbers, and steel, once considered “state-of-the-art” in shoreline protection, are now recognized as only part of the solution in protecting and restoring a lake’s water quality, wildlife, recreational opportunities, and scenic beauty. More recently, “soft” shoreline protection techniques, referred to as “vegetative shoreline protection,” involving a combination of materials, including native plantings, are increasingly required pursuant to Chapter NR 328 of the *Wisconsin Administrative Code*, and also increasingly popular as riparian owners have become aware of the value of protecting their shorelines, improving the viewshed, and providing natural habitat for wildlife.

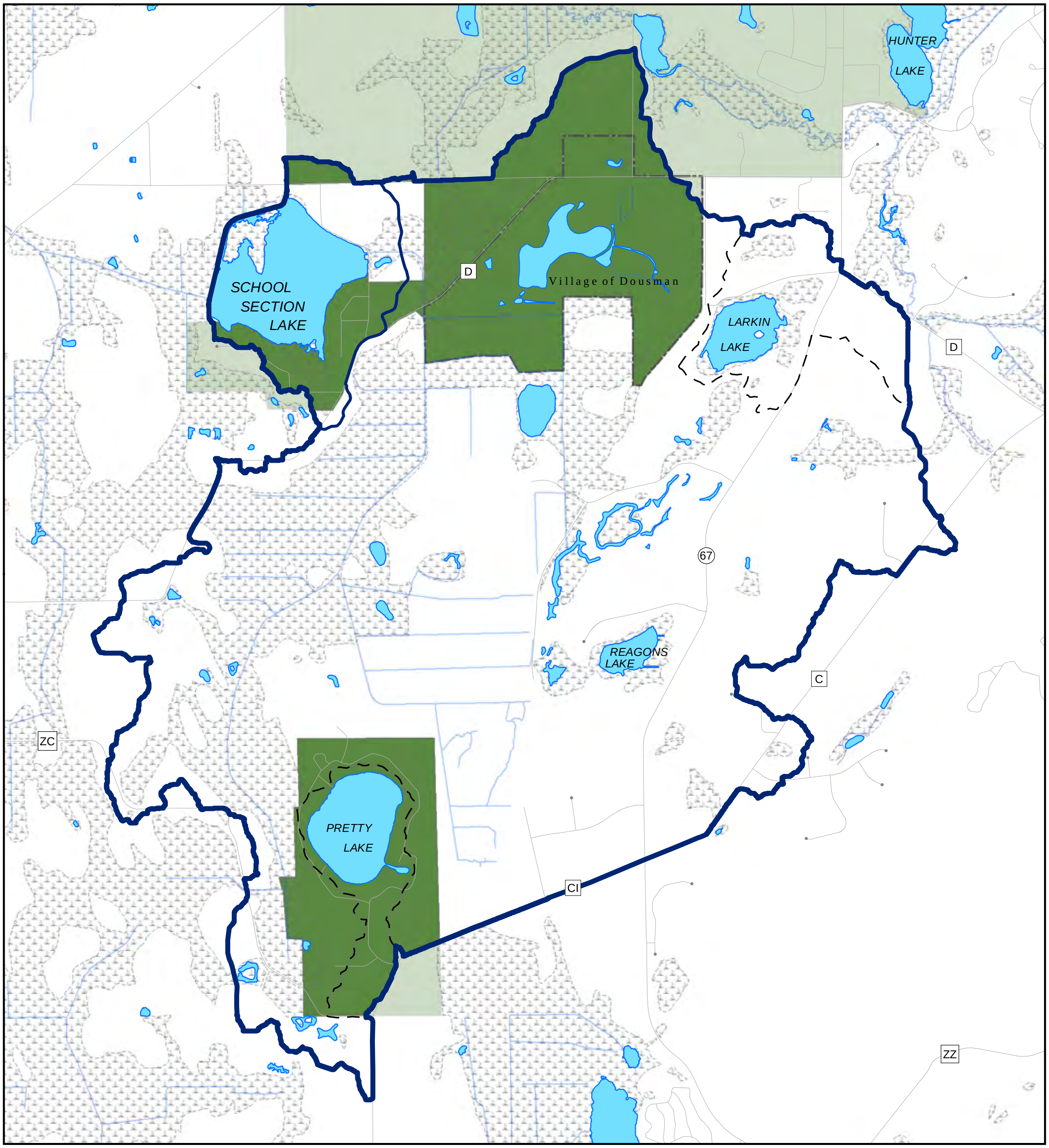
A survey of the types of shoreline protection found around School Section Lake was conducted by SEWRPC staff during the summer of 2012; the results of that survey are shown on Map A-17. As with most lakes in the Region, the shoreline of School Section Lake was found to be comprised of stretches of protected shoreline, either man-made or natural, as well as some areas of unprotected shoreline, such as where a riparian owner has mowed a lawn to water’s edge or the where the shoreline of a wooded lot has been left unprotected. Of the three main types of man-made protection structures observed (riprap, bulkhead or revetment), riprap was the most commonly occurring type and revetment was the least common type. In general, shoreline protection enhancement should be targeted at areas that are considered unprotected, i.e., “lawn.”

Onshore Buffer Zones

Buffer zones are those onshore areas adjacent to the shorelines of waterbodies, such as lakes, rivers, and wetlands, consisting of a band of vegetation populated with plant species that help stabilize shorelines against erosion, filter pollutants from runoff, and, when located along streambanks, can lessen downstream flooding and help maintain stream baseflows. Onshore buffers are a proven means of effectively reducing nonpoint source pollution

Map A-16

SANITARY SEWER SERVICE AREAS WITHIN THE SCHOOL SECTION LAKE WATERSHED: 2013



VILLAGE OF DOUSMAN

Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

INTERNALLY DRAINED AREAS

N

0 0.5 1 Miles

0 2,500 5,000 Feet

Source: SEWRPC.

Figure A-1

TYPICAL SHORELINE PROTECTION TECHNIQUES

RIPRAP

NATURAL VEGETATIVE

BULKHEAD

REVETMENT

Source: SEWRPC.

in the form of sediment, as well as additional sources of contamination, including, but not limited to, phosphorus, agrichemicals, urban pollutants (metals), and pathogens. When planted with native species, such buffers offer the additional advantage of improving the viewshed and attracting native wildlife.

The use of onshore buffer zones to enhance shoreline and water quality protection has been gaining support among those individuals and organizations charged with the protection of lakes and streams. Although neatly trimmed grass lawns along shorelines are popular, they offer limited benefits for water quality or wildlife habitat, and the cumulative effects of many houses with such shorelines can negatively impact streams, lakes, and

Map A-17

SHORELINE STRUCTURES ON SCHOOL SECTION LAKE: 2012

Source: U.S. Geological Survey, Marine Biochemists and SEWRPC.

wetlands.[14] When combined with stormwater management best practices, environmentally friendly yard care, effective wastewater treatment, conservation farm methods, and appropriate use of fertilizers and other agrichemicals, vegetative buffer zones complete the set of actions that can minimize impacts to our shared water resources.[15]

In general, there were no significant man-made buffer zones on School Section Lake, a condition not unusual for lakes in the Region. This will need to be addressed over time in order to enhance water quality and wildlife habitat in the School Section Lake watershed.

WATER QUALITY

Historic water quality data for School Section Lake includes water clarity measurements based on Secchi-disk readings dating from 1979 through 2013, and water chemistry measurements based on water samples taken in 1979 and 1980 and then fairly regularly several times a year starting in 2001. The primary sampling site used for the water chemistry measurements was located at the deepest portion of School Section Lake in the eastern part of the Lake basin, as can be seen on Map A-2.

Principal Water Quality Factors

Water Clarity

Water clarity, or transparency, is often used as an indication of a lake's water quality. It can be affected by physical factors, such as water color and suspended particles, and by various biologic factors, including seasonal variations in planktonic algal populations living in a lake. Water clarity is typically 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. This depth is known as the "Secchi-disk measurement." Such measurements provide a ready means of assessing water quality, and, hence, comprise an important part of lake water quality monitoring efforts. In a study of 54 lakes in southeastern Wisconsin, the mean Secchi-disk measurement was about five feet.[16] It should be noted that the data in this study conducted by R.A. Lillie and J.W. Mason, though comprehensive in its scope including water quality data for some 1,140 Wisconsin lakes over a 14-year period from 1966 through 1979 may be considered somewhat dated by the time of the current report (2014).

Secchi-disk measurements for School Section Lake have been taken at somewhat sporadic intervals since 1979; a summary of all recorded Secchi-disk measurements for School Section Lake is presented in Appendix G. Figure A-2, based on 50 summer measurements of water clarity, shows the average Secchi-disk measurements for School Section Lake for June to August only from 1987 through 2013, as well as the maximum depth of the Lake before and after the dredging operations were completed in the 1994. From the figure, it appears that there was a slight amount of improvement in water clarity immediately after the dredging through about 2005 and then a return to pre-dredging levels of clarity from 2007 through 2013. The overall summer average for 1987 through 2013, as presented in Figure A-2, was 4.8 feet, indicative of generally poor water quality.

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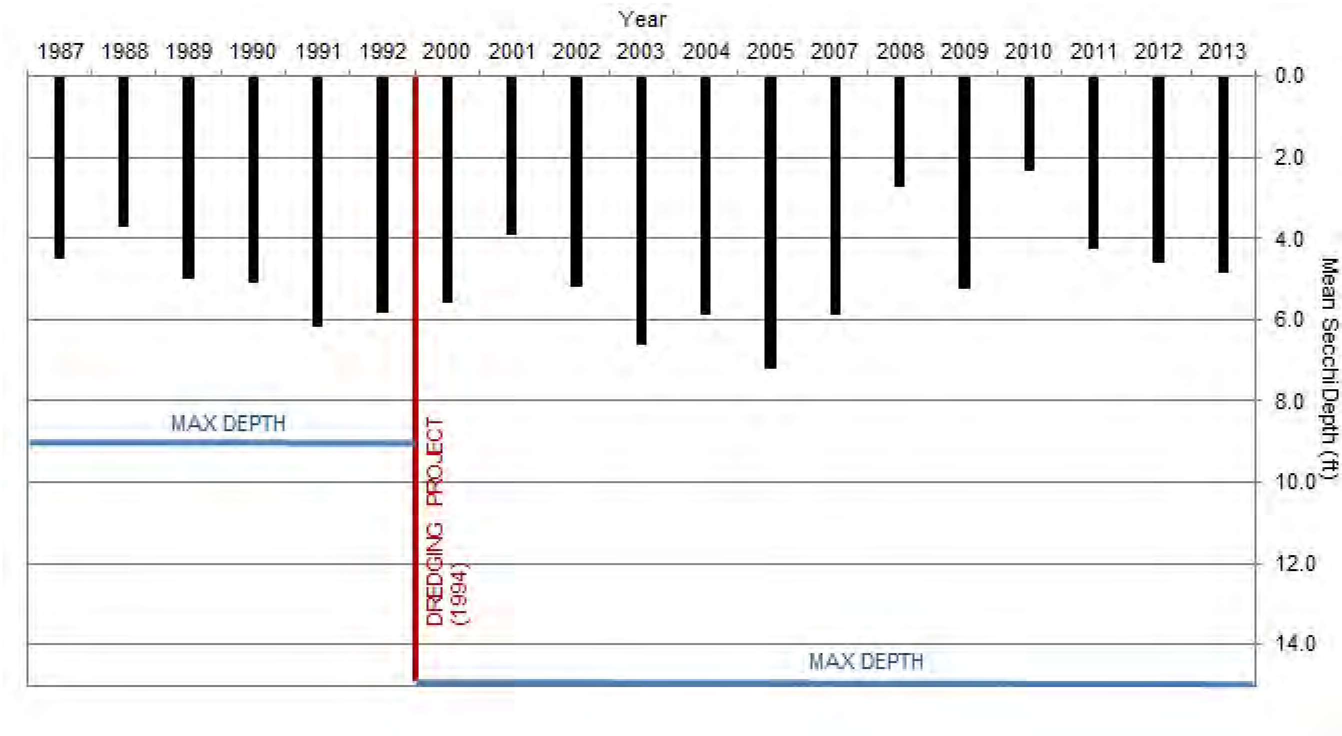
[14]*SEWRPC Riparian Buffer Management Guide No. 1,* Managing the Water's Edge: Making Natural Connections, *May 2010.*

[15]Ibid.

[16]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* Limnological Characteristics of Wisconsin Lakes, *1983.*

Figure A-2

MEAN SECCHI-DISK MEASUREMENTS IN SCHOOL SECTION LAKE FOR JUNE TO AUGUST: 1987-2013



Source: SEWRPC.

Water clarity for School Section Lake has also been estimated using remote sensing technology by the Environmental Remote Sensing Center (ERSC).[17] As shown in Table A-5, a total of 24 Landsat estimates from 1999 through 2013 ranged from 0.3 foot to 9.5 feet with an average of 4.5 feet. Given that several Landsat measurements widely varied from in-lake measurements taken at about the same date, e.g., August 15, 2009 Landsat measurement was 0.3 foot, while a field measurement taken on August 11 was 5.9 feet. Landsat measurements were not included in the overall water clarity analysis or in the determination of TSI values for School Section Lake (TSI will be discussed below).

Color

Two important characteristics affecting water transparency (i.e., water clarity) are color and turbidity. The perceived color of lake waters is often described as “green” or “brown,” or some combination of these colors, and is influenced by dissolved and suspended materials in the water, phytoplankton population levels, as well as

[17]*Environmental Remote Sensing Center (ERSC), established in 1970 at the University of Wisconsin-Madison campus, was one of the first remote sensing facilities in the United States. Using data gathered by satellite remote sensing over a three-year period, the ERSC generated a map based on a mosaic of satellite images showing the estimated water clarity of the largest 8,000 lakes in Wisconsin. The WDNR, through its volunteer Self-Help Monitoring Program (now the CLMN), was able to gather water clarity measurements from about 800 lakes, or about 10 percent of Wisconsin’s largest lakes. Of these, the satellite remote sensing technology utilized by ERSC was able to accurately estimate clarity, providing a basis for extrapolating water clarity estimates to the remaining 90 percent of lakes.*

Table A-5

COMPARISON OF LANDSAT AND FIELD MEASUREMENTS OF WATER CLARITY IN SCHOOL SECTION LAKE: 1999-2013

Criteria	LANDSAT (feet)	FIELD (feet)
Minimum	0.3	2.0
Maximum	9.5	9.2
Mean	4.5	4.8
Number of Measurements	24	43

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

various physical factors. The actual, or true, color of lake waters is the result of substances dissolved in the water. For example, the brown-stained color of lakes in the northern part of the State is the result of organic acids, such as tannins and lignins, from certain dissolved humic materials present in those waters which essentially "dye" the lake water in a similar fashion to tea. Consequently, the dark color of water does not necessarily coincide with polluted water. Several color scales have been developed over the years to measure and compare true color of lake water. In the United States, the most commonly used standard of measure is the platinum unit ("units") and the values range from 0 units for very clear lakes to 300 units for heavily stained bog water. The average for lakes in the Southeastern Wisconsin Region is 46 units.[18] Water color for School Section Lake for the period between 1980 and 2013, was found to average about 39 units, which is slightly lower, i.e., more clear, than the regional average of 46 units, although, again, it is worth noting that the regional average mentioned above (46 units) is based on data collected statewide between 1966 and 1979.

Turbidity

Another factor affecting water transparency in lakes is turbidity, which is the result of suspended particles in the lake water. The more turbid a lake's waters, the more suspended solids there are present and the less clear is the water. Turbidity in a lake's waters usually results from erosion of soil being washed into the lake ("runoff") and from the disturbance and re-suspension of the lake's bottom sediments. Turbidity measurements for the Southeast Region of Wisconsin have historically been the highest in the State, at 6.7 JTU's[19] (a measurement, as before-mentioned, based on data collected between 1966 to 1979).

There were only four recorded measurements for turbidity School Section Lake between in 2000 and 2012. The average value was about 6.4 NTU's (JTU's and NTU's being roughly equivalent), indicating the water a little less turbid than the regional average. Some historical measurements for turbidity were also taken in School Section Lake between 1979 and 1980, with an average of 4.0 NTU's. The comparison of the more recent values to historical values shows a marginal increase in turbidity. This could indicate potential increases in lake disturbances since the late seventies or could indicate that erosion and runoff has increased. Given the issues with sedimentation that have been raised by School Section Lake Residents (as is discussed in Chapter II of this plan), the latter of the two options is most likely.

Dissolved Oxygen

Dissolved oxygen levels are one of the most critical factors affecting the living organisms within 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. About 5.0 milligrams per liter (mg/l) is considered the minimum level below which oxygen-consuming organisms, such as fish, become stressed, while fish are

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[18]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* op cit.

[19]Ibid.

unlikely to survive when dissolved oxygen concentrations drop below 2.0 mg/l.[20] Oxygen levels near a lake's surface are commonly in the 10 to 12 mg/l range in lakes in the Southeastern Wisconsin Region, but can reach levels approaching 0 mg/l in the bottom waters near the end of summer (see section on Thermal Stratification below).

Figure A-3 shows how seasonal surface water measurements of dissolved oxygen in School Section Lake during the period from 2000 to 2013 compare with historic levels from 1979 to 1980. The figure shows that surface water dissolved oxygen levels are generally about the same as they have been since historic levels which ranged from about 8.0 mg/l to about 12 mg/l, with the exception of a few measurements where the oxygen level was actually higher than historical levels. Both the historic and recent surface values are considered good oxygen levels for fish populations, with levels only approaching the stress point of 5.0 mg/l in fall of 2005. It may also be noted that spring dissolved oxygen levels are higher than those in both summer and fall. This is likely related to the fact that dissolved oxygen can be temperature dependent, i.e., cold water can hold more dissolved oxygen then warm water.[21]

Thermal Stratification

Despite high oxygen levels at the surface of School Section Lake, measurements obtained at deeper levels, e.g., 12 feet, have been shown to go well below the 5.0 mg/l stress point, sometimes even reaching 0 mg/l. Low oxygen levels can happen as the result of a number of factors, primary among them being the natural process of *thermal stratification*. Thermal stratification is the result of the differential heating of the lake water and the resulting water temperature-density relationships at various depths within the water column. The process is illustrated diagrammatically in Figure A-4. The development of thermal stratification typically begins in early summer, although stratification may also occur during winter under the ice. As shown in Figure A-4, with the start of summer, the surface waters of a lake are warmed by a combination of increasing solar energy and warmer summer air. As the upper waters are heated, a physical barrier, created by the differing water densities between warm upper waters and cool deeper waters, may begin to form. A lake is said to be "stratified" when this physical barrier, created by a thermal gradient called a "thermocline," develops to such an extent that it acts as a barrier separating the upper waters, or "epilimnion," of the lake from the lower waters, or "hypolimnion," sometimes to the extent of preventing the two layers from mixing. Although this barrier is readily crossed by fish, provided sufficient oxygen exists, it essentially prohibits the exchange of water between the upper and lower layers. A common consequence of thermal stratification is that a lake's bottom waters are prevented from circulating to the surface to be replenished with oxygen that is continually diffusing into surface waters at the air-water interface.

To determine if a lake stratifies, data is gathered to look for evidence of the formation of a thermocline. The presence of a thermocline in a lake is generally detectable as a pronounced drop in water temperature over a relatively small change in depth, usually 1.0 degrees Celsius (°C) or about 2 degrees Fahrenheit (°F) drop in temperature for each three feet of depth. To detect a thermocline, measurements of water temperature are taken at regular depth intervals at the deepest part of a lake. This temperature-depth data can then be depicted graphically in what is known as a "profile." A thermocline, if present, will usually appear as a characteristic S-shaped curve in a portion of the profile, indicative of the rapid drop in temperature over a relatively narrow depth range.

Because of the importance of adequate oxygen in a lake's waters, often when water temperature-depth profile measurements are made, dissolved oxygen measurements are also taken so that profiles for both water

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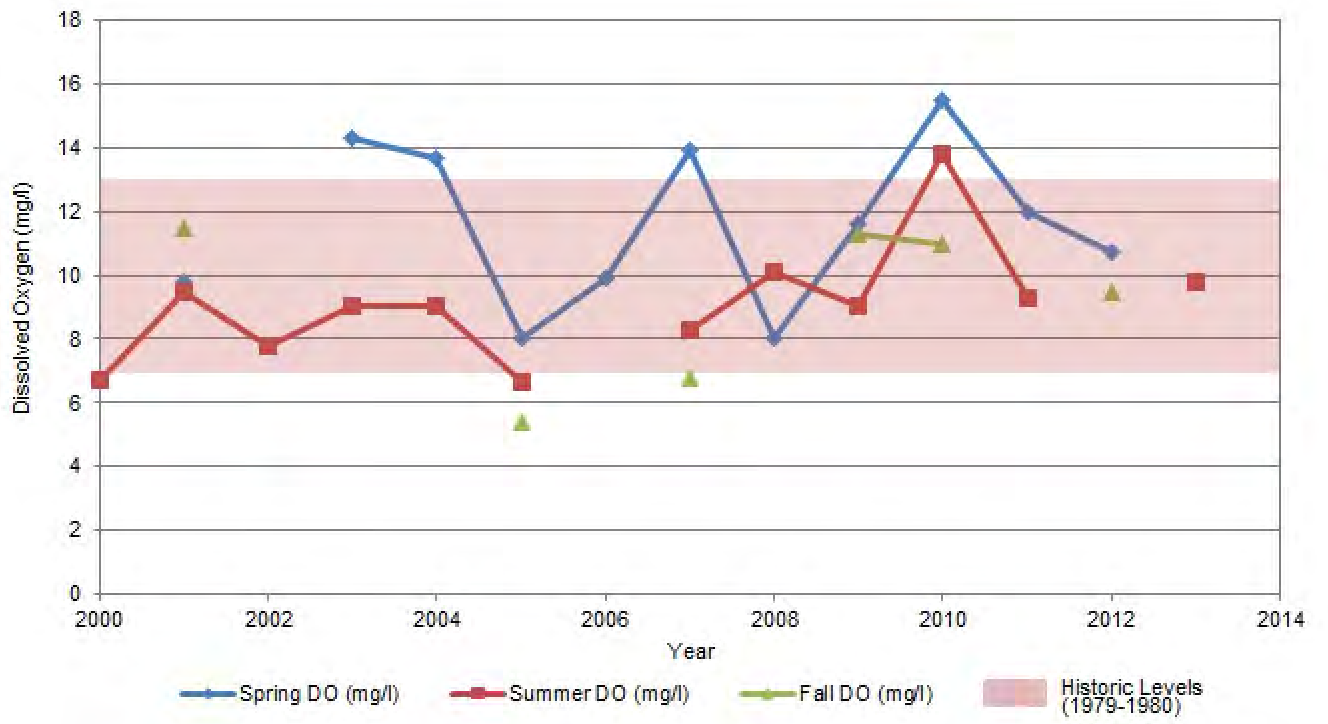
[20]*Gary A. Wedemeyer,* Environmental requirements for fish health, Proceedings of the International Symposium on Diseases of Cultured Salmonids*, Travolek, Inc., Seattle, Washington. 1977.*

[21]*Bruce B. Benson and Daniel Krause Jr.,* The Concentration and Isotopic Fractionation of Oxygen Dissolved in Freshwater and Seawater in Equilibrium with the Atmosphere*, Limnology and Oceanography, Vol. 29, No. 3, 1984, pp. 620-632.*

Figure A-3

SEASONAL SURFACE DISSOLVED OXYGEN CONCENTRATIONS IN SCHOOL SECTION LAKE: 2000-2013 vs. HISTORIC LEVELS



Source: SEWRPC.

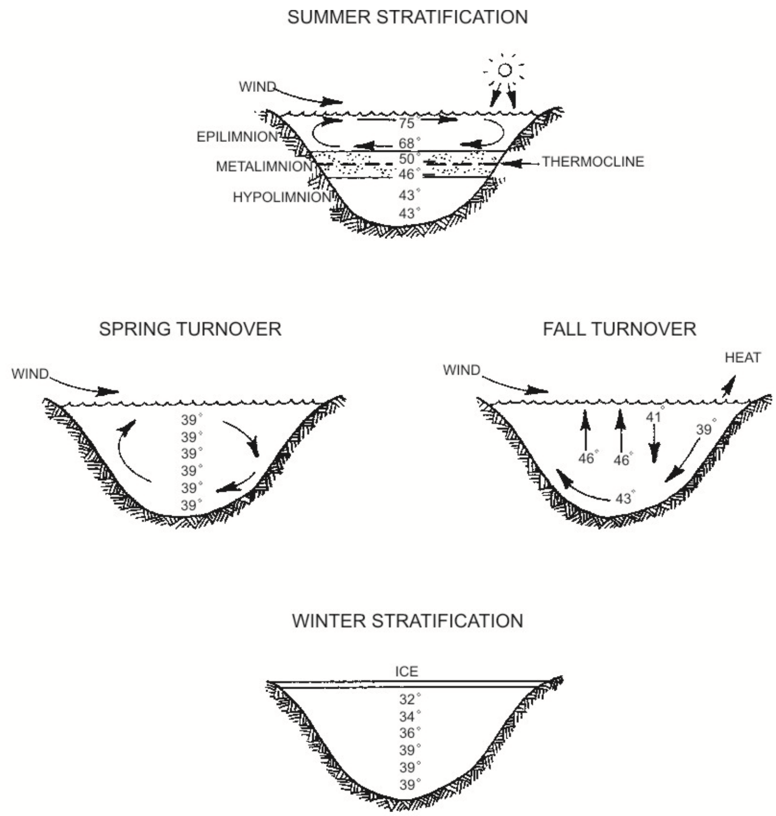
temperature and dissolved oxygen can be generated. In this way, the interplay between water depth, water temperature, and dissolved oxygen concentration can be more clearly seen and the characteristic S-curve in the water temperature profile will be reinforced with a similar S-curve in the oxygen profile at about the same depth, a clear indication of lake stratification.

Figure A-5 shows historic and recent temperature and dissolved oxygen profiles generated from School Section Lake data. As shown in Figure A-5, historic (1979) profiles, both spring and fall, show no indication of stratification; however, both spring and fall profiles from more recent years (2006 and 2009), indicate evidence of stratification occurring at about the eight- to 12-foot depth. This recent occurrence of stratification in School Section Lake was likely caused by the increase in maximum depth that resulted from the dredging project in 1994. In general, shallow lakes are less likely to stratify due to the fact that solar radiation can penetrate the full depth of a lake, thereby causing the entire water column to heat. This was likely the process that took place in School Section Lake prior to the dredging project, as the maximum depth of the Lake was nine feet. Now that the maximum depth is 15.5 feet and solar radiation cannot reach the lake bottom, stratification is much more likely to occur.

A more comprehensive set of dissolved oxygen and temperature profiles is included in Appendix H, where it can be seen that School Section Lake periodically experiences stratification in varying parts of the year. Evidence of stratification was found every year that profiles were recorded after 1994.

Figure A-4

THERMAL STRATIFICATION OF LAKES



Source: University of Wisconsin-Extension and SEWRPC.

Anoxia

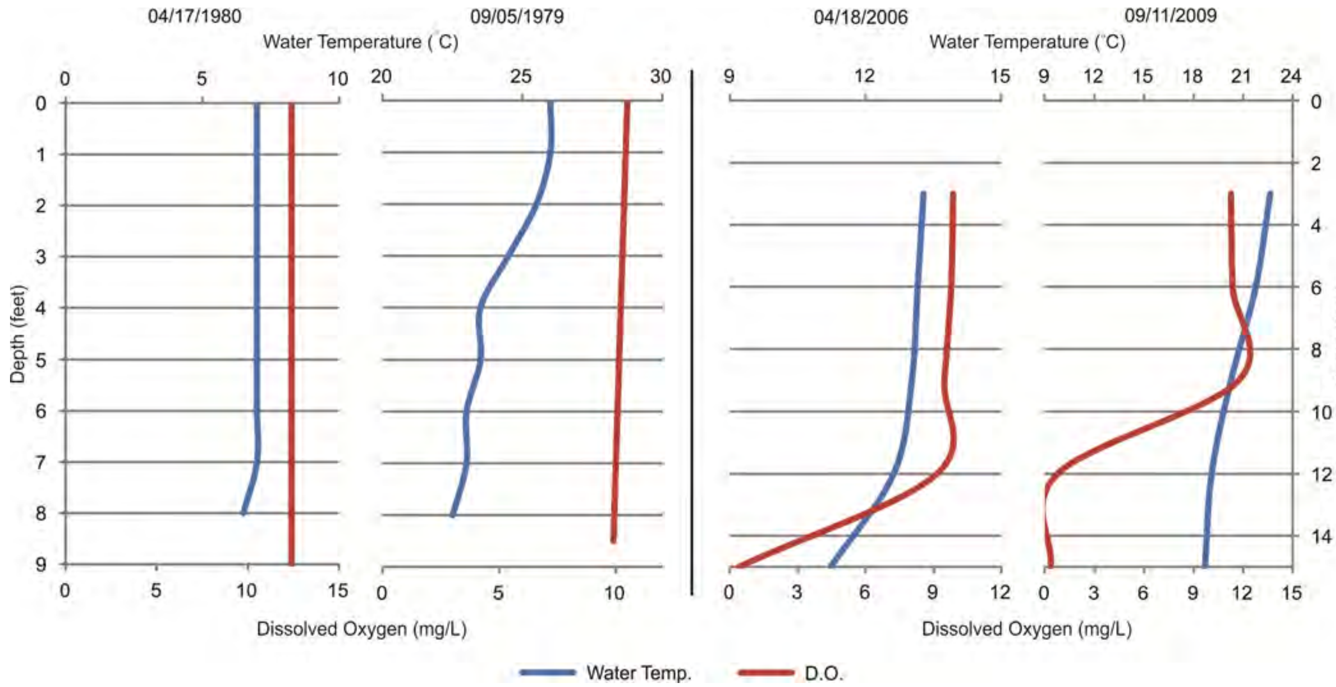
When the surface supply of oxygen is cut off from the bottom waters through stratification, eventually, if there is not enough dissolved oxygen in the lower waters to meet the demands of bottom-dwelling aquatic life and decaying organic material, the dissolved oxygen levels in the bottom waters may be reduced to zero. This condition, known as *anoxia*, or anaerobiasis, is explained in Figure A-6. Anoxia can have a number of negative impacts on the organisms, especially fish, living in a lake. For example, where this *hypolimnetic anoxia* (lack of oxygen at deep depths) develops in a lake, fish tend to move upward, nearer to the surface of a lake, where higher dissolved oxygen concentrations exist. This upward migration, when combined with the warmer water temperatures found near a lake's surface, can select against some fish species that prefer the cooler water temperatures and their competitive success may be severely impaired. Additionally, when there is insufficient oxygen in the lower waters, fish can be susceptible to summer kills. Such is a condition common in many of the lakes in southeastern Wisconsin. When this condition occurs during winter months (when ice cover prevents diffusion of dissolved oxygen and heavy snow cover blocks sunlight from reaching oxygen-producing plants) it can also lead to winter fish kills, as dissolved oxygen stores are not sufficient to meet the total demand for oxygen.

Although School Section Lake has a history of very low oxygen measurements at its lake bottom (see Appendix H) neither summer nor winterkills have been reported as an issue in School Section Lake in recent years. There were, however, records of severe winterkills prior to the dredging project, during the mid-1970s.[22]

[22]*Wisconsin Department of Natural Resources,* Feasibility Study Results, *1981,* op. cit.

Figure A-5

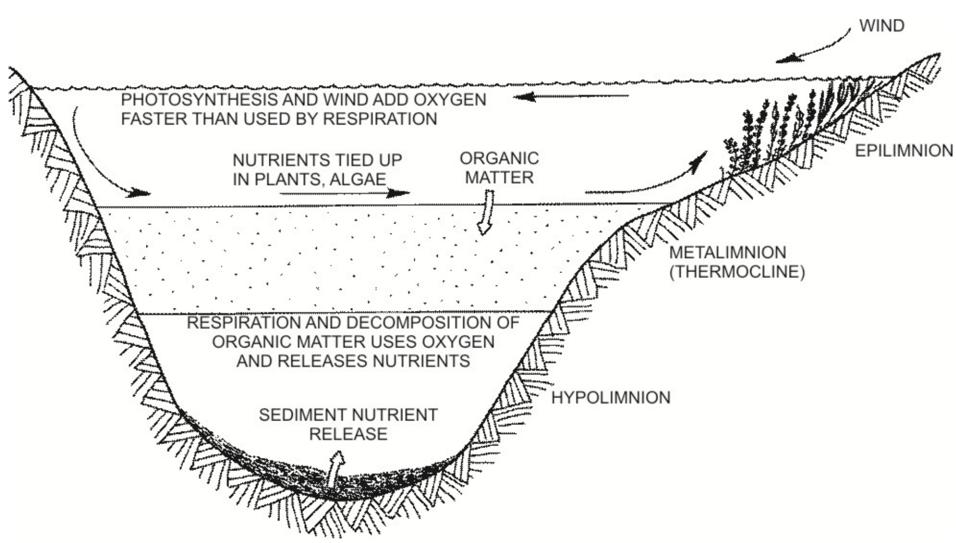
SPRING AND FALL DISSOLVED OXYGEN-TEMPERATURE PROFILES FOR SCHOOL SECTION LAKE: HISTORIC vs. RECENT



Source: SEWRPC.

Figure A-6

LAKE PROCESSES DURING SUMMER STRATIFICATION



Source: University of Wisconsin-Extension and SEWRPC.

Fall and Spring Turnover

Continuing with the process of lake stratification, Figure A-4 shows how the interactions between water temperature and depth play out through the annual progression of the seasons. As summer leads into fall, concurrent cooling air temperatures and the stirring action brought about by wind act together to degrade the thermocline in a lake. As surface waters cool, they become denser, eventually sinking and displacing the now warmer water below. Water is unique among liquids, in that it reaches its maximum density at 4°C (39.2°F), about 4°C (7°F) *above* its freezing point. Eventually, the entire water column is of uniform temperature; when this state is achieved, wind action will thoroughly mix all the waters in a lake, a process known as “fall turnover.” It is at this point that the hypolimnion can again be replenished with dissolved oxygen.

When the water temperature at the surface drops to the point of maximum density, 4°C (39.2°F), these surface waters begin to “sink” to the bottom. Eventually, the water at the surface cools past the point of maximum density, and, as it attains freezing temperature at 0°C (32°F), being less dense now than the water below, still at 4°C (39.2°F), it remains at the surface and changes into the layer of ice that will remain until spring thaw. As shown in Figure A-4, it is possible for a state of weak winter stratification to occur as the colder, lighter water and ice remain at the surface, separated from the relatively warmer, heavier water near the bottom of a lake.

Spring brings a reversal of the process. With the melting of the layer of ice, the upper layer of water warms past the freezing point (0°C or 32°F). Eventually, it warms to its maximum density at 4°C (39.2°F), the same temperature as the waters below, at which point the entire water column is again at uniform temperature, and, with the aid of the stirring action of wind, is thoroughly mixed; this is referred to as “spring overturn” as shown in Figure A-4. Spring overturn usually occurs within weeks after the ice goes out. After spring turnover, the water at the surface again warms and becomes less dense, causing it to “float” on the colder, denser water below. Thus, begins the eventual formation of a thermocline and another period of summer stratification.

Spring and fall mixing are evident in the profiles contained within Appendix H, where temperatures and dissolved oxygen profiles form straight lines in early April and in September.

Total Phosphorus

Phosphorus is an element of fundamental importance to living things, both as a nutrient and as a major cellular constituent. Consequentially, phosphorous is especially important to plant growth. Excessive levels of phosphorus in lakes, however, can lead to nuisance levels of plant growth, unsightly algae blooms, decreased water clarity, and oxygen depletion (due to decomposition of dead plants) that can stress or kill fish and other aquatic life. Phosphorus occurs naturally in soils and bedrock, although with the advent of the widespread use of soaps and detergents, quantities of phosphorus available to lakes has greatly increased. In response to this increase and its subsequent negative impacts on the State’s lakes, Wisconsin is one of 11 states that have banned the use of phosphorus fertilizers in the past 10 years.

Phosphorus may be found in any of four major fractions, or forms. One form, “ortho,” or “dissolved,” phosphorus (PO4), is the principle form of phosphorus and, being dissolved in the water column, is readily available for plant growth. However, its concentration can vary widely over short periods of time as plants take up and release this nutrient. Therefore, *total phosphorus* is usually considered a better indicator of nutrient status. Total phosphorus concentrations include: the phosphorus contained in plant and animal fragments suspended in the lake water; phosphorus bound to sediment particles; and phosphorus dissolved in the water column. In lakes, where wastewater and stormwater discharges from an urban or agricultural landscape dominate the inflow, dissolved or orthophosphate phosphorus can comprise the major form of phosphorus. Hence, these lakes tend to be characterized by high levels of biological production, as the nutrient is present in a form that is most suitable for uptake by the aquatic plants. Conversely, in lakes whose inflows are dominated by runoff from an undisturbed watershed, dissolved phosphorus is present in much lower concentrations, and in-lake productivity is less abundant.[23]

Statewide standards for phosphorus concentrations in lakes were adopted during November 2010. The statewide phosphorus standard supersedes the regional guideline value of 0.02 mg/l or less during spring turnover established by the regional water quality management plan.[24] Pursuant to Section NR 102.06, "Phosphorus," of the *Wisconsin Administrative Code*, School Section Lake would be considered to be a stratified drainage lake, and, as such, subject to a 0.030 mg/l total phosphorus criterion, above which value a lake would be considered to be impaired with respect to phosphorus. A concentration of less than 0.03 mg/l is the level considered as necessary to limit algal and aquatic plant growths to levels consistent with recreational water use objectives, as well as water use objectives for maintaining a warmwater fishery and other aquatic life.

The average total phosphorous level for School Section Lake was calculated as 0.036 mg/l, just above the WDNR phosphorous standards. Figure A-7 shows seasonal phosphorus levels in the surface waters of School Section Lake during the recent period from 2000 to 2013, compared to historic levels from 1979 to 1980. As indicated in the figure, historic phosphorus levels ranged from about 0.015 mg/l to about 0.04 mg/l, while during the current period values are generally higher, ranging from about 0.045 mg/l to as high as 0.085 mg/l. The aforementioned study by Lillie and Mason[25] found that about 21 percent (one of five) lakes in the Southeastern Wisconsin Region have total phosphorus measurements comparable to those of School Section Lake.

It should also be noted that there is an evident increase in total phosphorous levels in the Summer and Fall months between 2006 and 2010, with the highest levels occurring in 2010. These increases could potentially have been caused by the legally reprimanded development activities between 2006 and 2009 in the Village of Dousman.[26] Despite these increases, however, total phosphorous levels are still regularly above the threshold at which a lake's waters may be considered impaired as described above (0.03mg/L). As a result School Section Lake will be placed on the Wisconsin impaired waters list in Spring of 2014.[27] Future efforts to reduce phosphorous loads to School Section Lake will be an important part of any campaign to enhance water quality and reduce aquatic plant growth.

A summary of all of the collected total phosphorus data in School Section Lake is available in Appendix G.

Internal Loading

When aquatic organisms die, they usually sink to the bottom of a lake, where they decompose. Phosphorus from these organisms is then either stored in the bottom sediments or re-released into the water column. Because phosphorus is not highly soluble in water, it readily forms insoluble precipitates, with calcium, iron and aluminum,

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[23]*Sven-Olof Ryding and Walter Rast, "The Control of Eutrophication of Lakes and Reservoirs,"* Unesco Man and the Biosphere Series*, Volume 1, Parthenon Press, Carnforth, 1988; Jeffrey A. Thornton, Walter Rast, Marjorie M. Holland, Geza Jolankai, and Sven-Olof Ryding, "The Assessment and Control of Nonpoint Source Pollution of Aquatic Ecosystems,*" Unesco Man and the Biosphere Series, *Volume 23, Parthenon Press, Carnforth, 1999.*

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

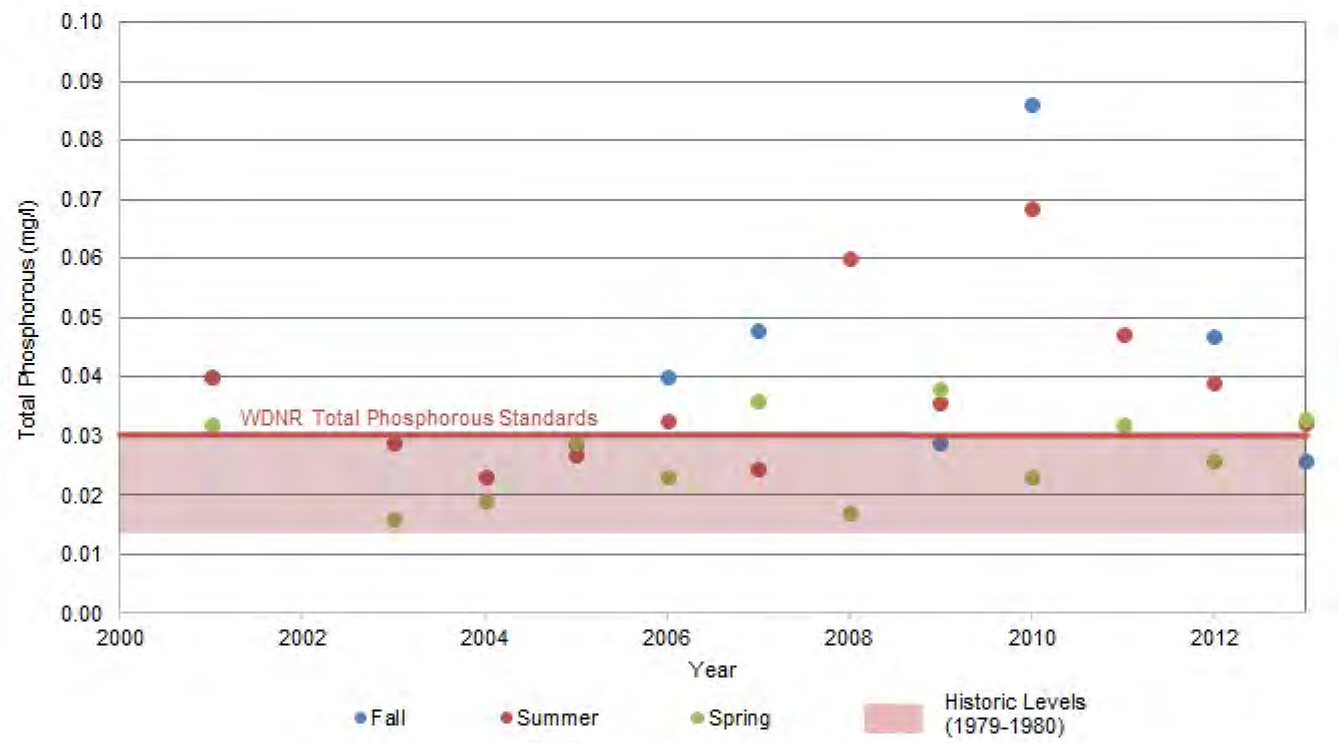
[25]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* op. cit.

[26]*Wisconsin Department of Justice,* Waukesha Developer Settles State Environmental Lawsuit Over Construction Site Violations for $240,000, *News Release, February 2010.*

[27]*Confirmed by Wisconsin Department of Natural Resources staff members.*

Figure A-7

SEASONAL TOTAL PHOSPHORUS CONCENTRATIONS IN SCHOOL SECTION LAKE: 2000-2013 vs. HISTORIC LEVELS



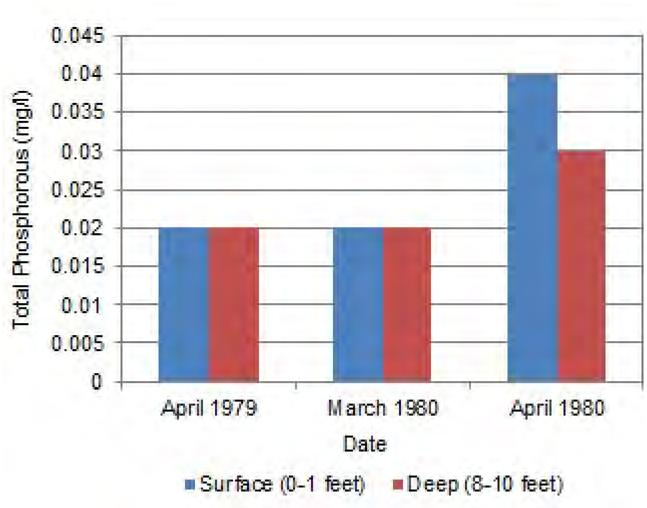
Source: SEWRPC.

under aerobic conditions (conditions where dissolved oxygen is present) and accumulates predominantly in a lake's bottom sediments. However, if the bottom waters become depleted of oxygen during stratification, as described above, the lack of dissolved oxygen (anaerobic conditions) at deep depths can enhance the development of chemoclines, or chemical gradients, with an inverse relationship to the dissolved oxygen concentration. The effect of these chemical changes is that phosphorus becomes soluble again and is more readily released from the iron and manganese complexes to which they were bound under aerobic conditions. This phosphorous releasing process is known as "internal loading." This process also occurs under aerobic conditions, but generally at a slower rate than under anaerobic conditions. As the waters mix, this phosphorus may be widely dispersed throughout a lake waterbody and become available for algal growth.

This "internal loading" can affect water quality significantly if these nutrients and salts are then mixed into the entire water column, especially during early summer when these nutrients can become available for algal and rooted aquatic plant growth. Because School Section Lake does stratify and also experiences periods of anoxia in its bottom waters, some degree of internal loading could be possible. Unfortunately, it is difficult to determine with any certainty if this is the case due to the minimal amount of phosphorus measurements comparing surface and bottom waters data in School Section Lake; Figure A-8 presents the small amount of such data available, dating back to 1979 and 1980 (pre-dredging). Notwithstanding, Figure A-8 would seem to indicate that internal loading was not occurring in School Section Lake at that time, as deep phosphorous levels do not supersede those at the surface. However, this data was taken prior to stratification becoming a common occurrence within the Lake. Consequentially, due to lack of data, it is not possible to determine if internal phosphorous loading is currently occurring in School Section Lake. This lack of data is an important consideration to consider when coordinating monitoring efforts in the future.

Figure A-8

COMPARISON OF TOTAL PHOSPHORUS CONCENTRATIONS AT SURFACE AND DEEP DEPTHS IN SCHOOL SECTION LAKE: 1979-1980



Source: SEWRPC.

Chlorophyll-a

Chlorophyll-*a* is 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. The mean chlorophyll-*a* concentration for lakes in the Southeastern Wisconsin Region is 43 μg/l, with a median concentration of 10 μg/l.[28] Chlorophyll-*a* levels above 10 μg/l generally result in a green coloration of the water that may be severe enough to impair recreational activities, such as swimming or waterskiing.[29]

The average chlorophyll-*a* value for School Section Lake is 17.2, below the regional average, yet above the level that generally impairs recreational activities. Figure A-9 shows chlorophyll-*a* measurements for School Section Lake, comparing recent observations in 2000 through 2013 with historic levels of 1980. As shown in the figure, as was the case with surface measurements of total phosphorus depicted in Figure A-7, chlorophyll-*a* measurements during recent years have also generally been above historic levels of about 5.0 to 8.0μg/l and within the range of values that is indicative of enriched nutrient conditions often associated with poor water quality in a lake. The aforementioned study by Lillie and Mason[30] found that about 12 percent (one of eight) lakes in the Southeastern Wisconsin Region have chlorophyll-*a* measurements comparable to those of School Section Lake.

A summary of the chlorophyll-*a* data available for School Section Lake is presented in Appendix G.

Other Water Quality Factors

Nitrogen

Nitrogen, especially in its reactive, or "organic" form, is an element second in importance only to phosphorus as essential to the growth of plants, terrestrial or aquatic. Most organic nitrogen is the result of a process known as "nitrogen fixation," which occurs in certain symbiotic microbes found in the roots of some plants, especially legumes and rice. Primary natural sources of nitrogen in lakes include: precipitation falling directly onto a lake's surface; nitrogen fixation processes occurring both in a lake's water and its sediments; and groundwater input and surface runoff. Man-made sources of organic nitrogen include: livestock wastes; agricultural fertilizers, including lawn fertilizers; and human sewage. Because of its association with plant growth, nitrogen level in a lake is considered a key chemical parameter in monitoring the chemical makeup of lake ecosystems.

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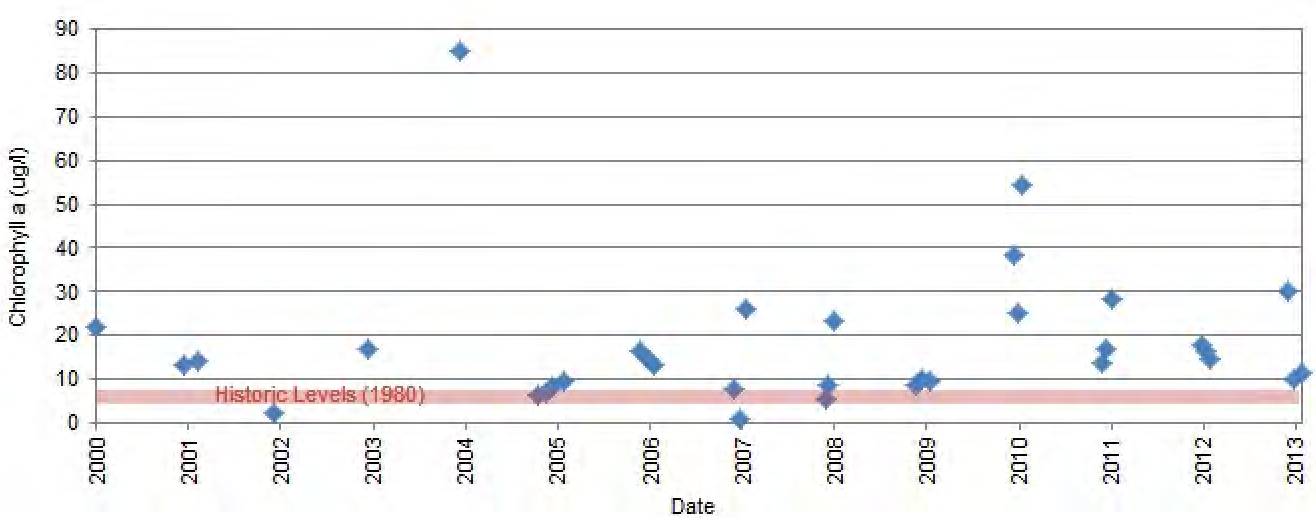
[28]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* op. cit.

[29]*J.R. Vallentyne, "The Process of Eutrophication and Criteria for Trophic State Determination," in* Modeling the Eutrophication Process—Proceedings of a Workshop at St. Petersburg, Florida*, November 19-21, 1969, pages 57-67.*

[30]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* op. cit.

Figure A-9

CHLOROPHYLL-*a* CONCENTRATIONS IN SCHOOL SECTION LAKE: 2000-2013 vs. HISTORIC LEVELS



Source: SEWRPC.

Lakes in the Southeastern Wisconsin Region have an average total nitrogen level of 1.43 mg/l, the highest level of any region in the State.[31]As shown in Table A-6, total nitrogen in the surface waters of School Section Lake has been measured nearly annually since 2000 with an additional five measurements taken from 1979 to 1980. The values for total nitrogen ranged from a low of 0.66 mg/l in in 2007 to a high of 1.67 mg/l in 2010.

Nitrogen-to-Phosphorus Ratios

Aquatic plants and algae require such nutrients as phosphorus and nitrogen for growth. In hard-water alkaline lakes, most of these nutrients are generally found in concentrations that exceed the needs of growing plants. However, in lakes where the supply of one or more of these nutrients is limited, plant growth is limited by the amount of the nutrient that is available in the least quantity relative to all of the others. The ratio (N:P) of total nitrogen (N) to total phosphorus (P) in lake water indicates which nutrient is the factor most likely to be limiting aquatic plant growth in a lake.[32] Where the N:P ratio is greater than 14:1, phosphorus is most likely to be the limiting nutrient. If the ratio is less than 10:1, nitrogen is most likely to be the limiting nutrient. The data presented in Table A-6 clearly indicates that, with an overall N:P ratio of 36:1, phosphorus is the limiting factor for plant production in School Section Lake. This situation is common for lakes in southeastern Wisconsin.

Alkalinity and Hardness

Alkalinity is a measure of a lake's ability to absorb and neutralize acidic loadings, "buffering." For example, lakes having a low alkalinity and, therefore, a low buffering capacity, may be more susceptible to the effects of acidic atmospheric deposition. A lake's alkalinity is often closely associated with the soils and bedrock of the lake's watershed. Lakes in the southeastern part of the State traditionally have high alkalinity, averaging about 173 mg/l,

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[31]Ibid.

[32]*M.O. Allum, R.E. Gessner, and T.H. Gakstatter, U.S. Environmental Protection Agency Working Paper No. 900,* An Evaluation of the National Eutrophication Data, *1976.*

Table A-6

TOTAL NITROGEN CONCENTRATIONS AND N:P RATIOS FOR SCHOOL SECTION LAKE: 1979-2013

Date	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)	N:P Ratio
08/21/13	1.19	0.030	38.0
09/05/12	1.21	0.040	29.5
07/19/11	1.03	0.040	27.1
09/08/10	1.67	0.090	19.4
08/11/09	1.12	0.030	32.9
08/06/08	1.37	0.070	21.1
08/22/07	0.66	0.020	33.0
08/23/06	1.44	0.030	42.4
10/17/05	1.08	0.030	43.2
08/10/05	1.12	0.030	37.3
08/04/04	1.37	0.020	59.6
08/11/03	1.25	0.030	43.1
10/01/01	1.14	0.040	28.5
08/08/01	1.12	0.040	28.0
08/28/00	1.53	0.060	27.8
04/17/80	1.30	0.040	32.5
03/14/80	0.80	0.020	40.0
11/09/79	0.73	0.020	36.5
09/05/79	0.75	0.010	57.7
04/26/79	0.89	0.020	44.5
Overall	1.14	0.035	36.1

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

reflective of the limestone and dolomite deposits that make up much of the underlying bedrock in this Region. Low-alkalinity lakes are mostly confined to the northern regions of the State.[33] Alkalinity is generally reported as mg/l $CaCO_3$ equivalents. As shown in Figure A-10, measurements in School Section Lake from 2000 to 2013 ranged from 162 mg/l to about 261 mg/l and are, therefore, consistent with the historic levels of about 190 mg/l to about 242 mg/l as well as consistent with the conclusion that the water supplied to the Lake is highly groundwater influenced. A summary of alkalinity measurements for School Section Lake is presented in Appendix G.

In contrast to alkalinity, water hardness is a measure of the multivalent metallic ion concentrations, such as those of calcium and magnesium, present in a lake. Generally, lakes with high levels of hardness produce more fish and aquatic plants than lakes whose water is soft.[34] Hardness is usually reported as an equivalent concentration of calcium carbonate (CaCO3). Hardness measurements for School Section Lake have not been documented.

pH

The pH of lake water influences many of the chemical and biological processes that occur there. For example, pH can influence how much of certain nutrients, such as phosphorus, nitrogen, and carbon, can be utilized by aquatic life. It can also affect what form of phosphorus is most abundant in water. Additionally, pH can determine solubility, and therefore the toxicity, of such heavy metals as lead, copper, and cadmium.

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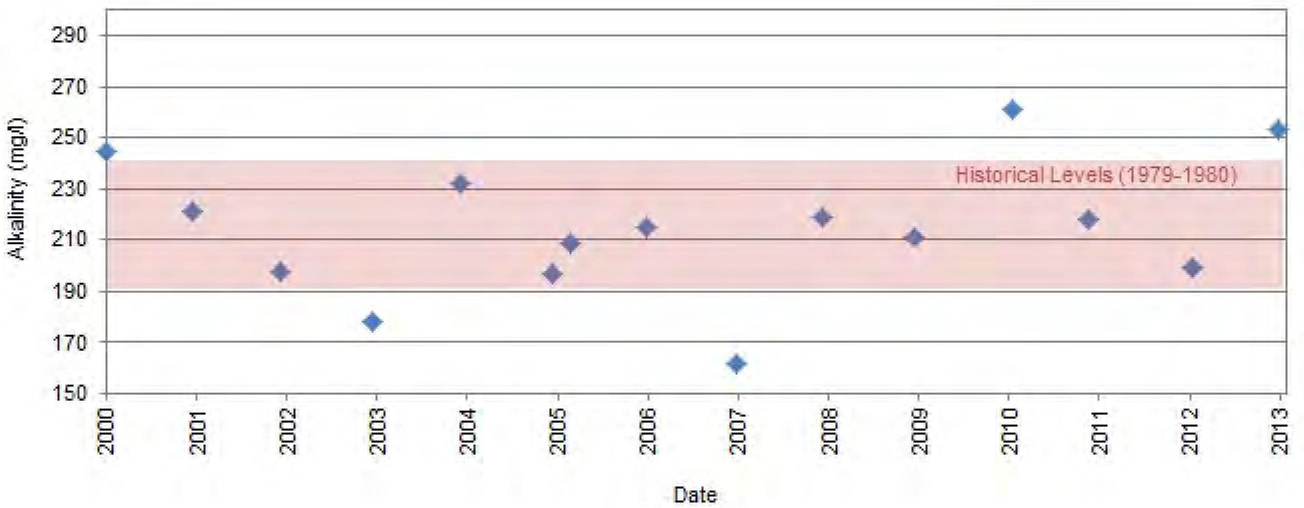
[33]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* op. cit.

[34]*Byron Shaw, Lowell Klessig, Christine Mechenich,* Understanding Lake Data, *University of Wisconsin-Extension Publication No. G3582, 2004.*

Figure A-10

ALKALINITY CONCENTRATIONS IN SCHOOL SECTION LAKE: 2000-2013 vs. HISTORIC LEVELS



Source: SEWRPC.

The pH is a logarithmic measure of hydrogen ion concentration on a scale of 0 to 14 standard units, with 7 indicating neutrality. A pH above 7 indicates basic (or alkaline) water, and a pH below 7 indicates acidic water. Even though moderately low/high pH may not directly harm fish or other organisms, pH near the ends of the scale can have adverse effects on the organisms living in a lake. Additionally, under conditions of very low (acidic) pH, certain metals, such as aluminum, zinc, and mercury, can become soluble if present in a lake's bedrock or watershed soils, leading to an increase in concentrations of such metals in a lake's waters, with subsequent potentially harmful effects to, not only the fish, but also to those organisms, including humans, who eat them.[35]

As in the case of alkalinity, the chemical makeup of the underlying bedrock has a great influence on the pH of lake waters. In the case of lakes in the Southeastern Wisconsin Region, where the bedrock is comprised largely of limestone and dolomite, the pH typically is in the alkaline range above a pH of 7. In general, the pH for most natural waterbodies is within the range of about 6.0 to about 8.5.[36] Measurements of pH from lakes in southeastern Wisconsin averaged 8.1, which, due to the underlying geology of the Region, was the highest recorded from any region in the State. By contrast, lakes in northeastern Wisconsin are slightly acidic with an average pH of 6.9.[37] As shown in Figure A-11, historic values for pH have generally ranged from about 7.9 to about 8.5; values from 2000 to 2013 have been a little below historic levels in the spring but a little above historic values in the summer ranging generally from about 7.5 to about 8.7. Appendix G presents a summary of pH data from School Section Lake from 1979 to 2013; Appendix H presents pH profiles for School Section Lake, indicating changes in pH at different water depths in the Lake. The average pH is 8.2, just above the regional average.

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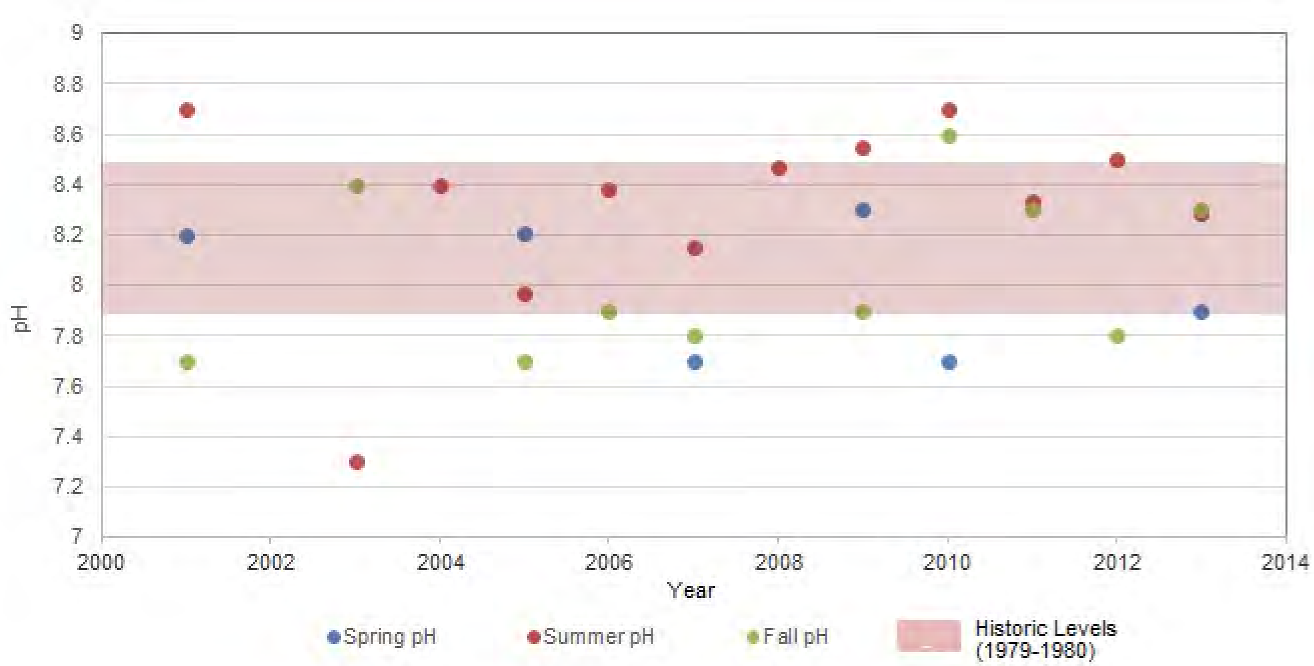
[35]Ibid.

[36]*Deborah Chapman*, Water Quality Assessments, *2nd Edition, E&FN Spon, 1996.*

[37]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* op. cit.

Figure A-11

pH CONCENTRATIONS IN SCHOOL SECTION LAKE: 2000-2013 vs. HISTORIC LEVELS



Source: SEWRPC.

Other factors influencing pH include precipitation, as well as biological, algal, activity within the Lake. Natural buffering of rainfall by carbon dioxide in the atmosphere and the carbonate system in the Lake, its tributary streams and drainage area, all tend to moderate the pH level in other lakes in the Region.

Conductivity

The electrical conductivity, or *EC*, of a lake's waters is a measure of how much resistance to electrical flow exists in the water. As the concentration of charged particles, "ions," in water increases, its resistance to electrical flow diminishes, i.e., as the concentration of ions increases, conductivity increases. Therefore, conductivity indirectly estimates the amount of dissolved ions in the water. Since many pollutants that affect a lake's water quality are associated with various ions, abnormally high levels of conductivity in a lake's waters often signal a potential pollution problem. Such pollutants include: wastewater from sewage treatment plants and onsite septic systems; urban runoff from roads, especially road salt used to clear road surfaces of ice and snow; animal wastes; and agricultural/lawn/garden runoff, primarily chemical fertilizers and pesticides. Generally, conductivity measurements are expected to fall within a range of about two times a lake's hardness values.[38]

Natural influences affect a lake's conductivity, too. For example, just as in the cases of alkalinity and pH, high concentrations of limestone in the soils of a lake's watershed and basin can lead to higher conductivity in a lake's waters due to the dissolution of carbonate minerals in the limestone. In addition, top versus bottom measurements of conductivity generally reveal increased levels of conductivity at depth due to decomposition of bottom

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[38]*Byron Shaw, Lowell Klessig, Christine Mechenich,* Understanding Lake Data, *University of Wisconsin-Extension. RP-6/2000-1M-350, 2000.*

sediments and acidic conditions that allow certain materials to become more soluble. Another natural influencing factor of conductivity is the proportion of a watershed size to a lake basin size. The larger the watershed, the more soil that's available for water to be in contact with as it drains to a lake. Other natural influences include such things as atmospheric deposition (in ocean coastal areas, ocean water increases the salt content of strong onshore winds and precipitation) and the concentration of dissolved salts through the process of evaporation of water from a lake's surface.

Until the late 1970s, conductivity was typically measured in units known as micromhos per centimeter (μmhos/cm); after that time, the standard unit was changed to microSiemens/cm (μS/cm). 1μmhos/cm = 1 μS/cm. In addition, since increasing temperature creates an increase in electrical flow in an ionic solution, conductivity measurements are automatically compensated to a standard temperature of 25°C (77°F), such measurements being referred to as *specific conductivity.*

Conductivity measurements can vary widely from lake to lake. For example, average conductivity for Lake Superior is around 97 μS/cm, while that for Lake Mead is around 850 μS/cm. Freshwater lakes commonly have a specific conductance in the range of 10 to 1,000 μS/cm, although measurements in polluted waters or in lakes receiving large amounts of land runoff can sometimes exceed 1,000 μS/cm.[39] Lakes in the Southeastern Wisconsin Region exhibit moderate levels of conductivity, usually within the 500 to 600 μS/cm range. The average conductivity for School Section Lake is 556, within the typical regional range. As shown in Figure A-12, conductivity measurements in School Section Lake during recent years from 2000 to 2013 are generally within the range of historic values of about 525 to about 640 μS/cm, although the trend, though not statistically significant, appears to be slightly increasing during recent years. This could potentially be caused by increasing sediment or pollution loads, although this cannot be confirmed. Appendix G presents a summary of all recorded conductivity measurements for School Section Lake.

Major Anions (ions with a "-" charge): Chlorine (Cl), Sulfates (SO4), Fluoride (F)

Chlorides

Just as the presence of high concentrations of ions in a lake's waters often are an indication of possible pollution, the *types* of ions present can sometimes give clues as to the possible sources of these pollutants. For example, chloride ions (Cl) are found in small quantities in nearly every lake due to the natural weathering from bedrock and soils in a lake's watershed. In large concentrations, chlorides are usually associated with human activities, in particular the heavy application of road salts during winter deicing operations, and in effluents from waste water treatment plants and onsite septic systems.

The observed increase in chloride concentration in southern Wisconsin lakes, particularly since the 1960s, seems to be closely aligned with a concomitant increase in the use of road salts for winter deicing. Such alignment is particularly noteworthy when viewed in the context of most lakes in Vilas County in northern Wisconsin, where chloride concentrations in lakes has been mostly constant over the years, except for a few cases in which lakes lying adjacent to major roadways and populated areas have begun to exhibit a rise in chloride concentrations.

Figure A-13 shows chloride concentration trends for a several lakes in the Southeastern Wisconsin Region for the time period from 1960 to 2004. As can be observed from this figure, the concentrations of chloride in the Region's lakes have been rising since 1960. How such an increase might be impacting lake ecosystems is not fully known. It may be that chloride, rather than being a significant pollutant in itself, at least at present concentrations, might serve as an "indicator" element, indicating that as chloride concentrations rise, other, more harmful pollutants that are not as easily measured may also be rising. Regionwide concentration of chlorides averages 19 mg/l, the highest in the State.

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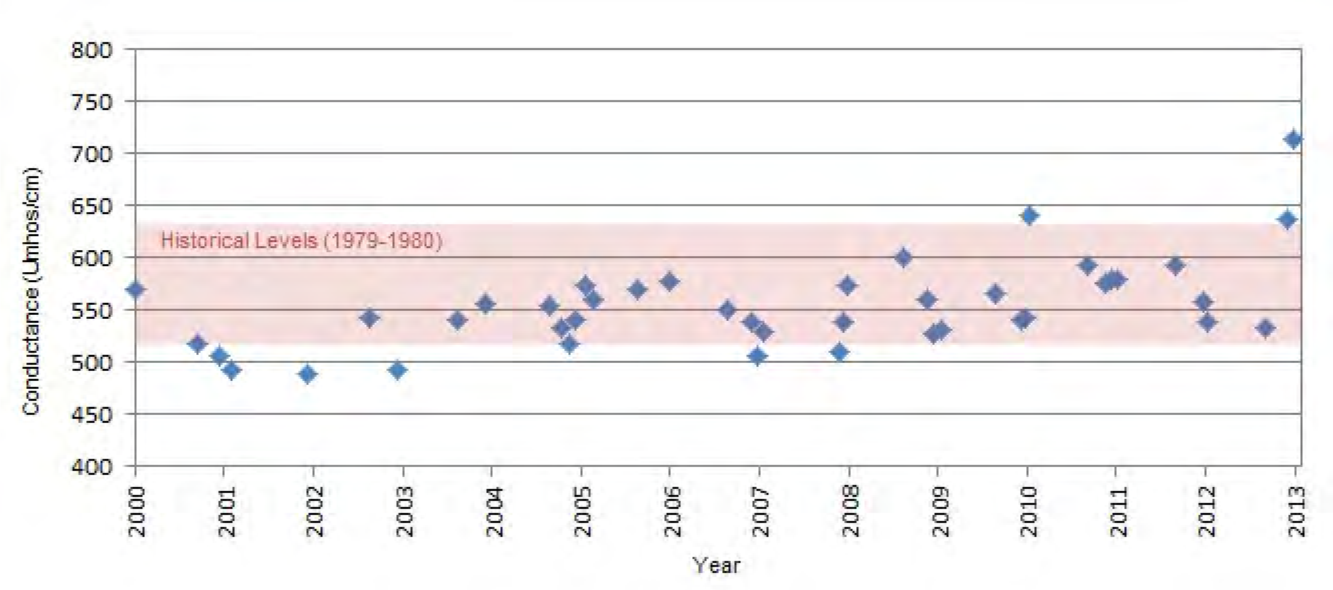
[39]*Deborah Chapan,* Water Quality Assessments, *2nd Edition,* op. cit.

Figure A-12

CONDUCTIVITY CONCENTRATIONS IN SCHOOL SECTION LAKE: 2000-2013 vs. HISTORIC LEVELS



Source: SEWRPC.

Figure A-14 compares chloride concentrations at several different locations in School Section Lake during 1979 and 1980. As shown in the figure, chloride levels at the Lake inlet have ranged from about 10 mg/l to about 12 mg/l; at the surface of the Lake from about 10 mg/l to about 16 mg/l; and, in the deep waters of the lake (pre-dredging) from about 10 mg/l to about 15 mg/l. Appendix G presents the data in Figure A-14 in empirical format.

Lack of recent data prevents any conclusions being drawn about chloride concentrations within School Section Lake. However, chloride pollution is an emerging issue, the effects of which are now being investigated in the academic community. Future monitoring of chloride concentrations should, therefore, be considered as a part of upcoming monitoring efforts.

Sulfates

Besides chlorides, sulfates are another significant water quality parameter. Sulfates are just one of several forms of sulfur and an important nutrient of many forms of aquatic life. Sulfur is a naturally occurring substance that can enter a lake through solubilization from rocks and from fertilizers, although in heavily industrialized areas, such as southeastern Wisconsin, sulfur input from atmospheric sources related to human activities, such as burning of fossil fuels and those combustion processes associated with the paper-making process, dominate all other sources.[40] The dominant form of sulfur in lakes is sulfate. Sulfates play a role in a lake's eutrophication process and can, in high concentrations, have a deleterious effect on certain aquatic plants. Wild rice, a plant with significant economic, cultural, and environmental value, grows best in lakes with relatively low sulfate concentrations. To safeguard this important plant, the State of Minnesota in 1973 adopted a standard of 10 mg/l as the highest permissible amount of sulfates allowed in waters used for the production of rice, either naturally or commercially.

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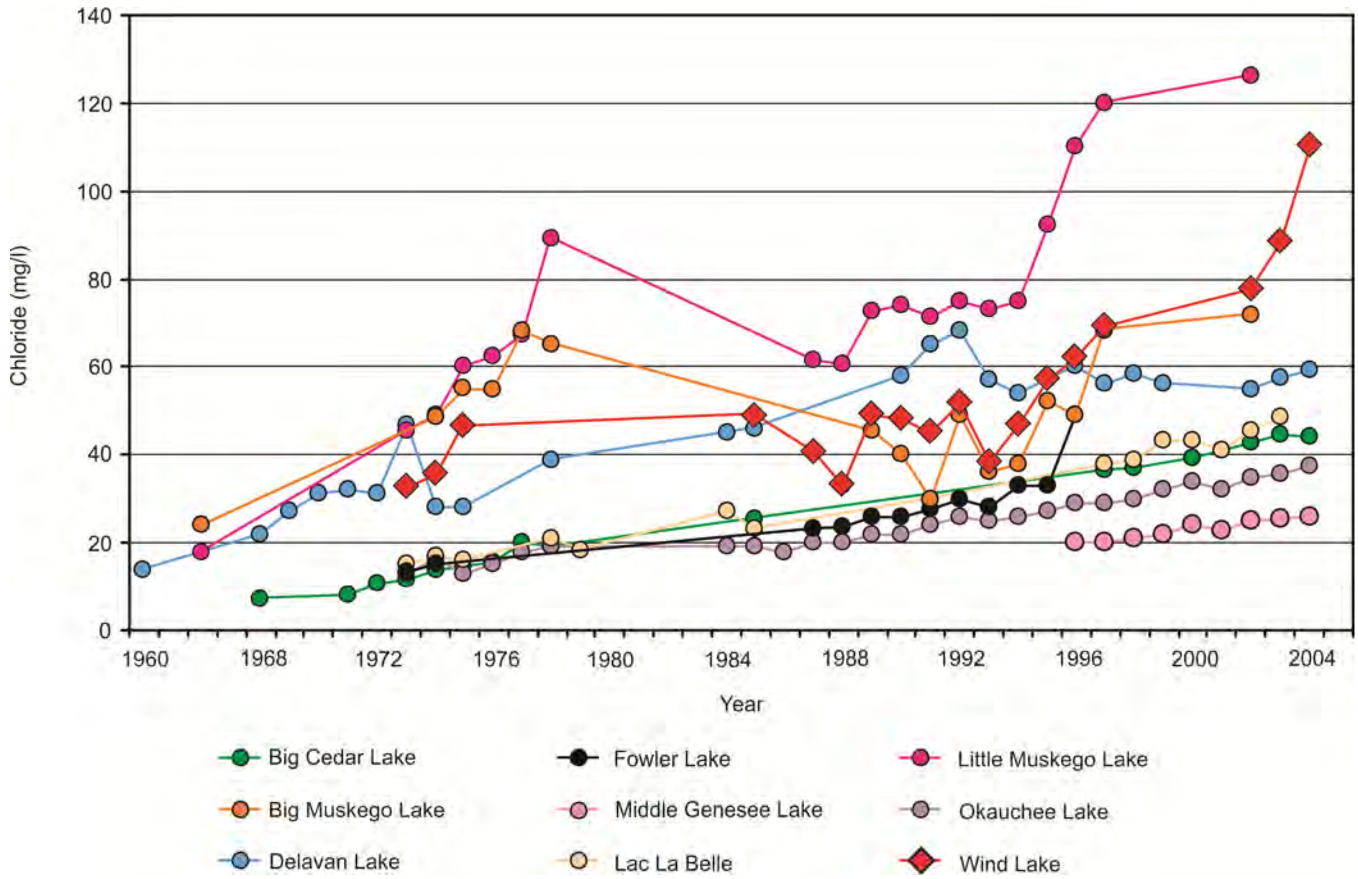
[40]*Robert G. Wetzel*, Limnology—Lake and River Ecosystems, *Third Edition*, *Academic Press*, *2001*.

Figure A-13

CHLORIDE CONCENTRATION TRENDS FOR SELECTED LAKES IN SOUTHEASTERN WISCONSIN: 1960-2004



Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, and SEWRPC.

Due to their stability when dissolved in water, sulfates tend to accumulate in a lake's bottom sediments unless removed. Like magnesium and calcium, to be discussed below, the highest concentrations of sulfates are found in lakes in the southeastern part of the State where high densities of population and industrialization occur. Generally, lakes in this part of Wisconsin experience sulfate levels in the 20 to 40 mg/l range, with some lakes in southeastern Wisconsin having sulfate levels above 40 mg/l.[41] There are no recorded measurements of sulfates in School Section Lake, thereby indicating that these measurements should be included in future monitoring efforts.

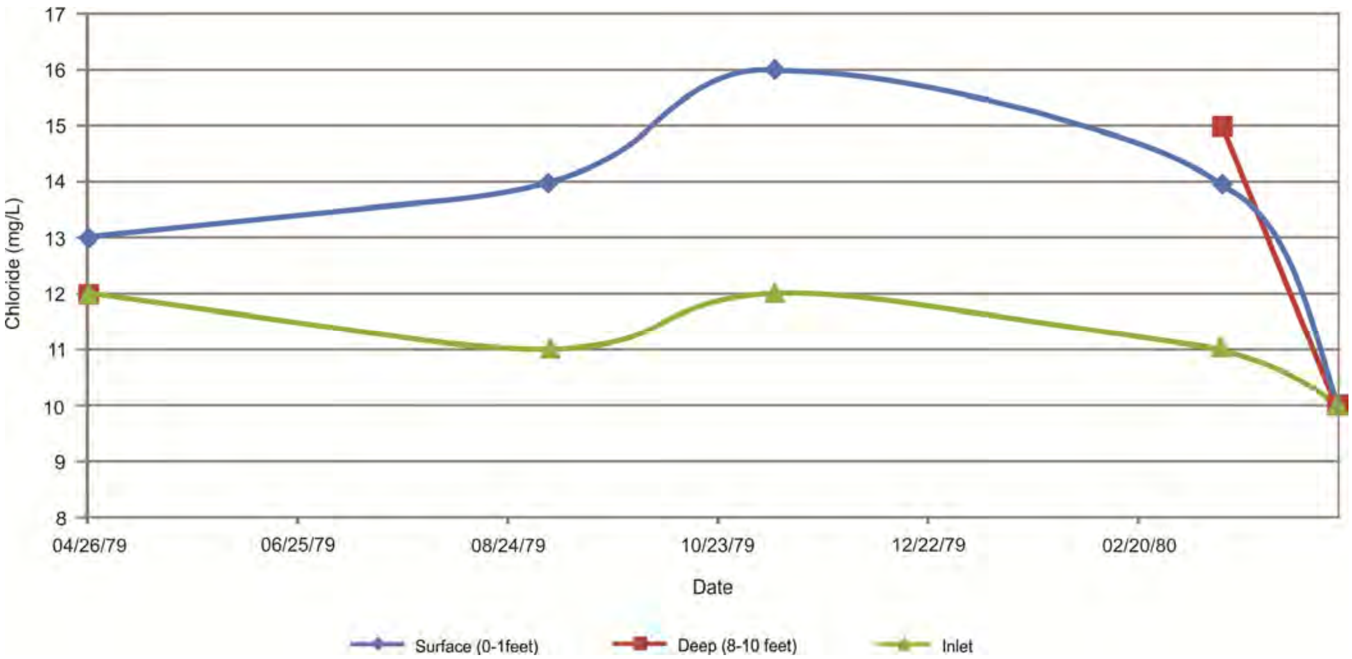
Fluoride

Fluoride is probably most widely associated with being added to domestic water supplies to harden teeth and fight tooth decay in humans. Usually present in only small amounts naturally in lakes, Wisconsin lakes usually contain between 0.08 to 0.51 mg/l. Fluoride has not been measured in School Section Lake.

[41]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* op. cit.

Figure A-14

CHLORIDE CONCENTRATIONS FOR SCHOOL SECTION LAKE: 1979-1980



Source: SEWRPC.

Major Cations (ions with a "+" charge)

Magnesium and Calcium

Calcium (Ca), due to its reactive nature with phosphorus, is often related to the growth of phytoplankton; it is also a required nutrient of metabolism in higher plants. Additionally, magnesium (Mg) is a fundamental building block of chlorophyll and, as such, is a vital nutrient to all green plants. The limestone and dolomite deposits, in the bedrock of much of the southeast Region, affect not only the alkalinity of the Region's lakes, as described above, but also result in elevated calcium and magnesium levels. Lakes in the southeast Region, therefore, average about 36 and 32 mg/l for calcium and magnesium, respectively, the highest levels in the State.[42]

Tables A-7 and A-8 provide calcium measurements for School Section Lake during the period of 1979 to 1980, and 2000 to 2005, respectively. As can be seen from the tables, surface measurements for calcium during the more recent period (2000-2005) averaged about 54 mg/l, which was slightly lower than those during the earlier time period (1979 to 1980), which averaged about 61 mg/l. Measurements of calcium during the earlier time period of 1979 to 1980, taken in the deeper waters of School Section Lake and at the inlet, averaged 69.7 mg/l and 72.2 mg/l, respectively, which was slightly higher than those at the surface during the same time period. There are no measurements in the deep waters or inlet for the more recent time period. All the above calcium measurements are above the regional average of about 36 mg/l.

Tables A-9 and A-10 show magnesium measurements for School Section Lake during the period of 1979 to 1980, and 2000 to 2013, respectively. As can be seen from the tables, all values for School Section Lake, whether in the earlier or more recent time period, are somewhat above the regional average of 32 mg/l. The earlier measurements

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[42]Ibid.

Table A-7

CALCIUM CONCENTRATIONS IN SCHOOL SECTION LAKE: 1979-1980

Date	Surface: 0 to 1 Feet (mg/l)	Deep: 8 to 10 Feet (mg/l)	Inlet (mg/l)
04/17/80	84	85	98
03/14/80	60	56	54
11/09/79	52	- -	73
09/05/79	44	- -	70
04/26/79	67	68	68
Overall	61.4	69.7	72.2

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

at the surface, which averaged about 38 mg/l, were slightly higher than the more recent surface measurements, which averaged about 36 mg/l. As was the case with calcium, the highest measurements were found at the Lake inlet during the earlier time period (magnesium measurements were not taken at the inlet or deeper waters during the recent time period); inlet levels of magnesium averaged more than 39 mg/l.

Sodium and Potassium
Sodium (Na) and potassium (K) have strong links to the growth of cyanobacteria, blue-green algae, which are among the most studied of all planktonic groups and whose toxic byproducts have been well documented for their adverse effects on freshwater lakes, especially those with enriched, or eutrophic, conditions. Concentrations of sodium and potassium in a lake are usually fairly uniform regardless of the depth or time of year. There are no published regional averages for these substances. Tables A-11 and A-12 show the measurements of sodium and potassium, respectively, in School Section Lake made in 1979 to 1980, the only data available at the time of this report. In School Section Lake, as shown in Table A-11, concentrations of sodium measured at the surface, the deeper waters and at the inlet, averaged 3.8 mg/l, 4.0 mg/l and 3.6 mg/l, respectively. As shown in Table A-12, concentrations of potassium measured at the surface, the deeper waters and at the inlet, averaged 1.7 mg/l, 1.8 mg/l and 1.5 mg/l, respectively. As can be seen from these two tables, measurements for sodium in School Section Lake during 1979 and 1980 were quite uniform regardless of the location in the Lake; the same can be said for the concentrations of potassium.

Silica
Although it is relatively inert regarding its chemical properties, silica plays a significant role in the production of many alga forms in freshwater lakes, especially the diatoms which depend on the substance for the production of their characteristic silicone casing. Therefore, the amount of dissolved silica available in a lake's waters can influence the composition of the phytoplankton population. Insufficient levels of silica in a lake's waters can shift algal population dominance from beneficial species, such as diatoms, to less desirable species, such as cyanobacteria, blue-green algae. The lowest amounts of silica are found in lakes associated with carbonate rocks, such as commonly the case in southeastern Wisconsin where limestone and dolomite deposits make up much of the underlying bedrock in the Region. Silica measurements have not been recorded in School Section Lake.

Solids
There are two measurements of solids. The first is total suspended solids (TSS), which refers to the amount of suspended solids, such as soils and sands, found suspended or floating within a sample of water. This amount is highly related to the previously discussed turbidity measurements, which can increase when water is disturbed or is being affected by high amounts of erosion.

Table A-8

CALCIUM CONCENTRATIONS IN SCHOOL SECTION LAKE: 2000-2005

Date	Surface: 0 to 1 Feet (mg/l)
08/10/05	46.6
08/04/04	66.5
08/11/03	40.5
08/02/02	46.5
08/08/01	55.3
08/28/00	71.0
Overall	54.4

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

The second measure is total dissolved solids (TDS), which is an estimation of the total amount of inorganic solids dissolved in the water. The abundance of these dissolved solids is influenced by several factors, including:

- The *geologic nature* of a lake's basin—the limestone and dolomite bedrock predominant in southeastern Wisconsin results in higher amounts of carbonates and bicarbonates in the lakes;
- The *topography* of a lake's watershed—as local topography increases in steepness, overrunning water (runoff) spends less time in contact with it and, therefore, reacts less with it;
- *Climate*—warm, moist climates can greatly increase the rate at which material dissolves in water; and
- *Time*—the longer the time water sits in a lake basin, the more it can react with the basin materials.

Probably the most significant source of dissolved solids in a lake's waters is geologic weathering, e.g., erosion and runoff, although atmospheric precipitation and human activities can also be contributors. Total dissolved solids have not been measured thus far in School Section Lake.

Overall Water Quality Assessment

Historic (1979 to 1980) water quality data and more current data (since 2000) for School Section Lake, especially in regards to water clarity (Secchi, turbidity, color and chlorophyll-*a*) all generally indicate somewhat poor water quality. This assessment seems to be reinforced by total phosphorus measurements, which indicate enriched conditions usually associated with poor water quality. Although the presence internal phosphorous loading was inconclusive, the fact that the Lake's deep waters sometimes become anoxic indicate that further monitoring should be done to determine if internal loading is a factor.

Dissolved oxygen levels in the Lake are generally sufficient to support a thriving fish community. However, the dredging that occurred in the 1990s appears to have deepened the Lake sufficiently to generate some amount of thermal stratification, with concomitant effects on oxygen levels. Phosphorus is the limiting factor in growth of aquatic plants in School Section Lake, a condition common for lakes in the Southeastern Wisconsin Region. Therefore, high phosphorous levels are the most likely explanation for high aquatic plant growth in the Lake (as discussed later in this appendix).

Conductivity measurements (high conductivity can be associated with pollutants) for School Section Lake were about normal for the Region, although there seemed to be evidence for some slight increasing in recent years. Chloride concentrations were lower in School Section Lake compared to many lakes in the Region that are being negatively affected by road salts and other chloride sources. However, more recent data needs to be acquired in order to draw any real conclusions; other water chemistry parameters were either not outstanding or not measured.

Overall, the Lake's water quality would likely benefit from regular collection of pertinent water chemistry measurements to assist in the development of recommendations for improvement. Additionally, efforts to reduce phosphorous levels and sediment loads to the Lake would be instrumental to enhancing the Lake's water quality.

Table A-9

MAGNESIUM CONCENTRATIONS IN SCHOOL SECTION LAKE: 1979-1980

Date	Surface: 0 to 1 Feet (mg/l)	Deep: 8 to 10 Feet (mg/l)	Inlet (mg/l)
04/17/80	31	31	33
03/14/80	38	40	36
11/09/79	44	- -	44
09/05/79	42	- -	51
04/26/79	34	34	33
Overall	37.8	35.0	39.4

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

POLLUTANT LOADINGS

Pollutant loading of sediments, phosphorous and metals to a lake are generated by various natural processes and human activities that take place in the area tributary to a lake. These loads are transported to a lake through various means including: through the atmosphere as dry fallout and direct precipitation; across the land surface directly as surface runoff and indirectly as groundwater inflows; and by way of inflowing streams as surface water inflows. Calculation of these loads within a watershed can be helpful in determining the potential issues that may occur within a Lake. Additionally, the calculations can help target efforts towards reducing pollutant inputs to lakes.

In drained lakes with no identifiable point source discharges (e.g., discharges from wastewater treatment facilities or industries), like School Section Lake, the principal routes for pollutant loadings are: 1) precipitation which falls directly onto the lake's surface; and 2) nonpoint source runoff from the watershed.[43] For this reason, the loading calculations and discussions that follow focus on nonpoint source pollutant loadings to the Lake, which include: urban sources including runoff from residential, commercial, industrial, transportation and recreational land uses; and rural sources including runoff from agricultural lands, wetlands, woodlands and surface water.

All of the calculations for nonpoint sourced phosphorus, suspended solids, and urban-derived metal inputs to School Section Lake were estimated using the Wisconsin Lake Model Spreadsheet (WiLMS version 3.0),[44] and the unit area load-based (UAL) models developed for use within the Southeastern Wisconsin Region. These two models operate on the general principal that, depending on land use (agricultural, residential, etc.), a given surface area of land within a lake's watershed will deliver a typical mass of pollutants to the lake. Values predicted by these two models can then be used to compute in-lake phosphorus concentrations that can be compared to those

[43]*Sven-Olof Ryding,* et al., op. cit.*; Jeffrey A. Thornton,* et al., op. cit.

[44]*John C. Panuska and Jeff C. Kreider, Wisconsin Department of Natural Resources Publication No. PUBL-WR-363-94,* Wisconsin Lake Modeling Suite Program Documentation and User's Manual, Version 3.3 for Windows, *August 2002.*

Table A-10

MAGNESIUM CONCENTRATIONS IN SCHOOL SECTION LAKE: 2000-2013

Date	Deep Hole (mg/l)
08/21/13	36.7
08/10/05	37.7
08/04/04	37.4
08/11/03	35.4
10/01/01	36.4
08/08/01	35.5
08/28/00	33.0
Overall	35.9

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

values actually observed at monitoring stations in a lake, when such data is available. This comparison serves two purposes: 1) the identification of potential water quality issues of concern, and 2) the indication of potential sources of water pollution not accounted for on the basis of land use.[45]

Phosphorus Loadings

Table A-13 sets forth the year 2010 phosphorus loads to School Section Lake from its watershed which were estimated using land use inventory data set forth in the regional land use plan.[46] Under year 2010 conditions, the total estimated phosphorus load to School Section Lake from its watershed was about 1,356 pounds. Of the annual total phosphorus load, it was estimated that 1,249 pounds per year, or about 92 percent of the total loading, were contributed by runoff from rural lands, mostly from agricultural uses, and about 107 pounds per year, or about 8 percent, were contributed by runoff from urban lands, mostly from residential sources.

Table A-13 also shows the estimated phosphorus loads to School Section Lake from its watershed under planned year 2035 conditions.[47] As a result of anticipated land use changes expected to occur through 2035, the annual total phosphorus load to the Lake is estimated to diminish as agricultural activities within the School Section Lake watershed are replaced by urban residential land uses. The annual total phosphorus load to the Lake under the planned conditions is estimated to be 1,128 pounds. Of the total annual planned condition phosphorus load, about 958 pounds per year, or about 85 percent of the total loading, are estimated to be contributed by runoff from rural land, and about 169 pounds per year, or about 15 percent of the total loading, are estimated to be contributed by runoff from urban land. Thus, it may be anticipated that from 2010 to 2035, not only will the total amount of the phosphorus load decrease, but the phosphorus load sources to the Lake may change. The amount of phosphorus being contributed from urban sources, for example, will nearly double from about 8 percent of the total in 2000 to about 15 percent of the total in 2035, while the amount of phosphorus from agricultural sources will decrease from about 92 percent of the total in 2000 to about 85 percent of the total in 2035.

In-Lake Phosphorus Concentration Predictors

Using the estimated phosphorus load and the hydrographical characteristics of the Lake as inputs to the Organization for Economic Cooperation and Development (OECD) phosphorus loading model,[48] in-lake surface

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[45]*The forecast total phosphorus load to a lake, generated through the WiLMS and UAL models, allows calculation of the likely in-lake average annual total phosphorus concentration which can be compared with the observed values reported in the USGS TSI or Level 2 CLMN datasets. Significant differences between forecast and observed values generally indicates the presence of an unidentified source; occasionally, such a difference can be ascribed to the fact that a lake may fall outside the range of typical lakes used to derive the mathematical relationships used in the WiLMS and UAL models.*

[46]*SEWRPC Planning Report No. 48,* op. cit.

[47]Ibid.

[48]*Organization for Economic Cooperation and Development,* Eutrophication of Waters: Monitoring, Assessment and Control*, OECD, 1982.*

Table A-11

SODIUM CONCENTRATIONS IN SCHOOL SECTION LAKE: 1979-1980

Date	Surface: 0 to 1 Feet (mg/l)	Deep: 8 to 10 Feet (mg/l)	Inlet (mg/l)
04/17/80	4	4	4
03/14/80	4	5	3
11/09/79	4	- -	4
09/05/79	4	- -	4
04/26/79	3	3	3
Overall	3.8	4.0	3.6

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

Table A-12

POTASSIUM CONCENTRATIONS IN SCHOOL SECTION LAKE: 1979-1980

Date	Surface: 0 to 1 Feet (mg/l)	Deep: 8 to 10 Feet (mg/l)	Inlet (mg/l)
04/17/80	1.7	1.7	1.4
03/14/80	1.7	1.9	1.1
11/09/79	1.9	- -	1.7
09/05/79	1.3	- -	1.5
04/26/79	1.7	1.7	1.7
Overall	1.7	1.8	1.5

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

water total phosphorus concentration can be estimated. The results of this model predicted an in-lake value of about 0.0742 mg/l for 2010, which is above the average value of 0.0615 μg/l actually observed in School Section Lake during 2010. This disagreement, albeit relatively small in this case, between predicted and observed values suggests that either the phosphorus loads entering the School Section Lake system are being reduced through natural filtering processes (e.g. through the wetlands upstream of School Section Lake), or that conservation methods aimed at reducing phosphorous loads within the watershed are working. Given that there have not been reported targeted efforts at nutrient loading reduction within the School Section Lake watershed, the former of these options is more likely.

Comparison to Regional Water Quality Management Plan

Based on historic in-lake total phosphorus values and in anticipation of increased urban development in the School Section Lake watershed, the regional water quality management plan[49] originally estimated that no reduction in nonpoint source pollutant runoff would be required to satisfy then-planned year 2000 water quality standards. However, in the intervening years since that plan, total phosphorus levels in the Lake have increased significantly above the 0.02 mg/l threshold established by SEWRPC for full, unimpaired warmwater recreational activities. In fact, as previously mentioned, the WDNR has currently proposed that School Section Lake be added to the Wisconsin Impaired Waters list. This unanticipated rise in total phosphorous levels was likely because the

[49]*SEWRPC Planning Report No. 30, Volume Two*, op. cit.

Table A-13

ESTIMATED ANNUAL POLLUTANT LOADINGS BY LAND USE CATEGORY WITHIN THE AREA TRIBUTARY TO SCHOOL SECTION LAKE: 2010 AND 2035

Land Use Category	Pollutant Loads: 2010			
	Sediment (tons/year)	Phosphorus (pounds/year)	Copper (pounds/year)	Zinc (pounds/year)
Urban				
Residential[a]	2.1	58.1	0.8	7.7
Commercial	0.8	2.4	0.4	3.0
Industrial	- -	- -	- -	- -
Governmental	- -	- -	- -	- -
Transportation	5.3	10.6	23.0	82.6
Recreational	1.6	35.4	- -	- -
Subtotal	9.8	106.5	24.2	93.3
Rural				
Agricultural	308.7	1,179.9	- -	- -
Wetlands	1.9	40.1	- -	- -
Woodlands	0.9	19.0	- -	- -
Water	7.3	10.1	- -	- -
Subtotal	318.8	1,249.1	- -	- -
Total	328.6	1,355.6	24.2	93.3

Land Use Category	Pollutant Loads: 2035			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential[a]	6.9	111.8	0.8	10.4
Commercial	0.8	2.4	0.4	3.0
Industrial	- -	- -	- -	- -
Governmental	- -	- -	- -	- -
Transportation	8.6	17.2	37.4	134.2
Recreational	1.7	37.8	- -	- -
Subtotal	18.0	169.2	38.6	147.6
Rural				
Agricultural	232.7	889.2	- -	- -
Wetlands	1.9	40.1	- -	- -
Woodlands	0.9	19.0	- -	- -
Water	7.3	10.1	- -	- -
Subtotal	242.8	958.4	- -	- -
Total	260.8	1,127.6	38.6	147.6

NOTE: For purposes of determining the impact of the above pollutants on School Section Lake, quantitative comparisons should not be made across columns, i.e., 0.4 pound per year of copper is not comparable to 0.4 pound per year of zinc or phosphorus or sediment in terms of the harmful effects on the Lake.

Source: SEWRPC.

regional water quality management plan only took into account runoff that entered the Lake directly, i.e., from the shorelines, rather than incorporating phosphorous loading that enter the Lake through its tributary and subsequently, its larger watershed.

Sediment Loadings

The estimated sediment loadings to School Section Lake from its watershed under existing year 2000 and planned year 2035 conditions and as set forth in the adopted regional land use plan[50] are shown in Table A-13. A total annual sediment loading of 329 tons was estimated to be contributed to School Section Lake from its watershed under year 2000 conditions, as shown in Table A-13. Of the likely annual sediment load, it was estimated that 319 tons per year, or about 97 percent of the total loading, were contributed by runoff from rural lands, mostly from agricultural sources, and 10 tons, or 3 percent, were contributed by urban lands.

Under 2035 conditions, the annual sediment load to the Lake from its watershed is anticipated to diminish. The annual sediment load to the Lake under 2035 land use conditions is estimated to be 261 tons. Of this forecast sediment load anticipated for School Section Lake, 243 tons of sediments are estimated to be contributed to the Lake from rural sources and 18 tons from urban sources.

It is important to note that even though these loading calculations are predicted using the land use in the watershed, they do not take into account the ability of the watershed to trap sediments prior to entering the Lake. Given the fact that past sediment studies[51] have documented that erosional deposits are not entering the Lake at a large scale, and given the lack of steep slopes in the area, it is likely that much of these sediment loads are actually depositing in the upstream wetland, as opposed to the Lake itself. However, some in-field investigation of this may be necessary in order to confirm this finding.

Urban Heavy Metals Loadings

Urbanization brings with it increased use of metals and other materials that contribute pollutants to aquatic systems.[52] The majority of these metals become associated with sediment particles,[53] and are, consequently, likely to be encapsulated into the bottom sediments of a lake.

The estimated loadings of copper and zinc contributed to School Section Lake from its watershed under existing year 2000 land use conditions and forecast year 2035 conditions are shown in Table A-13. Under year 2000 land use conditions, 24 pounds of copper and 93 pounds of zinc were estimated to be contributed annually to School Section Lake, all from urban lands. Under planned year 2035 conditions, as set forth in the adopted regional land use plan,[54] the annual heavy metal loads to the Lake are anticipated to increase to about 39 pounds of copper and 148 pounds of zinc per year.

Management Implications of Loadings Calculations

Since the in-lake phosphorous concentration model calculations were so close to observed values within the Lake, Table A-13 should be used as a guideline for where to target phosphorous load reduction efforts. Agriculture, for

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[50]*SEWRPC Planning Report No. 48,* op. cit.

[51]*Aqua-Tech, Inc.,* School Section Lake, Inland Feasibility Study, *1979-1980; and Wisconsin Department of Natural Resources,* School Section Lake, Waukesha County, Feasibility Study Results*, 1981.*

[52]*Jeffrey A. Thornton, et al.,* op. cit.

[53]*Werner Stumm and James J. Morgan,* Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters, *Wiley-Interscience, New York, 1970.*

[54]*SEWRPC Planning Report No. 48,* op. cit.

example, is the largest contributor of phosphorous and sediment loads, therefore, phosphorous control measures should focus on agricultural areas (as can be located on Map A-12). Similarly, though heavy metals are not currently measured in the Lake, it can be seen that an increase in residential and industrial development will cause an increase in heavy metals inputs to the Lake. Therefore, stormwater management efforts within urban areas should be considered a priority if further development occurs within the watershed.

TROPHIC STATUS

Lakes are commonly classified according to their degree of nutrient enrichment, or trophic status. The ability of lakes to support a variety of recreational activities and healthy fish and other aquatic life communities is often correlated to the degree of nutrient enrichment that has occurred. There are three terms generally used to describe the trophic status of a lake: oligotrophic, mesotrophic, and eutrophic.

Oligotrophic lakes are nutrient-poor lakes. These lakes characteristically support relatively few aquatic plants and often do not contain very productive fisheries. Oligotrophic lakes may provide excellent opportunities for swimming, boating, and waterskiing. Because of the Region's naturally fertile soils and the intensive land use activities, there are relatively few oligotrophic lakes in southeastern Wisconsin.

Mesotrophic lakes are moderately fertile lakes that may support abundant aquatic plant growths and productive fisheries. However, nuisance growths of algae and macrophytes are usually not exhibited by mesotrophic lakes. These lakes may provide opportunities for all types of recreational activities, including boating, swimming, fishing, and waterskiing. Many lakes in southeastern Wisconsin are mesotrophic.

Eutrophic lakes are nutrient-rich lakes. These lakes often exhibit excessive aquatic macrophyte growths and/or experience frequent algae blooms. If the lakes are shallow, fish winterkills may be common. While portions of such lakes are not ideal for swimming and boating, eutrophic lakes may support very productive fisheries. Although some eutrophic lakes are present in the Region, highly eutrophic lakes are rare, especially since the implementation of recommendations put forth under the regional water quality management plan. Highly enriched lakes are sometimes referred to as being hypertrophic.

Several numeric "scales," based on one or more water quality indicators (usually Secchi-disk measurements, total phosphorus, and/or chlorophyll-*a* levels), have been developed to define the trophic condition of a lake. Because trophic state is actually a continuum from very nutrient poor to very nutrient rich, a numeric scale is useful for comparing lakes and for evaluating trends in water quality conditions. Care must be taken, however, that the particular scale used is appropriate for the lake to which it is applies. In this case, two indices appropriate for Wisconsin lakes have been used; namely, the Vollenweider-OECD open-boundary trophic classification system,[55] and the Wisconsin Trophic State Index value (WTSI).[56] The WTSI is a refinement of the Carlson TSI,[57] and is designed to account for the greater humic acid content, brown water color, present in Wisconsin lakes, and has been adopted by the WDNR for use in lake management investigations.

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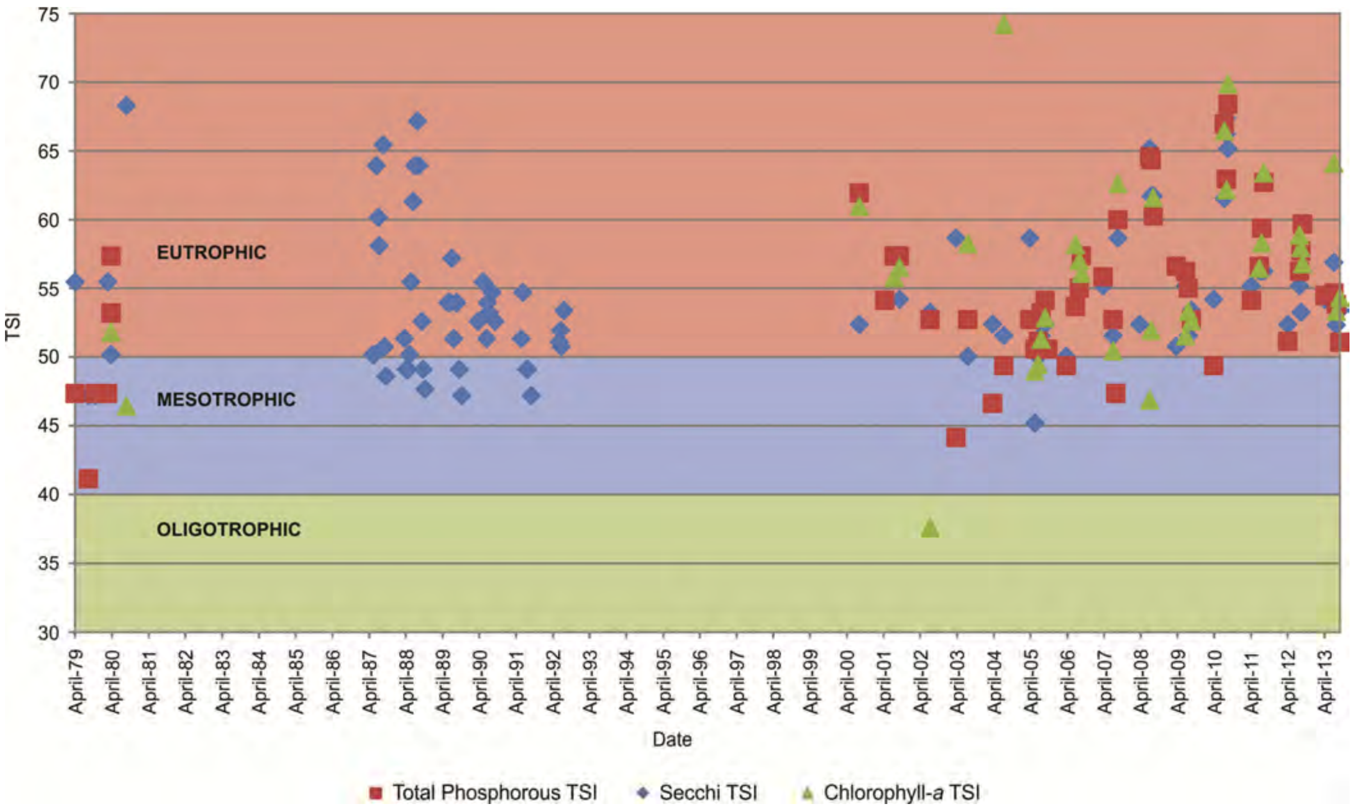
[55] *H. Olem and G. Flock, U.S. Environmental Protection Agency Report EPA-440/4-90-006,* The Lake and Reservoir Restoration Guidance Manual, *2nd Edition, Walworth, D.C., August 1990.*

[56] *See R.A. Lillie, S. Graham, and P. Rasmussen, "Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes,"* Research and Management Findings, *Wisconsin Department of Natural Resources Publication No. PUBL-RS-735 93, May 1993.*

[57] *R.E. Carlson, "A Trophic State Index for Lakes,"* Limnology and Oceanography, *Vol. 22, No. 2, 1977.*

Figure A-15

WTSI VALUES FOR SCHOOL SECTION LAKE: 1979-2013



Source: SEWRPC.

WTSI numeric scales are based, over time, on average total phosphorus and chlorophyll-*a* levels and Secchi-disk depths in Wisconsin. Using the WTSI numeric scales, lakes with WTSI values in the range of 30 to 40 would be considered oligotrophic, values in the 40 to 50 range would be mesotrophic, and values above 50 would be considered eutrophic. Figure A-15 shows WTSI values for School Section Lake based on measurements of water clarity (Secchi disk), total phosphorus and chlorophyll-*a* for the period from 1977 through 2013. Although there are some gaps in the data during this time, in general, the figure indicates that School Section Lake would be considered a eutrophic waterbody. This is not an uncommon condition observed in many lakes in southeastern Wisconsin, indeed, as was cited in the aforementioned Lillie and Mason study, “The generally high trophic status of the Southeastern Wisconsin Region lakes was quite apparent as 47 percent of the Region’s lakes were identified as green in appearance.”[58]

AQUATIC PLANTS

Aquatic plants include larger plants, or macrophytes, and microscopic algae, or phytoplankton. These plants form an integral part of the aquatic food web, converting inorganic nutrients present in the water and sediments into organic compounds that are directly available as food to other aquatic organisms. In this process, known as photosynthesis, plants utilize energy from sunlight and release the oxygen, required by many other aquatic life

[58]*SEWRPC Memorandum Report No. 93*, op. cit.

forms, into the water. Aquatic plants also serve a number of other valuable functions in a lake ecosystem, including: improving water quality by filtering excess nutrients from the water; providing habitat for invertebrates and fish, stabilizing lake bottom substrates, and supplying food for waterfowl and various lake-dwelling animals.

Aquatic plants are often described using the terms *submerged*, *floating*, and *emergent*, depending on where the plant is found in the lake ecosystem. *Submerged* plants are found in the main lake basin and, although most are rooted in the bottom substrate, some forms, such as coontail (*Ceratophylum demersum*) are free-floating. *Floating* plants, such as water lilies, generally have large, floating leaves and are usually found in shallow water areas of a few feet in depth or less that contain loose bottom sediments. Floating plants may also be either rooted (water lily) or free-floating (duckweed, *Lemna* spp.). *Emergent* plants are those that grow along the shoreline areas of a lake, such as the bulrushes and cattails. All three types have significant roles to play in the overall working of a lake's ecosystem.

Aquatic Plant Surveys

To document the types, distribution, and relative abundance of aquatic macrophytes in School Section Lake during the current study period, an aquatic plant survey was conducted by SEWRPC staff during the summer of 2012. This survey utilized a point intercept methodology[59] in which predetermined GPS points arranged in a grid pattern across the entire lake surface are used as sampling sites. The staff located each point using global positioning system (GPS) technology. At each sampling site, a single rake haul is taken and a quantitative assessment of the rake fullness, on a scale of zero to three, is made for each species identified. Map A-18 shows the locations of the survey sampling sites on School Section Lake, as well as pictorial representations of the relative rake fullness amounts used to determine the quantitative assessments. Of the 173 sites sampled in School Section Lake, 137 sites had vegetation.

A list of aquatic plant species observed during the 2012 survey of School Section Lake, along with various statistical parameters describing the abundance factors of those plants, is presented in Table A-14. Individual species maps showing the relative abundances and distributions of each species in School Section Lake, along with comments regarding the ecological significance of each plant, how to identify it and a photograph of it, can be found in Appendix B. It should also be noted that the dominance value for bulrush, white water lily, and spatterdock may be underestimated in the 2012 study due to several sites not being sampled because of the high density of bulrushes and inadequate water depth.

Aquatic Plant Diversity in School Section Lake

A key aspect of the ability of an ecosystem, such as a lake, to maintain its ecological integrity is through "biological diversity," or "species richness." Overall, with 23 (21 native; 2 nonnative) different submerged, emergent and floating species of aquatic plants identified in the 2012 survey, School Section Lake contains a very good diversity of aquatic species, especially for a lake of its size. By way of comparison, nearby Pretty Lake contained 14 (12 native; two nonnative) species of submersed aquatic plants in a 2005 survey[60] and Hunters Lake contained 13 (11 native; two nonnative) species of submersed, floating, and emergent species in a 1997 survey.[61]

Map A-18 also shows degrees of biodiversity, or *species richness*, as it applies to native plant species found in School Section Lake during the 2012 survey. In general, areas of greatest species richness in the Lake are along the northern shoreline and in the southern part of the main Lake basin.

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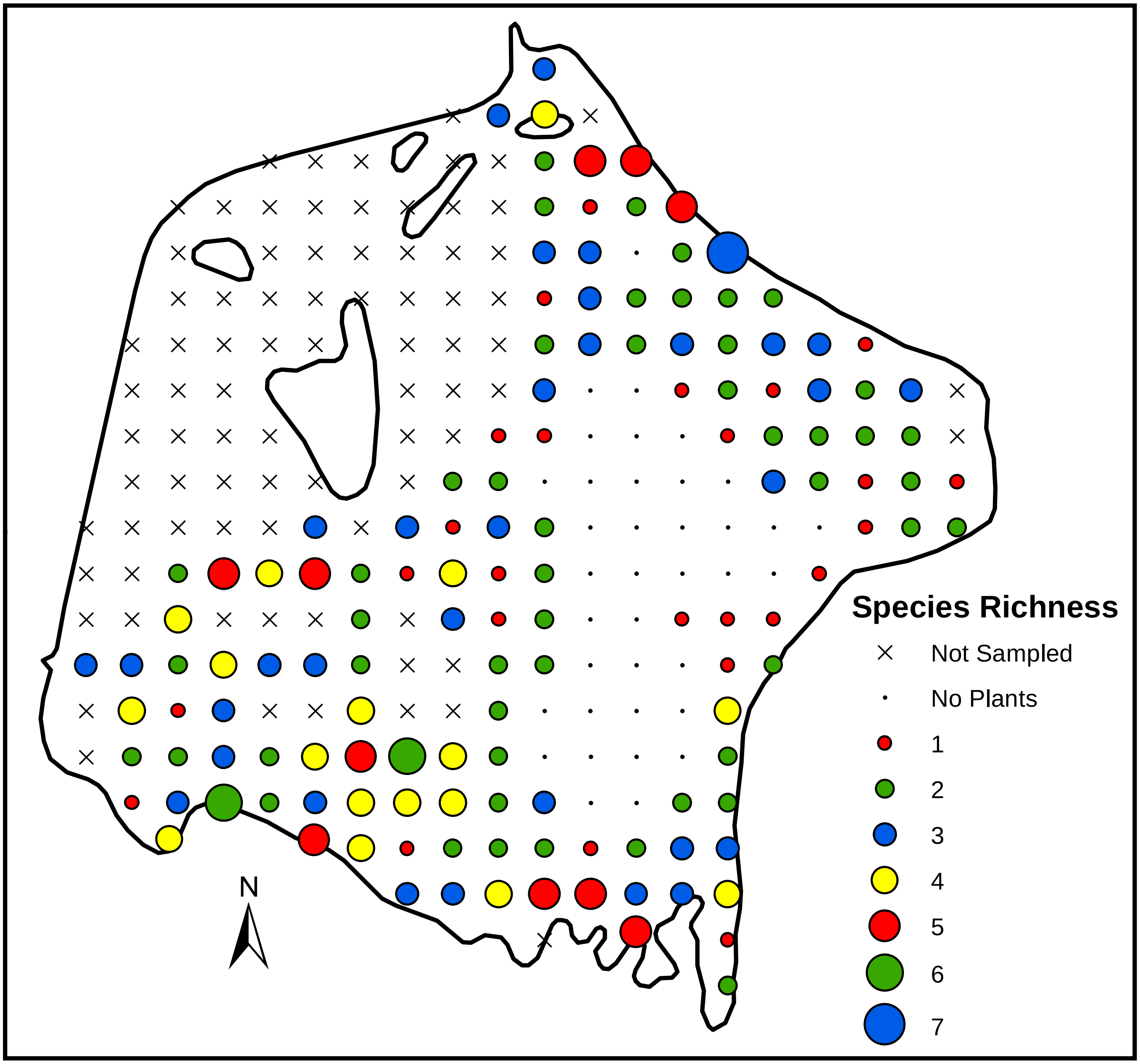
[59]*Wisconsin Department of Natural Resources, Publication No. PUB-SS-1068 2010,* Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry and Analysis, and Applications, *2010.*

[60]*SEWRPC Memorandum Report No. 122*, op. cit.

[61]*SEWRPC Memorandum Report No. 120*, op. cit.

Map A-18

AQUATIC PLANT SURVEY SITES AND SPECIES RICHNESS IN SCHOOL SECTION LAKE: 2012



NOTE: The above diagram presents the data for number of species observed in School Section Lake at each sampling site during the 2012 aquatic plant survey; sampling occurred at 173 sampling sites, 137 had vegetation.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table A-14

ABUNDANCE DATA FOR AQUATIC PLANT SPECIES IN SCHOOL SECTION LAKE: 2012

Aquatic Plant Species[a]	Native or Invasive	Number of Sites Found	Dominance Value[b]
Floating Plants			
Nymphaea odorata (white water lily)[c]	Native	26	80.3
Nuphar variegate (spatterdock) [c]	Native	8	17.5
Emergent Plants			
Scirpus terminalis (water bulrush)[c]	Native	15	44.3
Chara spp. (muskgrass)	Native	91	291.2
Submergent Plants			
Myriophyllum spicatum (Eurasian water milfoil)	Invasive	58	123.4
Ceratophyllum demersum (coontail)	Native	49	113.9
Utricularia spp. (Bladderwort)	Native	43	78.1
Vallisneria americana (eel-grass)	Native	30	73.0
Stuckenia pectinata (Sago pondweed)	Native	25	41.6
Potamogeton gramineus (variable pondweed)	Native	10	23.4
Potamogeton natans (floating-leaf pondweed)	Native	9	18.3
Najas marina (spiny, or brittle, naiad)	Invasive	10	17.5
Myriophyllum sibiricum (native milfoil)	Native	11	16.0
Nitella spp. (Nitella)	Native	7	16.0
Najas flexilis (bushy pondweed)	Native	8	11.0
Potamogeton nodosus (long-leaf pondweed)	Native	3	9.5
Potamogeton crispus (curly-leaf pondweed)	Invasive	5	7.3
Zosterella dubia (water stargrass)	Native	2	4.4
Elodea canadensis (waterweed)	Native	3	2.9
Potamogeton illinoensis (Illinois pondweed)	Native	2	2.9
Ranunculus longirostris (white-water crowfoot)	Native	1	2.9
Potamogeton praelongus (white-stem pondweed)	Native	2	2.2
Potamogeton richardsonii (clasping-leaf pondweed)	Native	1	1.5

NOTE: Sampling occurred at 173 sampling sites; 137 sites had vegetation. Also, in surveys prior to 2012, *Nuphar variegate* (spatterdock) is labelled as *Nuphar advena* (yellow water lily), considered by SEWRPC botanists to likely be a misidentification; likewise, *Nuphar odorata* has been re-identified as *Nymphaea odorata.*

[a]*Listed within groups in descending order of dominance.*

[b]*The* ***dominance value*** *of a species is derived from a combination of how often it was observed at sampling sites that had some kind of vegetation present and it's relative density at those sites; it provides an indication of the dominance of a species within a community.*

[c] *Abundance of these plant is likely underestimated due to the high density of bulrushes and inadequate water depth making it not possible to survey several sample sites.*

Source: SEWRPC.

Dominant Aquatic Plants in School Section Lake

As shown in Table A-14, during the 2012 survey, 21 different native aquatic plant species were observed in School Section Lake. The overall most dominant species in the Lake, as determined by the "importance value" (see Table A-14) of each species, was muskgrass (*Chara* spp.). Eurasian water milfoil (*Myriophyllum spicatum*), a nonnative plant, and coontail (*Ceratophyllum demersum*), were also present in significant numbers. As explained above, informative distribution maps for these species are located in Appendix B.

Other Aquatic Plant Species of Special Significance in School Section Lake

Native Plants

Aquatic plants, in much the same way as their terrestrial counterparts, do not live in isolation, but in community with one another. They develop complex interactions and mutual dependencies that are of great significance in how these dynamic communities function within a lake. *Native* aquatic plant species are specifically adapted to local aquatic environments and many kinds of wildlife depend on the presence of specific plant species for survival. Of the 23 aquatic plants found in School Section Lake, 21 of them were native.

Pondweeds

The presence of native pondweeds is generally considered to be indicative of a healthy lake and good habitat for fishes and aquatic life. Pondweeds, as a group, tend to occur at very specific times during the year; hence, though pondweeds may not be present when the plant survey is conducted they may still be present within the aquatic plant community. Pondweeds provide good habitat and serve as food and shelter for a variety of aquatic organisms and waterfowl. The 2012 survey identified eight native pondweed species in School Section Lake. Additionally, though not found in this survey, an additionally species, Spotted pondweed, was found by WDNR in 2006.

Of the pondweeds that occur in the Region, white-stem pondweed (*Potamogeton praelongus*) is of special importance because of its sensitivity to changes in water quality and intolerance of turbidity. It is considered a valuable water quality indicator species, since its disappearance from a lake is usually an indication of deteriorating water quality. Conversely, its presence in a lake is usually an indicator of good water quality.[62] Of the 137 sampling sites that contained vegetation, only two sites contained white-stem pondweed. This species should be given special attention in future aquatic plant surveys in School Section Lake to determine if its population is increasing or decreasing.

Aquatic Invasive Species (AIS)

The introduction of nonnative (invasive) plant and animal species into an area can cause great disruption to both terrestrial and aquatic natural systems. This is because many invasive species have no natural predators to keep their numbers in control and often reproduce explosively, outcompeting native species for necessary resources. This can have devastating effects on native wildlife species that have developed dependencies on the availability of specific native plants. The most common and destructive invasive species in Wisconsin Lakes are Eurasian water milfoil and Curly-leaf pondweed,

Two invasive species of aquatic plants, Eurasian water milfoil and curly-leaf pondweed, were found in School Section Lake. Both of these species are declared nuisance species identified in Chapters NR 40 and NR 109 of the *Wisconsin Administrative Code.*

Eurasian Water Milfoil

Eurasian water milfoil is one of eight milfoil species found in Wisconsin and the only one known to be exotic or nonnative. As mentioned above, because of its nonnative nature, Eurasian water milfoil has few natural enemies that can inhibit its growth, which can be explosive under suitable conditions. The plant exhibits this characteristic growth pattern in lakes with organic-rich sediments, or where the lake bottom has been disturbed, e.g., it frequently has been reported as a colonizing species following dredging. Unless its growth is anticipated and controlled, Eurasian water milfoil can displace native plant species and interfere with the aesthetic and recreational use of waterbodies, as was evidenced by the overgrowth that occurred in School Section Lake over the past decade. This plant has also been known to cause severe recreational use problems in lakes within the Southeastern Wisconsin Region.

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[62] *Wisconsin Lakes Partnership,* Through the Looking Glass...A Field Guide to Aquatic Plants, *University of Wisconsin-Extension.*

Eurasian water milfoil reproduces by the rooting of plant fragments. Consequently, some recreational uses of lakes can result in the expansion of Eurasian water milfoil communities. For example, when boat propellers fragment Eurasian water milfoil plants, these fragments, as well as fragments that occur for other reasons, such as wind-induced turbulence or fragmentation of the plant by fishes, are able to generate new root systems, allowing the plant to colonize new sites. The fragments also can cling to boats, trailers, motors, and/or bait buckets, and can stay alive for weeks contributing to the transfer of milfoil to other lakes. For this reason, it is very important to remove all vegetation from boats, trailers, and other equipment after removing them from the water and prior to launching in other waterbodies.

Of the 137 sampling sites in School Section Lake that contained vegetation, Eurasian water milfoil was found in 58 sites, or 42 percent. Map A-19 shows the distribution and relative densities of Eurasian water milfoil infestations around School Section Lake in 2012. This map can be used for aquatic plant management purposes until the next survey is performed.

Aquatic plant surveys were also performed in 2004 and 2011 by Aron and Associates and WDNR, respectively. The occurrence of Eurasian water milfoil for these surveys is presented in Maps A-20 and A-21 for the purpose of making comparisons. In 2004, this species seemed to have been somewhat more widespread in the Lake in comparison to recent surveys. The diminishing abundance of this species is particularly apparent along the east shoreline of the Lake, where the plant was abundant in 2004 and nearly nonexistent in 2011 and 2012. Other areas of the Lake where the plant was observed in 2004, namely along the northern shore, down the center of the Lake and in much of the southern portion of the Lake basin, still contained the bulk of this species' population in the Lake. Future aquatic plant surveys in School Section Lake will be necessary to monitor whether this species in increasing or decreasing in abundance.

Curly-Leaf Pondweed

Curly-leaf pondweed thrives in cool water and exhibits a peculiar split-season growth cycle that helps give it a competitive advantage over native plants and makes management of this species difficult. In late summer, the plant produces specialized over-wintering structures, or "turions." In late summer, the main body of the plant dies off and drops to the bottom, where the turions lie dormant until the cooler fall water temperatures trigger the turions to germinate. Over the winter, the turions produce winter foliage that thrives under the ice. In spring, when water temperatures begin to rise again, the plant has a head start on the growth of native plants and quickly grows to full size, producing flowers and fruit earlier than its native competitors. Because it can grow in more turbid waters than many native plants, protecting or improving water quality is an effective method of control of this species, as clearer waters in a lake can help native plants compete more effectively.

Curly-leaf pondweed has been observed in aquatic plant surveys in School Section Lake since 1994, although in relatively small numbers. Map A-22 shows the locations of the sampling points that contained curly-leaf pondweed during the 2012 survey. As can be seen from the map, this species' greatest concentration in School Section Lake is in the northeast bay in the vicinity of the Lake inlet stream.

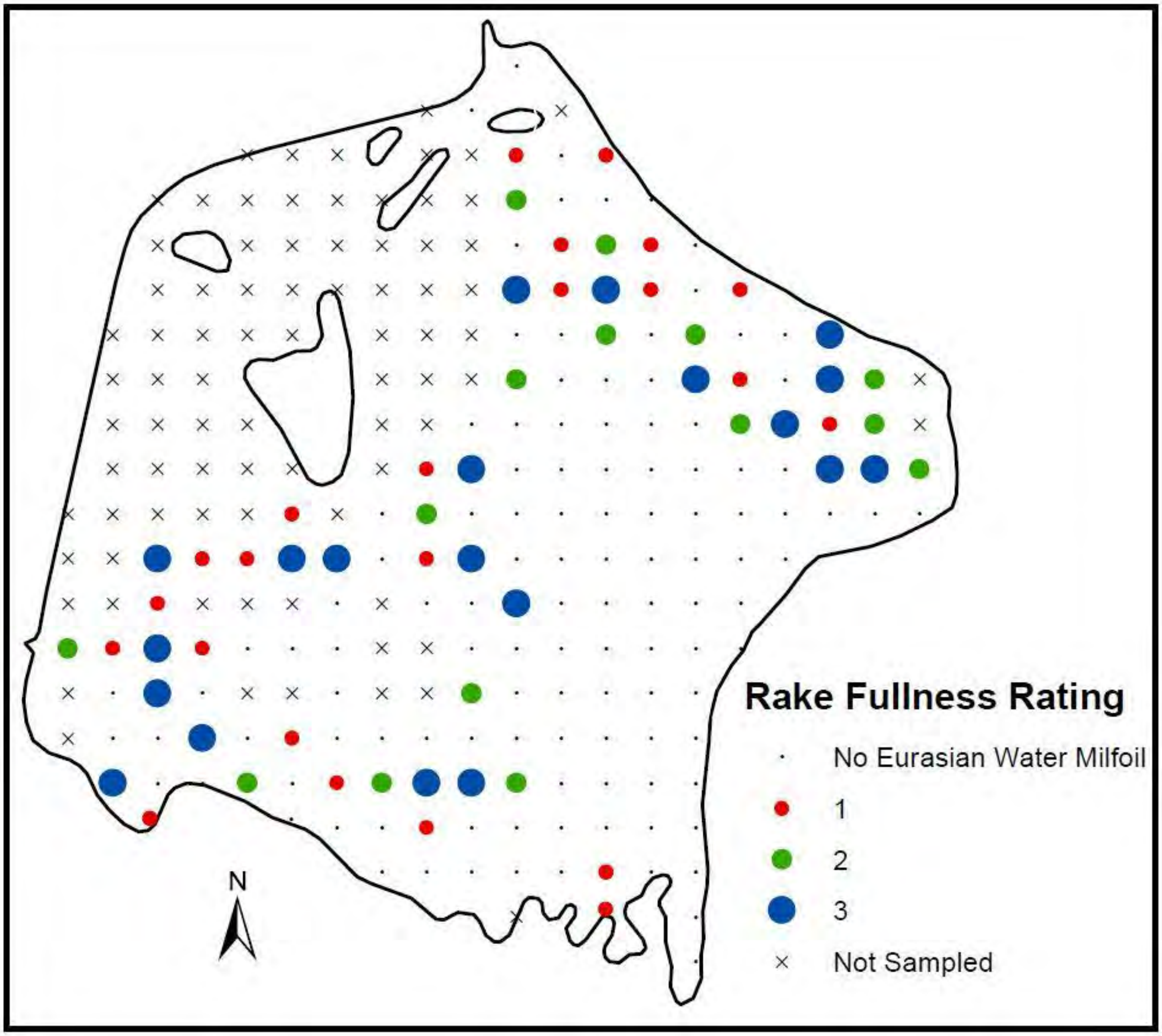
The species distribution map for curly-leaf pondweed in 2011 (see Map A-23) show a distribution similar to that found in 2012 (see Map A-22), although it does show its occurrence over a larger portion of the Lake. This somewhat "wider" distribution may however be influenced by a variety of factors, e.g., time of year the survey was taken, annual weather, etc., and is not necessarily an indication of a sudden great increase in the population of this plant. As with Eurasian water milfoil, future aquatic plant surveys in School Section Lake will be necessary to monitor whether this species in increasing or decreasing in abundance.

Changes in the Aquatic Plant Communities in School Section Lake

Aquatic plant communities do undergo cyclical and periodic changes which reflect, in part, changing climatic conditions on an interannual scale and, in part, the evolution of the aquatic plant community in response to long-term changes in a lake's "hydroclimate." These latter changes include factors such as long-term trends in nutrient

Map A-19

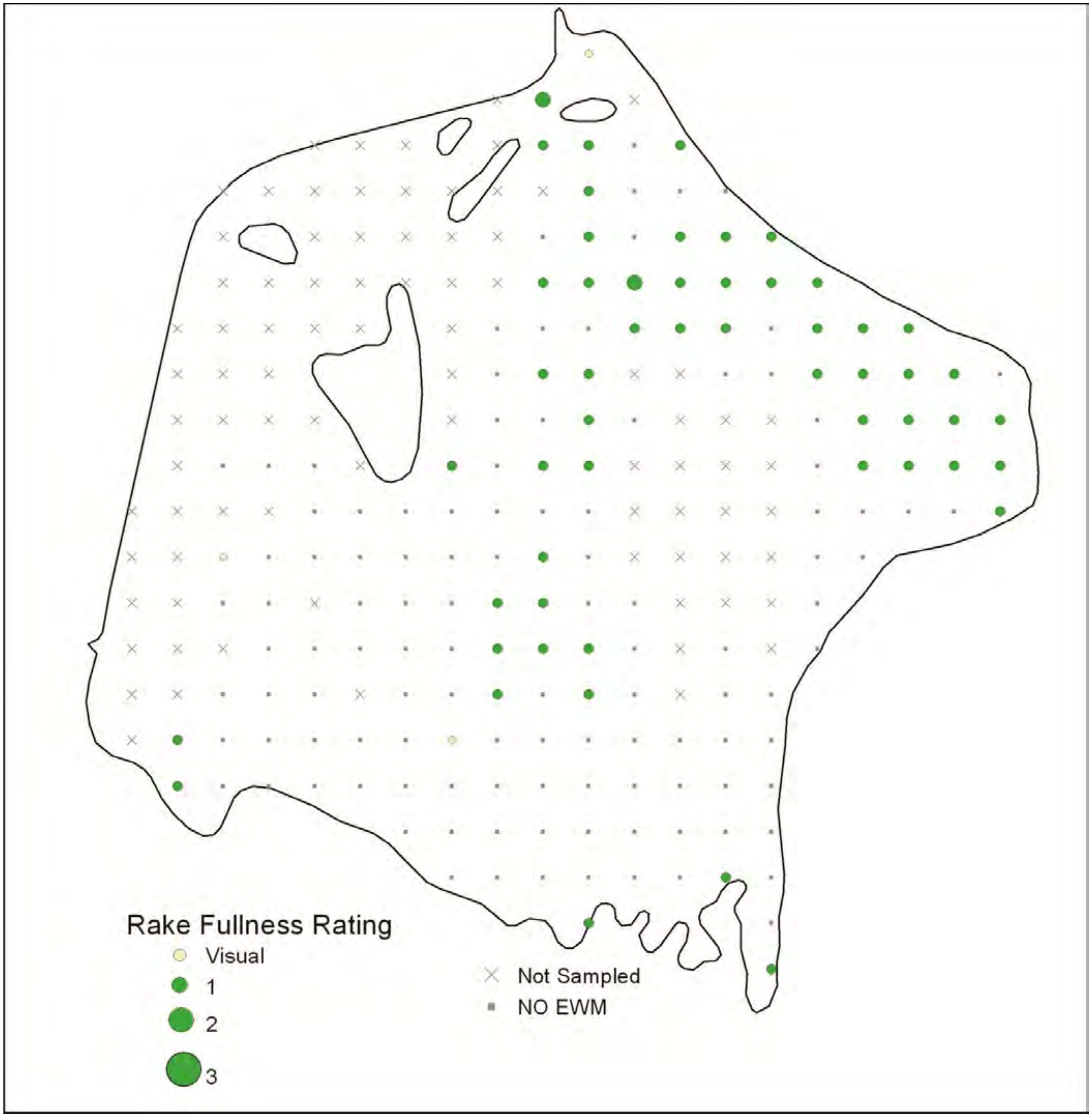
DISTRIBUTION AND ABUNDANCE OF EURASIAN WATER MILFOIL IN SCHOOL SECTION LAKE: 2012



Source: SEWRPC.

Map A-20

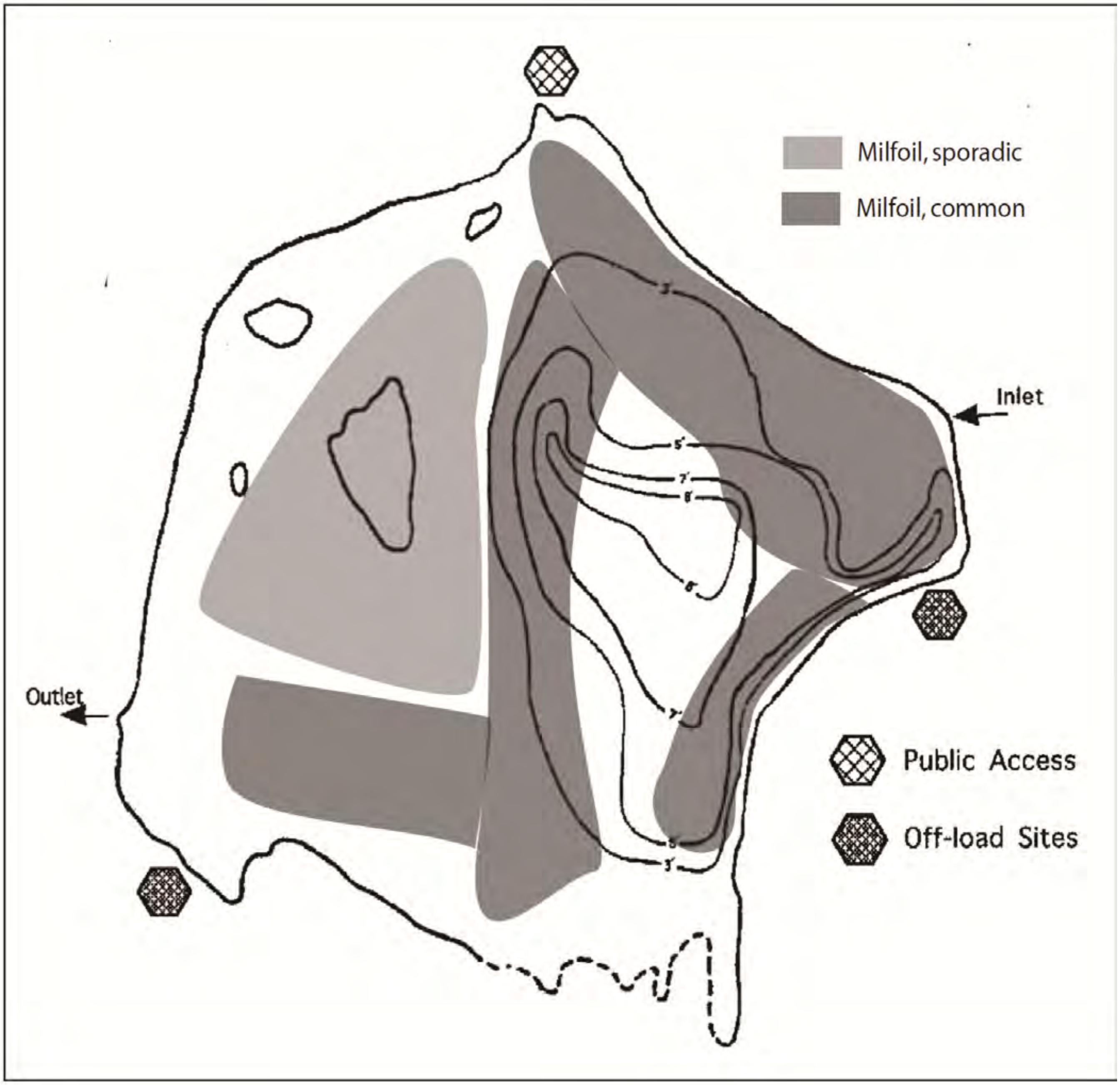
DISTRIBUTION AND ABUNDANCE OF EURASIAN WATER MILFOIL IN SCHOOL SECTION LAKE: 2011



Source: Wisconsin Department of Natural Resources.

Map A-21

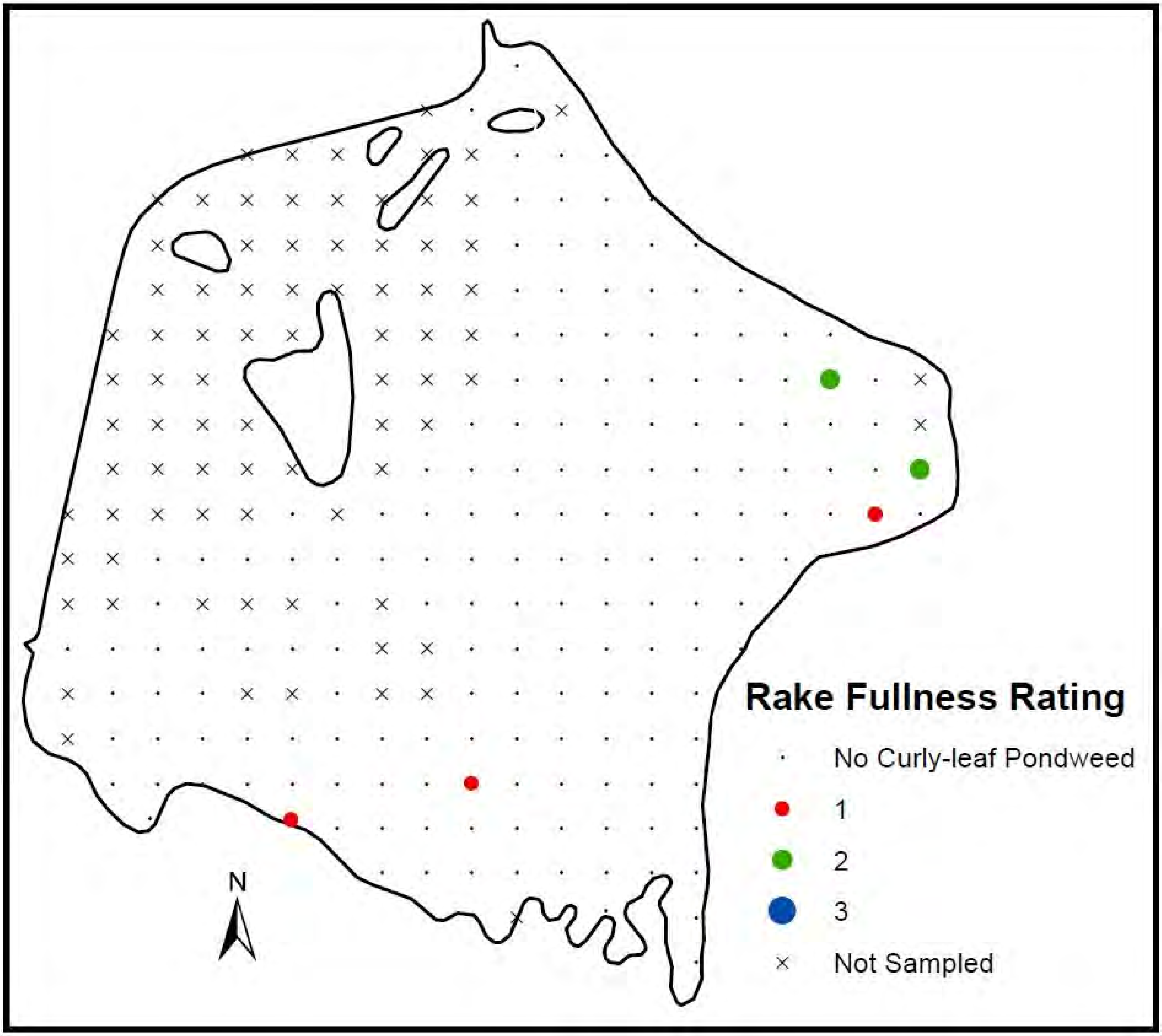
DISTRIBUTION AND ABUNDANCE OF EURASIAN WATER MILFOIL IN SCHOOL SECTION LAKE: 2004



Source: Aron & Associates.

Map A-22

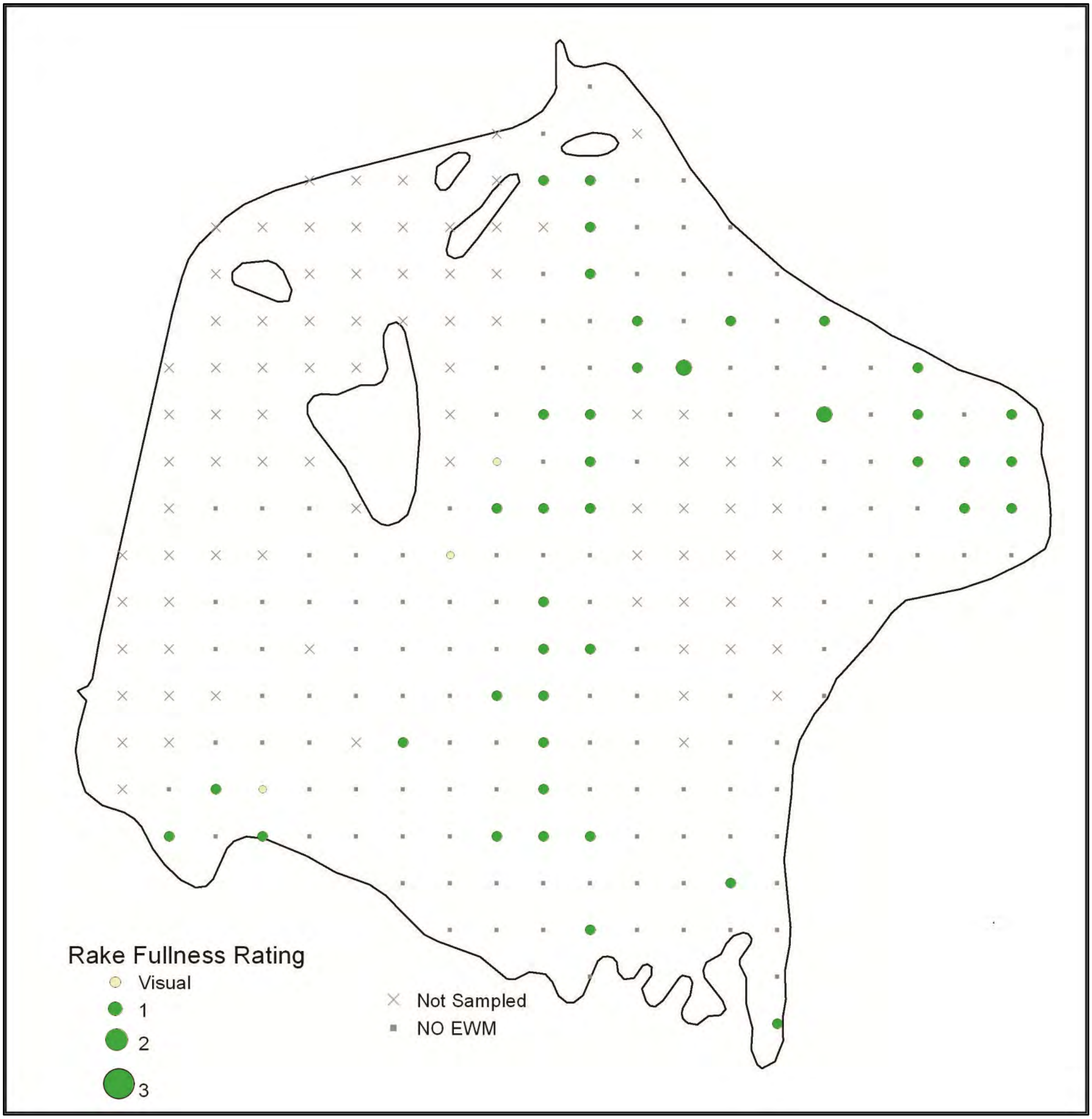
DISTRIBUTION AND ABUNDANCE OF CURLY-LEAF PONDWEED IN SCHOOL SECTION LAKE: 2012



Source: SEWRPC.

Map A-23

DISTRIBUTION AND ABUNDANCE OF
CURLY-LEAF PONDWEED IN SCHOOL SECTION LAKE: 2011



Source: Wisconsin Department of Natural Resources.

loading, sedimentation rates, and recreational use patterns. The former, interannual changes may occur over a period of three to seven years, and may be temporary; the latter, evolutionary changes may occur over a decadal period or longer and are longer-lasting. Some species, such as the pondweeds noted above, exhibit distinct seasonality, with individual species having well-defined growing periods that reflect water temperature, isolation, and other factors. In addition, the changes in aquatic plant populations in a lake may reflect the results of aquatic management practices and/or may reflect a natural periodicity experienced by a species. Such periodicity, especially in Eurasian water milfoil populations, has been observed elsewhere in southeastern Wisconsin, and potentially reflects the influences of a combination of stressors. These stressors include biological factors, such as the activities of naturally occurring Eurasian water milfoil weevils, as well as climatic and limnological factors, such as insolation, water temperature, and lake circulation patterns.

Aquatic plant surveys have previously been conducted on School Section Lake in 1976, 1980, 1994, 2003 and 2004.[63] The methodology for these aquatic plant surveys vary, thus making it difficult to define any changes to the aquatic plant community. The 1976 and 1980 surveys, completed by SEWRPC and WDNR respectively, for example, used an unknown methodology, while the 1994 and 2004 surveys by Aron and Associates, along with the 2003 SEWRPC survey, were completed using the transect method. Finally, as explained in the Aquatic Plant Surveys section above the survey completed for this report utilized the point intercept method. Future aquatic plant surveys in School Section Lake will, hopefully, continue with the same grid system utilized in the 2012 survey so that more accurate comparisons will be able to be made as to the changing plant communities in School Section Lake.

Table A-15 shows the aquatic plant species observed during the aforementioned aquatic plant surveys, as well as those observed in the most recent survey completed by SEWRPC in 2012. As mentioned above, it is not possible to draw any firm conclusions regarding the types or degree of changes that may be occurring in School Section Lake. However, the table does give some indication that the aquatic plant community of School Section Lake, like most natural systems, is dynamic and reflective of changes occurring within the watershed.

Comparing the two most recent aquatic plant surveys in 2004 and 2012 does, however, provide some indication of changes in the aquatic plant communities over the intervening years. For example, in 2004, the dominant plants were coontail and slender naiad (bushy pondweed). In 2012, the dominant plants were muskgrass, Eurasian water milfoil and coontail, with bushy pondweed declining dramatically in number, being observed in only eight of the 137 sites with vegetation, and bladderwort (*Utricularia*, sp.) replacing it as the fourth most dominant plant in the Lake. Additionally, 2004 saw the first recorded observations of three species: white-stem pondweed, Nitella and water stargrass. White-stem pondweed is of special interest due to its intolerance of degraded water quality conditions, as described above. It is encouraging to note that this species was still observed, albeit in only two of the 137 sites, in 2012.

Past and Present Aquatic Plant Management Practices

Records of aquatic plant management efforts on Wisconsin lakes were first maintained by the WDNR beginning in 1950. Prior to 1950, aquatic plant management interventions are likely, but were not recorded. Currently, all forms of aquatic plant management are subject to permitting by the WDNR pursuant to authorities granted the Department under Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code*.

[63] *Aron and Associates*, School Section Lake Aquatic Plant Management Plan, First Reassessment, *2005*.

Table A-15

COMPARISON OF AQUATIC PLANT SPECIES IN SCHOOL SECTION LAKE: 1981-2012

Aquatic Plant Species	1976[b] (SEWRPC)	1980 (WDNR)	1994[d] (ARON)	2003 (SEWRPC)	2004 (ARON)	2012 (SEWRPC)
Floating Plants						
Nuphar variegata (spatterdock)	C	C	X	X[e]	X	S (5.8)[g]
Nymphaea odorata[a] (white water lily)	C	D	X	X[e]	X	C (19.0)[g]
Emergent Plants						
Sagittaria sp. (arrowhead)	- -	C	- -	- -	- -	- -
Scirpus terminalis (water bulrush)	D	D	X[e]	X[e]	X[e]	C (10.9)[g]
Submergent Plants						
Ceratophyllum demersum (coontail)	- -	S	D	S (4.2)	D[f]	D (35.8)
Chara sp. (muskgrass)	C	D (80)	X	D (95.8)	X	D (66.4)
Elodea canadensis (waterweed)	C	C	X	- -	- -	S (2.2)
Myriophyllum sibiricum (native milfoil)	- -	- -	- -	- -	- -	C (8.0)
Myriophyllum spicatum (Eurasian water milfoil)	C[c]	C[c]	X	D (91.7)	X	D (42.3)
Myriophyllum verticillatum (whorled milfoil)	- -	- -	X	- -	- -	- -
Najas flexilis (bushy pondweed)	- -	C	X	C (91.7)	D[f]	S (5.8)
Najas marina (spiny, or brittle, naiad)	- -	- -	X	C (25.0)	X	C (7.3)
N. sp. (*Unidentified naiad)*	- -	- -	- -	- -	- -	- -
Nitella sp. (Nitella)	- -	- -	- -	- -	X	C (5.1)
Potamogeton alpinus (alpine pondweed)	- -	- -	X	- -	X	
Potamogeton crispus (curly-leaf pondweed)	- -	- -	X	X[e]	X	S (3.6)
Potamogeton friesii (Fries pondweed)	- -	- -	X	- -	X	- -
Potamogeton gramineus (variable pondweed)	- -	S	X	C (25.0)	X	C (7.3)
Potamogeton illinoensis (Illinois pondweed)	- -	- -	- -	- -	- -	S (1.5)
Potamogeton natans (floating-leaf pondweed)	- -	C	X	C (8.3)	X	C (6.6)
Potamogeton nodosus (long-leaf pondweed)	- -	- -	- -	- -	- -	S (2.2)
Potamogeton praelongus (white-stem pondweed)	- -	- -	- -	- -	X	S (1.5)
Potamogeton richardsonii (clasping-leaf pondweed)	- -	- -	- -	- -	- -	S (0.7)
Potamogeton zosterformis (flat-stem pondweed)	C	S	- -	- -	- -	- -
Potamogeton sp. (unidentified pondweed)	- -	C	- -	- -	- -	- -
Ranunculus longirostris (white-water crowfoot)	- -	- -	- -	- -	- -	S (0.7)
Stuckenia pectinata (Sago pondweed)	C	C	X	C (25.0)	X	C (18.2)
Utricularia spp. (Bladderwort)	- -	C	X	C (16.7)	X	C (31.4)
Vallisneria americana (eel-grass or wild celery)	- -	C	X	C (12.5)	X	C (21.9)
Zosterella dubia (water stargrass)	- -	- -	- -	- -	- -	S (1.5)

NOTES: All numbers within the table correspond with available frequency of occurrence percentages. In the 2003 and 2012 studies, a frequency of occurrence of: 1) less than 5 percent was considered "Sparse"; 2) greater than 5 but less than 35 percent was considered "Common"; and 3) greater than 35 percent was considered "Dominant."

D = Dominant C = Common S = Sparse X = Present

[a]*In surveys prior to 2012,* Nuphar variegate *(spatterdock) is labelled as* Nuphar advena *(yellow water lily), considered by SEWRPC botanists to likely be a misidentification; likewise,* Nuphar odorata *has been re-identified as* Nymphaea odorata*.*

[b]*This survey was likely not a complete aquatic plant survey, but done visually.*

[c]*Identified as general water milfoil; however, assumed to be Eurasian water milfoil as northern water milfoil was not identified in the Lake until more recent studies.*

[d]*Data provided in the table is interpreted from the 2004 Aron & Associates report.*

[e]*These plants were not formally present in the aquatic plant survey, but are considered likely to have been present due to their presence in historic and the more recent 2012 aquatic plant surveys.*

[fl]*Identified as dominant based on aquatic plant narrative (i.e., very dense).*

[g]*Frequency is likely underestimated in the 2012 aquatic plant survey due to high density of bulrushes and lilies as well as inadequate water depth making it not possible to survey several sample sites.*

Source: Wisconsin Department of Natural Resources, Aron &Associates, and SEWRPC.

Table A-16

CHEMICAL CONTROLS ON SCHOOL SECTION LAKE: 1956-2000

Year	Macrophyte Control						Algal Control	
	Sodium Arsenite (pounds)	Diquat (gallons)	Endothall/ Aquathol (gallons)	Hydrothol		2,4-D (gallons)	Cutrine-Plus (gallons)	Copper Sulfate (pounds)
				Gallons	Pounds			
1956	- -	- -	- -	- -	- -	- -	- -	300
1969	- -	- -	17	- -	- -	- -	- -	72
1971	- -	- -	20	- -	- -	- -	- -	- -
1972	- -	- -	150 lbs.	- -	- -	- -	- -	- -
1982	- -	- -	150 lbs.	- -	- -	- -	15 lbs.	- -
1984	- -	- -	- -	- -	- -	20.0	- -	- -
1985	- -	- -	- -	- -	- -	20.0	- -	- -
2000	- -	- -	- -	- -	- -	2.5	- -	- -
Total	- -	- -	37 + 300 lbs.	- -	- -	42.5	15 lbs.	372

NOTE: In 1990, 0.75 gallon of Roundup were applied to the Lake; in 2002, 0.45 pound of floridone granular were applied to the Lake.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Past aquatic plant management practices on School Section Lake are not well documented. Table A-16 shows the records of chemical applications in School Section Lake. Unlike many waterbodies in southeastern Wisconsin, there are no records of the use of sodium arsenite as an aquatic herbicide on School Section Lake.[64]

Since about 1985, the primary method of aquatic plant control on School Section Lake has been through the use of a mechanical plant harvesting machine that is owned and operated by the School Section Lake Management District (SSLMD). Aquatic plants are removed from the harvester by an onshore conveyer that loads the plant material onto a dump truck for transport to the disposal site. Individual shoreline property owners are responsible for raking floating plant material from around their piers and removing it from the Lake.

FISH AND WILDLIFE

Fish and Fisheries

School Section Lake has been recommended for the maintenance of a warmwater sportfishery and full recreational use.[65] According to the WDNR website, panfish are considered to be “common,” while northern pike and largemouth bass, which were stocked on varying years from 1983 to 1992, and 1977 and 2012 respectively, are listed as “present.”[66] Records of stocking of School Section Lake are presented in Table A-17.

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[64]*Sodium arsenite was typically sprayed onto the surface of a lake, within an area of up to 200 feet from the shoreline, between mid-June and mid-July in a volume sufficient to result in a concentration of about 10 mg/l sodium arsenite (about 5.0 mg/l arsenic) in the treated lake water. The sodium arsenite typically remained in the water column for less than 120 days, during which period the arsenic residue was naturally converted from a highly toxic form to a less toxic, less biologically active form that subsequently was deposited in the lake sediments. By 1969, it became apparent that arsenic was accumulating in the sediments of treated lakes, so the use of sodium arsenite was discontinued in the State.*

[65]*SEWRPC Memorandum Report No. 93,* op. cit.

[66]*Wisconsin Department of Natural Resources Publication No. PUB-FH-800 2005,* Wisconsin Lakes*, 2005.*

Table A-17

FISH STOCKED INTO SCHOOL SECTION LAKE

Year	Species Stocked	Age Class	Number Stocked	Average Length (inches)
1983	Largemouth Bass	Fingerling	3,000	3.0
1987		Fingerling	2,385	5.0
1988		Fingerling	8,500	1.0
1989		Fingerling	12,500	1.0
1991		Fingerling	12,600	2.0
1992		Fingerling	6,250	2.0
1992		Small fingerling	6,250	1.0
1977	Northern Pike	Fry	150,000	
1979		Fry	125,000	
1996		Fingerling	508	4.3
1998		Small fingerling	585	3.9
1999		Small fingerling	585	3.7
2000		Small fingerling	585	3.5
2001		Small fingerling	1,420	2.9
2002		Small fingerling	585	3.1
2006		Small fingerling	585	2.5
2008		Large fingerling	510	10.2
2009		Large fingerling	174	7.9
2010		Large fingerling	581	12.8
2012		Large fingerling	244	8.0

Source: Wisconsin Department of Natural Resources and SEWRPC.

The WDNR completed fish surveys in School Section Lake, using electrofishing, in 2001, 2003, 2006, and 2008 for the purpose of evaluating the types and size structures of the fish within the Lake. In general, these surveys revealed that the quality of the fishery as “very good,” with panfish size structure and largemouth bass structure and abundances being well balanced (with numerous quality sized black crappie and bluegill). Northern pike, however, often showed highly truncated size structures (not many large fish) indicating above average exploitation by anglers.[67]

School Section Lake does not currently contain any State listed species of special concern.

Other Wildlife

Amphibians and reptiles are vital components of the School Section Lake ecosystem, and include frogs, toads, salamanders, turtles and snakes. In Waukesha County, there are 15 verified and one probable species of amphibian (frogs and salamanders) and 15 verified and three probable species of reptiles (snakes and turtles). Amongst these species, three are reported as endangered (i.e. the Blanchard’s cricket frog, the queen snake, and the eastern massasuaga snake) while eight are reported as of “special concern” (i.e. the American bullfrog, the pickerel frog, the northern leopard frog, the northern ring-necked snake, the eastern hog-nosed snake, the butler’s gartersnake, the plains gartersnake, and the blanding’s turtle).[68] Given the health of the aquatic plant

[67]*Fisheries summary provided by the designated WDNR Fish Biologist Contact for the 2001, 2003, 2006, and 2008 surveys completed on School Section Lake, Waukesha.*

[68]*University of Wisconsin-Milwaukee Field Station, Wisconsin Herpetological Atlas Project, February 2015. Available online at* http://www4.uwm.edu/fieldstation/herpetology/AtlasFr1.html.

community in School Section Lake, as well as the resources the Lake provides which are necessary to amphibian and reptile lifecycles, it is likely that many of these species may be located in the watershed.

The watershed would also be expected to support a significant population of waterfowl, including mallards, wood duck, and blue-winged teal.[69] During the migration seasons a greater variety of waterfowl would likely be present and in greater numbers.

Finally, with respect to wildlife, most of the wildlife remaining in and around the shorelands of the Lake would be expected to be urban-tolerant species such as muskrats, beaver, smaller animals (shrews, mice), and waterfowl in the lakeshore areas and grey and fox squirrels and cottontail rabbits more widely distributed throughout the immediate riparian areas. Larger mammals, such as the whitetail deer, are likely to be confined to the larger wooded areas and the open meadows found within the watershed of the Lake. The remaining undeveloped areas provide the best-quality cover for many wildlife species.

IMPORTANT NATURAL AREAS

Many important interlocking and interacting relationships occur between living organisms and their environment. The destruction or deterioration of any one element of a natural environment may lead to a chain reaction of deterioration and destruction among the others. The drainage of wetlands, for example, may have far-reaching effects. Such drainage may destroy fish spawning grounds, wildlife habitat, groundwater recharge areas, and natural filtration and floodwater storage areas. The resulting deterioration of surface water quality could then, in turn, lead to a deterioration of the quality of the groundwater which serves as a source of domestic, municipal, and industrial water supply and provides low flows in rivers and streams. Although the effects of any one environmental change may not be overwhelming in isolation, the combined effects may lead eventually to the deterioration of the underlying and supporting natural resource base, and of the overall quality of the environment for life. The need to protect and preserve the wetlands, uplands, environmental corridors, and other natural areas within the watershed is, therefore, crucial if School Section Lake is to be maintained as a healthy lake system.

Wetlands

Historically, wetlands were largely viewed as wastelands, presenting obstacles to agricultural production and development. Private interests, as well as governmental institutions, supported the transformation of wetlands into desired uses through large-scale draining and filling. This misunderstanding of the importance of wetlands led to dramatic wetland losses until scientific research revealed the value of wetlands as extremely productive and biologically diverse ecosystems that provide natural pollution reduction.[70]

In terms of diversity, wetlands are most known for their variety of plant life from *submergent* species, including algae; floating species, such as pond lilies; *emergent* species, such as cattails and bulrush; and *woody* species, such as tamarack trees and various species of shrubs. Species of both aquatic and terrestrial wildlife communities that have been found to rely on, or are associated with, wetlands for at least part of their lives include: crustaceans, mollusks, and other aquatic insect larvae and adults; fishes, including forage fish and important game fish species, like trout, northern pike, and largemouth bass; amphibians; reptiles; mammals, including deer, muskrat, and beaver; resident bird species, such as turkey; and migrant species, like sandhill and whooping cranes. Thus, wetlands help maintain biologically diverse communities of ecological and economic value.

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[69]*Wisconsin Society for Ornithology, Wisconsin Breeding Bird Atlas, 2014. Available online at* http://www.uwgb.edu/birds/wbba/index.htm.

[70]*J.A. Cherry, "Ecology of Wetland Ecosystems: Water, Substrate, and Life,"* Nature Education Knowledge, *Volume 3, No. 10, 2012, pp. 16,* http://www.nature.com/scitable/knowledge/library/ecology-of-wetland-ecosystems-water-substrate-and-17059765.

In addition to maintaining biodiversity, wetlands provide a host of additional services that include: storing floodwaters; improving water quality by filtering pollutants; protecting groundwater aquifers; serving as sinks, sources, or transformers of materials; and providing recreation sites for boating and fishing.[71] This recognition of the value and importance of wetlands has led to the creation of rules and regulations to protect wetlands around the world, as well as nationally, i.e., the Federal Clean Water Act of 1972, statewide, and locally. Most recently, the U.S. Army Corp of Engineers and U.S. Environmental Protection Agency, in coordination with the U.S. Fish and Wildlife Service, WDNR and SEWRPC have updated the delineation of wetlands in areas of special natural resource interest for the entire regional area to protect these areas and their associated critical species habitats through Advanced Delineation and Identification (ADID).[72] These efforts are designed to protect or conserve wetlands and the ecosystem services they provide.

Wetlands in the School Section Lake watershed are distributed as shown on Map A-24. As it can be seen, most are located in close proximity to School Section Lake and several other of the waterbodies within the School Section Lake watershed, as well as a large portion of the watershed to the south of School Section Lake.

Woodlands

Woodland areas in the School Section Lake watershed are also shown on Map A-24. The remaining woodland areas in the Lake's watershed are comprised of a number of small, fragmented parcels scattered generally over the entire watershed area. Such fragmentation greatly diminishes the ability of a woodland to provide adequate habitat for many wildlife species, thereby indicating that the remediation and connection of woodlands should be encouraged to increase their ability to support wildlife. As can be seen on the map, these areas may be located within or outside of wetland areas.

Uplands

Upland habitats are basically natural areas that are not defined as wetland. These areas are usually higher in elevation than wetlands and are located outside wetlands further away from open water, so they are drier in character. For example, as shown on Map A-25, the various types of upland areas within the School Section Lake watershed are generally located outside of the transitional wetland areas. There are, however, many exceptions to this attempt to classify uplands that can be seen even within the School Section Lake watershed. Upland can sometimes be very difficult to distinguish from wetland, because these features form broad and complex mosaics or combinations across the landscape. It is precisely this combination and linkages between these unique community types that provides the critical habitats to sustain healthy and diverse aquatic and terrestrial wildlife.

Like wetland ecosystems, as described above, upland habitats also provide many critical functions to an eco-system, including: production of food, livestock and crops; groundwater recharge and maintenance of water quality; air quality enhancement; soil conservation; wildlife management potential through provision of critical breeding, nesting, resting, and feeding grounds, and refuge from predators for many species of upland game and nongame species; recreation; tourism; and, education.

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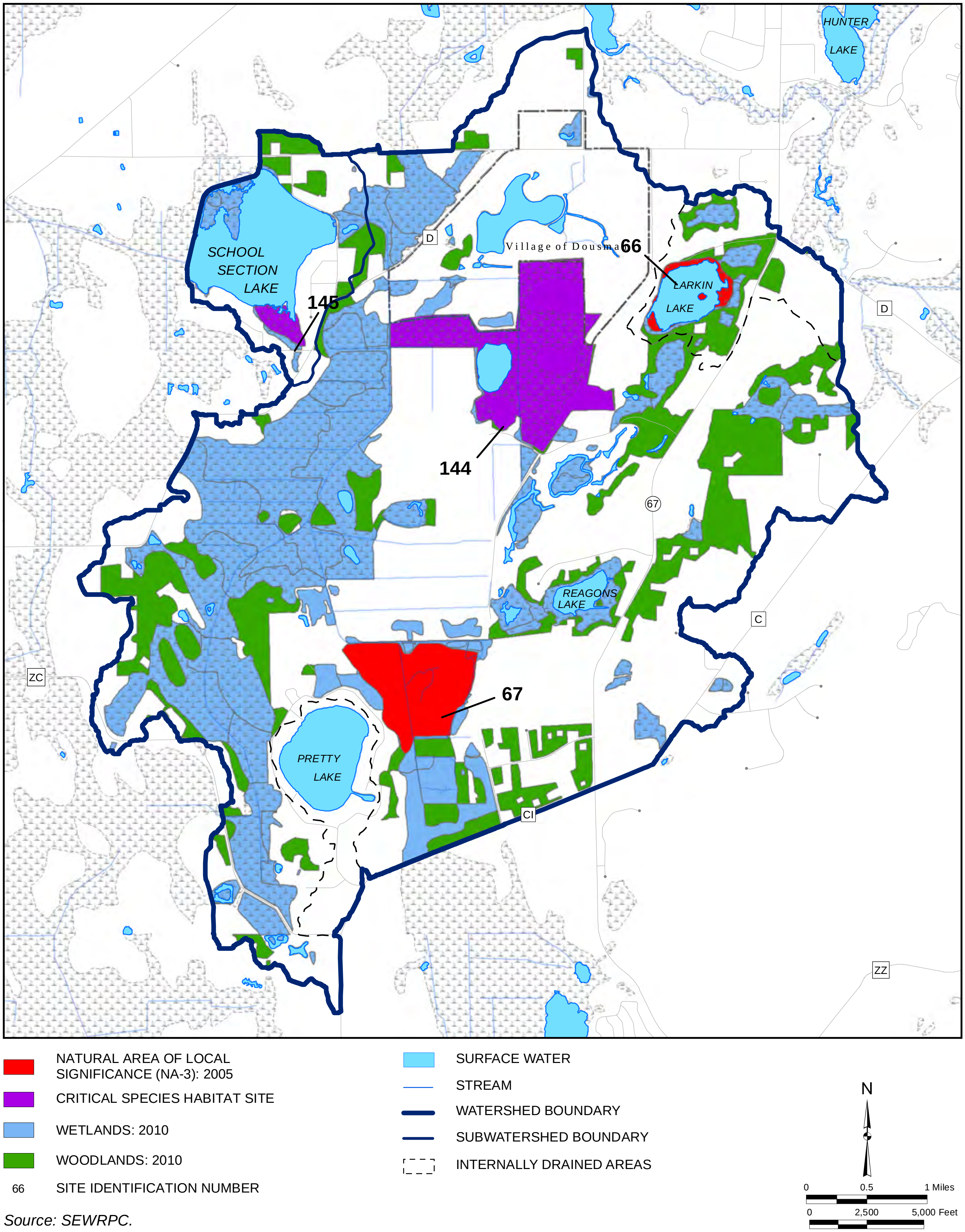
[71]*Marsden Jacob Associates*, Literature Review of the Economic Value of Ecosystem Services that Wetlands Provide, *Final Report prepared for the Department of Sustainability, Environment, Water, Population and Communities, September 2012; The Ramsar Convention on Wetlands*, http://www.ramsar.org/cda/en/ramsar-july13-homeindex/main/ramsar/1%5E26239_4000_0__.

[72]*Pursuant to Section NR 103.04(4) of the* Wisconsin Administrative Code, *wetlands in areas of special natural resources interest includes those wetlands both within the boundary of designated areas of special natural resource interest and those wetlands which are in proximity to or have a direct hydrologic connection to such designated areas, which include Advanced Delineation and Identification study (ADID) areas. See SEWRPC Planning Report No 42,* Amendment to the Natural Areas and Critical Species Habitat Protection and Management Plan for the Southeastern Wisconsin Region, *December 2010.*

Map A-24

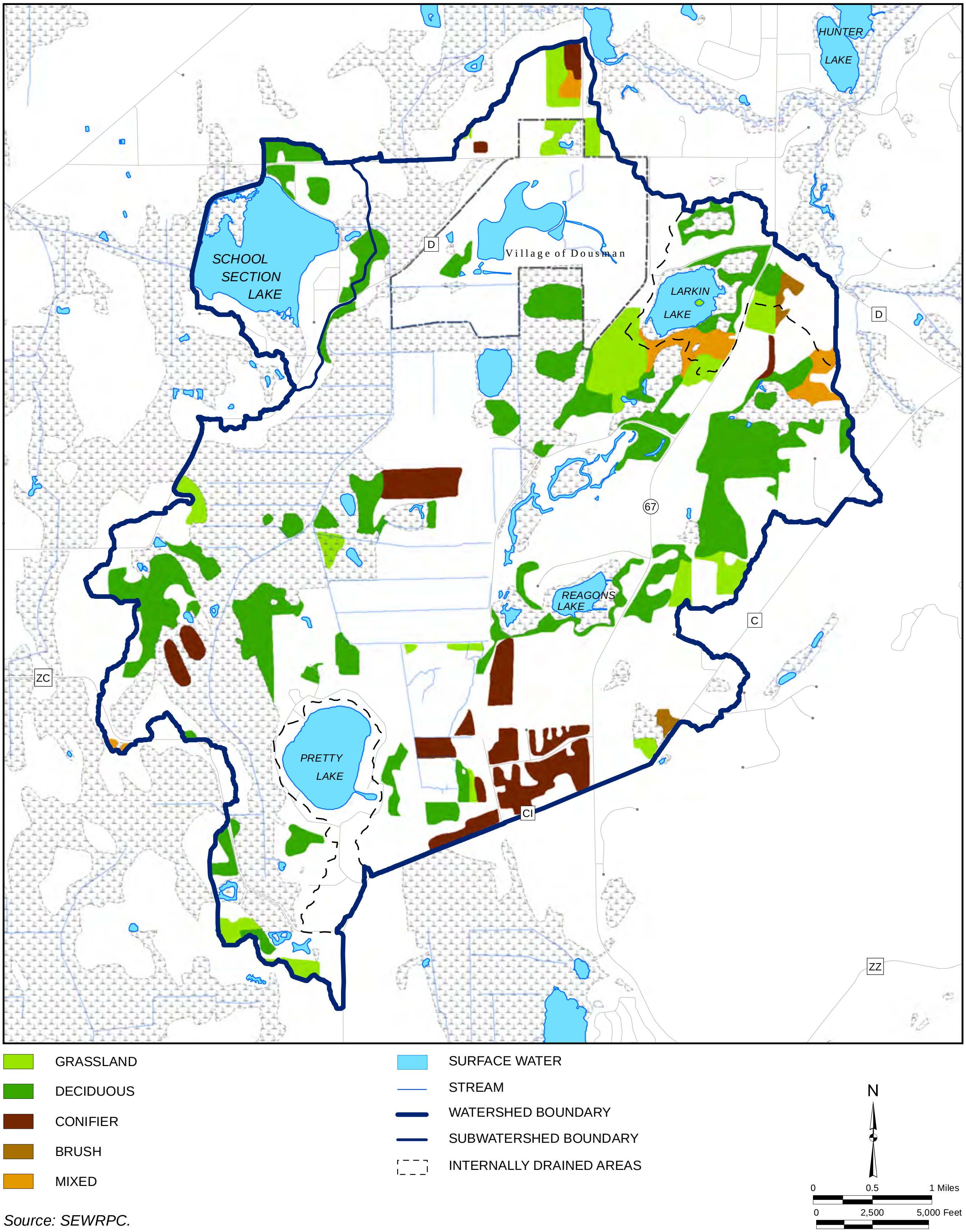
NATURAL AREAS, CRITICAL SPECIES HABITAT, WETLANDS, AND WOODLANDS
WITHIN THE SCHOOL SECTION LAKE WATERSHED



Source: SEWRPC.

Map A-25

UPLAND COVER TYPES WITHIN THE SCHOOL SECTION LAKE WATERSHED: 2005



Source: SEWRPC.

Another important contrast between upland and wetland is that the upland soils generally pose many fewer limitations for urban development. In general, uplands have a lower water table than wetlands. Also, relative to wetlands soils, upland soils have lower compressibility, greater stability, greater bearing capacity, and lower shrink-swell potential. These conditions usually result in less flooding, dry basements, more stable foundations, more stable pavements, and less failure of sanitary sewer and water lines. Therefore, there are significantly lower costs associated with onsite preparation and maintenance for development on upland soils, particularly in connection with roads, foundations, and public utilities. It is precisely these characteristics that make upland areas desirable for urban development and in turn highly vulnerable. It is, therefore, important to communicate the benefits of uplands and promote their protection wherever possible in order to maintain the extensive benefits they provide to a watershed.

SEWRPC-Designated Environmental Corridors

The environmental corridors concept is an essential planning tool for protecting the most important remaining natural resource features in the Southeastern Wisconsin Region and elsewhere. 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. The process does this by providing a framework centered on the designation and protection of "environmental corridors," to guide future growth, land development, and land conservation decisions in appropriate areas to protect both community and natural resource assets.

"Environmental corridors" refer to interconnected green space networks of natural areas and features, public lands, and other open spaces that provide natural resource value. They are divided into the following three categories:

- ***Primary environmental corridors*** (PEC) which contain concentrations of the most significant natural features. They are at least 400 acres in size, at least two miles in length, and at least 200 feet wide.

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

- ***Isolated natural resource areas*** (INR) which are isolated "pockets" of natural resources that have been designated significant. They are at least five acres in size and 200 feet wide.

Primary Environmental Corridors

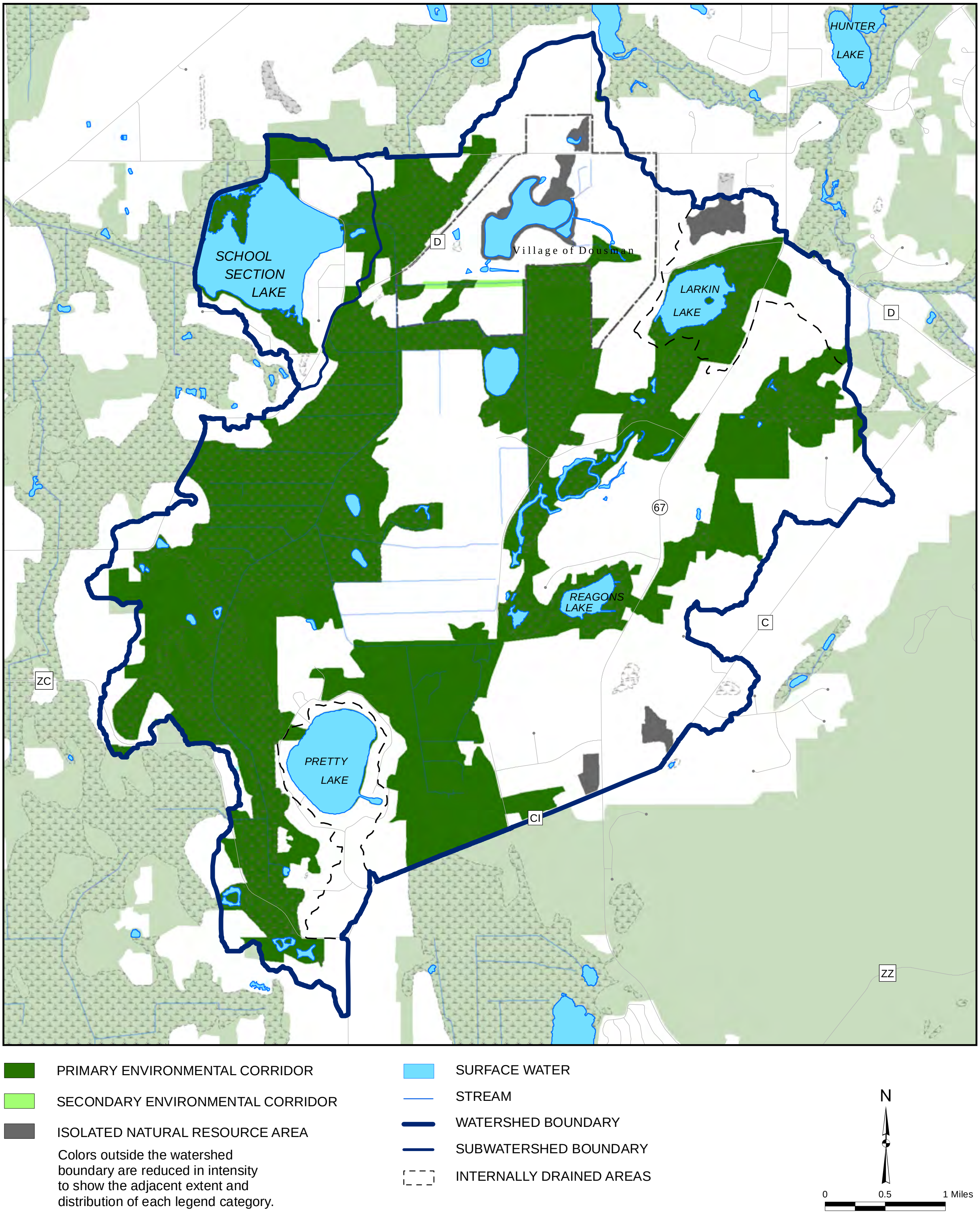
PECs encompassed about 1,950 acres, or about 48 percent, of the School Section Lake watershed in 2010, including School Section Lake itself. These PECs represent a composite of the best remaining elements of the natural resource base, and contain almost all of the best remaining woodlands, wetlands, and wildlife habitat areas in the watershed. Although School Section Lake is typically shown as open water, it is also important to note that the lakes, rivers, and streams and their associated shoreland areas, including School Section Lake, are, in fact, PECs, which is why they are shown as such on Map A-26. In other words, the Lake and its associated shoreland areas are part of the highest quality natural resources within the School Section Lake watershed, thereby providing further evidence that these nearshore areas are vitally important to protect and maintain the quality and integrity of School Section Lake.

Secondary Environmental Corridors

Secondary environmental corridors (SECs) facilitate surface water drainage, maintain pockets of natural resource features, and provide corridors for the movement of wildlife, as well as for the movement and dispersal of seeds for a variety of plant species. SECs occupied only about five acres in the School Section Lake watershed; Map A-26 shows their location in the watershed as of 2005.

Map A-26

ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS WITHIN THE SCHOOL SECTION LAKE WATERSHED: 1950-2010



Source: SEWRPC.

Isolated Natural Resource Areas
Smaller concentrations of natural resource features that have been separated physically from the environmental corridors by intensive urban or agricultural land uses, called isolated natural resource areas, have also been identified. Widely scattered throughout the School Section Lake watershed, isolated natural resource areas included about 83 acres, or about 2 percent, of the total study area in 2005. Isolated natural resource areas in the School Section Lake watershed are also shown on Map A-26.

Other Considerations
Since development of the environmental corridor concept, there have been significant advancements in landscape ecology that have furthered the 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 these new technologies in combination with protecting environmental corridors and further developing riparian buffers.[73]

SEWRPC-Designated Natural Areas and Critical Species Habitat
Natural areas, as defined by the Wisconsin Natural Areas Preservation Council, are tracts of land or water that have been so minimally modified by human activity, or have sufficiently recovered from the effects of such activity, that they contain intact native plant and animal communities believed to be representative of pre-European settlement. Natural areas are generally comprised of wetland or upland vegetation communities and/or complex combinations of both these fundamental ecosystem units (see the Wetlands and Uplands subsections). In fact, some of the highest quality natural areas within the Southeastern Wisconsin Region are wetland complexes that have maintained adequate or undisturbed linkages, i.e., landscape connectivity, between the upland/wetland habitats. These findings are consistent with research findings in other areas of the Midwest.[74]

As part of its regional planning program, and as a logical extension of its environmental corridor concept expounded through the regional-, county-, and local-level land use plans for southeastern Wisconsin,[75] SEWRPC has identified natural areas and critical species habitat areas within the Southeastern Wisconsin Region in SEWRPC Planning Report No. 42, "*A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin*," published in September 1997, and amended in 2008 and 2010. This plan was developed to assist Federal, State, and local units and agencies of government, and nongovernmental organizations, in making environmentally sound land use decisions, including acquisition of priority properties, management of public lands, and siting of development in appropriate locations that will protect and preserve the natural resource base of the Region.

The identified natural areas were classified into three categories based upon consideration of several factors, including: the diversity of plant and animal species and community types present; the structure and integrity of the native plant or animal community; the extent of disturbance by human activity, such as logging, grazing, water level changes, and pollution; the frequency of occurrence within the Region of the plant and animal communities present; the occurrence of unique natural features within the area; the size of the area; and the educational value. These categories are as follows:

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[73]Ibid.

[74]*O. Attum, Y.M. Lee, J.H. Roe, and B.A. Kingsbury, "Wetland complexes and upland-wetland linkages: landscape effects on the distribution of rare and common wetland reptiles,"* Journal of Zoology*, Volume 275, 2008, pp. 245-251.*

[75]*See SEWRPC Planning Report No. 7,* The Regional Land Use-Transportation Study*, 1965, and subsequent editions; see also Bruce P. Rubin and Gerald H. Emmerich, Jr., "Refining the Delineation of Environmental Corridors in Southeastern Wisconsin,"* SEWRPC Technical Record*, Volume 4, Number 2, March 1981.*

1. Natural area of statewide or greater significance (NA-1);

2. Natural area of countywide or regional significance (NA-2); or

3. Natural area of local significance (NA-3).

The natural areas and critical species habitats identified in the School Section Lake watershed are shown on Map A-24:

- Map Reference No. 66. located in the northeast portion of the School Section Lake watershed, refers to Larkin Lake, a 40-acre very shallow, mostly undeveloped lake, surrounded by uplands that have been grazed and plowed and are threatened by future residential development; it is classified an NA-3 area of local significance partially under protective ownership through the State of Wisconsin Public Land Trust;

- Map Reference No. 67, located in the south-central portion of the School Section Lake watershed, refers to the Pretty Lake Tamarack Relict, an 84-acre tamarack relict with lowland hardwoods and a sedge fen; it is classified NA-3 and under private ownership;

- Map Reference No. 144, located in the north-central portion of the School Section Lake watershed, refers to the Lurvey Tamaracks, a 179-acre disturbed low woods; this area is under private ownership and is classified CSH in acknowledgement of its containing critical species habitat providing habitat for a number of critical bird species in addition to the State-designated special concern species Showy Lady's-Slipper orchid (*Cypripedium reginae*);

- Map Reference No. 145, located in the southeast corner of School Section Lake, refers to the 10-acre wetlands adjacent to the Lake; this area is under private ownership and is classified CSH for providing habitat for the black tern, a critical bird species.

These areas should be protected from development and maintained to the greatest extent possible.

Lands in Public and Private Protection

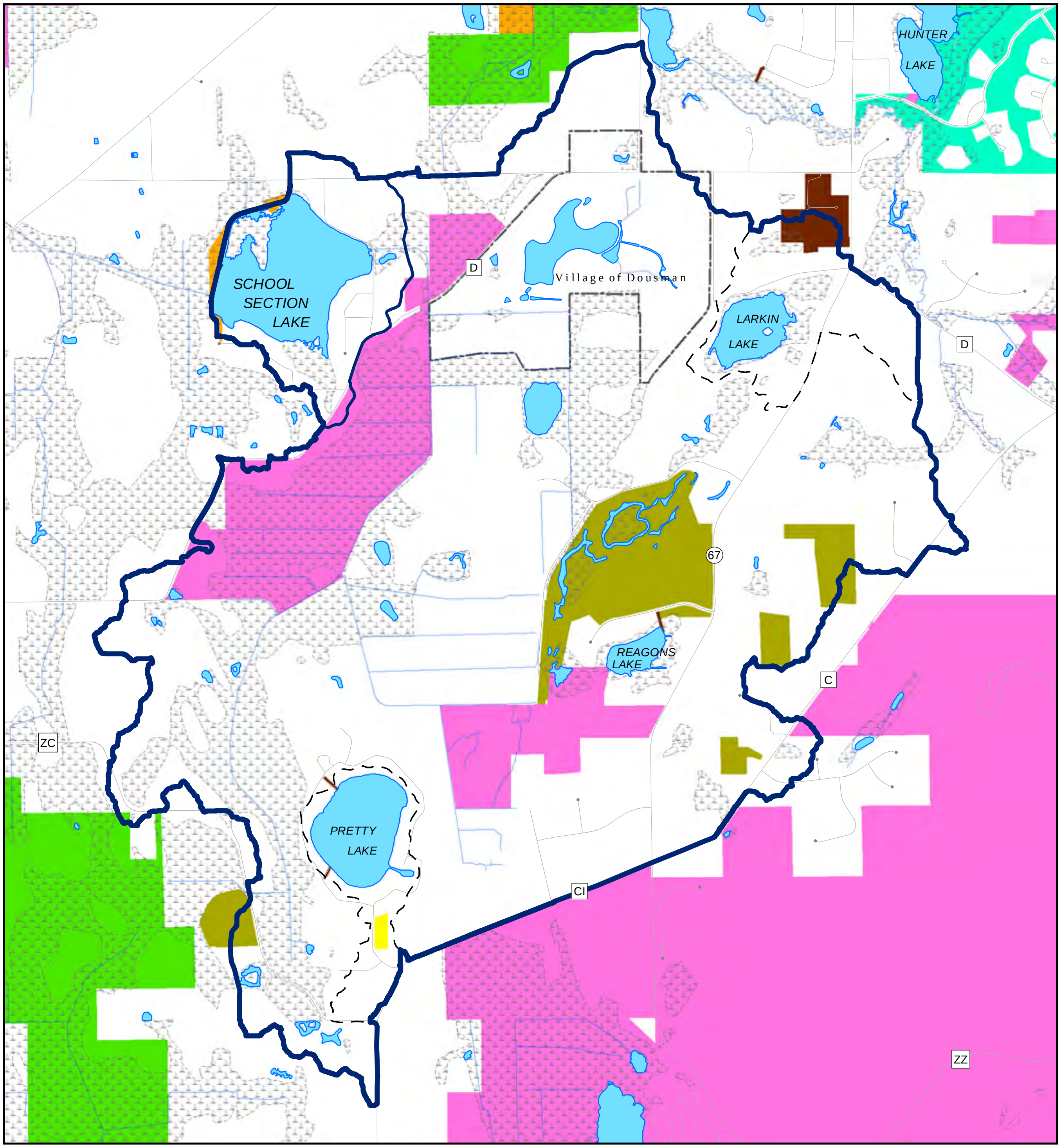
Within, and immediately adjacent to, the School Section Lake watershed are several land areas that are under public, i.e., State of Wisconsin, Waukesha County, and Town of Ottawa; and private, i.e., commercial or organizational; ownership/protection. Those areas are shown on Map A-27. Of note are the parcels of Waukesha County-owned property along the west and northwest shorelines of School Section Lake, the northwestern most parcel currently being in use as a public boat access site.

WDNR-Designated Sensitive Areas

Within or immediately adjacent to bodies of water, the WDNR, pursuant to authorities granted under Chapter 30 of the *Wisconsin Statutes* and Chapter NR 107 of the *Wisconsin Administrative Code*, can designate environmentally sensitive areas on lakes that have special biological, historical, geological, ecological, or archaeological significance, "offering critical or unique fish and wildlife habitat, including seasonal or life-stage requirements, or offering water quality or erosion control benefits of the body of water." School Section Lake is not listed by the WDNR as containing any officially designated sensitive areas.

Map A-27

LANDS IN PUBLIC AND PRIVATE PROTECTION WITHIN AND ADJACENT TO THE SCHOOL SECTION LAKE WATERSHED



STATE
COUNTY
TOWN
COMMERCIAL
PRIVATE
ORGANIZATIONAL: SCHOOLS, YMCA's, CAMPS (SCOUTS ETC.), SPORT CLUBS, GUN CLUBS
NON-PROFIT/CONSERVATION ORGANIZATION
SURFACE WATER
STREAM
WATERSHED BOUNDARY
SUBWATERSHED BOUNDARY
INTERNALLY DRAINED AREAS

N

0 0.5 1 Miles

0 2,500 5,000 Feet

Source: SEWRPC.

Table A-18

WATERCRAFT DOCKED OR MOORED ON SCHOOL SECTION LAKE: 2012[a]

Type of Watercraft									
Powerboat	Fishing Boat	Pontoon Boat	Personal Watercraft	Canoe	Sailboat	Kayak	Pedalboat	Rowboat	Total
2	5	11	4	7	1	8	4	9	51

[a]*Including trailered watercraft and watercraft on land observable during survey.*

Source: SEWRPC.

RECREATIONAL USES

School Section Lake is used year-round for a variety of active recreational purposes, as well as a visual amenity. As set forth in the regional water quality management plan,[76] School Section Lake is considered to have water quality able to support a full range of active and passive recreational uses. Active recreational uses include: fishing, powerboating, waterskiing, tubing, canoeing, kayaking and swimming during the summer months; and ice-fishing, snowmobiling, ice-skating, cross-country skiing and snowshoeing during the winter. Popular passive recreational uses include walking, bird watching and picnicking. Like many of the lakes in the Region, School Section Lake experiences occasional intense recreational boating use on weekends and holidays in the summer.

Watercraft Census

The types of watercraft docked or moored on a lake, as well as the relative proportion of nonmotorized to motorized watercraft, reflect the attitudes of the primary users of a lake, the lake residents. A census of watercraft docked or moored on School Section Lake was conducted by SEWRPC staff during 2012. At that time, a total of 51 watercraft were observed, either moored in the water or stored on land in the shoreland areas around the Lake, as shown in Table A-18. About 43 percent of all docked or moored boats were motorized, with pontoon boats comprising the most common types; about 57 percent of all docked or moored boats were nonmotorized, with kayaks, rowboats and canoes being the most common.

To assess the degree of recreational boat use on a lake, it has been estimated that, in Southeastern Wisconsin, the total number of watercraft of all kinds operating on a lake at any given time is between about 2 percent and 5 percent of the total number of watercraft docked and moored. On School Section Lake, this would equal from about one boat to about three boats, of all kinds. These numbers would produce boating densities on School Section Lake that would range from about one boat per 122 acres down to about one boat per 41 acres; these estimates are based on boats of all kinds. If only boats of high-speed capability are used in these determinations, the boating densities diminish to about half the values estimated above, i.e. a maximum density of only about one boat per 122 acres. It is of note, however, that much of the Lake cannot be used for high speed boating due to inadequate depths in about half of the Lake consequently boat densities will be higher in the deeper portions

“Slow boating” activities, such as canoeing, kayaking, pedalboating, and rowboating, are generally distinguished from fast boating” activities, such as sailing, waterskiing/tubing, motorboating, or “fast cruising.” This there is a range of opinions on the issue of what constitutes optimal boating density, or the optimal number of acres of open water available on which to operate a boat. During the mid-1970s and 1980s, for example, an average area of about 16 acres per powerboat or sailboat was considered suitable for the safe and enjoyable use of such watercraft

[76]*SEWRPC Planning Report No. 30,* op. cit. *See also SEWRPC Memorandum Report No. 93,* op. cit.

on a lake.[77] However, as motorized watercrafts of all kinds have steadily increased in power and speed, this density has become less accurate. As a result, since 1995, Chapter NR 1 of the *Wisconsin Administrative Code* established standards for recreational boating access to public inland lakes in the State. For a lake with the surface area of School Section Lake, 122 acres, these standards impose a minimum requirement for provision of car-trailer unit parking at one or more access sites which, in total, provide a combination of one car-trailer unit per 30 acres but no less than five units for lakes of 50 to 150 open acres of water, up to a maximum of one car-trailer unit per 15 open water acres. Based on this standard, School Section Lake would likely be well within the range of having adequate surface area in which to safely operate high-speed watercraft under most normal and nonholiday conditions. The Town of Ottawa-owned and operated public access site, located in the northwest corner of the Lake (see Map A-2), satisfies WDNR regulations for adequate public access to a lake the size of School Section Lake.

Recreational Use Surveys

Another way to assess the degree of recreational watercraft use on a lake is through direct counts of boats actually in use on a lake at a given time. During 2012, surveys of the types of watercraft in use and how they were being used on typical summer weekdays and typical summer weekend days were conducted by SEWRPC staff. The results of these surveys are shown in Tables A-19 and A-20. As indicated in Table A-19, during typical summer weekdays there is very little boating activity on School Section Lake. Consequently, it is unlikely that high-speed boating traffic on School Section Lake during weekdays would constitute a safety issue from overcrowding. Weekend boating activities, as shown in Table A-20, generally exceed those on weekdays, as would be expected. Fishing; high-speed cruising, mainly PWCs; waterskiing/tubing; and low-speed cruising, mainly pontoons, are the most popular weekend boating activities on School Section Lake. During the weekend days when the surveys were conducted, boating densities were always less than one watercraft per 15 acres.

Tables A-21 and A-22 show the various types of recreational activities engaged in by people using School Section Lake during typical summer weekdays and weekend days in 2012. The most popular weekday recreational activities on the Lake were swimming and waterskiing/tubing; on weekend days, the most popular activities were swimming, fishing from boats, high-speed cruising and waterskiing/tubing.

Overall, during the summer months, the Lake receives a moderate amount of use primarily by fishermen during the week, while on weekends fishermen are the primary users until late morning at which time local boating ordinances (see Appendix C) allow for high-speed boating traffic to commence.

LOCAL ORDINANCES

Civil Divisions

Superimposed on the watershed is a pattern of local political boundaries. As shown on Map A-28, the School Section Lake watershed is located within the boundaries of the Village of Dousman and the Town of Ottawa, in Waukesha County. Geographic boundaries of the civil divisions are an important factor that must be considered in the lake protection plan, since civil divisions, including lake management districts and lake protection and rehabilitation districts, form the basic foundation of the public decision-making framework within which intergovernmental, environmental, and developmental problems must be addressed. These divisions should be considered when determining lake management efforts within the School Section Lake watershed.

Civil Division Zoning Ordinances

Zoning is a tool used to regulate the use of land in a manner that serves to promote the general welfare of its citizens, the quality of the environment and the conservation of resources. It is also a tool used to implement land

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

Table A-19

ACTIVE RECREATIONAL WATERCRAFT AND RELATED ACTIVITIES ON SCHOOL SECTION LAKE—WEEKDAYS: SUMMER 2012

		Time and Date								
		6:00 to 8:00 a.m.	8:00 to 10:00 a.m.	10:00 a.m. to Noon		Noon to 2:00 p.m.		2:00 to 4:00 p.m.		4:00 to 6:00 p.m.
Category	Observation	August 15	August 17	June 21	August 23	June 19	August 23	June 26	July 26	July 31
Type of Watercraft (number in use)	Power/ski boat	0	0	0	0	0	0	0	1	0
	Pontoon boat	0	1	0	0	0	0	0	0	0
	Fishing boat	0	3	1	2	0	1	1	0	0
	Personal watercraft	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Kayak/canoe	0	0	0	0	0	0	1	0	0
	Rowboat	0	0	0	0	0	0	0	0	0
	Sailboat	0	0	0	0	0	0	0	0	0
	Wind board/paddle board	0	0	0	0	0	0	0	0	0
	Paddleboat (pedalboat)	0	0	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0	0
Activity of Watercraft (number engaged)	Motorized cruise/pleasure									
	Low speed	0	0	0	0	0	0	0	0	0
	High speed	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Fishing	0	4	1	2	0	1	2	0	0
	Skiing/tubing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Sailing/windsurfing	0	0	0	0	0	0	0	0	0
	Rowing/paddling/pedaling	0	0	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0	0
Total	On water	0	4	1	2	0	1	2	0	0
	In high-speed use	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

NOTES: Town of Ottawa boating ordinances governing use of motorboats on School Section Lake prohibit speeds greater than slow, no-wake between sunrise and sunset; no motorboat may be operated between sunset and sunrise.

N/A = Does not apply.

Source: SEWRPC.

Table A-20

ACTIVE RECREATIONAL WATERCRAFT AND RELATED ACTIVITIES ON SCHOOL SECTION LAKE—WEEKENDS: SUMMER 2012

Category	Observation	Time and Date						
		6:00 to 8:00 a.m.	8:00 to 10:00 a.m.	10:00 a.m. to Noon	Noon to 2:00 p.m.		2:00 to 4:00 p.m.	4:00 to 6:00 p.m.
		August 19	July 21	August 11	August 19	August 25	July 21	August 11
Type of Watercraft (number in use)	Power/ski boat	0	0	0	0	0	0	0
	Pontoon boat	0	0	0	0	0	1	0
	Fishing boat	0	5	2	2	2	1	3
	Personal watercraft	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Kayak/canoe	0	0	0	0	0	0	0
	Rowboat	0	0	0	0	0	0	0
	Sailboat	0	0	0	0	0	0	0
	Wind board/paddle board	0	0	0	0	0	0	0
	Paddleboat (pedalboat)	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0
Activity of Watercraft (number engaged)	Motorized cruise/pleasure							
	Low speed	0	0	0	0	0	1	0
	High speed	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Fishing	0	5	2	2	2	1	3
	Skiing/tubing	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Sailing/windsurfing	0	0	0	0	0	0	0
	Rowing/paddling/pedaling	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0
Total	On water	0	5	2	2	2	2	3
	In high-speed use	N/A	N/A	N/A	N/A	N/A	N/A	N/A

NOTES: Town of Ottawa boating ordinances governing use of motorboats on School Section Lake prohibit speeds greater than slow, no-wake between sunrise and sunset; no motorboat may be operated between sunset and sunrise.

N/A = Does not apply.

Source: SEWRPC.

Table A-21

RECREATIONAL ACTIVITIES OBSERVED ON SCHOOL SECTION LAKE—WEEKDAYS: SUMMER 2012

Activity Observed (average number of people)	Time and Date								
	6:00 to 8:00 a.m.	8:00 to 10:00 a.m.	10:00 a.m. to Noon		Noon to 2:00 p.m.		2:00 to 4:00 p.m.		4:00 to 6:00 p.m.
	August 15	August 17	June 21	August 23	June 19	August 23	June 26	July 26	July 31
Park Goer	0	0	0	0	0	0	0	0	0
Beach Swimming	0	0	0	0	0	0	0	0	0
Boat/Raft Swimming	0	0	0	0	0	0	0	0	0
Canoeing/Kayaking	0	0	0	0	0	0	0	0	0
Sailboating	0	0	0	0	0	0	0	0	0
Wind Surfing/Paddle Boarding	0	0	0	0	0	0	0	0	0
Rowing	0	0	0	0	0	0	0	0	0
Paddleboating	0	0	0	0	0	0	0	0	0
Fishing from Boats	0	6	3	7	0	1	3	0	0
Fishing from Shore	0	0	0	0	0	0	1	2	0
Low-Speed Cruising	0	0	0	0	0	0	0	0	0
High-Speed Cruising	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Skiing/Tubing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Personal Watercraft Operation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Other	0	0	0	0	0	0	0	0	0

NOTES: Town of Ottawa boating ordinances governing use of motorboats on School Section Lake prohibit speeds greater than slow, no-wake between sunrise and sunset; no motorboat may be operated between sunset and sunrise.

N/A = Does not apply.

Source: SEWRPC.

Table A-22

RECREATIONAL ACTIVITIES OBSERVED ON SCHOOL SECTION LAKE—WEEKENDS: SUMMER 2012

Activity Observed (average number of people)	Time and Date						
	6:00 to 8:00 a.m.	8:00 to 10:00 a.m.	10:00 a.m. to Noon	Noon to 2:00 p.m.		2:00 to 4:00 p.m.	4:00 to 6:00 p.m.
	August 19	July 21	August 11	August 19	August 25	July 21	August 11
Park Goer	0	0	0	0	0	0	0
Beach Swimming	0	0	0	0	0	0	0
Boat/Raft Swimming	0	0	0	0	2	4	0
Canoeing/Kayaking	0	0	0	0	0	0	0
Sailboating	0	0	0	0	0	0	0
Wind Surfing/Paddle Boarding	0	0	0	0	0	0	0
Rowing	0	0	0	0	0	0	0
Paddleboating	0	0	0	0	0	0	0
Fishing from Boats	0	10	4	4	4	1	6
Fishing from Shore	0	1	0	2	0	0	2
Low-Speed Cruising	0	0	0	0	0	3	0
High-Speed Cruising	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Skiing/Tubing	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Personal Watercraft Operation	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Other	0	0	0	0	0	0	0

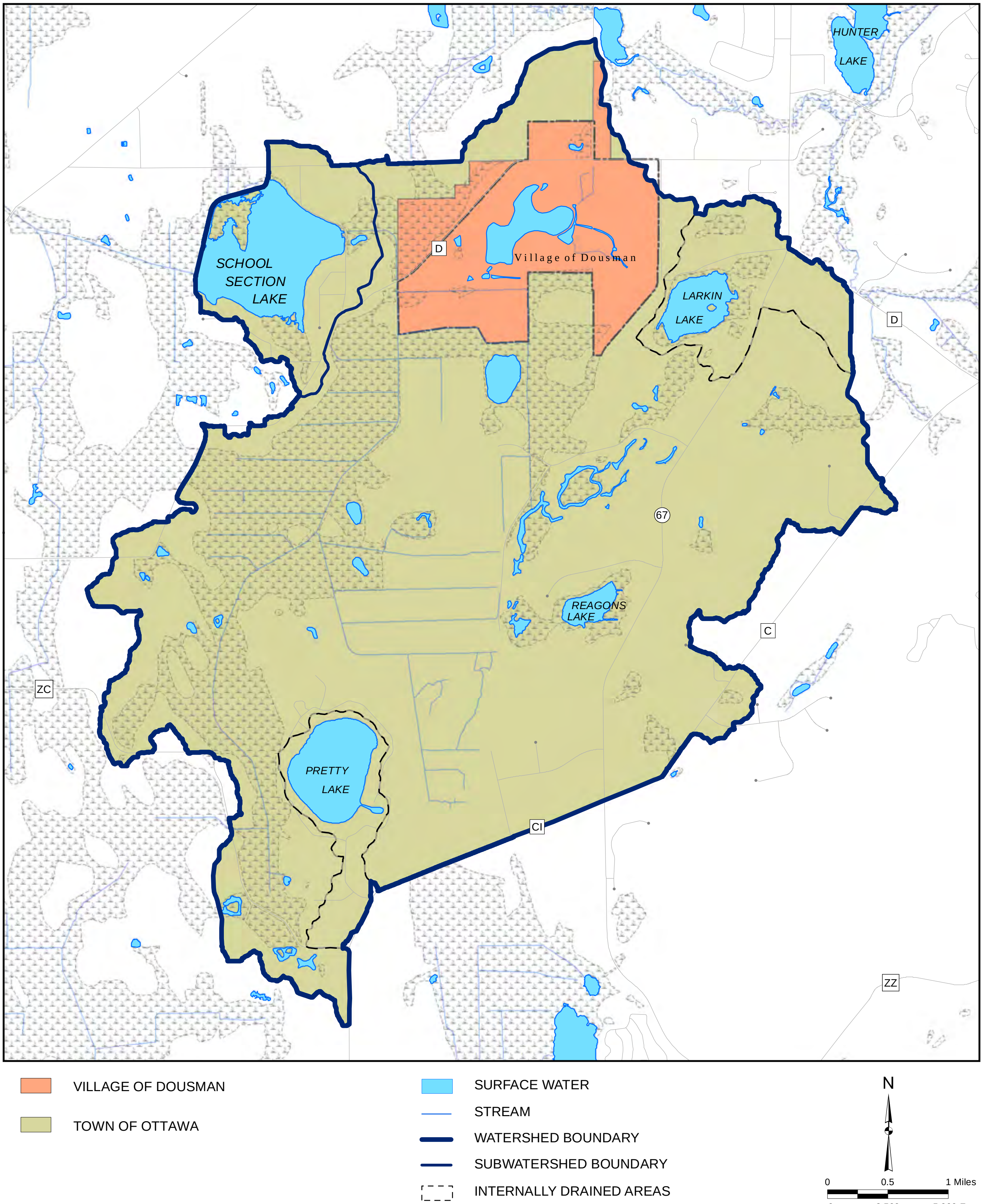
NOTES: Town of Ottawa boating ordinances governing use of motorboats on School Section Lake prohibit speeds greater than slow, no-wake between sunrise and sunset; no motorboat may be operated between sunset and sunrise.

N/A = Does not apply.

Source: SEWRPC.

Map A-28

CIVIL DIVISIONS WITHIN THE SCHOOL SECTION LAKE WATERSHED: 2013



Source: SEWRPC.

Table A-23

LAND USE REGULATIONS WITHIN THE AREA TRIBUTARY TO SCHOOL SECTION LAKE IN WAUKESHA COUNTY BY CIVIL DIVISION

Community	Type of Ordinance				
	General Zoning	Floodland Zoning	Shoreland or Shoreland-Wetland Zoning	Subdivision Control	Construction Site Erosion Control and Stormwater Management
Waukesha County.............	Adopted	Adopted	Adopted	Adopted[a]	Adopted
Town of Ottawa..............	County ordinance	County	County	Adopted	County
Village of Dousman.........	Adopted	Adopted	None	Adopted	Adopted

[a]*The Waukesha County subdivision ordinance applies only within shoreland areas.*

Source: SEWRPC.

use plans. Local zoning regulations include general, or comprehensive, zoning regulations and special-purpose regulations, such as those governing floodland areas, shoreland and shoreland-wetland areas, subdivisions, construction zone erosion control, and stormwater management. General zoning and special-purpose zoning regulations may be adopted as a single ordinance or as separate ordinances; they may or may not be contained in the same document. Any analysis of locally proposed land uses must take into consideration the provisions of both general and special-purpose zoning. Table A-23 shows the general- and special-purpose zoning ordinances for the civil divisions that are part of the School Section Lake watershed.

General Zoning

Villages in Wisconsin are granted comprehensive, or general, zoning powers under Section 61.35 of the *Wisconsin Statutes.* Counties are granted general zoning powers within their unincorporated areas under Section 59.69 of the *Wisconsin Statutes.* However, a county zoning ordinance becomes effective only in those towns that ratify the county ordinance. Towns that have not adopted a county zoning ordinance may adopt village powers, and subsequently utilize the village zoning authority conferred in Section 62.23, subject, however, to county board approval where a general-purpose county zoning ordinance exists. Alternatively, a town may adopt a zoning ordinance under Section 60.61 of the *Wisconsin Statutes* where a general-purpose county zoning ordinance has not been adopted, but only after the county board fails to adopt a county ordinance at the petition of the governing body of the town concerned.

Waukesha County and the Village of Dousman have each adopted general zoning ordinances, and the Town of Ottawa uses the Waukesha County general ordinance, as shown in Table A-23.

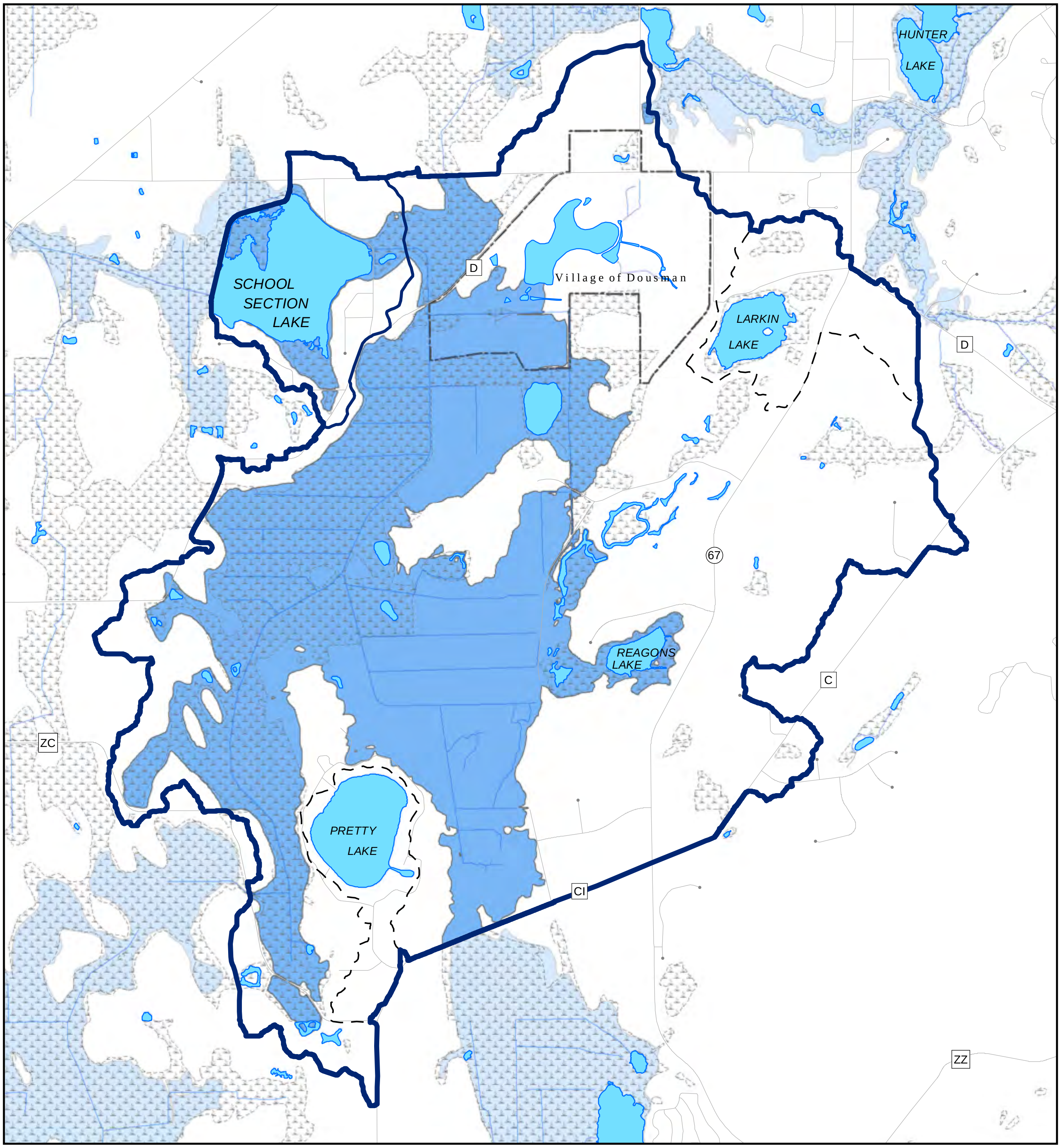
Floodplain Zoning

Flooding is a natural occurrence associated with many lakes and streams. It becomes a problem when it occurs in areas where human development exists; *floodplains* are those lands that may become flooded during a flooding event. Map A-29 shows the extent of floodplains within the School Section Lake watershed based on a one-percent-annual-probability (100-year recurrence interval), which is the regulatory standard applied for local zoning and Federal flood insurance purposes.

Section 87.30 of the *Wisconsin Statutes* requires that villages and counties, with respect to their unincorporated areas, adopt floodland zoning to preserve the floodwater conveyance and storage capacity of floodplain areas and to prevent the location of new flood-damage-prone development in flood hazard areas. The minimum standards which such ordinances must meet are set forth in Chapter NR 116, "Wisconsin's Floodplain Management Program," of the *Wisconsin Administrative Code*. As shown in Table A-23, Waukesha County and the Village of Dousman have adopted floodland zoning ordinances; the Town of Ottawa uses the Waukesha County floodland zoning ordinance.

Map A-29

FLOODPLAINS WITHIN THE SCHOOL SECTION LAKE WATERSHED



1 PERCENT ANNUAL PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAIN

Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

SURFACE WATER

STREAM

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

INTERNALLY DRAINED AREAS

N

0 0.5 1 Miles

0 2,500 5,000 Feet

Source: SEWRPC.

Shoreland Zoning

Shoreland zoning regulations play an important role in protecting water resources. Under Section 59.692 of the *Wisconsin Statutes*, counties in Wisconsin (within their unincorporated areas) are required to adopt zoning regulations within statutorily defined shoreland areas, which are defined as those lands within 1,000 feet of a navigable lake, pond, or flowage; 300 feet of a navigable stream; or to the landward side of the floodplain, whichever distance is greater.[78] Shoreland zoning has the goal of protecting water quality, fish and wildlife habitat, recreation, and natural beauty. To accomplish these goals, the statewide minimum standards for county shoreland zoning ordinances in Chapter NR 115, "Wisconsin's Shoreland Management Program," of the *Wisconsin Administrative Code*[79] create a 35-foot vegetated buffer strip and a 75-foot building setback around navigable waters, control the intensity of development around navigable waters, and protect wetlands within shorelands.

Waukesha County has adopted shoreland and shoreland-wetland zoning ordinances, the Town of Ottawa has adopted, with minor revisions, the County shoreland or shoreland-wetland zoning ordinances, and the Village of Dousman has no shoreland or shoreland-wetland ordinances, as indicated in Table A-23.

Subdivision Zoning

Chapter 236 of the *Wisconsin Statutes* requires the preparation of a subdivision plat whenever five or more lots of 1.5 acres or less in area are created either at one time or by successive divisions within a period of five years. The *Wisconsin Statutes* set forth requirements for surveying lots and streets, for plat review and approval by State and local agencies and for recording approved plats. Section 236.45 of the *Wisconsin Statutes* allows any city, village, town or county that has established a planning agency to adopt a land division ordinance, provided the local ordinance is at least as restrictive as the State platting requirements. Local land division ordinances may include the review of other land divisions not defined as "subdivisions" under Chapter 236, such as when fewer than five lots are created or when lots larger than 1.5 acres are created. As shown in Table A-23, Waukesha County, the Town of Ottawa and the Village of Dousman have each adopted their own subdivision control ordinances.

Construction Site Erosion Control and Stormwater Management Zoning

Stormwater management and erosion control ordinances help minimize water pollution, flooding, and other negative impacts of urbanization on water resources (lakes, streams, wetlands, and groundwater) and property owners, both during and after construction activities. These ordinances are an important tool for accomplishing watershed protection goals because they apply to the whole watershed.

The *Wisconsin Statutes* grant authority to counties (Section 59.693), villages (Section 61.653), and towns (Section 60.627) in Wisconsin to adopt ordinances for the prevention of erosion from construction sites and the management of stormwater runoff, which generally apply to new development from lands within their jurisdictions. A county ordinance would apply to all unincorporated areas and newly annexed lands, unless the annexing city or village enforces an ordinance at least as restrictive as the county ordinance.

As shown in Table A-23, Waukesha County and the Village of Dousman have each adopted construction site erosion control and stormwater management zoning ordinances, and the Town of Ottawa uses the Waukesha County ordinances.

[78]*Definitive determination of navigability and location of the ordinary high water mark on a case-by-case basis is the responsibility of the Wisconsin Department of Natural Resources.*

[79]*The most recent revisions to Chapter NR 115 were promulgated in 2014.*

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Appendix B

SCHOOL SECTION LAKE
AQUATIC PLANT SPECIES DETAILS

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Figure B-1

RAKE FULLNESS RATINGS

RAKE FULLNESS RATINGS

0	**1**	**2**	**3**
NO **VEGETATION**			

Source: Wisconsin Department of Natural Resources and SEWRPC.

SOURCES OF INFORMATION:

Borman, S., Korth, R., & Temte, J. (1997). *Through the Looking Glass: A Field Guide to Aquatic Plants.* Stevens Point, WI, USA: Wisconsin Lakes Partnership.

Robert W. Freckman Herbarium: *http://wisplants.uwsp.edu*

Skawinkinski, P. M. (2011). *Aquatic Plants of the Upper Midwest: A Photographic Field Guide to Our Underwater Forests*. Wausau, Wisconsin, USA: Self-Published.

University of Michigan Herbarium: *http://www.michiganflora.net/home.aspx*

Ceratophyllum demersum — Coontail

Native

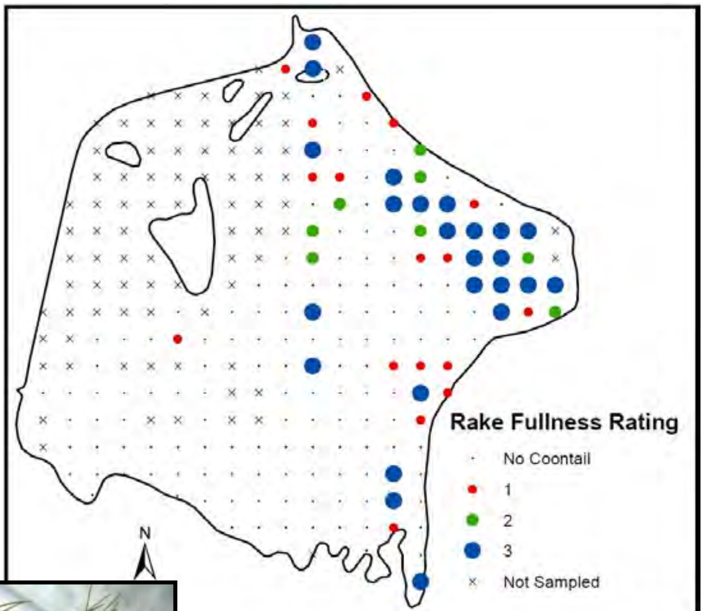
Identifying Features

- Often bushy near tips of branches, giving the raccoon tail-like appearance ("coontail")
- Whorled leaves with one to two orders of branching and small teeth on their margins
- Flowers (rare) small and produced in leaf axils

Coontail is similar to spiny hornwort (*C. echinatum*) and muskgrass (*Chara* spp.), but spiny hornwort has some leaves with three to four orders of branching, and coontail does not produce the distinct garlic-like odor of muskgrass when crushed

Ecology

- *Common in lakes and streams, both shallow and deep*
- *Tolerates poor water quality (high nutrients, chemical pollutants) and disturbed conditions*
- *Stores energy as oils, which can produce slicks on the water surface when plants decay*
- *Anchors to the substrate with pale, modified* leaves rather than roots
- Eaten by waterfowl, turtles, carp, and muskrat

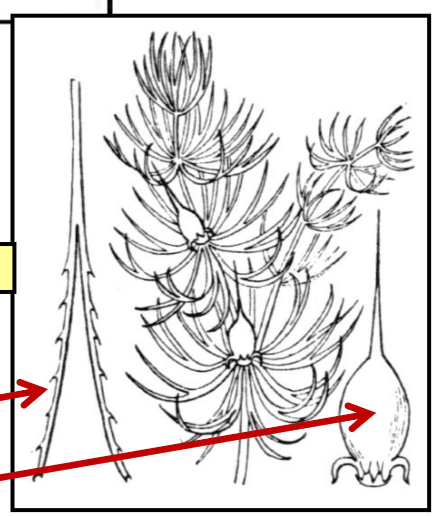


Second-Order Leaf Branching

First-Order Leaf Branching

Toothed Leaf Margins

Fruit (rare)



Chara spp. — Muskgrasses

Native

Algae (not vascular plants)

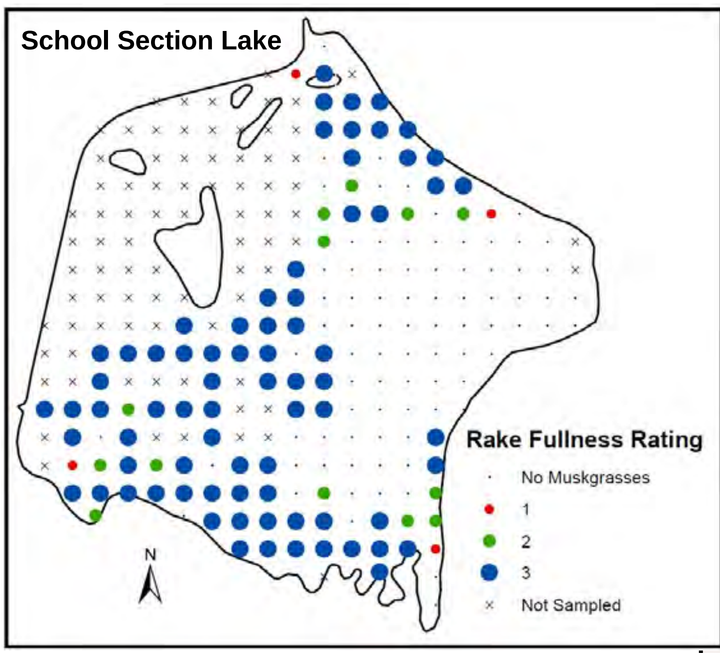
Identifying Features

- Leaf-like, ridged side branches develop in whorls of six or more
- Often encrusted with calcium carbonate, which appears white upon drying (see photo on left, below)
- Yellow reproductive structures develop along the whorled branches in summer
- Emits a garlic-like odor when crushed

Stoneworts (*Nitella* spp.) are similar large algae, but their branches are smooth rather than ridged and more delicate

Ecology

- Found in shallow or deep water over marl or silt, often growing in large colonies in hard water
- Overwinters as rhizoids (cells modified to act as roots) or fragments
- Stabilizes bottom sediments, often among the first species to colonize open areas
- Food for waterfowl and excellent habitat for small fish



Elodea canadensis
Native

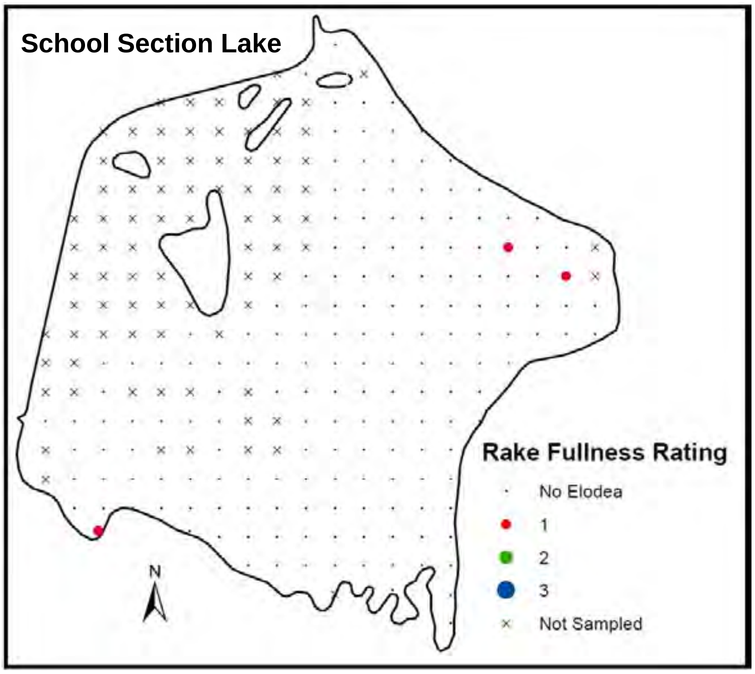
Common Waterweed

Identifying Features

- Slender stems, occasionally rooting
- Leaves lance-shaped, in whorls of three (rarely two or four), 6.0 to 17 mm long and averaging 2.0 mm wide
- When present, tiny male and female flowers on separate plants (females more common), raised to the surface on thread-like stalks

Ecology

- Found in lakes and streams over soft substrates tolerating pollution, eutrophication and disturbed conditions
- Often overwinters under the ice
- Produces seeds only rarely, spreading primarily via stem fragments
- Provides food for muskrat and waterfowl
- Habitat for fish or invertebrates, although dense stands can obstruct fish movement



Lythrum salicaria — Purple Loosestrife

Nonnative/Exotic

Identifying Features

- Terrestrial or semi-aquatic, emergent forb
- Stems often angled with four, five, or more sides, and growing one to two m tall
- Flowers deep pink or purple, six-parted, 12 to 25 mm wide, and in groups
- Leaves lance-like, four to 11 cm long and either opposite or in whorls of three

Purple loosestrife, if small, is similar to winged loosestrife (*Lythrum alatum*), but winged loosestrife differs in having leaves generally smaller (<5.0 cm long), leaves mostly alternate (only lower leaves opposite), and flowers mostly held singly in the leaf axils rather than in pairs or groups

Ecology/Control

- Found in shallows, along shores, and in wet to moist meadows and prairies
- Invasive and continues to escape from ornamental plantings
- Galerucella beetles have been successfully used to control purple loosestrife. Plants may also be dug or pulled when small, but they subsequently should be placed in a landfill or burned. Several herbicides are effective, but application near water may require permits and aquatic-use formulas

Myriophyllum sibiricum — Northern Water Milfoil

Native

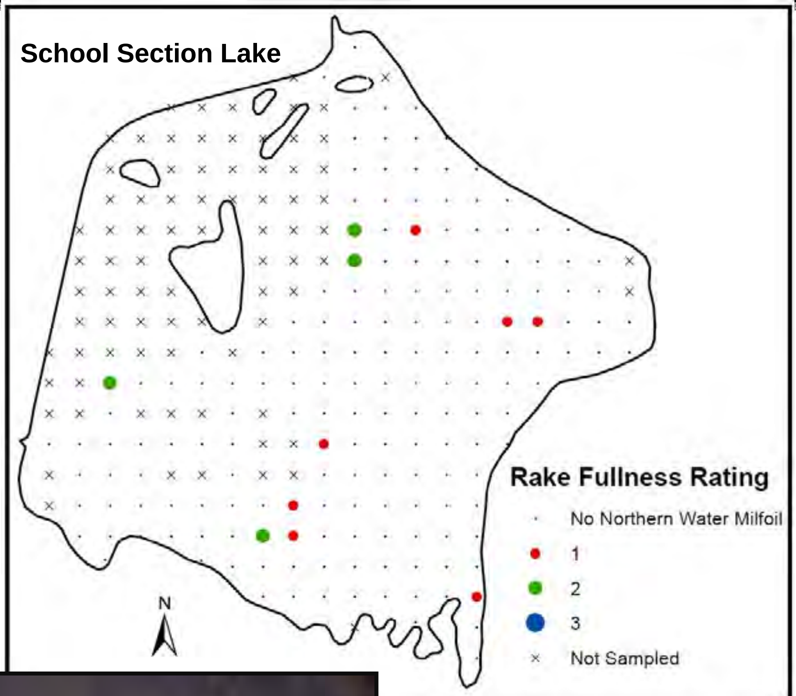
Identifying Features

- Light-colored, stout stems
- Leaves in whorls of four to five, divided into four to 12 pairs of leaflets, lower leaflets longer than the upper ones
- Forms winter buds (turions) in autumn

Northern water milfoil is similar to other water milfoils. Eurasian water milfoil (*M. spicatum*) tends to produce more leaflets per leaf and have more delicate, pinkish stems

Ecology

- Found in lakes and streams, shallow and deep
- Overwinters as winter buds and/or hardy rootstalks
- Consumed by waterfowl
- Habitat for fish and aquatic invertebrates
- Hybridizes with Eurasian water milfoil, resulting in plants with intermediate characteristics



Myriophyllum spicatum — Eurasian Water Milfoil

Nonnative/Exotic

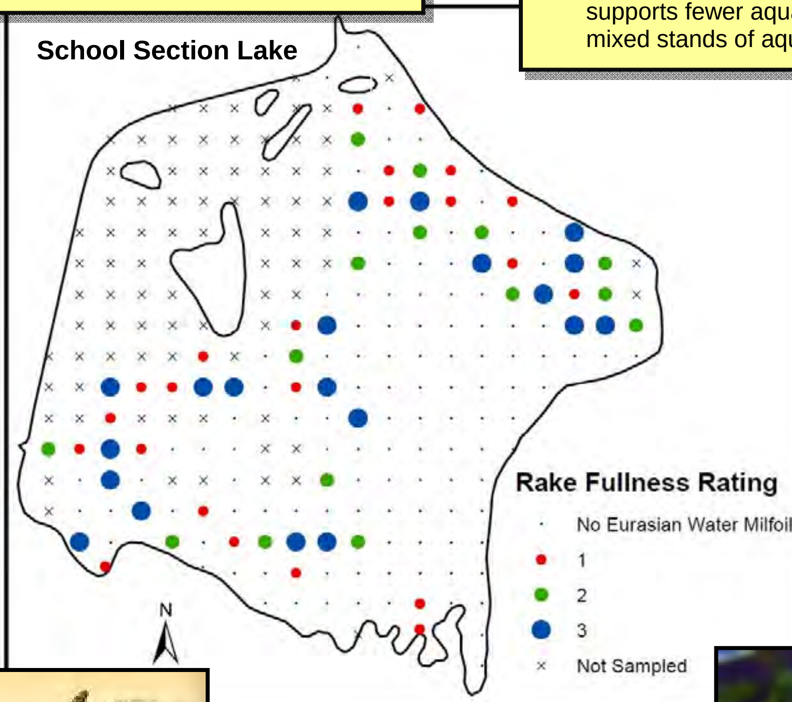
Identifying Features

- Stems spaghetti-like, often pinkish, growing long with many branches near the water surface
- Leaves with 12 to 21 pairs of leaflets
- Produces no winter buds (turions)

Eurasian water milfoil is similar to northern water milfoil (*M. sibiricum*). However, Northern water milfoil has five to 12 pairs of leaflets per leaf and stouter white or pale brown stems

Ecology

- Hybridizes with Northern (native) water milfoil, resulting in plants with intermediate characteristics
- Invasive, growing quickly, *forming canopies*, and getting a head-start in spring due to an ability to grow in cool water
- Grows from root stalks *and stem fragments* in both lakes and streams, shallow and deep; tolerates disturbed conditions
- Provides some forage to waterfowl, but supports fewer aquatic invertebrates than mixed stands of aquatic vegetation



Najas flexilis Bushy Pondweed or Slender Naiad

Native

Identifying Features

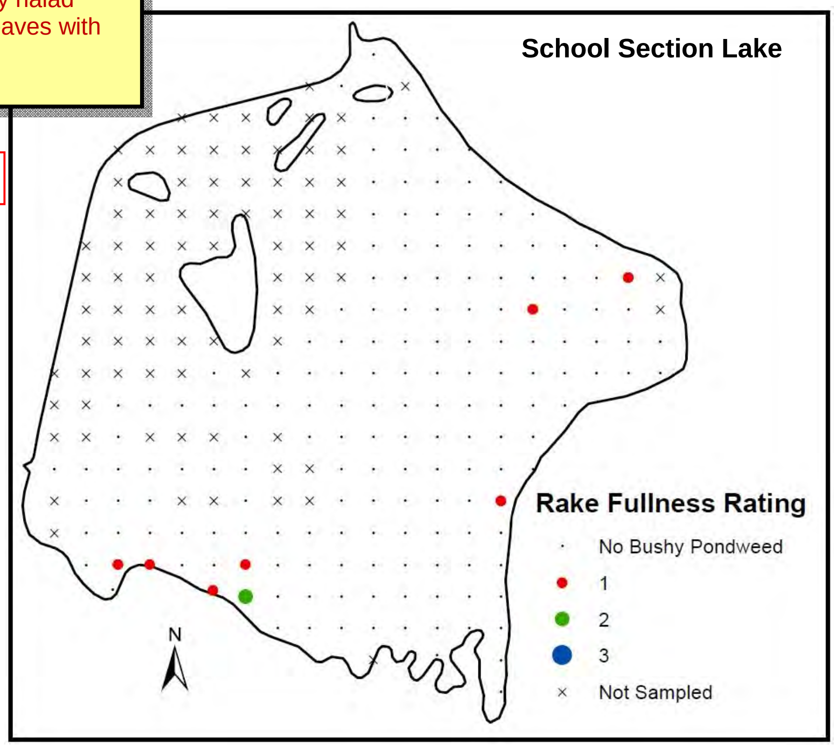
- Leaves narrow (0.4 to 1.0 mm) and pointed with broader bases where they attach to the stem and finely serrated margins
- Flowers, when present, tiny and located in leaf axils
- Variable size and spacing of leaves, as well as compactness of plant, depending on growing conditions

Two other *Najas* occur in southeastern Wisconsin. Southern naiad (*N. guadalupensis*) has wider leaves (to 2.0 mm). Spiny naiad (*N. marina*) has coarsely toothed leaves with spines along the midvein below

Ecology

- In lakes and streams, shallow and deep, often in association with wild celery
- *One of the most important forages of waterfowl*
- An annual plant that completely dies back in fall and regenerates from seeds each spring; also spreading by stem fragments during the growing season

Leaves narrow with serrated edges



Najas marina — Spiny Naiad

Nonnative/Exotic

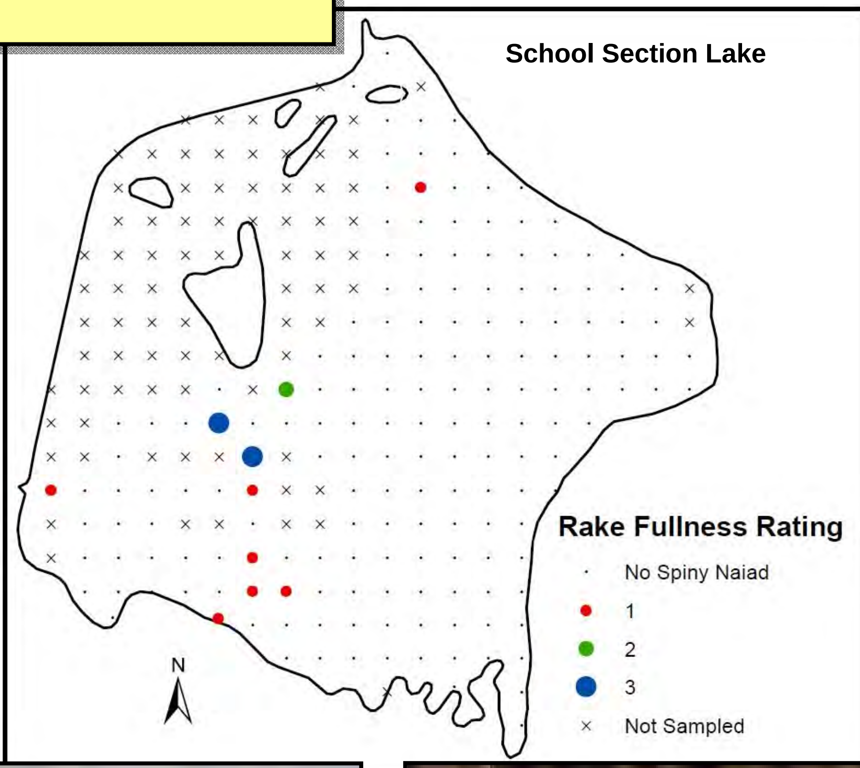
Identifying Features

- Stems stiff and spiny, often branching many times
- Leaves stiff, 1.0 to 4.0 mm thick, with coarse teeth along the margins and midvein on the underside

Spiny naiad is quite distinct from other naiads due to its larger, coarsely toothed leaves and the irregularly pitted surface of its fruits. Spiny naiad is presumably introduced in Wisconsin, but it is considered native in other states, including Minnesota

Ecology

- Alkaline lakes, water quality ranging from good to poor
- An annual, regenerating from seed each year
- Occurs as separate male and female plants
- Capable of growing aggressively



Nitella spp. — Nitellas (Stoneworts)

Algae (not vascular plants) Native

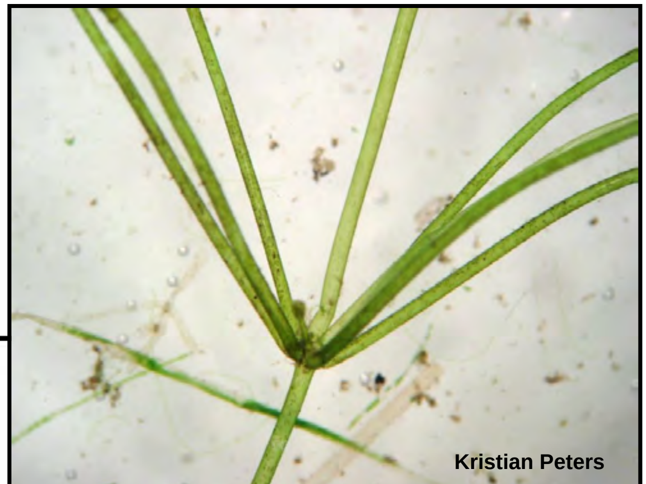
Identifying Features

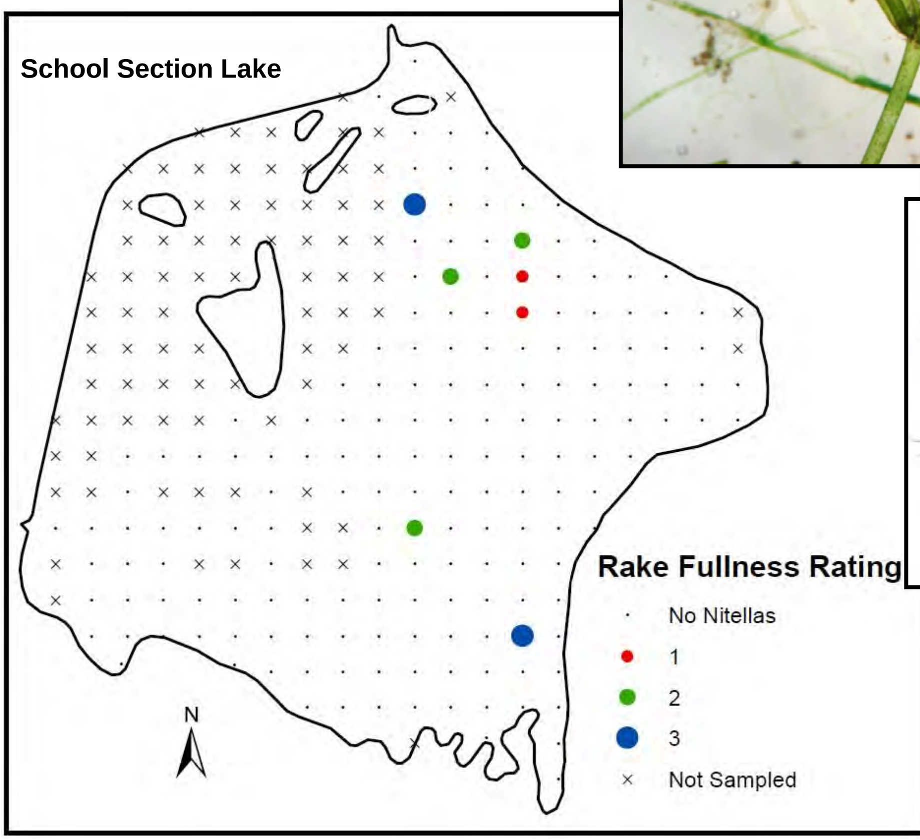
- Stems and leaf-like side branches delicate and smooth, side branches arranged in whorls
- Bright green
- Reproductive structures developing along the whorled branches

Muskgrasses (*Chara* spp.) are large algae similar to stoneworts (*Nitella* spp.), but their branches are ridged and more robust than those of stoneworts. Another similar group of algae, *Nitellopsis* spp., differ from stoneworts by having whorls of side branches that are at more acute angles to the main stem and star-shaped, pale bulbils that, when present, are near where side branches meet the main stem

Ecology

- Often found in deep lake waters over soft sediments
- Overwinters as rhizoids (cells modified to act as roots) or fragments
- Habitat for invertebrates, creating foraging opportunities for fish
- Sometimes browsed upon by waterfowl


Kristian Peters



Nuphar variegata — Spatterdock

Native

Identifying Features

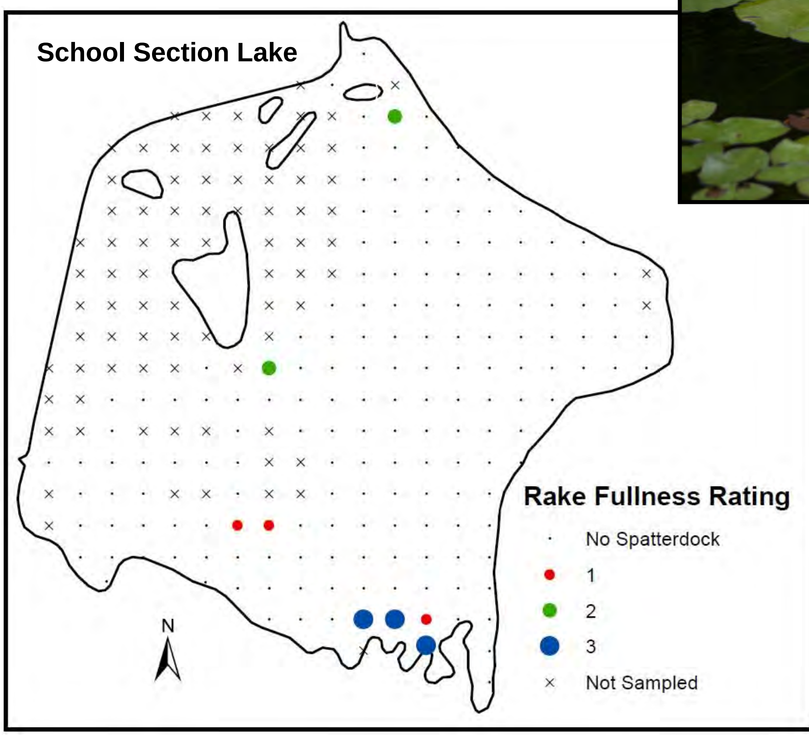
- Leaf stalks winged in cross-section
- Most leaves floating on the water surface, heart-shaped, and notched, with rounded lobes at the base
- Yellow flowers, 2.5 to 5.0 cm wide, often with maroon patches at the bases of the sepals (petal-like structures) when viewed from above

Unlike spatterdock, the similar yellow pond lily (*Nuphar advena*) has leaf stalks that are not winged in cross-section, leaves that more often emerge above the water surface, and leaf lobes that are more pointed. Spatterdock is superficially similar to water lilies (*Nymphea* spp.), but it has yellow versus white flowers and leaves somewhat heart-shaped versus round. American lotus (*Nelumbo lutea*) is also similar, but its leaves are round and un-notched, and its flowers are much larger

Ecology

- In sun or shade and mucky sediments in shallows and along the margins of ponds, lakes, and slow-moving streams
- Overwinters as a perennial rhizome
- Flowers opening during the day, closing at night, and with the odor of fermented fruit
- Buffers shorelines
- Provides food for waterfowl (seeds), deer (leaves and flowers), and muskrat, beaver, and porcupine (rhizomes)
- Habitat for fish and aquatic invertebrates

Ron Edwards



Jason Hollinger

Nymphaea odorata — White Water Lily

Native

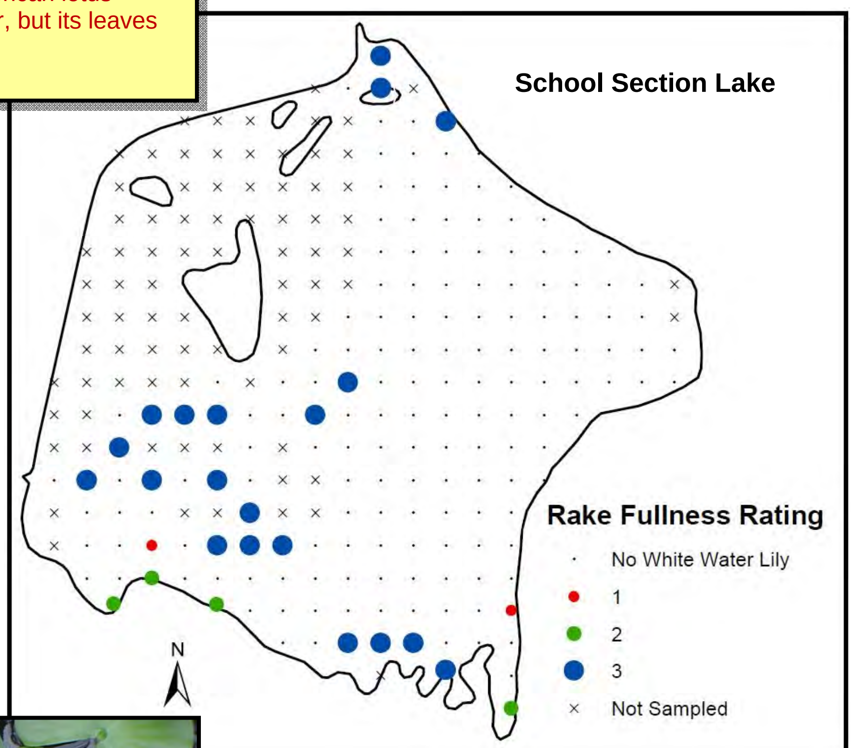
Identifying Features

- Leaf stalks round in cross-section with four large air passages
- Floating leaves round (four to 12 inches wide under favorable conditions), *with a notch* from the outside to the center, and reddish-purple underneath
- Flowers white with a yellow center, three to nine inches wide

Pond lilies (*Nuphar* spp.) are superficially similar, but have yellow flowers and leaves somewhat heart-shaped. American lotus (*Nelumbo lutea*) is also similar, but its leaves are *unnotched*

Ecology

- Found in shallow waters over soft sediments
- Leaves and flowers emerge from rhizomes
- Flowers opening during the day, closing at night
- Seeds consumed by waterfowl, rhizomes consumed by mammals



Potamogeton crispus
Nonnative/Exotic/Invasive

Curly-Leaf Pondweed

Identifying Features

- Stems slightly flattened and both stem and leaf veins often somewhat pink
- Leaf margins very wavy and finely serrated
- Stipules (3.0 to 8.0 mm long) partially attached to leaf bases, disintegrating early in the season
- Produces pine cone-like overwintering buds (turions)

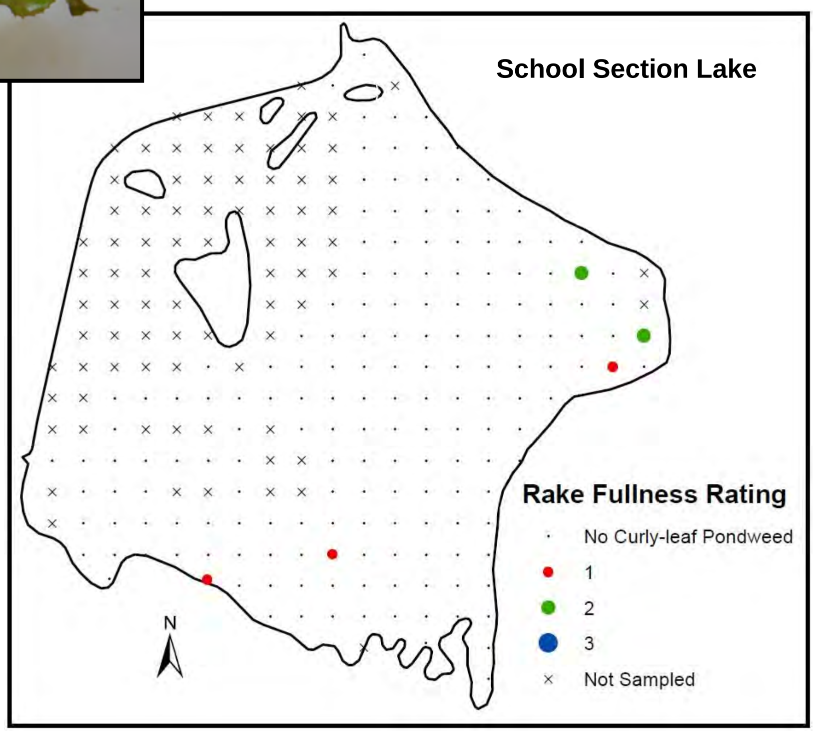
Curly-leaf pondweed may resemble clasping-leaf pondweed (*P. richardsonii*), but the leaf margins of the latter are not serrated

Ecology

- Found in lakes and streams, both shallow and deep
- Tolerant of low light and turbidity
- Disperses mainly by turions
- Adapted to cold water, growing under the ice while other plants are dormant, but dying back during mid-summer in warm waters
- Produces winter habitat, but mid-summer die-offs can degrade water quality and cause algal blooms
- Maintaining or improving water quality can help control this species, because it has a competitive advantage over native species when water clarity is poor


Zofia Noe


Zofia Noe



Potamogeton gramineus — Variable Pondweed

Native

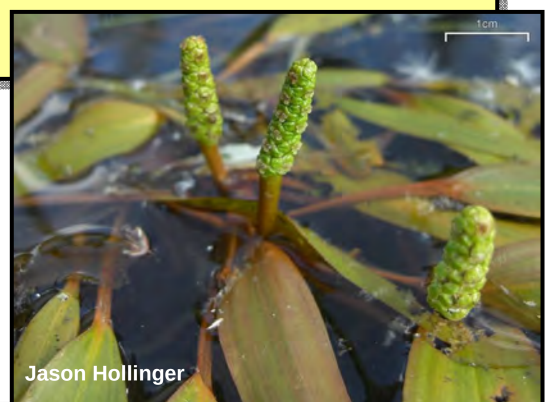
Identifying Features

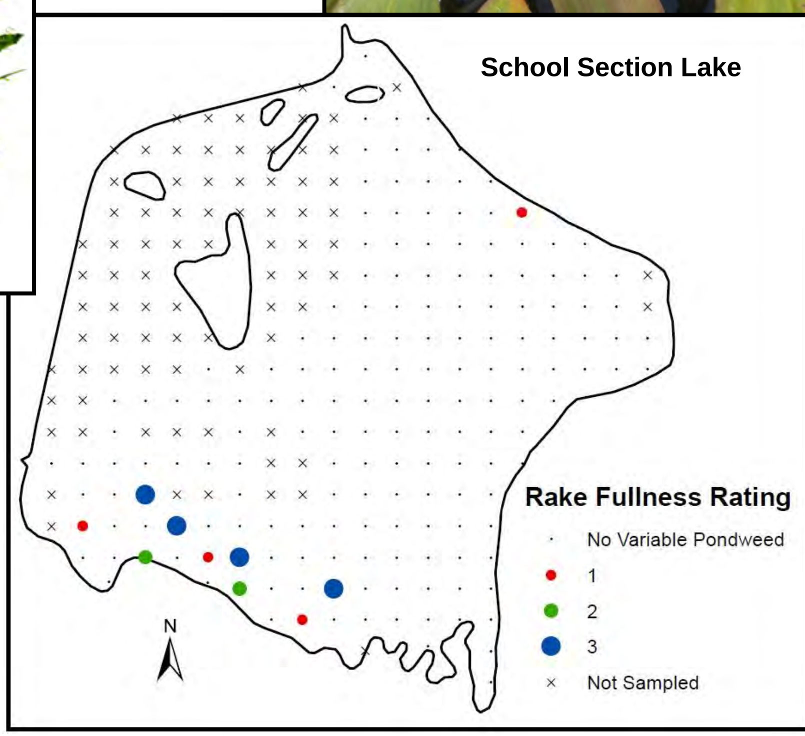
- Often heavily branched
- Submerged leaves narrow to lance-shaped, with three to seven veins, smooth margins, without stalks, but the blade tapering to the stem
- *Floating leaves* with 11 to 19 veins and a slender stalk that is usually longer than the blade
- Often covered with calcium carbonate in hard water

Variable pondweed is similar to Illinois pondweed (*P. illinoensis*), but Illinois pondweed has submerged leaves with nine to 19 veins

Ecology

- Shallow to deep water, often with muskgrass, wild celery, and/or slender naiad; requires more natural areas that receive little disturbance
- Overwinters as rhizomes or winter buds (turions)
- Provides food for waterfowl, muskrat, deer, and beaver
- Provides habitat for fish and aquatic invertebrates





Potamogeton illinoensis
Native

Illinois Pondweed

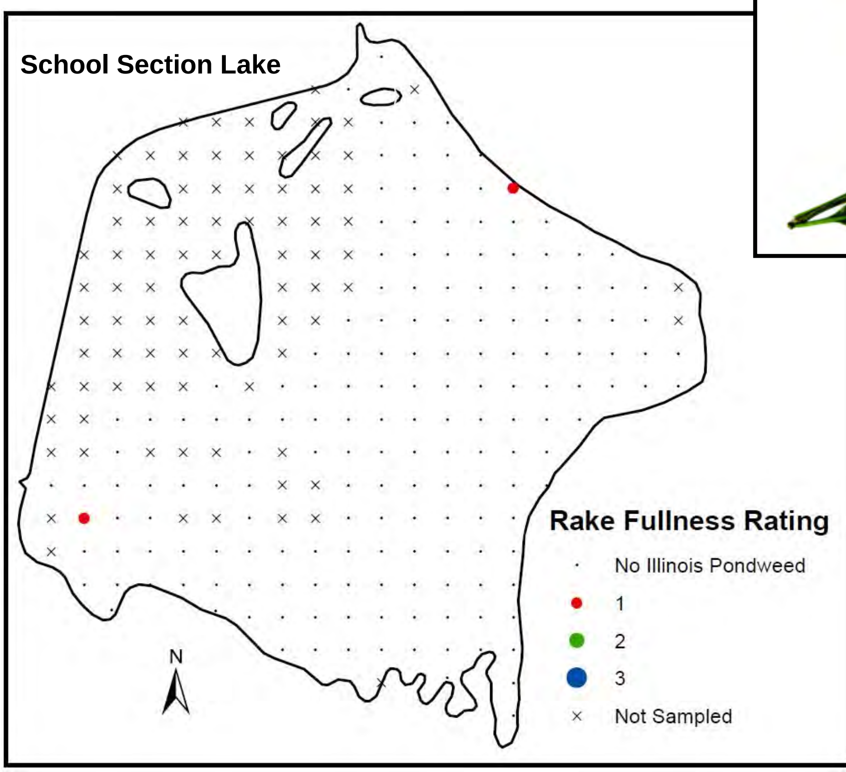
Identifying Features

- Stout stems up to 2.0 m long, often branched
- Submerged leaves with nine to 19 veins (midvein prominent) on short stalks (up to 4.0 cm) or attached directly to the stem
- Floating leaves, if produced, elliptical, with 13 to 29 veins
- Often covered with calcium carbonate in hard water

Variable pondweed (*P. gramineus*) is similar to Illinois pondweed, but differs in having three to seven veins on submerged leaves

Ecology

- Lakes with clear water, shallow or deep, neutral or hard, over soft sediments
- Overwinters as rhizomes or remains green under the ice
- Provides food for waterfowl, muskrat, deer, and beaver
- Provides excellent habitat for fish and aquatic invertebrates



Potamogeton natans — Floating-Leaf Pondweed

Native

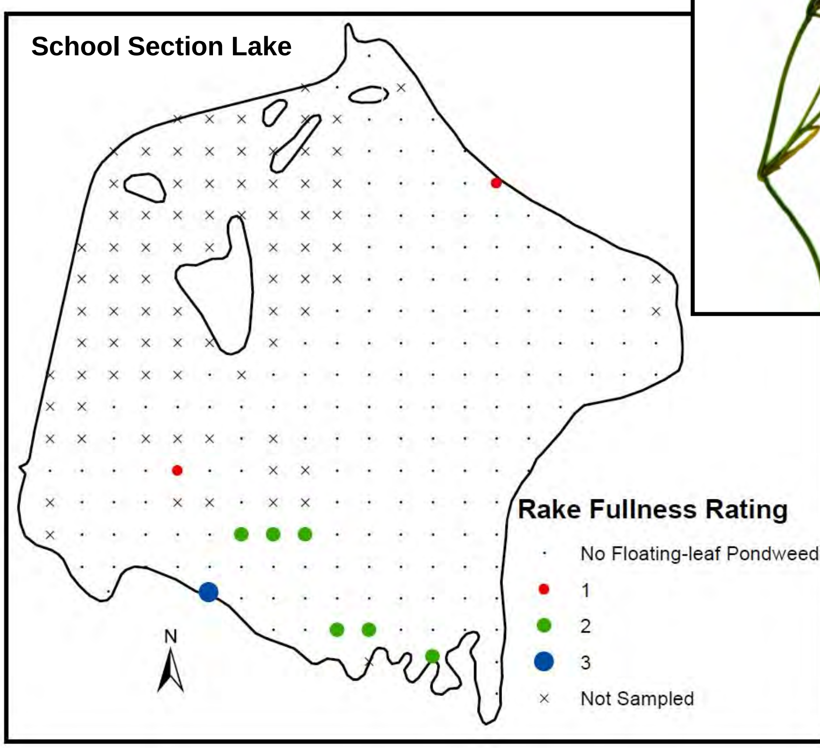
Identifying Features

- Floating leaves (5.0 to 10 cm long) with heart-shaped bases and 17 to 37 veins
- Floating leaf stalks bent where they meet the leaf, causing the leaf to be held at roughly a 90-degree angle to the stalk
- Submersed leaves (1.0 to 2.0 mm wide) linear and stalk-like, with three to five veins

Floating-leaf pondweed is similar to Oakes' pondweed (*P. oakesianus*) and spotted pondweed (*P. pulcher*). Oake's pondweed is smaller, with floating leaves 2.5 to 6.0 cm long and submersed leaves 0.25 to 1.0 mm wide. Spotted pondweed differs in having small black spots on its stems and leaf stalks and lance-shaped submersed leaves with wavy margins

Ecology

- Usually in shallow waters (<2.5 m) over soft sediment
- Emerges in spring from buds formed along rhizomes
- Provides food for waterfowl, muskrat, beaver, and deer
- Holds fruit on stalks until late in the growing season, which provides valuable feeding opportunities for waterfowl
- Provides good fish habitat



Potamogeton nodosus — Long-Leaf Pondweed

Native

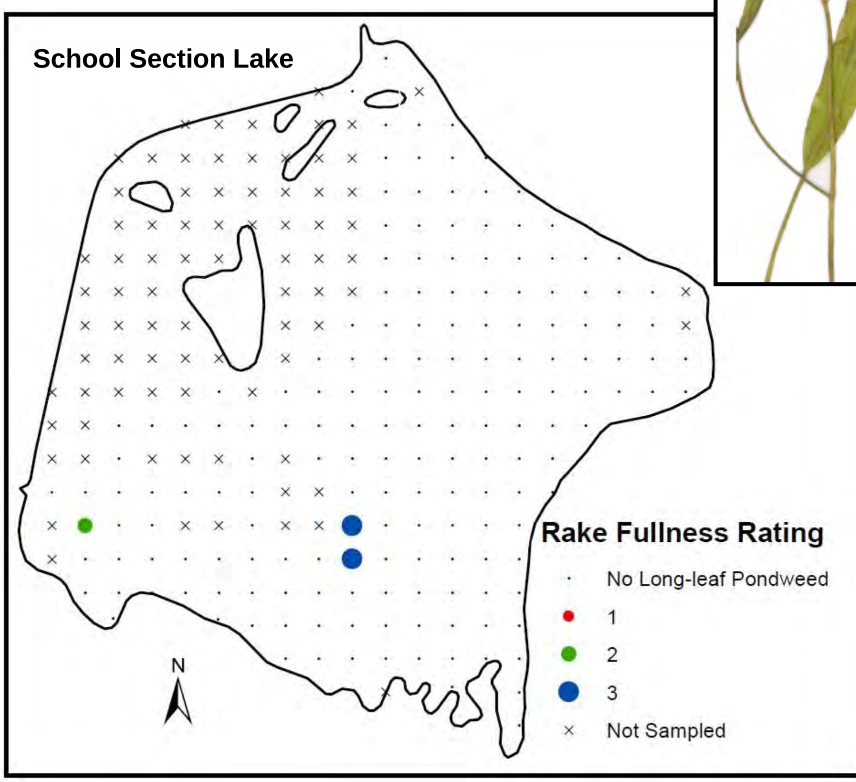
Identifying Features

- Floating leaves 5.0 to 13 cm long, tapering to leaf stalks that are longer than the attached leaf blades
- Submersed leaves up to 30 cm long and 1.0 to 2.5 mm wide, with seven to 15 veins, and long leaf stalks
- Stipules 4.0 to 10 cm long, free from the leaves, disintegrating by midsummer

Long-leaf pondweed may be distinguished from other pondweeds that have similar floating leaves (e.g. *P. illinoensis* and *P. natans*) by the long leaf stalks of its submersed leaves. The floating leaves of *P. natans* also differ by having a heart-shaped base and by being held to the leaf stalks at roughly 90-degree angles. In *P. illinoensis* the stalks of floating leaves, if produced, are shorter than the leaf blades

Ecology

- Streams and lakes, shallow and deep, but more often in flowing water
- Emerges in spring from buds formed along rhizomes
- Provides food for waterfowl, muskrat, beaver, and deer
- Harbors large numbers of aquatic invertebrates, which provide food for fish



Potamogeton pectinatus — Sago Pondweed

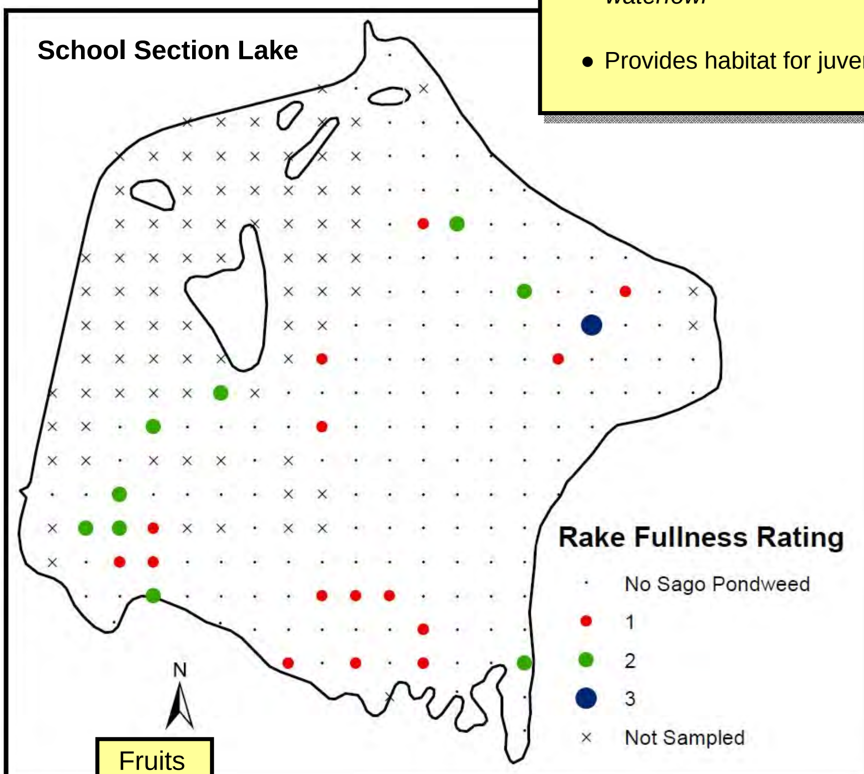
Native

Identifying Features

- Stems often *slightly zig-zagged* and forked multiple times, yielding a fan-like form
- Leaves one to four inches long, very thin, and ending in a sharp point
- Whorls of fruits spaced along the stem may appear as beads on a string

Ecology

- Lakes and streams
- Overwinters as rhizomes and starchy tubers
- Tolerates murky water and disturbed conditions
- Provides abundant fruits and tubers, which are an *important food for waterfowl*
- Provides habitat for juvenile fish



Potamogeton praelongus White-Stem Pondweed

Native

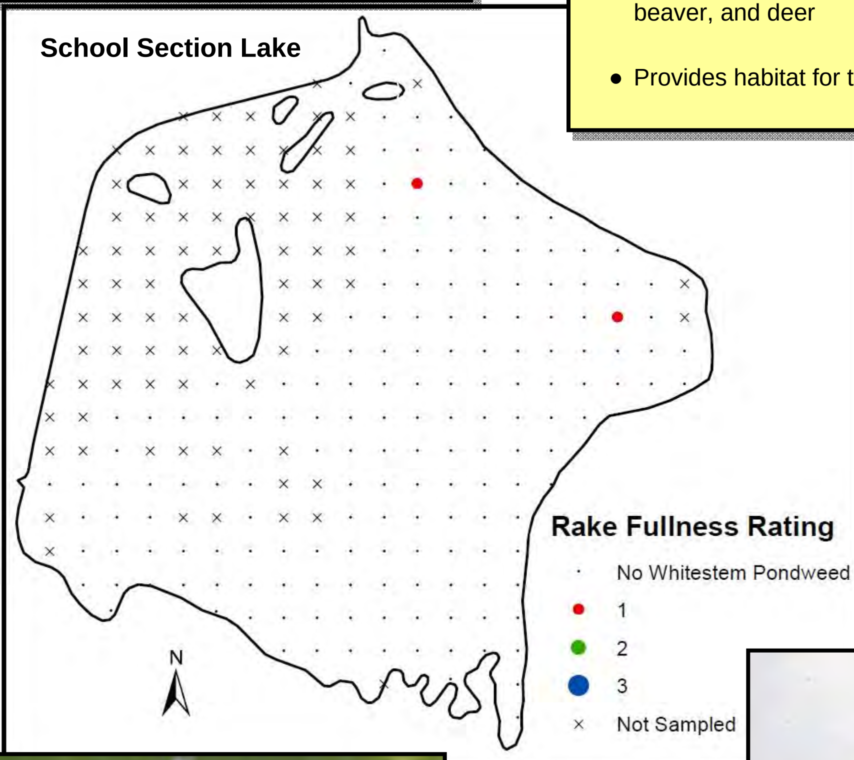
Identifying Features

- Stems usually pale and zig-zagging
- Leaves clasping, alternate, with three to five prominent veins and 11 to 35 smaller ones, with boat-shaped tips that often split when pressed between fingers

White-stem pondweed is similar to clasping-leaf pondweed (*P. richardsonii*), but the leaves of clasping-leaf pondweed do not have boat-shaped tips that split when pressed

Ecology

- Found in clear lakes in water three to 12 feet deep over soft sediments
- *"Indicator species"* due to its sensitivity to water quality changes; its disappearance indicating degradation; requires more natural areas that receive little disturbance
- Sometimes remains evergreen beneath the ice
- Provides food for waterfowl, muskrat, beaver, and deer
- Provides habitat for trout and muskellunge



Potamogeton richardsonii
Native

Clasping-Leaf Pondweed

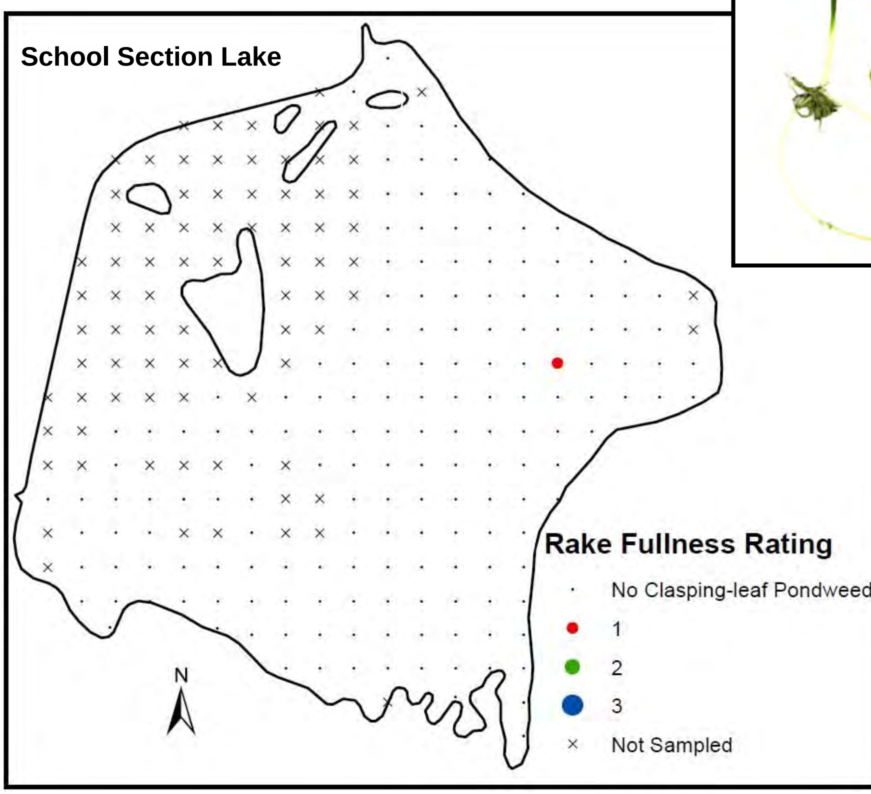
Identifying Features

- Leaves alternating along and clasping the stem, with wavy edges, coming to a point at the tip, and often with three to five veins prominent among many more that are faintly visible
- Produces no floating leaves

Clasping pondweed is similar to white-stem pondweed (*P. praelongus*), but the latter has boat-shaped leaf tips that split when pressed between one's fingers. The exotic curly-leaf pondweed (*P. crispus*) may appear similar, but differs by having serrated leaf margins

Ecology

- In lakes and streams, shallow and deep, often in association with coontail
- Tolerant of disturbance
- Fruits a food source for waterfowl and plants browsed by muskrat, beaver, and deer
- Stems emerging from perennial rhizomes



Ranunculus aquatilis
Native

White Water Crowfoot

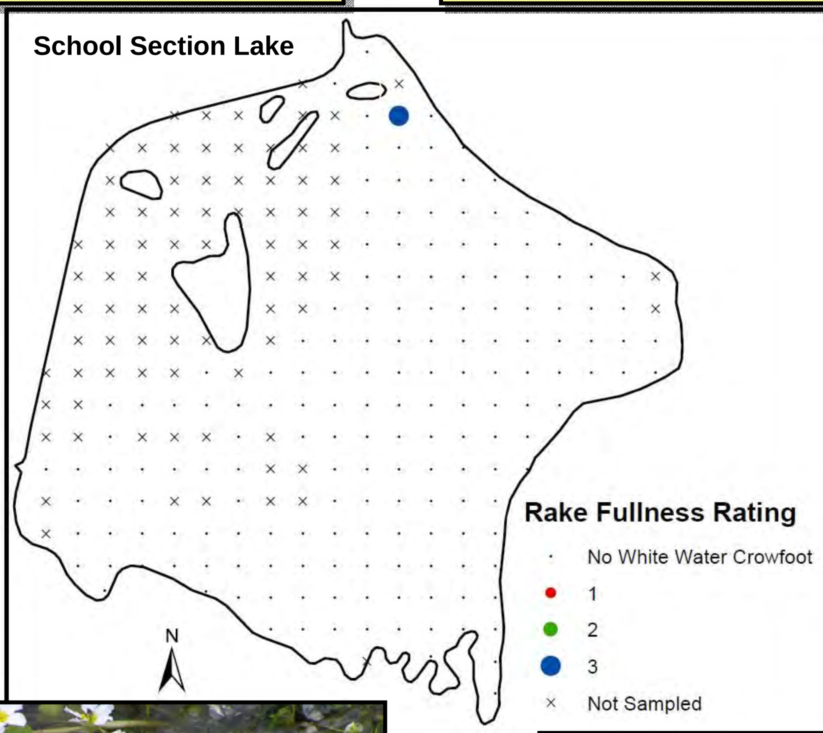
Identifying Features

- Submersed leaves finely divided into thread-like sections, and arranged alternately along the stem
- Flowers white, with five petals
- May or may not produce floating leaves

White water crowfoot is similar to other aquatic *Ranunculus* spp. However, the latter have yellow flowers and leaf divisions that are flat, rather than thread-like

Ecology

- Shallow water in lakes or streams, often with high alkalinity
- Often forms dense patches near springs or sand bars
- Emerges from rhizomes in the spring
- Fruit and foliage consumed by waterfowl and upland birds alike
- Habitat for invertebrates that are food for fish like trout



Scirpus subterminalis — Water Bulrush

Native

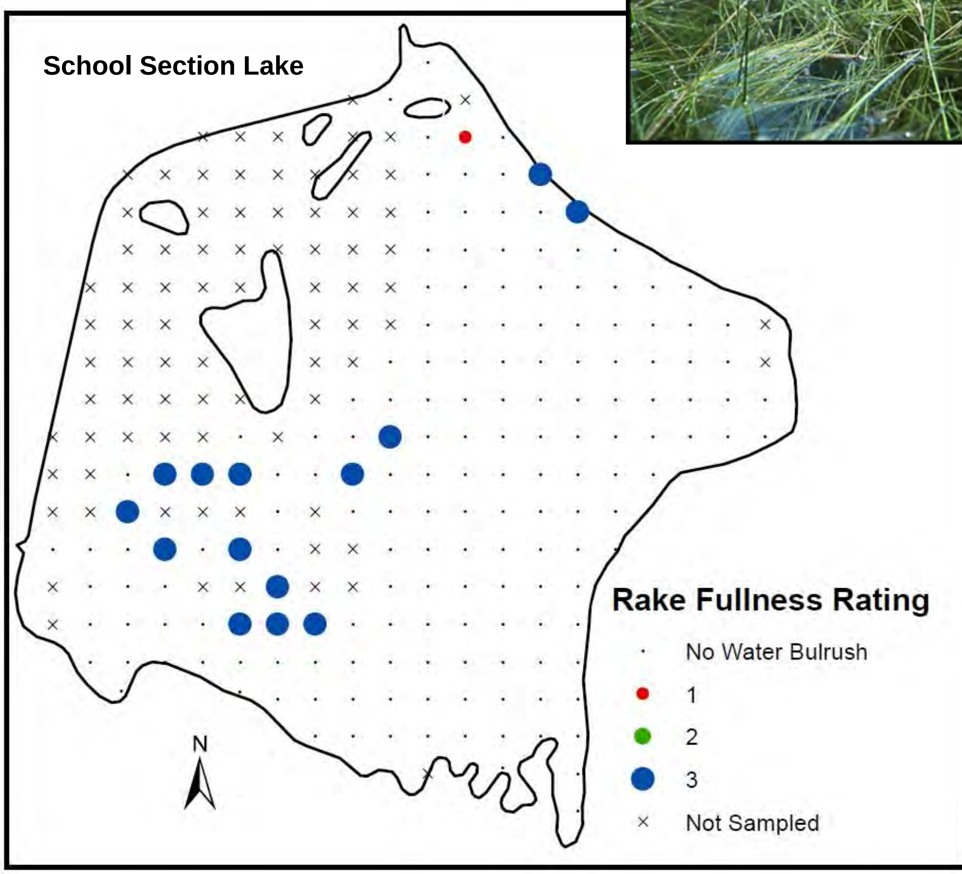
Identifying Features

- Leaves hair-like, with one to five veins length-wise and some perpendicular "cross veins"
- Leaves sheathing one another at the base
- Spikelets (fertile structures), when present, 7.0 to 12 mm long, with a floral leaf extending above the spikelet

The fine submersed leaves of water bulrush could be confused with the fine, submersed stems of Robbins' spikerush (*Eleocharis robbinsii*). However, the stems of Robbins' spikerush are separate from one another, unlike the fine leaves of water bulrush, which sheath each other at the base of each shoot

Ecology

- Found in a variety of shallow to deep waters
- Spreading by rhizomes, forming grass-like, submersed meadows
- Provides phosphorus to algae that grow on its surface, which, in turn, are important for invertebrate growth
- Provides habitat for invertebrates and fish



Utricularia spp.
Native

Bladderworts

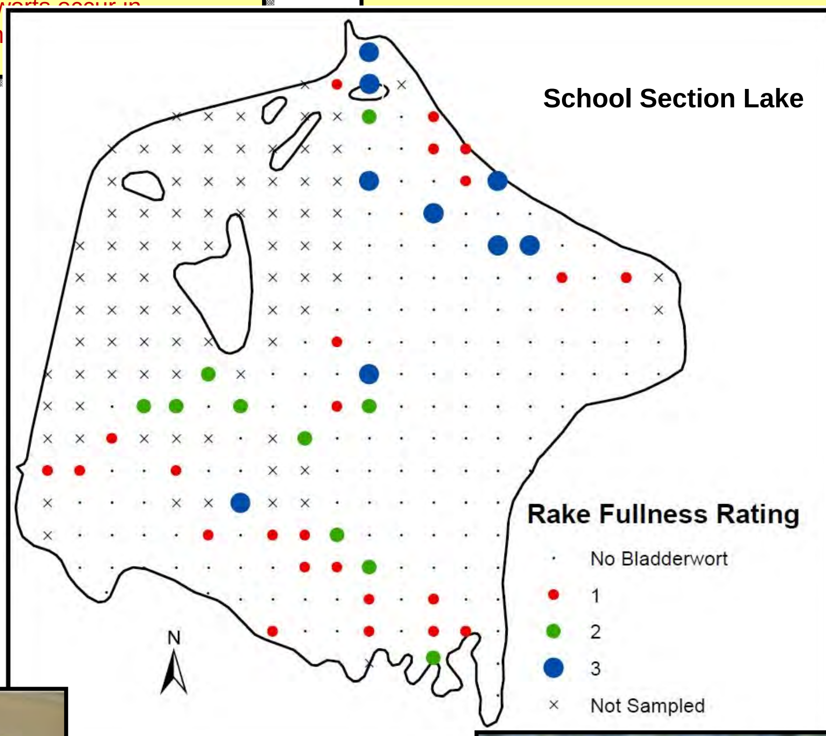
Identifying Features

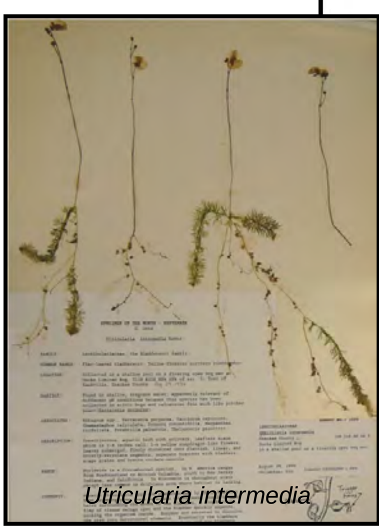
- Flowers snapdragon-like, yellow or purple, held on stalks above the water surface
- *Producing bladders* (small air chambers on the stem) that capture prey and give buoyancy to the stem
- Stems either floating (due to air bladders) or anchored in the substrate; branches finely divided, if floating

Several similar bladderworts occur in southeastern Wisconsin

Ecology

- Most species found in quiet shallows and along shores, but common bladderwort (*Utricularia vulgaris*) sometimes occurring in water several feet deep
- Provides forage and cover for a wide range of aquatic organisms
- Bladders capturing and digesting prey, including small invertebrates and protozoans




Utricularia intermedia


Utricularia gibba
David Midgley


Utricularia vulgaris
Kirill Ignatyev


Utricularia purpurea

Vallisneria americana — Eelgrass

Native

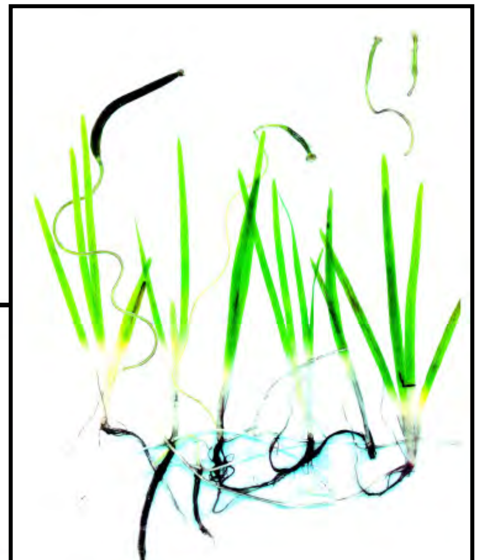
Identifying Features

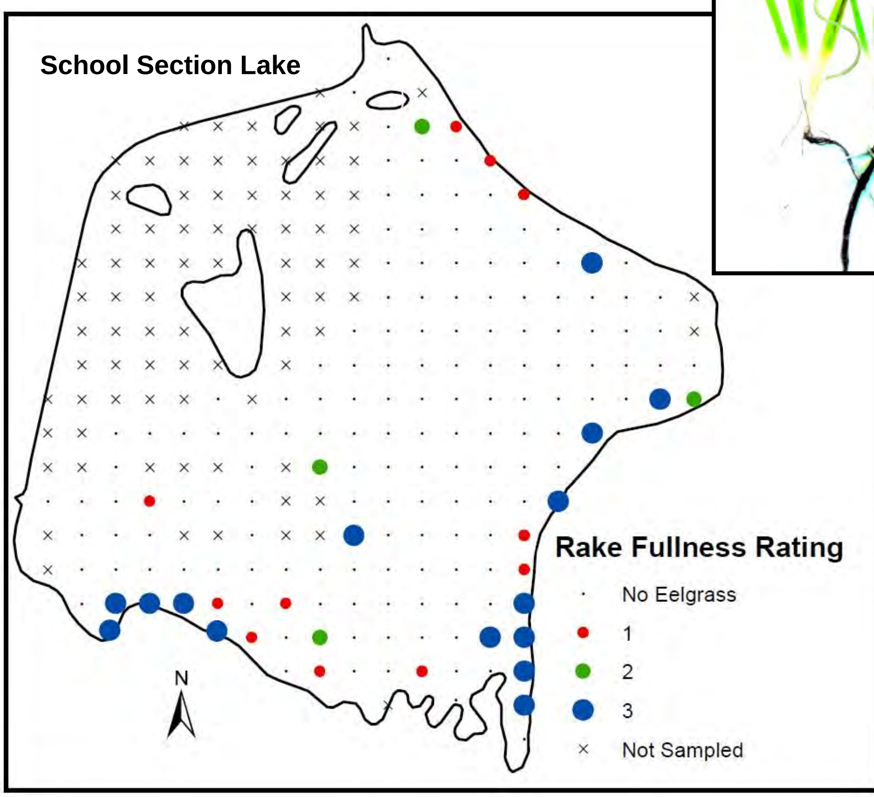
- Leaves ribbon-like, up to two meters long, with a prominent stripe down the middle, and emerging in clusters along creeping rhizomes
- Male and female flowers on separate plants, female flowers raised to the surface on spiral-coiled stalks

The foliage of eelgrass could be confused with the submersed leaves of bur-reeds (*Sparganium* spp.) or arrowheads (*Sagittaria* spp.), but the leaves of eelgrass are distinguished by their prominent middle stripe. The leaves of ribbon-leaf pondweed (*Potamogeton epihydrus*) are also similar to those of eelgrass, but the leaves of the former are alternately arranged along a stem rather than arising from the plant base

Ecology

- Firm substrates, shallow or deep, in lakes and streams
- Spreads by seed, by creeping rhizomes, and by offsets that break off and float to new locations in the fall
- All portions of the plant consumed by waterfowl, an especially important food source for Canvasback ducks
- Provides habitat for invertebrates and fish





Zosterella dubia — Water Stargrass

Native

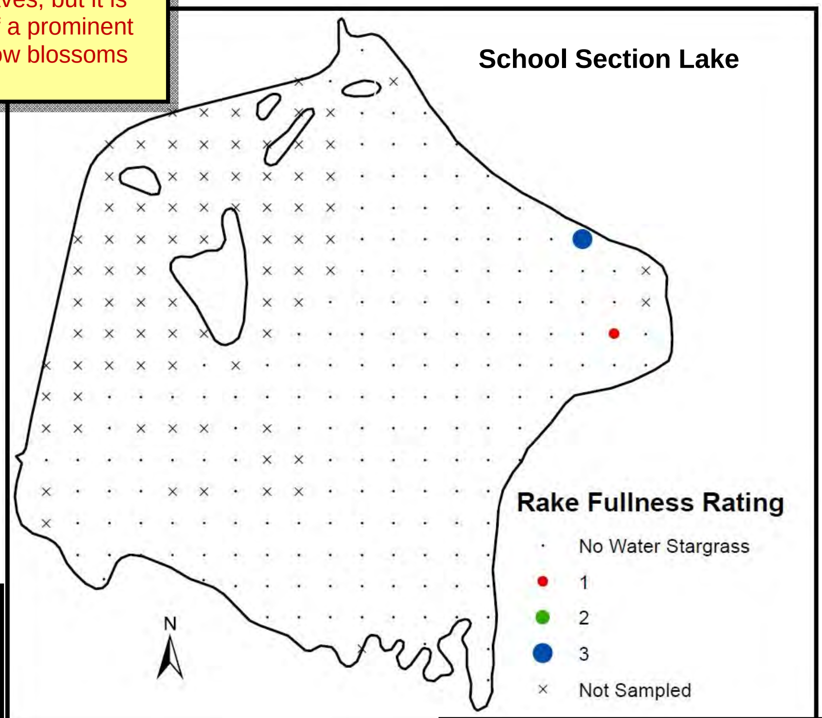
Identifying Features

- Stems slender, slightly flattened, and branching
- Leaves narrow, alternate, with no stalk, and lacking a prominent midvein
- When produced, flowers conspicuous, yellow, and star-shaped (usually in shallow water) or inconspicuous and hidden in the bases of submersed leaves (in deeper water)

Yellow stargrass may be confused with pondweeds that have narrow leaves, but it is easily distinguished by its lack of a prominent midvein and, when present, yellow blossoms

Ecology

- Found in lakes and streams, shallow and deep
- Tolerates somewhat turbid waters
- Overwinters as perennial rhizomes
- Limited reproduction by seed
- Provides food for waterfowl and habitat for fish



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Appendix C

BOATING ORDINANCES FOR SCHOOL SECTION LAKE

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CHAPTER 20

LAKES AND BEACHES

20.01 BOAT TRAFFIC. (1) Sections 30.50 through 30.71 inclusive, and §30.80 (1) and (2), Wis. Stats., are hereby adopted by reference except where the provisions of this chapter are more restrictive and in that event the provisions of this chapter shall control.

(2) No person shall swim more than 150' from shore unless accompanied by an escort boat.

(3) All power boats must travel in counter-clockwise direction at all times.

(4) No motor boat shall operate at a speed in excess of slow-no-wake under the following conditions:

(a) Before 11 a.m. and after 6 p.m.

(b) When closer than 100' to any bathing beach or anchored boat.

(5) No person shall water ski between rafts and shorelines.

(6) No person shall operate any boat unless such boat shall be equipped with U.S. Coast Guard approved personal flotation devices as required under §NR 5.13, Wis. Adm. Code.

(7) All waterskiers shall wear U.S. Coast Guard approved life jackets, Type I, II or III, (PFD).

20.02 PUBLIC ACCESS POINTS. (1) PARKING. (a) Parking shall be prohibited on both sides of Pretty Lake Road at all times.

(b) Parking shall be permitted for 4 vehicles only at designated public access points leading to Pretty Lake between 6 a.m. and 10 p.m. Parking at points which are not designated and at all other times not specified herein is prohibited.

(2) RESTRICTIONS. No person shall do any of the following on public access points and areas leading to public access points within the Town:

(a) Consume beverages or food.

(b) Camp or picnic.

(c) Have pets or livestock including horses.

(d) Litter.

20.03 HENRIETTA LAKE AND UTICA LAKE. (1) APPLICATION. The provisions of this ordinance shall apply to the waters of Henrietta Lake and Utica Lake, within the jurisdiction of the Town of Summit and the Town of Ottawa. The provisions of this ordinance shall be enforced by the officers of the Water Safety Patrol Unit and police of the jurisdiction of the Town of Summit.

(2) STATE BOATING AND WATER SAFETY LAWS ADOPTED.

(a) Except as otherwise specifically provided in this ordinance, the current and future statutory provisions describing and defining regulations with respect to water traffic, boats, boating, and relating water activities in §§30.50 up to and including 30.71, of the Wisconsin Statutes, exclusive of any provisions therein relating to the penalties to be imposed or the punishment for violation of said statutes, are hereby adopted and by reference made a part of this ordinance as if fully set forth herein. Any act required to be performed or prohibited by any current or future statute incorporated herein by reference is required or prohibited by this ordinance. Any further additions, amendments, revisions or modifications of the statute incorporated herein are intended to be made part of this ordinance in order to secure uniform state-wide regulation of the waterways of the State.

(b) All rules and orders created by the Wisconsin Department of Natural Resources, modifying or supplementing the foregoing provisions of State Law or which may be adopted or made in the future, are hereby incorporated in and made a part of this ordinance by deferring to the same as if they are or were to be set out herein verbatim.

(3) OPERATION OF MOTOR BOATS. No motor boat shall be operated on Henrietta Lake and Utica Lake at any time at a speed in excess of slow no wake.

(4) SWIMMING REGULATIONS. No person, unless said person is engaging in activities and subject to the provisions of §30.70, Wisconsin Statutes, entitled Skin Diving, shall:

(a) Swim from any unmanned boat, unless such boat is anchored, or

(b) Swim more than 150 feet from the shoreline unless is a designated swimming zone or unless accompanied by a competent person in a boat, or

(c) Swim more than 150 feet from the shoreline between sunset and sunrise.

(5) PENALTY.

(a) STATE BOATING AND WATER SAFETY LAWS AND ALL OTHER VIOLATIONS AS SET FORTH IN §2 OF THIS ORDINANCE.

Any forfeiture for violation of the State statute, rule or order adopted by reference in §2 of this ordinance shall conform to the forfeiture permitted to be imposed for violation of such statutes as set forth in the Uniform Wisconsin Deposit and Bail Schedule for Conservation, Boating, Snowmobile, and ATV Violations, including any variations or increases for subsequent offenses, which schedule is adopted by reference.

(b) LOCAL BOATING LAWS AS SET FORTH IN §§3, 4 and 5 OF THIS ORDINANCE.

Any person 16 years or older violating the provisions of this ordinance shall be subject to a forfeiture of not more than $500 plus court costs and penalty assessment. Failure to pay any forfeiture hereunder shall subject the violator to imprisonment in the County Jail or loss of license.

Any person 14 or 15 years of age shall be subject to a forfeiture of not less than $10 nor more than $25 plus court costs and penalty assessment per each offense or referred to the proper authorities as provided in Chapter 48, Wisconsin Statutes. Failure to pay any forfeiture hereunder shall subject the violator to the provisions of §48.17(2), Wisconsin Statutes.

Any person under the age of 14 shall be referred to the proper authorities as provided in Chapter 48, Wisconsin Statutes.

(6) ENFORCEMENT.

(a) Enforcement Procedure. The statutory provisions of §§66.115, 66.119, 66.12, 30.29, 30.50 to 30.71, and Chapter 799, Wisconsin Statutes, are adopted and by reference made a part of this ordinance as if fully set herein. Any act required to be performed or prohibited by any statute incorporated herein by reference is required or prohibited by this ordinance. Any future additions, amendments, revisions or modifications of the statutes incorporated herein are intended to be made part of this ordinance in order to secure uniform state-wide regulation and enforcement of boating ordinance violations. Further, the Town of Summit and the Town of Ottawa specifically elect to use the citation method of enforcement.

(b) Deposits.

1. Schedule of Deposits. The schedule of cash deposits shall be as follows:

§2: Applicable sections of Uniform Wisconsin Deposit and Bail Schedule for Conservation, Boating, Snowmobile and ATV Violations plus current assessment fees and current court costs if applicable.

§§3, 4 and 5: $50 plus court costs and assessments plus current assessment fees and current court costs if applicable.

2. Deposit for Repeat Offenses. Any person found guilty of violating this ordinance or any part thereof who was previously convicted of the same section within the last year shall forfeit twice the deposit delineated above plus court costs and penalty assessment.

3. Non-Scheduled Deposit. If a deposit schedule has not been established for a specific violation, the arresting officer shall require the alleged offender to deposit not less than the maximum forfeiture permitted hereunder.

4. Depository. Deposits should be made in cash, money order, or certified check to the Clerk of Municipal Court, who shall issue a receipt therefore as required by Wisconsin Statute. If the deposit is mailed, the signed statement required by Wisconsin Statute shall be mailed with the deposit.

(c) Nonexclusivity.

1. Other Ordinances. Adoption of this ordinance does not preclude the Town Boards from adopting any other ordinance or providing for the enforcement of any other law or ordinance relating to the same or other matter.

2. Other Remedies. The issuance of a citation hereunder shall not preclude the Town Boards or any authorized office from proceedings under any other ordinance of law or by any other enforcement method to enforce any ordinance, regulation or order.

20.04 SCHOOL SECTION LAKE. (1) APPLICATION. The provisions of this ordinance shall apply to the waters of School Section Lake.

(2) OPERATION OF MOTOR BOATS.

(a) No boats shall be operated at a speed greater than slow, no wake, between the hours of sunrise and sunset.

(b) No motor boats whatsoever shall be allowed to operate between the hours of sunset and sunrise.

(3) ADDITIONAL RESTRICTIONS. The restrictions contained in this subsection are in addition to all other boating regulations contained within the Town of Ottawa Town Code. In the event there is a conflict between the restrictions contained in this subsection and restrictions contained elsewhere in the Town of Ottawa Town Code, the restrictions of this particular subsection shall apply.

20.05 PENALTY. Except as otherwise provided, any person who shall violate any provision of this chapter, or any regulation, rule or order made hereunder, shall be subject to a penalty as provided in §25.04 of this General Code.

Appendix D

WETLAND DELINEATION FOR HARVESTING DISPOSAL SITE ON SCHOOL SECTION LAKE

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SVY3681
CA730-74

EXHIBIT A

PRELIMINARY VEGETATION SURVEY
JEROME AND JACLYN SMUKOWSKI PROPERTY

Date: May 18, 2010

Observers: Donald M. Reed, Ph.D., Chief Biologist
Lawrence A. Leitner, Ph.D., Principal Biologist
Christopher J. Jors, Biologist
Southeastern Wisconsin Regional Planning Commission

Location: Town of Ottawa in parts of the Southeast one-quarter of U.S. Public Land Survey Section 17, Township 6 North, Range 17 East, Waukesha County, Wisconsin.

Species List: Plant Community Area No. 1

EQUISETACEAE
Equisetum arvense--Common horsetail

GRAMINEAE
Calamagrostis canadensis--Canada bluejoint
Phalaris arundinacea[1,2]--Reed canary grass

CYPERACEAE
Carex blanda--Wood sedge
Carex pellita--Woolly sedge
Carex lacustris--Lake sedge

ARACEAE
Arisaema triphyllum--Jack-in-the-pulpit

LEMNACEAE
Lemna minor--Lesser duckweed

JUNCACEAE
Juncus tenuis--Path rush

SALICACEAE
Populus tremuloides--Quaking aspen
Populus deltoides--Cottonwood
Salix nigra--Black willow
Salix bebbiana--Beaked willow

ULMACEAE
Ulmus americana--American elm

RANUNCULACEAE
Ranunculus recurvatus--Hooked buttercup
Thalictrum dasycarpum--Tall meadow rue

CRUCIFERAE
Alliaria officinalis[1]--Garlic-mustard

SAXIFRAGACEAE
Ribes americanum--Wild black currant

ROSACEAE

- **Geum canadense--White avens**
- **Rubus strigosus--Red raspberry**
- **Agrimonia gryposepala--Agrimony**
- **Rosa multiflora[1]--Multiflora rose**

ACERACEAE

- **Acer saccharinum--Silver maple**
- **Acer negundo[2]--Boxelder**

RHAMNACEAE

- **Rhamnus cathartica[1,2]--Common buckthorn**
- **Rhamnus frangula[1]--Glossy buckthorn**

VITACEAE

- **Vitis riparia--Riverbank grape**
- **Parthenocissus quinquefolia--Virginia creeper**

VIOLACEAE

- **Viola cucullata--Blue marsh violet**

LYTHRACEAE

- **Lythrum salicaria[1]--Purple loosestrife**

ONAGRACEAE

- **Epilobium coloratum--Willow-herb**
- **Circaea lutetiana--Enchanter's nightshade**

CORNACEAE

- **Cornus amomum--Silky dogwood**
- **Cornus racemosa--Grey dogwood**

OLEACEAE

- **Fraxinus pennsylvanica--Green ash**

RUBIACEAE

- **Galium triflorum--Sweet-scented bedstraw**

CAPRIFOLIACEAE

- **Viburnum opulus[1]--European highbush-cranberry**
- **Viburnum trilobum--Highbush-cranberry**
- **Viburnum lentago--Nannyberry**

COMPOSITAE

- **Solidago altissima--Tall goldenrod**
- **Erigeron strigosus--Daisy fleabane**
- **Taraxacum officinale[1]--Common dandelion**

Total number of plant species: 42
Number of alien, or non-native, plant species: 8 (19 percent)

This approximately 2.3-acre plant community area is part of the School Section Lake floodplain-wetland complex and consists of fresh (wet) meadow and second growth, Southern wet to wet-mesic lowland hardwoods. Disturbances to the plant community area include past agricultural land management activities, dumping, the ad hoc establishment of footpaths, filling, pond excavation, side casting of dredge spoil material, siltation and sedimentation due to stormwater runoff from adjacent lands, and water level changes due to past ditching and draining. While no Federal- or State-designated Special Concern, Threatened, or Endangered species were observed during the field inspection, the subject wetlands are known to provide suitable habitat for Blanding's turtle (Emydoidea blandingii), a State-designated Threatened species.

---

[1] Alien or non-native plant species
[2] Co-dominant plant species

Plant Community Area No. 2

EQUISETACEAE
Equisetum arvense--Common horsetail

CUPRESSACEAE
Juniperus virginiana--Red-cedar

GRAMINEAE
Bromus inermis[1]--Smooth brome grass
Poa pratensis[1]--Kentucky bluegrass
Phalaris arundinacea[1]--Reed canary grass

CYPERACEAE
Carex rosea--Curly-styled wood sedge
Carex blanda--Wood sedge
Carex gracillima--Graceful sedge

ARACEAE
Arisaema triphyllum--Jack-in-the-pulpit

SALICACEAE
Populus tremuloides[2]--Quaking aspen

JUGLANDACEAE
Carya ovata--Shagbark hickory

FAGACEAE
Quercus rubra--Northern red oak

ULMACEAE
Ulmus americana--American elm

URTICACEAE
Urtica dioica--Stinging nettle

CARYOPHYLLACEAE
Myosoton aquaticum[1]--Water chickweed

RANUNCULACEAE
Ranunculus recurvatus--Hooked buttercup
Ranunculus septentrionalis--Swamp buttercup

CRUCIFERAE
Capsella bursa-pastoris[1]--Shepherds purse
Barbarea vulgaris[1]--Yellow rocket
Alliaria officinalis[1]--Garlic-mustard

SAXIFRAGACEAE
Ribes americanum--Wild black currant

ROSACEAE
Geum canadense--White avens
Prunus serotina--Black cherry
Prunus virginiana--Chokecherry
Pyrus malus[1]--Apple

FABACEAE
Amphicarpa bracteata--Hog peanut

GERANIACEAE
Geranium maculatum--Wild geranium

ANACARDIACEAE
- Rhus radicans--Poison ivy

ACERACEAE
- Acer negundo[2]--Boxelder

RHAMNACEAE
- Rhamnus cathartica[1,2]--Common buckthorn

VITACEAE
- Vitis riparia--Riverbank grape
- Parthenocissus quinquefolia--Virginia creeper

VIOLACEAE
- Viola sororia--Woolly blue violet

ONAGRACEAE
- Circaea lutetiana--Enchanter's nightshade

CORNACEAE
- Cornus racemosa--Grey dogwood

CONVOLVULACEAE
- Convolvulus sepium--Hedge bindweed

LABIATAE
- Glechoma hederacea[1]--Creeping Charlie
- Prunella vulgaris--Selfheal

PLANTAGINACEAE
- Plantago major[1]--Common plantain

RUBIACEAE
- Galium aparine--Annual bedstraw
- Galium triflorum--Sweet-scented bedstraw

CAPRIFOLIACEAE
- Viburnum opulus[1]--European highbush-cranberry
- Viburnum lentago--Nannyberry
- Sambucus canadensis--Elderberry
- Lonicera X bella[1]--Hybrid honeysuckle

COMPOSITAE
- Xanthium strumarium--Cocklebur
- Solidago gigantea--Giant goldenrod
- Erigeron strigosus--Daisy fleabane
- Conyza canadensis--Horseweed
- Arctium minus[1]--Common burdock
- Carduus nutans[1]--Nodding thistle
- Cirsium arvense[1]--Canada thistle
- Taraxacum officinale[1]--Common dandelion

Total number of plant species: 53
Number of alien, or non-native, plant species: 17 (32 percent)

This approximately 1.0-acre plant community area is part of a larger primary environmental corridor and consists of second growth, Southern wet-mesic to dry-mesic hardwood forest. Disturbances to the plant community area include past agricultural land management activities, clearing of vegetation along the corridor edge, dumping, establishment of footpaths, filling, and selective cutting of trees. No Federal- or State-designated Special Concern, Threatened, or Endangered species were observed during the field inspection.

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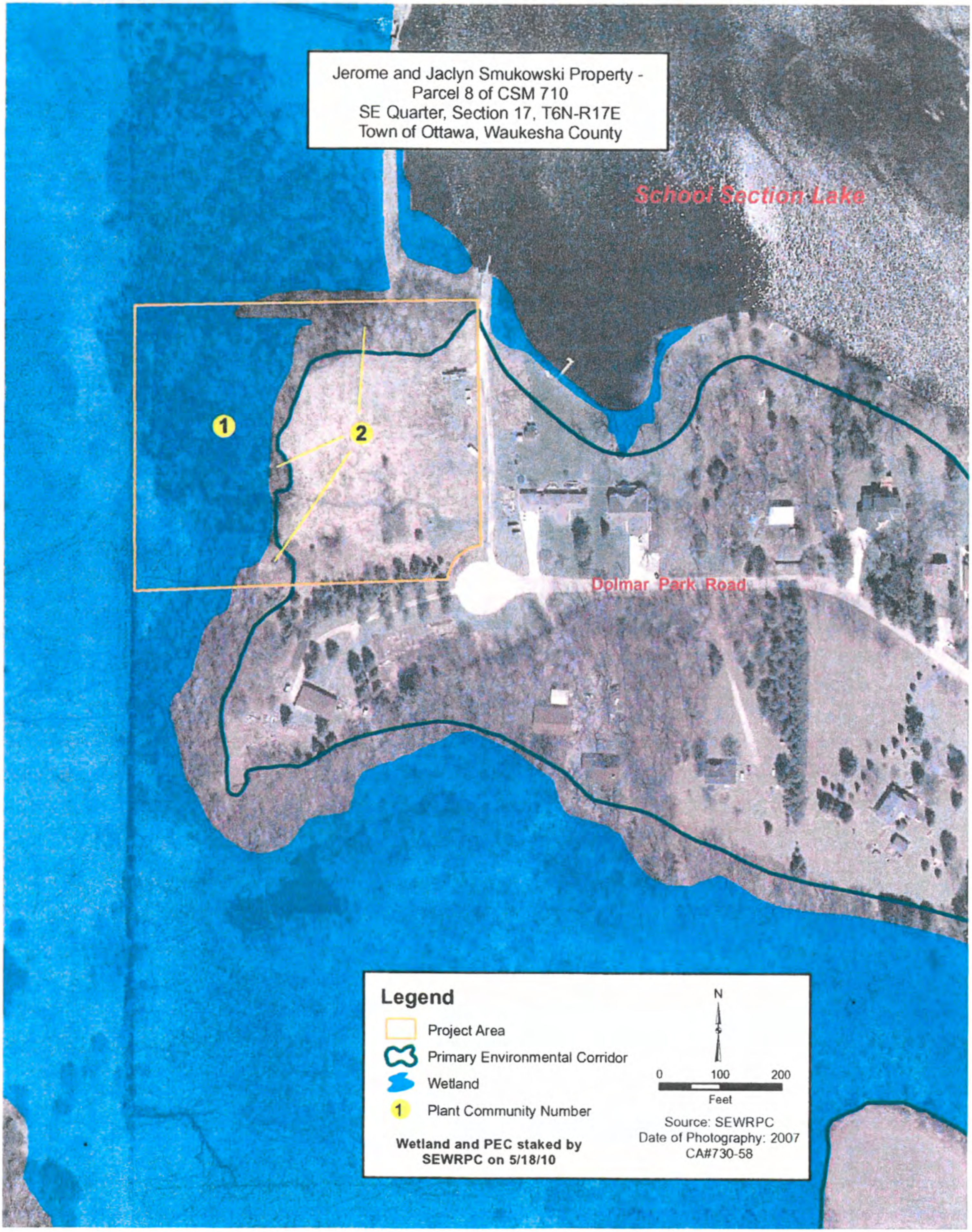
[1] Alien or non-native plant species
[2] Co-dominant plant species


Jerome and Jaclyn Smukowski Property -
Parcel 8 of CSM 710
SE Quarter, Section 17, T6N-R17E
Town of Ottawa, Waukesha County
School Section Lake
1
2
Dolmar Park Road
Legend
Project Area
Primary Environmental Corridor
Wetland
Plant Community Number
Wetland and PEC staked by SEWRPC on 5/18/10
N
0
100
200
Feet
Source: SEWRPC
Date of Photography: 2007
CA#730-58

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Appendix E

GUIDANCE FOR HARVESTING OPERATORS ON SCHOOL SECTION LAKE

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GUIDANCE FOR HARVESTER OPERATORS ON SCHOOL SECTION LAKE WAUKESHA COUNTY, WISCONSIN

- ONLY CUT IN DEPTHS MORE THAN THREE FEET—Map provides bathymetry of Lake, but lake levels change, so ***you will need to monitor this as you cut***.

- TOP CUT IN AREAS WITH HIGH NATIVE PLANT COMMUNITIES—Map areas labeled 1 indicate where these areas will most likely be; however, **identifying these regions will require plant identification knowledge**. In these areas restrict cutting to ***only three feet below the water's surface***.

- DEEP CUT AREAS DOMINATED BY EURASIAN WATER MILFOIL AND COONTAIL—Map area labeled 2 indicates where this region is most likely, however **identifying these regions will require plant identification knowledge**. In this area ***you must leave 12 inches of plant on the lake bottom***.

- CUT 50-FOOT-WIDE ACCESS LANE FROM BOAT ACCESS SITE—This lane should extend approximately 250 feet into the center of the Lake. In this area ***you must leave 12 inches of plant on the lake bottom***. Map Area 3 shows where this is located.

- CUT 10-FOOT-WIDE NAVIGATION LANES THROUGH HIGH-VALUE NATURAL AREA—In this area ***you must leave 12 inches of plant on the lake bottom***. These lanes should only be cut if depths are more than three feet. Map areas labeled 4 indicate where these lanes should be located, while map areas labeled 5 indicate the high-value areas.

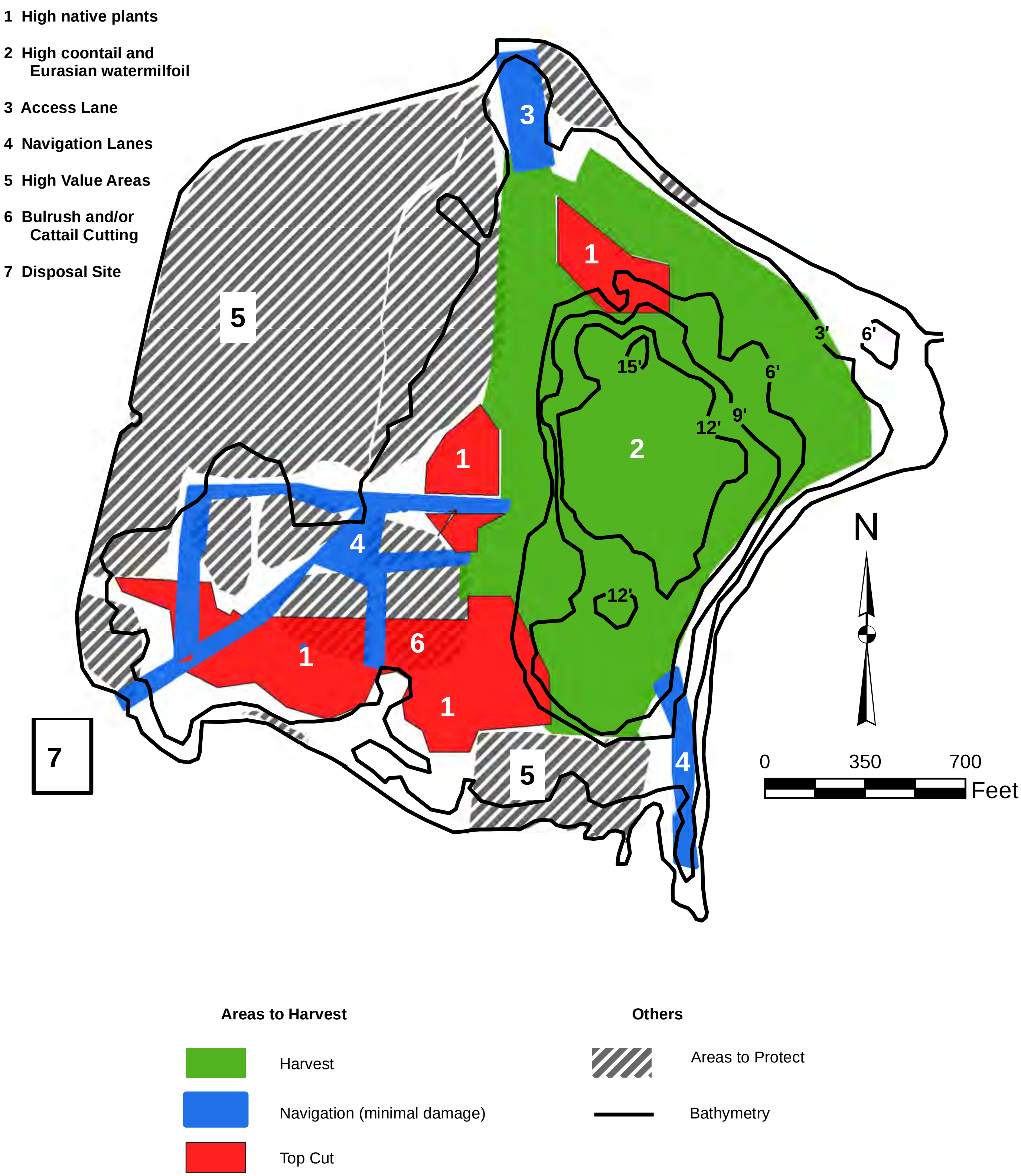
- CUT CATTAILS AND BULRUSH ONLY IN AREAS WHERE THEY IMPEDE NAVIGATION LANES—This may occur when cutting access lane at the north end of the Lake, when cutting the navigation lanes at the southern end of the Lake, or when performing the "top cut" at the south end of the Lake. The area labeled 6 on the map indicated a potential area where this will likely occur.

- ALL CUT MATERIAL SHOULD BE INSPECTED FOR FISH AND ANIMALS. ANY ORGANISMS FOUND SHOULD IMMEDIATELY BE RETURNED TO THE LAKE—This should be completed as soon as the harvester returns to land.

- ALL CUT MATERIALS SHOULD BE DEPOSITED ON DESIGNATED DISPOSAL SITE—This area is labeled at 7 on the map. Precaution should be made to ***ensure that the plant material does not get placed in the wetland region*** to the west of the disposal site.

* * *

HARVESTING MAP FOR SCHOOL SECTION LAKE



Source: SEWRPC.

Appendix F

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.

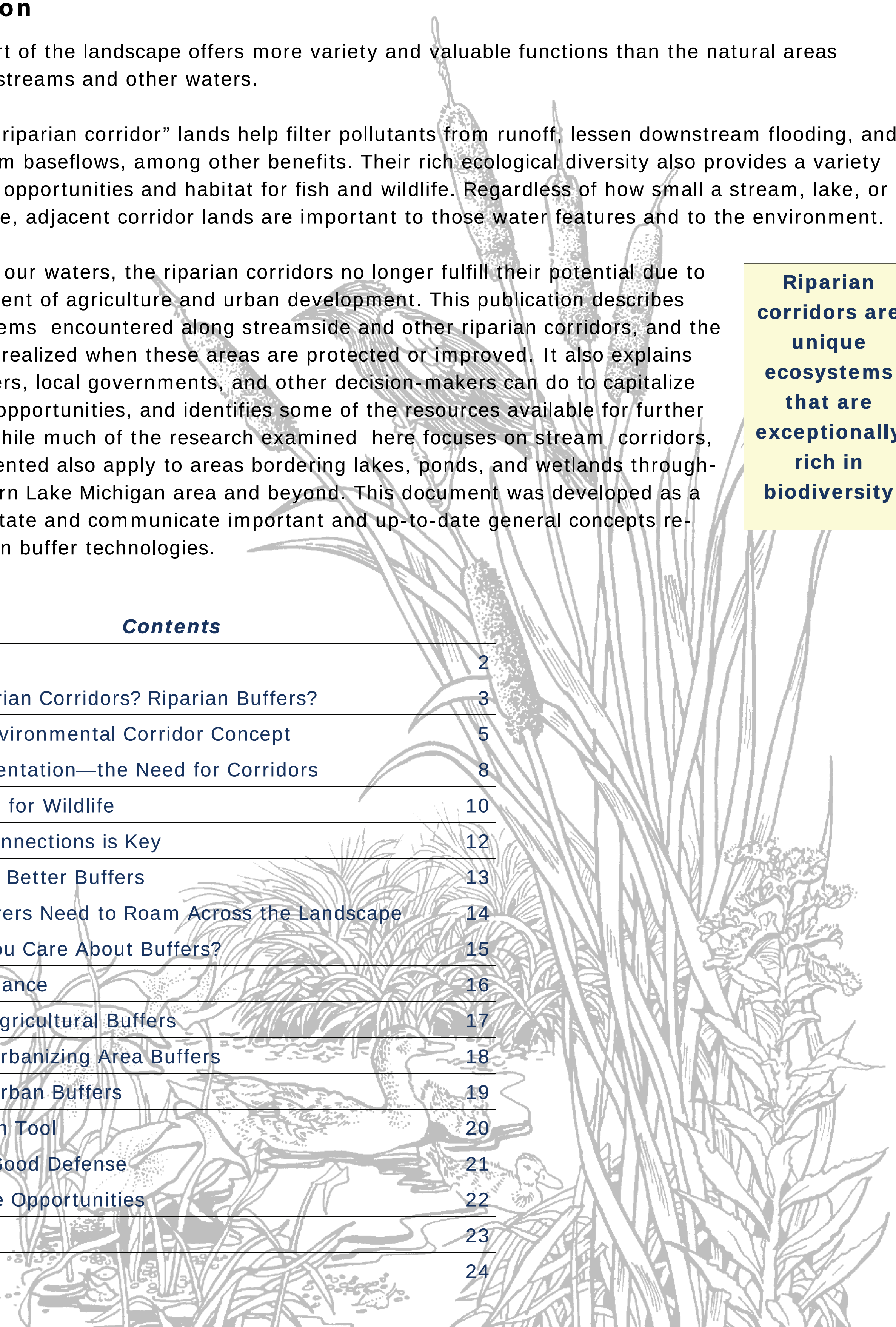
Introduction

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.

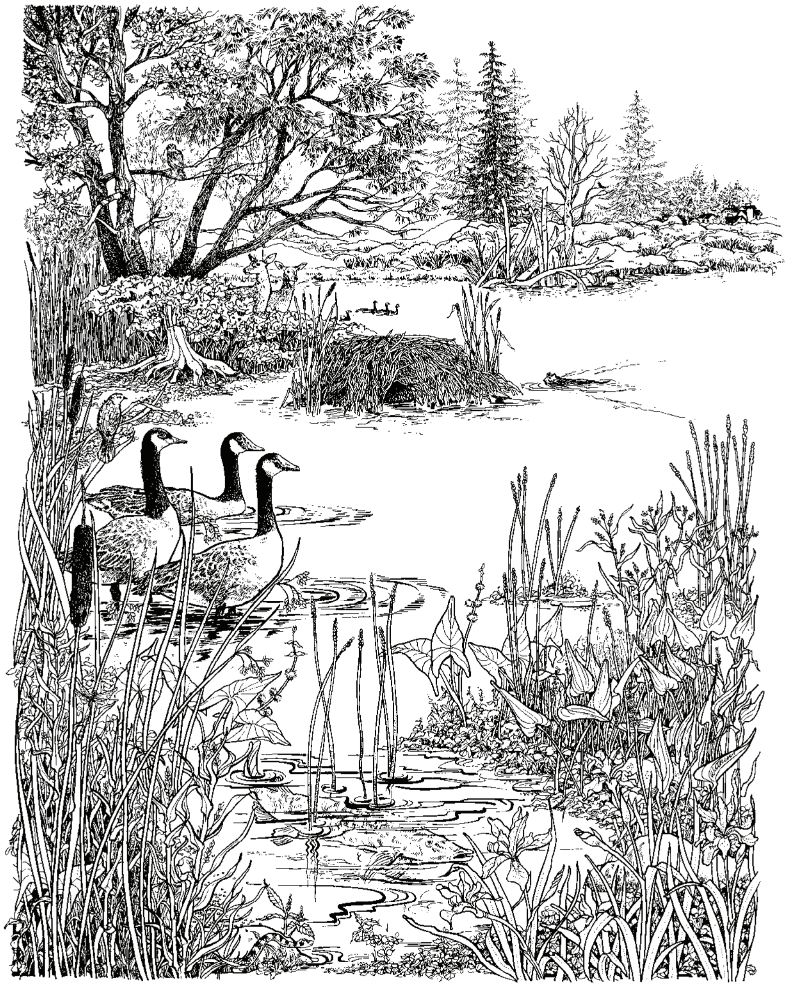
Riparian corridors are unique ecosystems that are exceptionally rich in biodiversity



Contents

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.

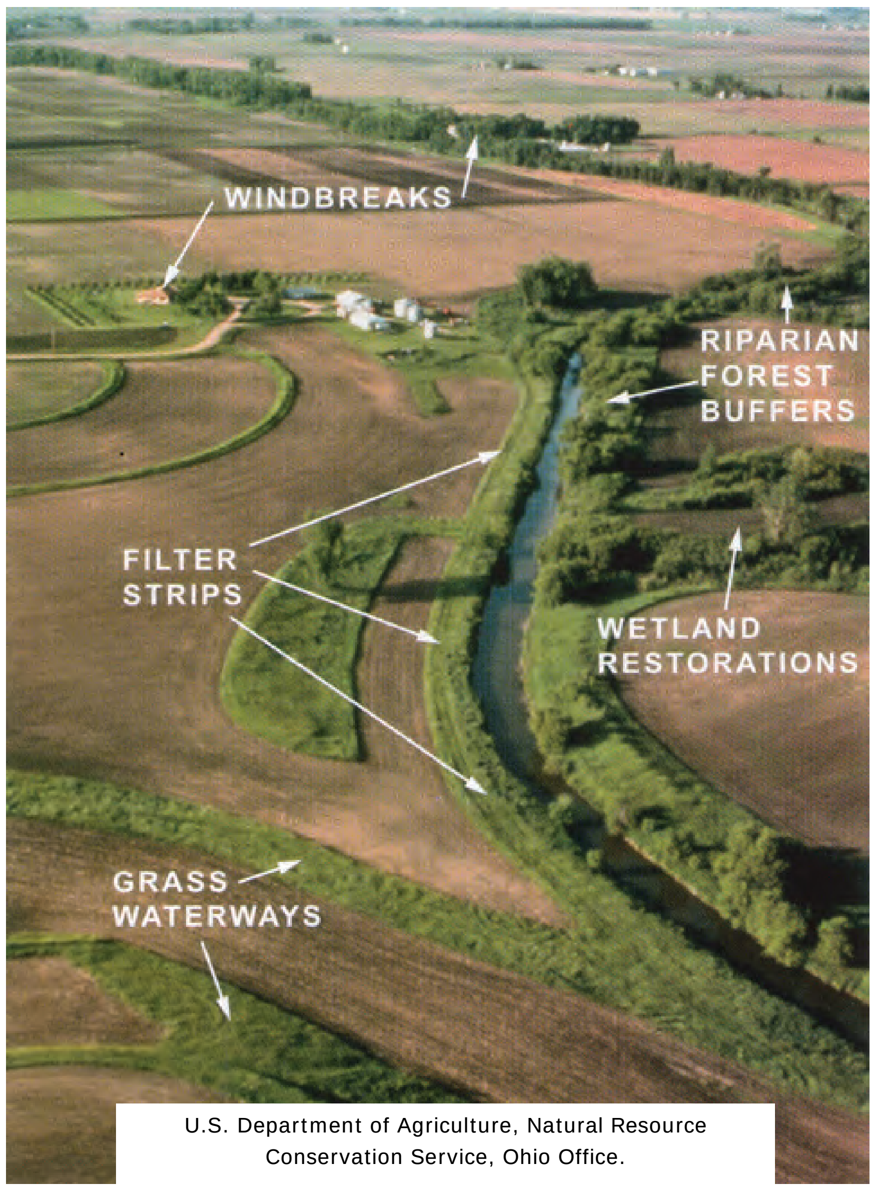
Riparian buffers are zones adjacent to waterbodies such as lakes, rivers, and wetlands that simultaneously protect water quality and wildlife, including both aquatic and terrestrial habitat. These zones minimize the impacts of human activities on the landscape and contribute to recreation, aesthetics,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

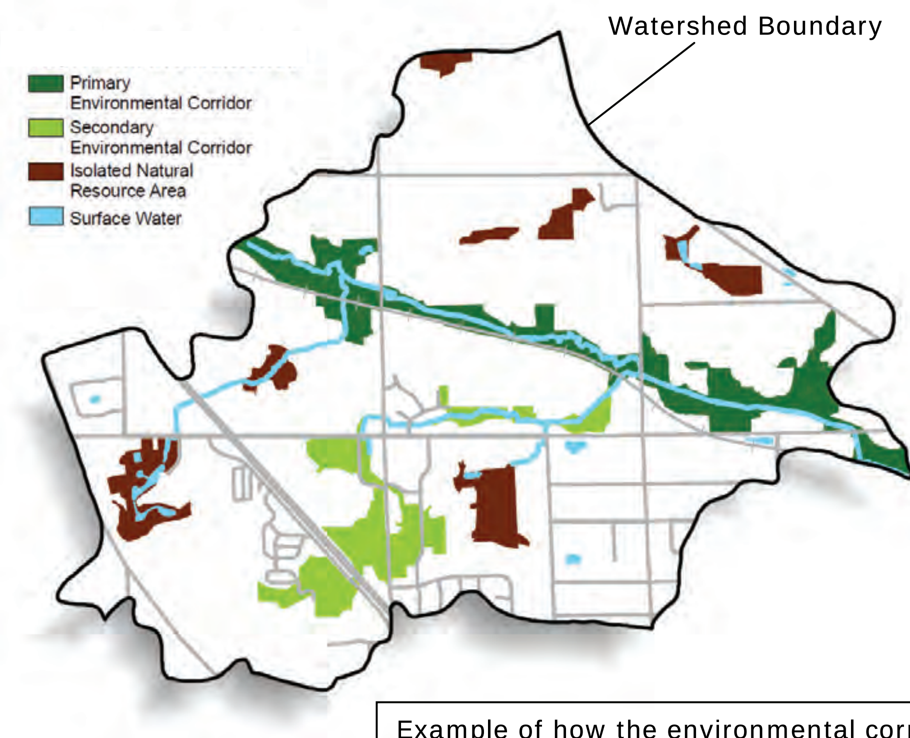
- **Secondary environmental corridors** contain significant but smaller concentrations of natural resources. They are at least 100 acres in size and at least one mile long, unless serving to link primary corridors.

- **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

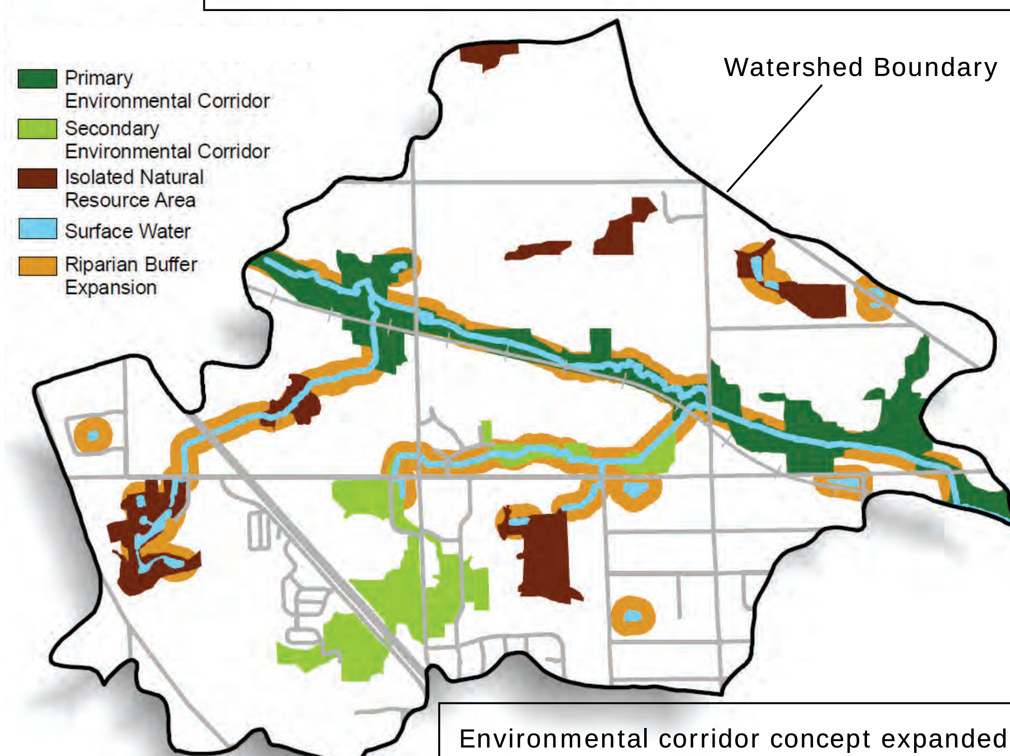


The Minimum Goals of **75** within a Watershed

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.

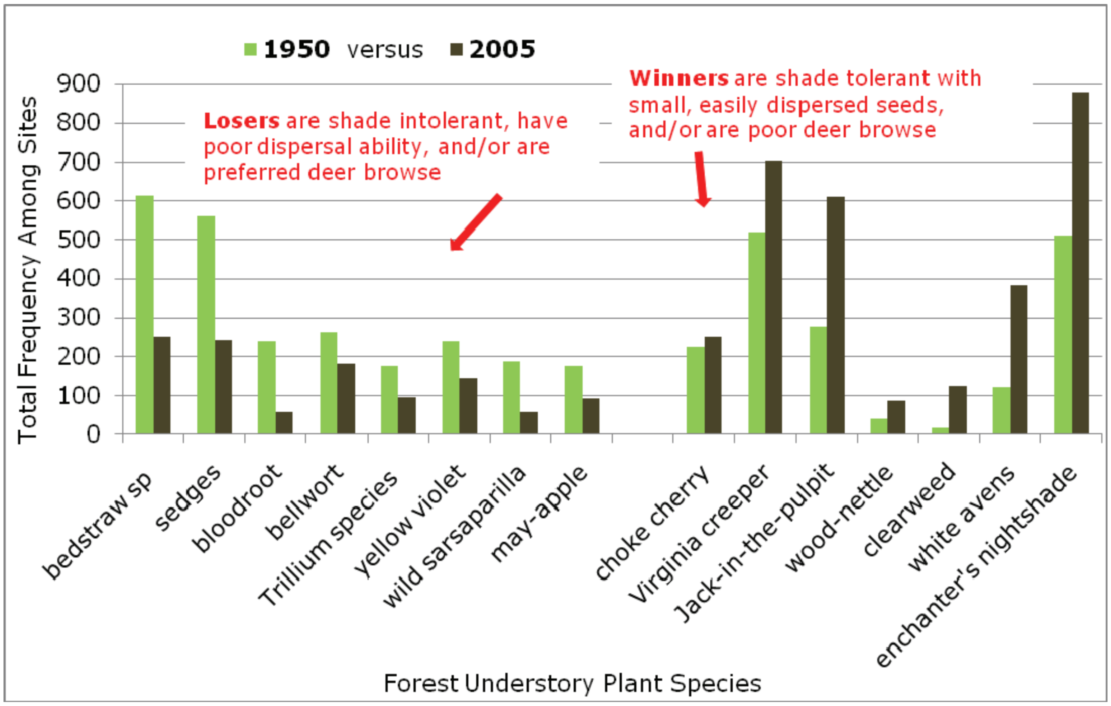
At the time of conversion of agricultural lands to urban uses, there are opportunities to re-create and expand riparian buffers and environmental corridors reconnecting uplands and waterways and restoring ecological integrity and scenic beauty locally and regionally. For example, placement of roads and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



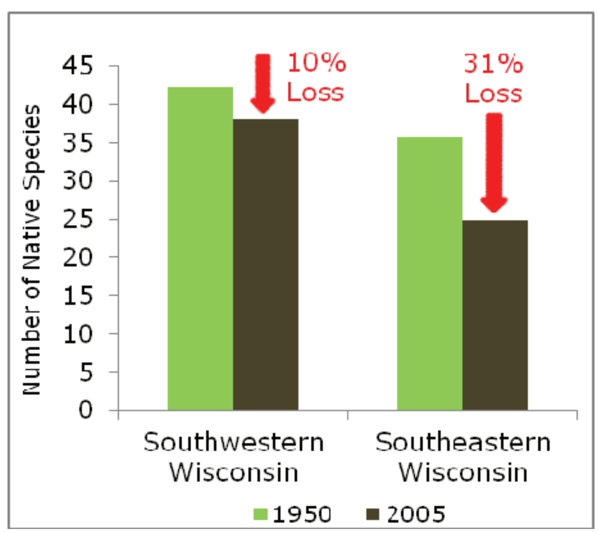
Forest fragmentation has led to significant plant species loss within Southern Wisconsin

(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

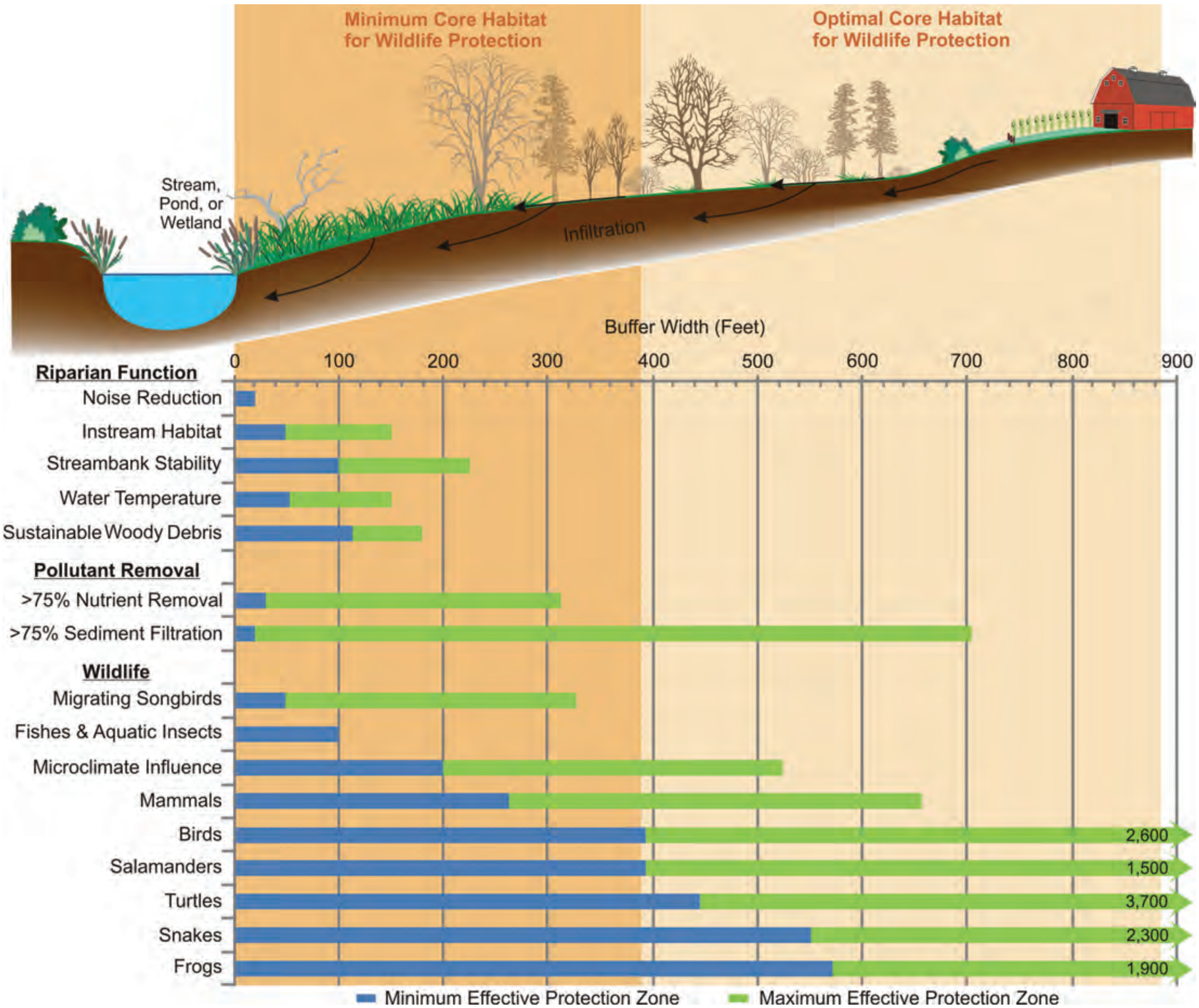
Since the 1950s, forests have increasingly become more fragmented by land development, both agricultural and urban, and associated roads and infrastructure, which have caused these forests to become isolated "islands of green" on the landscape. In particular, there has been significant loss of forest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

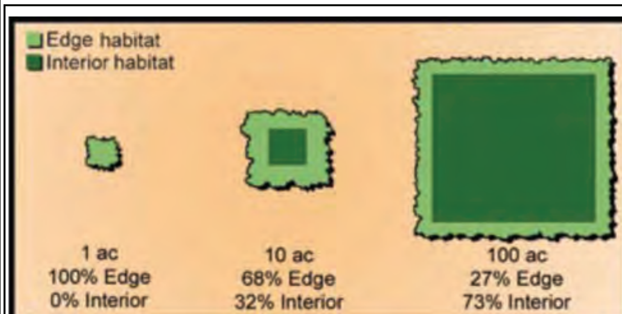
Wider is Better for Wildlife

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.*



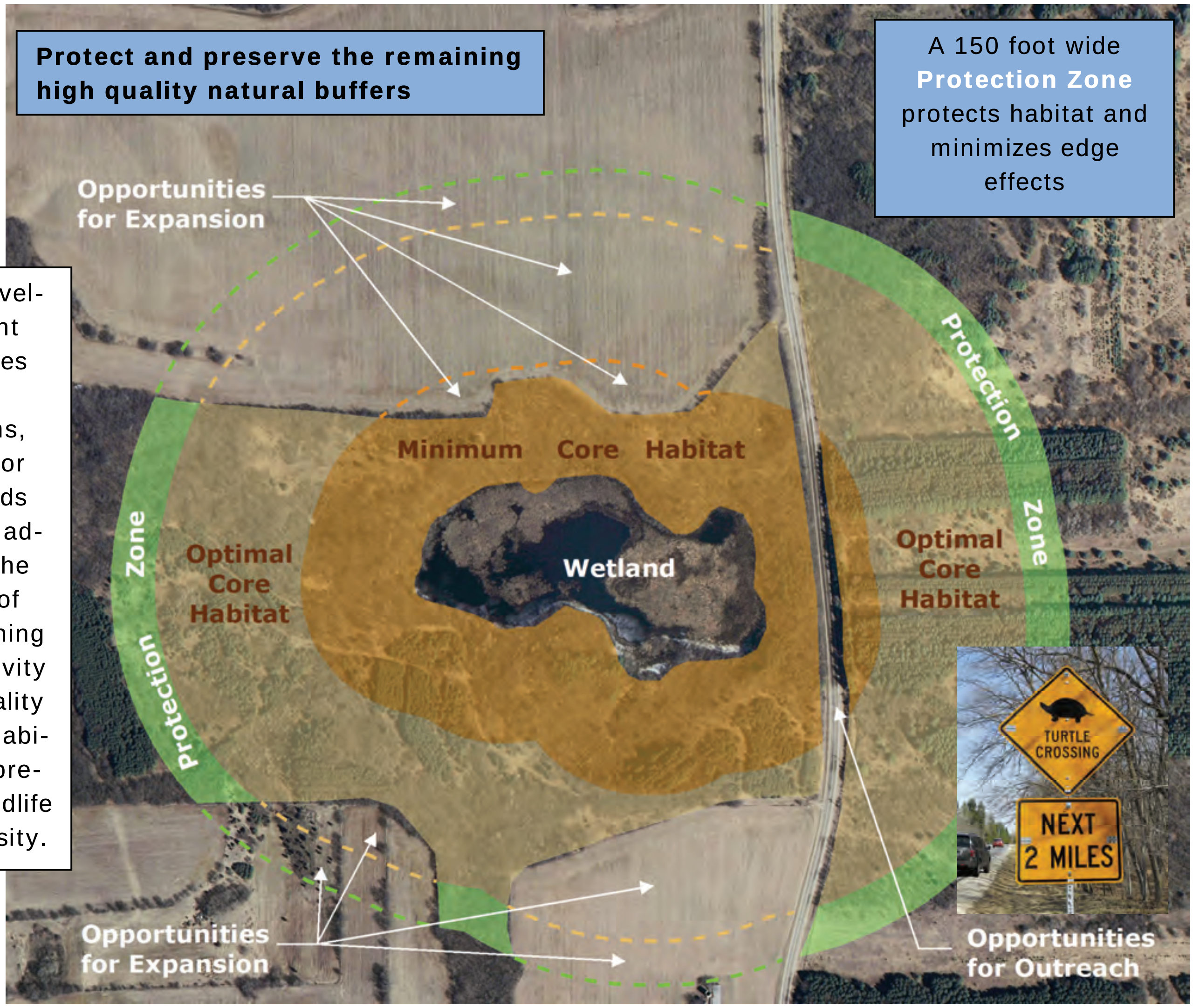
"Large patches typically conserve a greater variety and quality of habitats, resulting in higher species diversity and abundance." *Larger patches contain greater amounts of interior habitat and less edge effects, which benefits interior species, by providing safety from parasitism, disease, and invasive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

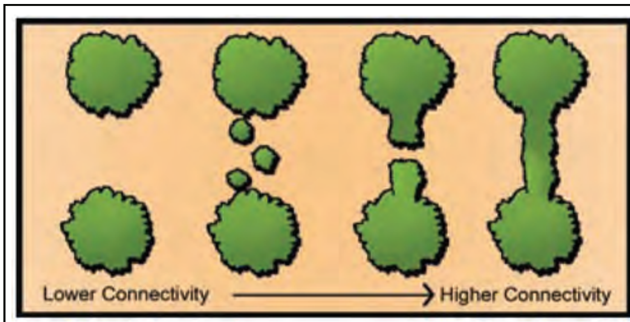
(Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station)

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.

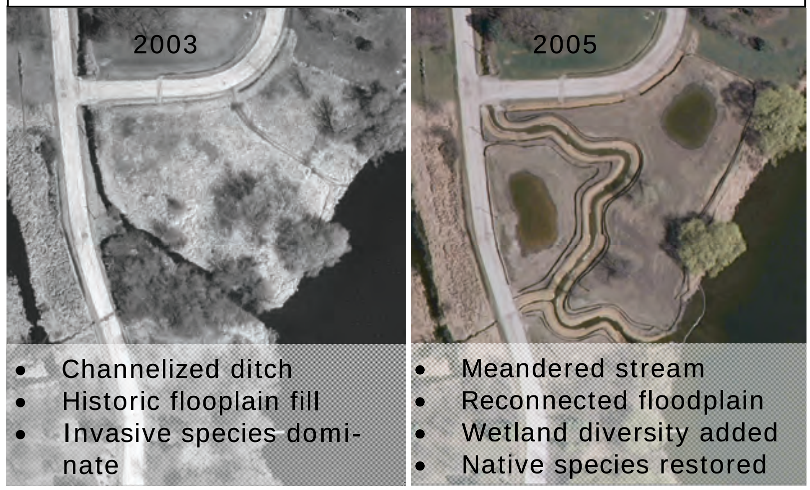




Increasing connectivity among quality natural landscapes (wetlands, woodlands, prairies) can benefit biodiversity by providing access to other areas of habitat, increasing gene flow and population viability, enabling recolonization of patches, and providing habitat (Bentrup 2008).

Basic Rules to Better Buffers

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



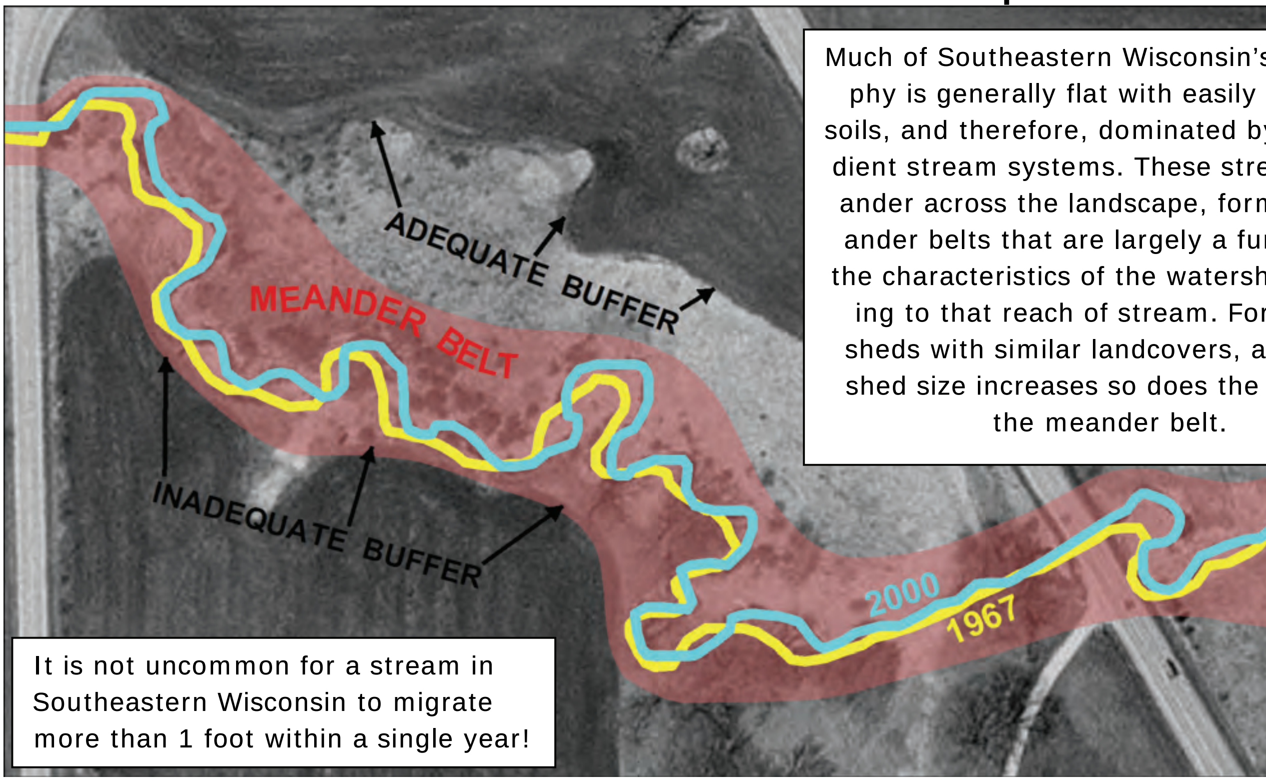
Protecting the integrity of native species in the region is an objective shared by many communities. The natural environment is an essential component of our existence and contributes to defining our communities and neighborhoods. Conservation design and open space development patterns in urbanizing 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.

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:

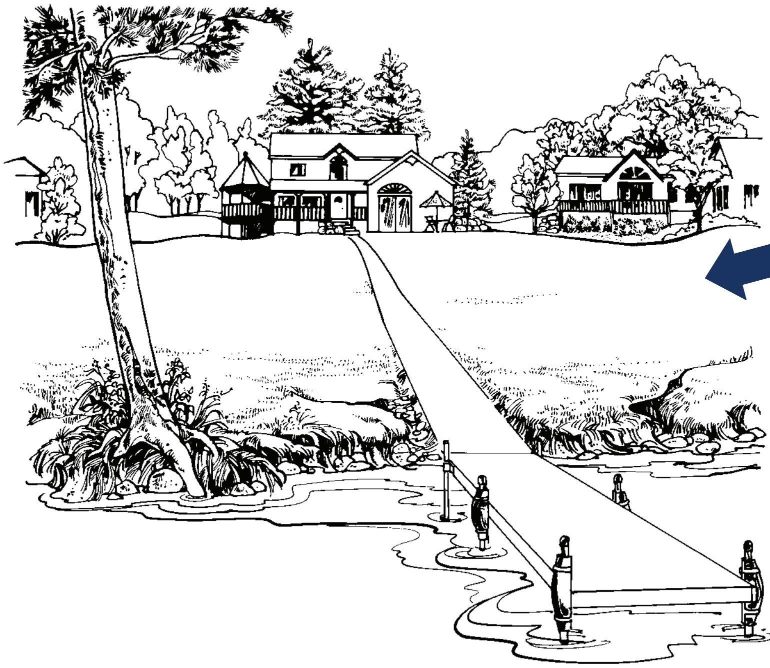
- Increased quality of the canoeing/kayaking experience
- Improved fishing and hunting quality by improving habitat
- Improved bird watching/wildlife viewing quality and opportunities
- Increased potential for expansion of trails for hiking and bicycling
- Opportunities made available for youth and others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

University of Wisconsin—Extension

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).

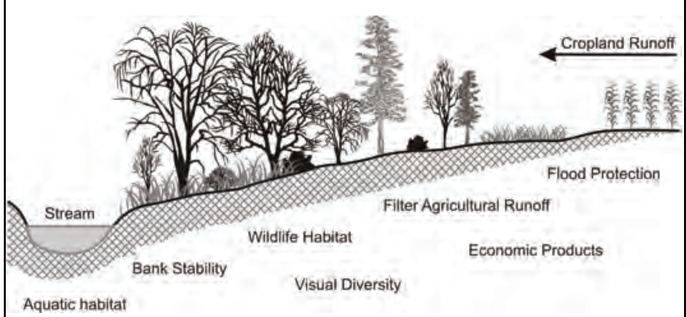
Challenge:
Buffers may take land out of cultivated crop production and require additional cost to install and maintain. Cost sharing, paid easements, and purchase of easements or development rights may sometimes be available to offset costs.

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.

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.*).

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:

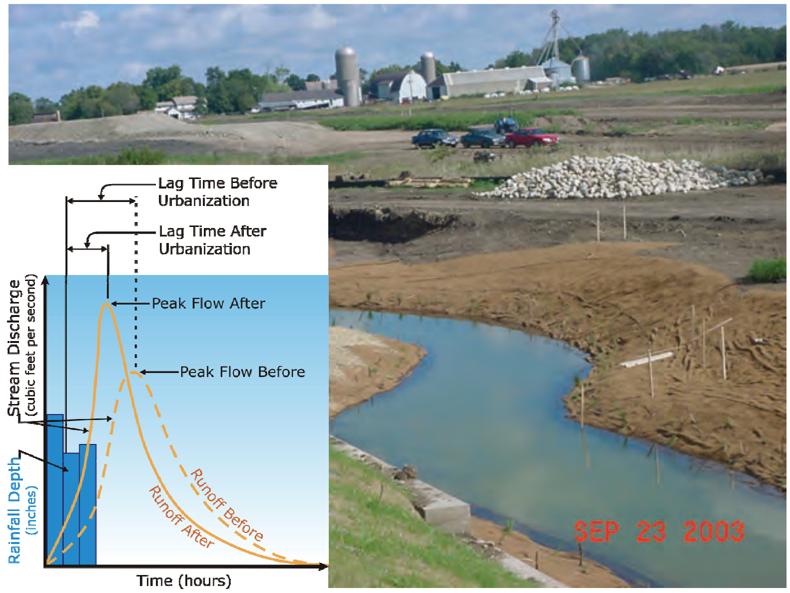
1-Determine what buffers functions are needed
2-Identify the best types of vegetation to provide the needed benefits
3-Determine the minimum acceptable buffer width to achieve desired benefits
4-Develop an installation and maintenance plan

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.

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.

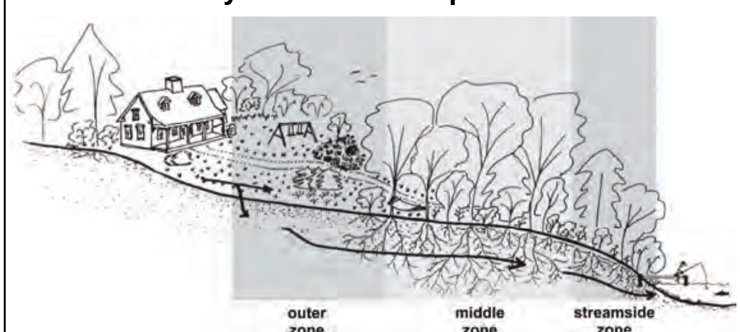


Comparison of hydrographs before and after urbanization. Note the rapid runoff and greater peak streamflow tied to watershed development. (Adapted from Federal Interagency Stream Restoration Working Group (FISRWG), Stream Corridor Restoration: Principles, Processes, and Practices, October 1998)

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.

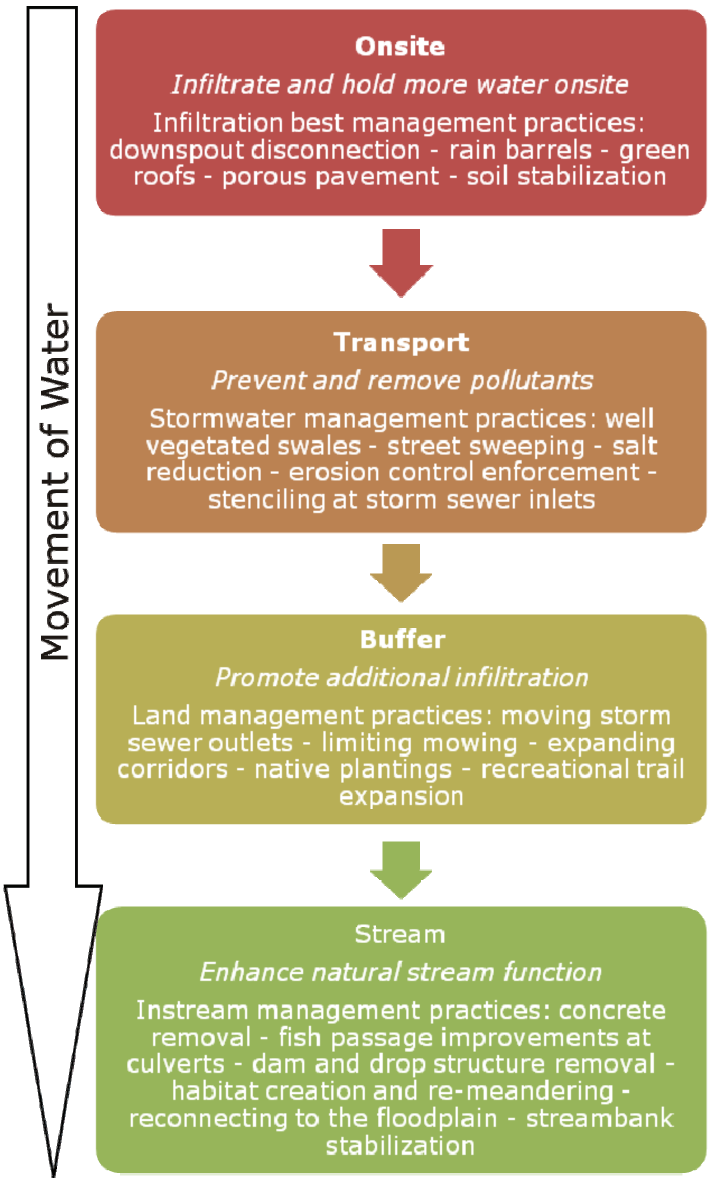
Streamside Zone-Area from the water's edge to the top of the bank or uplands that provides critical connection between water, wetland, and upland habitats for wildlife as well as protect streams from bank erosion

(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.

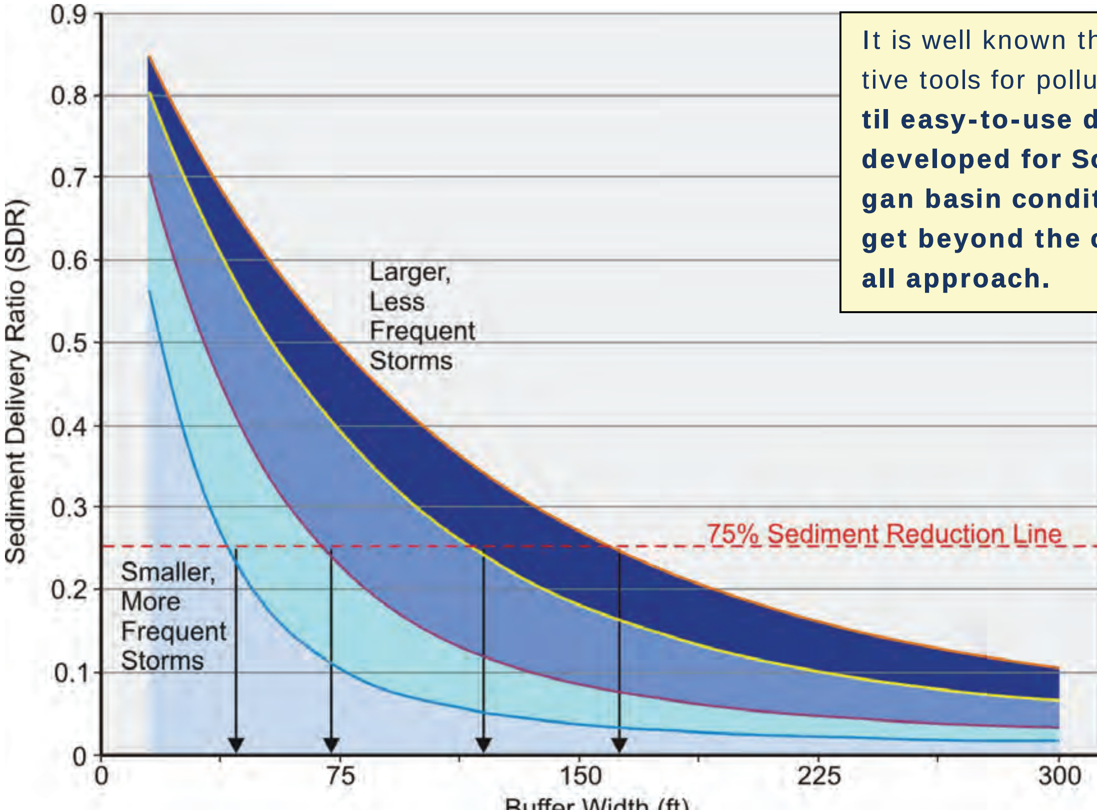
Much traditional stormwater infrastructure intercepts runoff and diverts it directly into creeks and rivers, bypassing any benefits of buffers to infiltrate or filter pollutants. This is important to consider in design of a buffer system for urban waterways, which begin in yards, curbsides, and construction 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.

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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May 7, 2010

Appendix G

SUMMARY OF WATER QUALITY PARAMETERS IN SCHOOL SECTION LAKE

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Table G-1

SECCHI-DISK MEASUREMENTS OF WATER CLARITY IN SCHOOL SECTION LAKE: 1979-2013

Year	Mean (feet)	Minimum (feet)	Maximum (feet)	Number of Measurements
2013	5.0	4.1	5.6	4
2012	4.9	4.3	5.6	4
2011	4.3	4.3	4.6	4
2010	2.9	2.0	4.9	5
2009	5.5	4.6	6.2	4
2008	3.4	2.3	5.6	4
2007	4.7	3.6	5.9	3
2006	6.6	6.6	6.6	1
2005	6.2	3.6	9.2	5
2004	5.7	5.6	5.9	2
2003	5.1	3.6	6.6	2
2002	5.2	5.2	5.2	1
2001	4.6	3.9	4.9	3
2000	5.6	5.6	5.6	1
1992	5.8	5.2	6.3	4
1991	6.6	4.8	8.0	5
1990	5.2	4.5	6.0	7
1989	5.6	4.0	8.0	8
1988	5.1	2.0	7.8	12
1987	4.8	2.3	7.3	8
1980	4.8	1.9	6.5	4
1979	6.8	4.5	8.0	3
Overall	5.1	1.9	9.2	94

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

Table G-2

DISSOLVED OXYGEN CONCENTRATIONS IN SCHOOL SECTION LAKE: 1979-2013

Year	Mean (mg/l)	Minimum (mg/l)	Maximum (mg/l)	Number of Measurements
2013	9.8	9.8	9.8	1
2012	9.9	9.1	10.7	3
2011	10.0	8.0	12.0	4
2010	13.5	11.0	15.5	4
2009	10.2	11.6	8.7	4
2008	9.6	8.0	11.7	4
2007	9.3	6.8	13.9	4
2006	9.9	9.9	9.9	1
2005	6.7	8.0	5.4	5
2004	11.4	9.0	13.7	2
2003	11.7	9.0	14.3	2
2002	7.8	7.8	7.8	1
2001	10.0	8.9	11.5	3
2000	6.7	6.7	6.7	1
1980	9.7	6.9	12.4	2
1979	9.6	8.7	10.5	2
Overall	9.8	6.7	15.5	43

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

Table G-3

TOTAL PHOSPHORUS CONCENTRATIONS IN SCHOOL SECTION LAKE: 1979-2013

Year	Mean (μg/l)	Minimum (μg/l)	Maximum (μg/l)	Number of Measurements
2013	31	26	33	4
2012	38	26	47	4
2011	44	32	58	4
2010	62	23	86	4
2009	35	29	38	4
2008	49	17	66	4
2007	33	20	48	4
2006	32	23	40	4
2005	28	25	32	6
2004	21	19	23	2
2003	23	16	29	2
2002	29	29	29	1
2001	37	32	40	3
2000	55	55	55	1
1980	30	20	40	2
1979	18	13	20	3
Overall	36	13	86	52

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

Table G-4

CHLOROPHYLL-*a* CONCENTRATIONS IN SCHOOL SECTION LAKE: 1980-2013

Year	Mean (μg/l)	Minimum (μg/l)	Maximum (μg/l)	Number of Measurements
2013	17.2	10.1	30.3	3
2012	16.1	14.4	17.8	3
2011	19.7	13.9	28.3	3
2010	39.4	24.9	54.6	3
2009	9.3	8.4	10.1	3
2008	12.5	5.2	23.5	3
2007	11.5	0.8	26.1	3
2006	14.9	13.4	16.6	3
2005	7.8	6.5	9.6	4
2004	85.0	85.0	85.0	1
2003	16.7	16.7	16.7	1
2002	2.0	2.0	2.0	1
2001	13.5	13.0	14.0	2
2000	22.0	22.0	22.0	1
1980	6.8	5.0	8.7	2
Overall	17.2	0.8	85.0	36

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

Table G-5

ALKALINITY CONCENTRATIONS IN SCHOOL SECTION LAKE: 1979-2013

Date	Alkalinity (mg/l)
08/21/13	253
09/05/12	199
07/19/11	218
09/08/10	261
08/11/09	211
08/06/08	219
08/22/07	162
08/23/06	215
10/17/05	209
08/10/05	197
08/04/04	232
08/11/03	178
08/02/02	198
08/08/01	221
08/28/00	245
04/17/80	208
03/14/80	242
11/09/79	210
09/05/79	190
04/26/79	222
Overall (Mean)	214.50

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

Table G-6

pH CONCENTRATIONS IN SCHOOL SECTION LAKE: 1979-2013

Year	Annual Mean (SU)	Minimum (SU)	Maximum (SU)	Number of Measurements
2013	8.2	7.9	8.4	4
2012	8.2	7.8	8.5	2
2011	8.3	8.1	8.6	4
2010	8.4	7.7	8.8	4
2009	8.3	7.9	8.6	4
2008	6.4	8.3	8.7	4
2007	8.0	7.7	8.4	4
2006	8.1	7.9	8.4	2
2005	8.0	7.7	8.5	6
2004	8.4	8.4	8.4	1
2003	7.9	7.3	8.4	2
2002	9.5	9.5	9.5	1
2001	8.2	7.7	8.7	3
2000	8.3	8.3	8.3	1
1980	8.5	8.4	8.5	2
1979	8.0	7.9	8.1	3
Overall	8.2	7.3	9.5	47

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

Table G-7

CONDUCTIVITY CONCENTRATIONS IN SCHOOL SECTION LAKE: 1979-2013

Year	Annual Mean (μS/cm)	Minimum (μS/cm)	Maximum (μS/cm)	Number of Measurements
2013	628.0	533.0	714.0	3
2012	563.7	539.0	594.0	3
2011	582.0	575.0	594.0	4
2010	573.0	541.0	641.0	4
2009	554.8	527.0	601.0	4
2008	541.0	511.0	573.0	3
2007	532.0	507.0	551.0	4
2006	574.0	571.0	577.0	2
2005	547.0	519.0	573.0	6
2004	548.5	541.0	556.0	2
2003	518.5	493.0	544.0	2
2002	489.0	489.0	489.0	1
2001	506.0	493.0	519.0	3
2000	571.0	571.0	571.0	1
1980	575.0	510.0	640.0	2
1979	564.7	554.0	576.0	3
Overall	556.4	489.0	714.0	47

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

Table G-8

SUMMARY OF CHLORIDE CONCENTRATIONS IN SCHOOL SECTION LAKE: 1979-1980

Date	Surface 0-1 foot (mg/l)	Deep 8-10 feet (mg/l)	Inlet (mg/l)
04/17/80	10	10	10
03/14/80	14	15	11
11/09/79	16	- -	12
09/05/79	14	- -	11
04/26/79	13	12	12
Overall	13.4	12.3	11.2

Source: Wisconsin Department of Natural Resources, Citizen Lake Monitoring Network, and SEWRPC.

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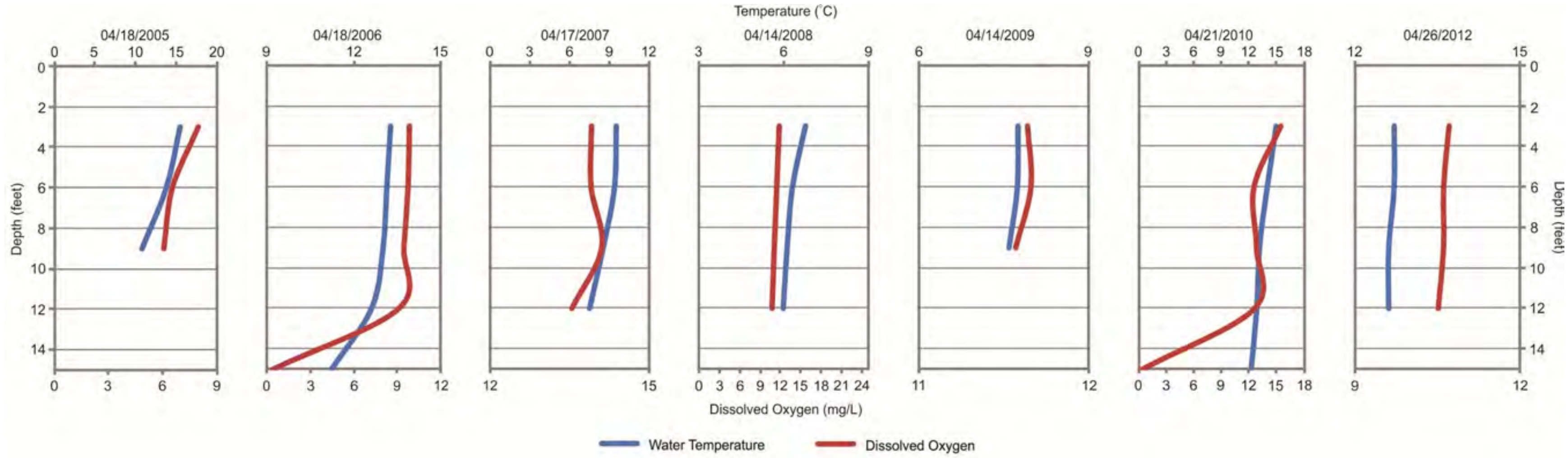
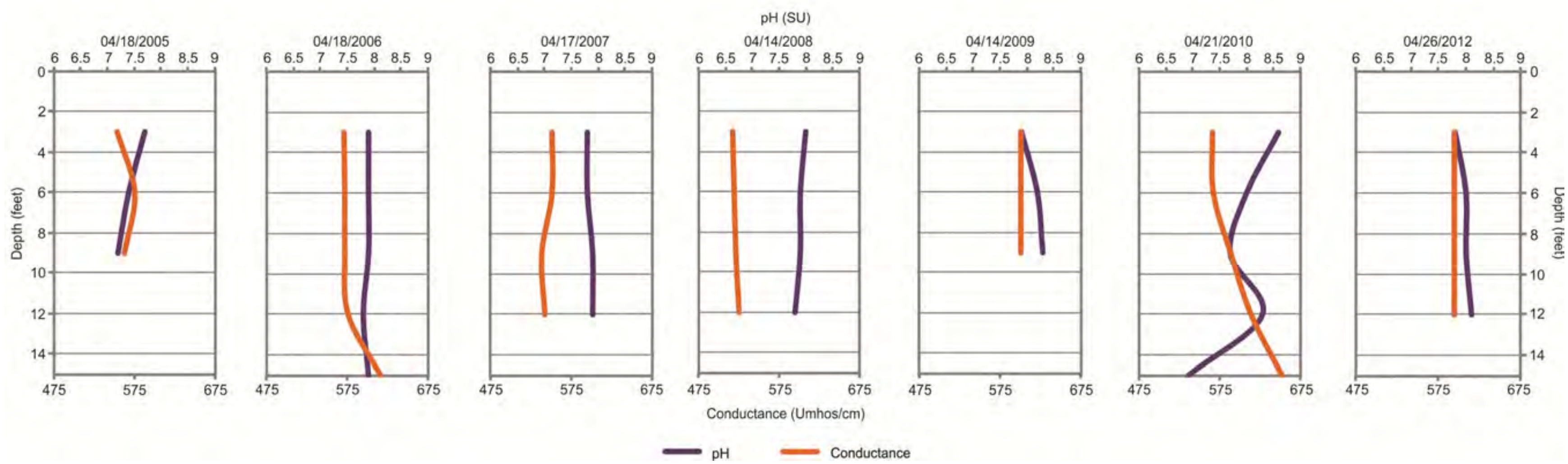
Appendix H

DISSOLVED OXYGEN, TEMPERATURE, pH, AND CONDUCTANCE PROFILES: 2005-2012

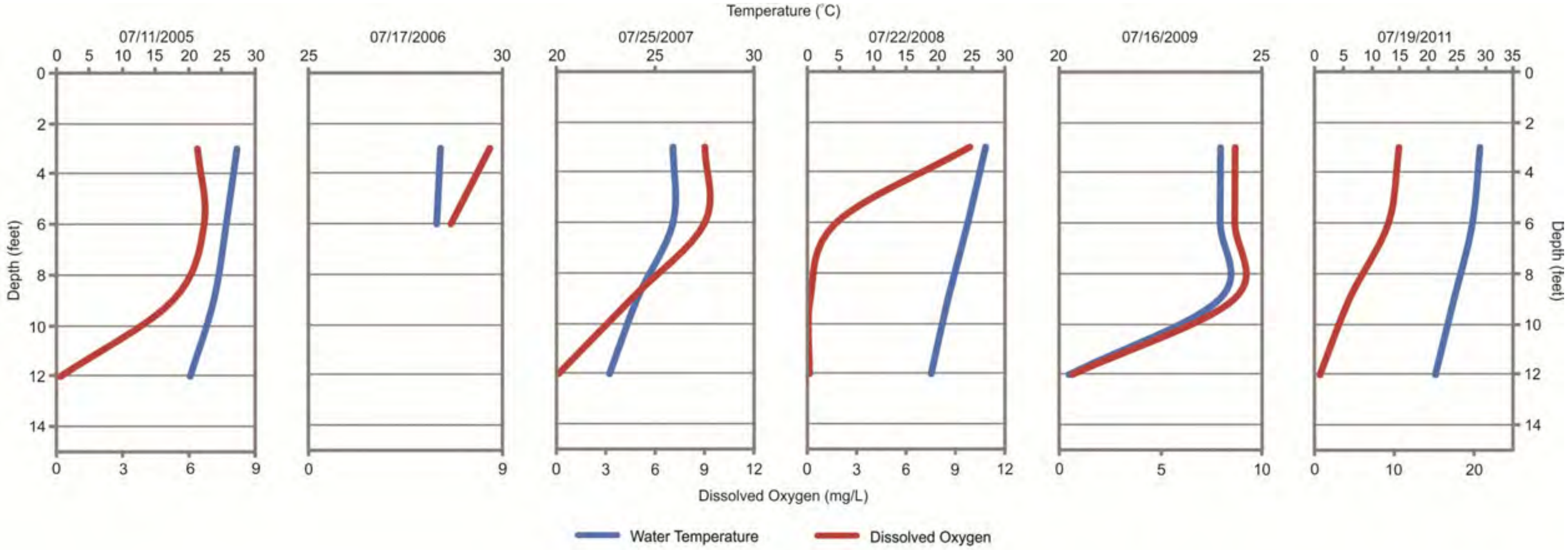
MID-APRIL

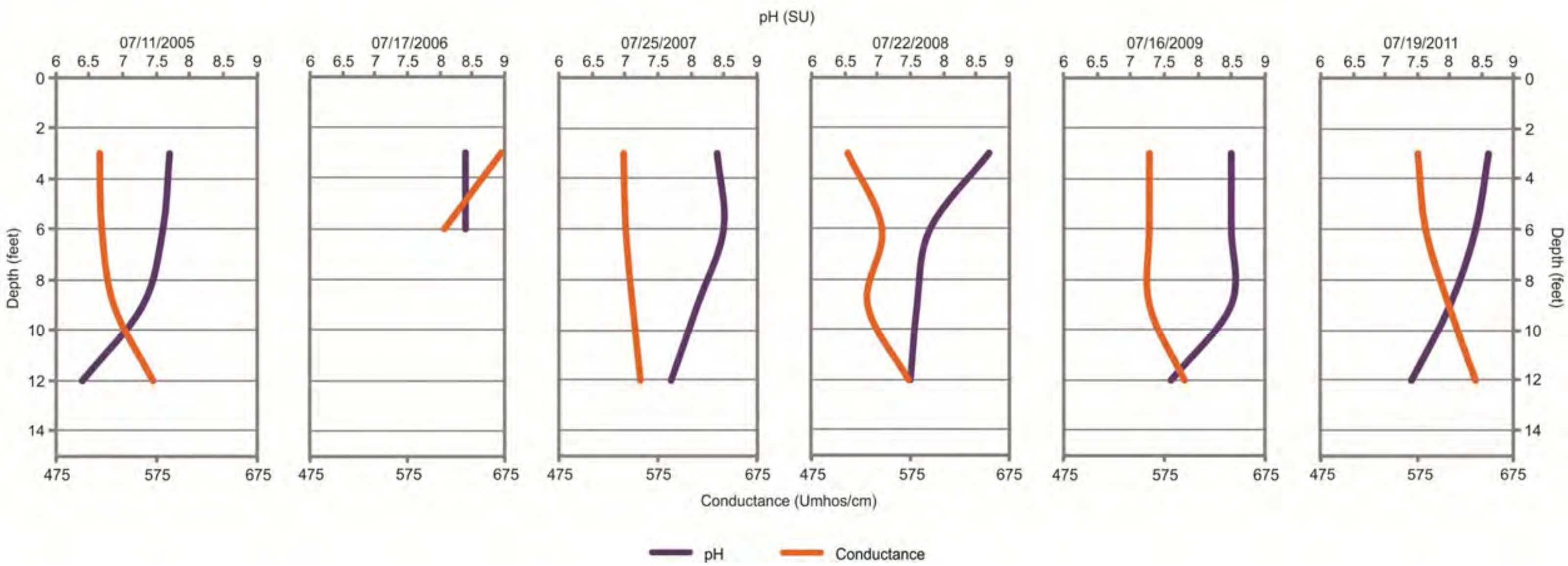




Appendix H (continued)

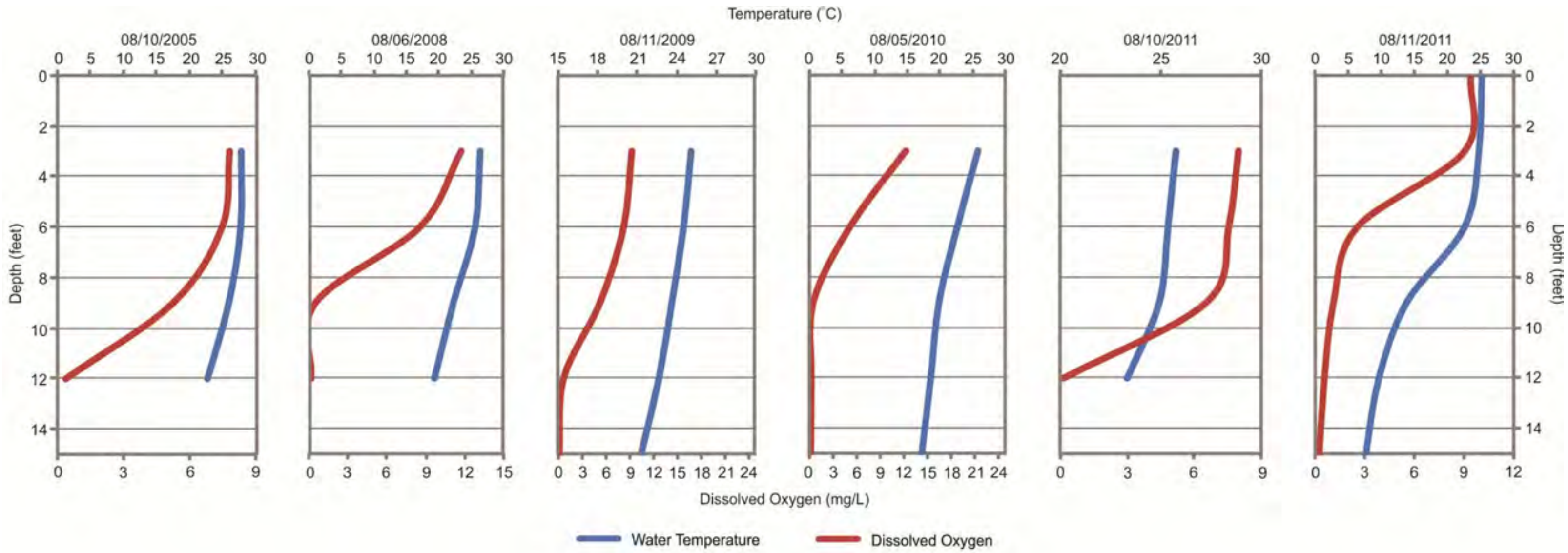
MID- TO LATE-JULY

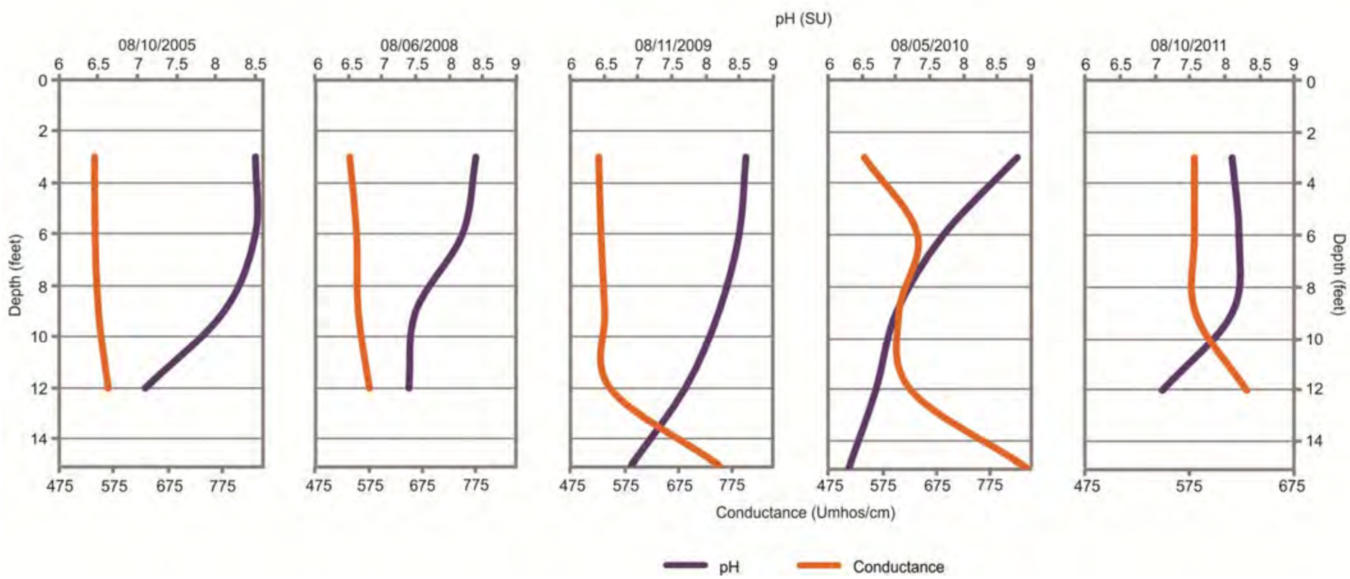




Appendix H (continued)

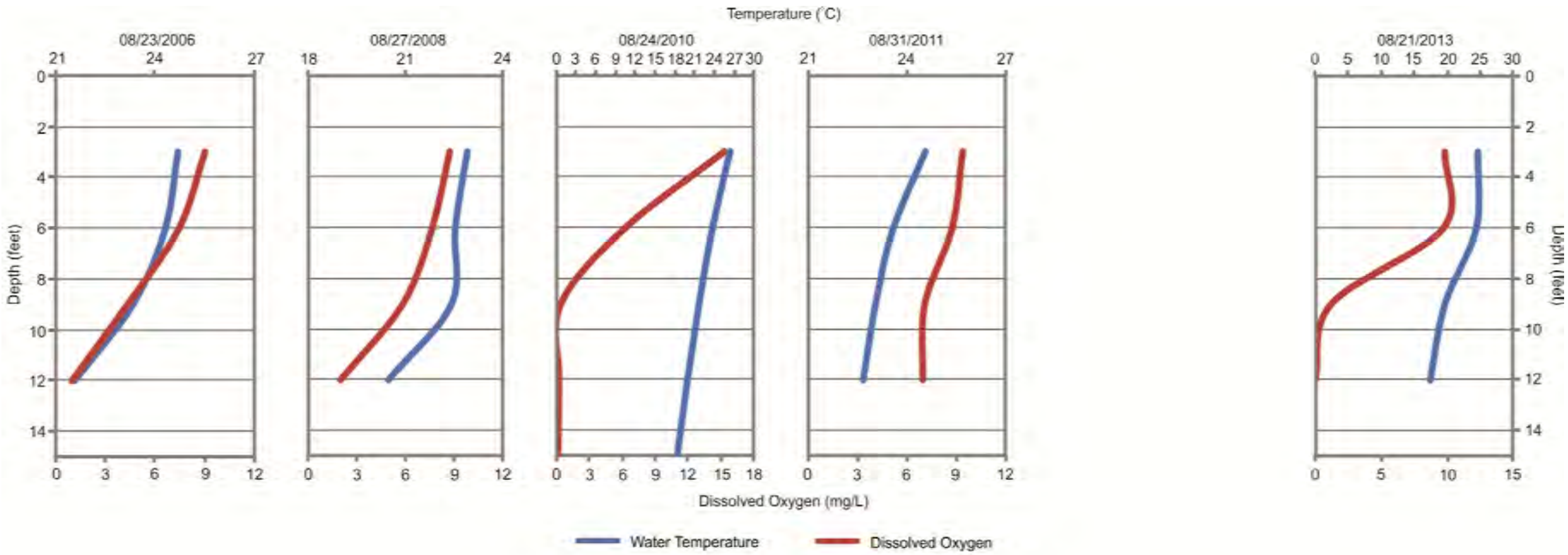
EARLY- TO MID-AUGUST

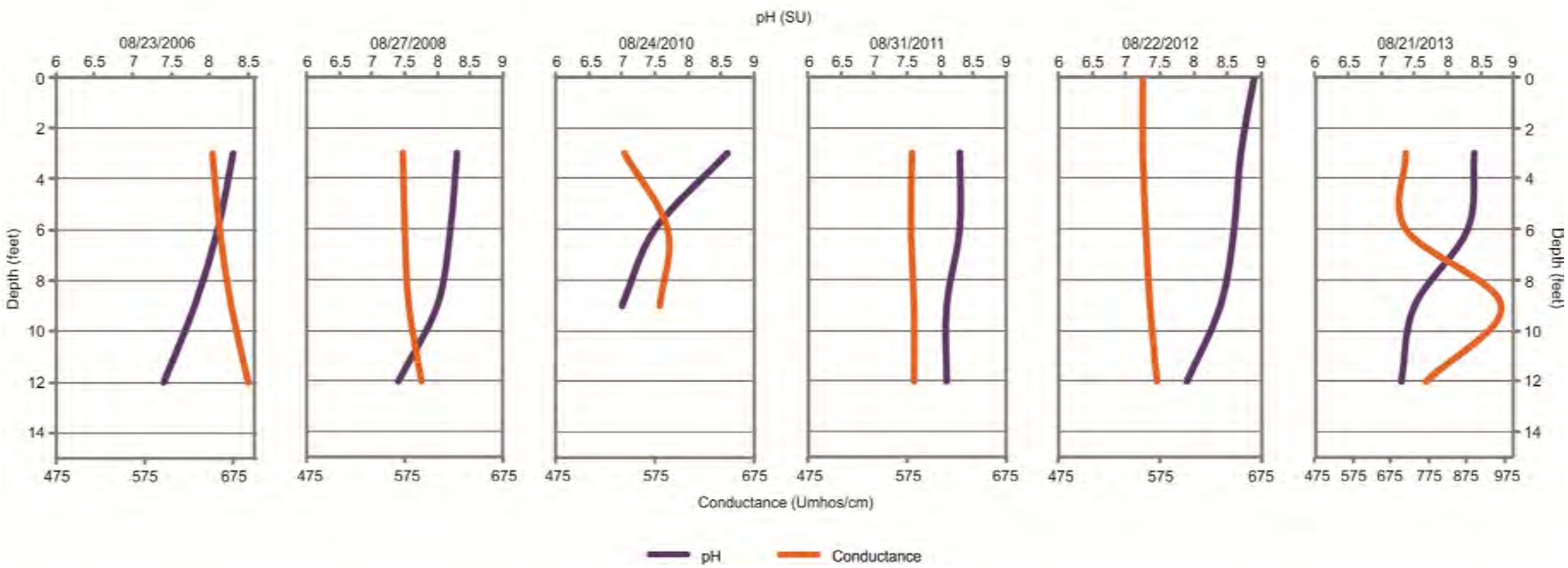




Appendix H (continued)

LATE AUGUST





Appendix H (continued)

SEPTEMBER