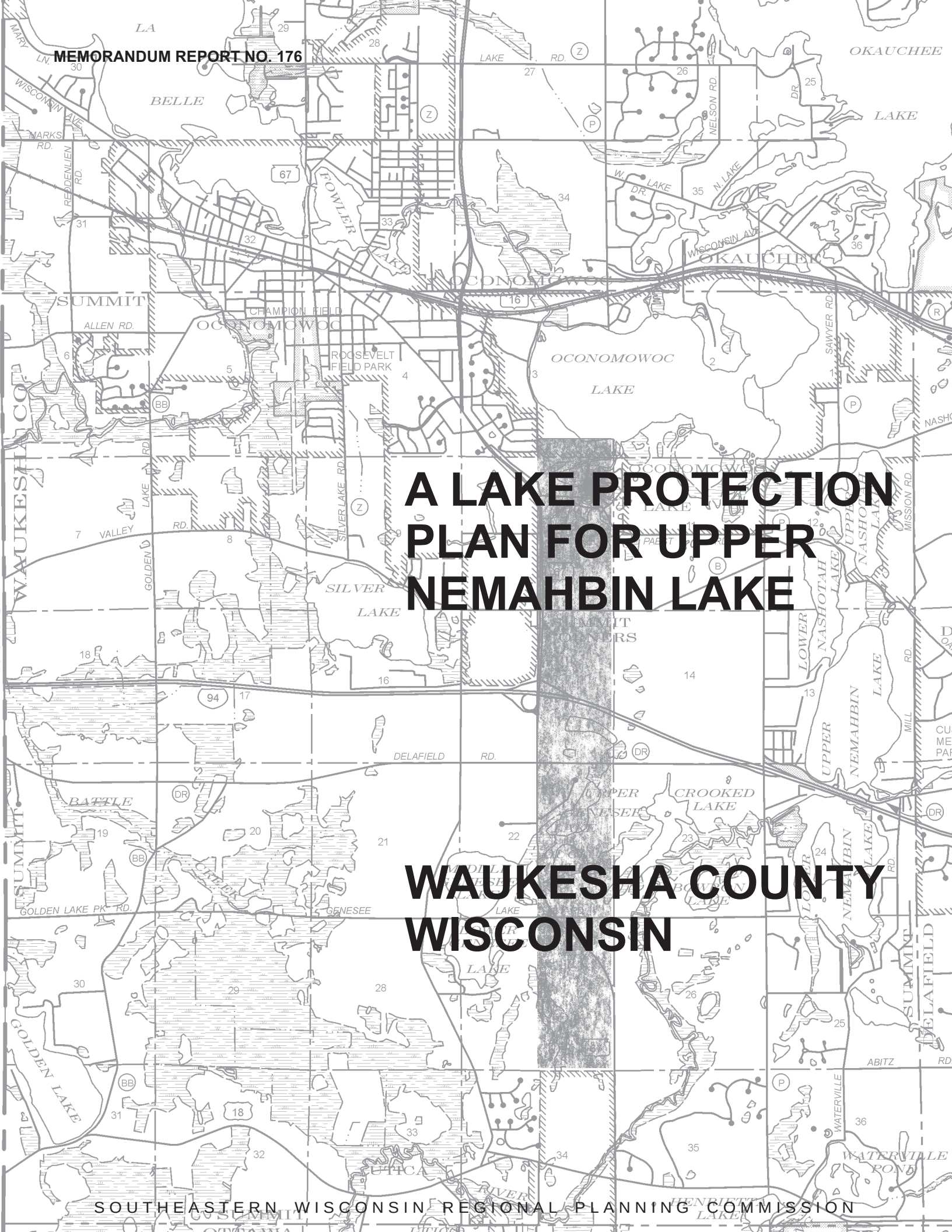
MEMORANDUM REPORT NO. 176



A LAKE PROTECTION PLAN FOR UPPER NEMAHBIN LAKE

WAUKESHA COUNTY WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Special acknowledgement is due to Dr. Jeffrey A. Thornton, CLM, PH, and Dr. Thomas M. Slawski, SEWRPC Principal Planners; Mr. Edward J. Schmidt, SEWRPC GIS Planning Specialist; Mr. Aaron W. Owens and Ms. Sara Wilder Teske, SEWRPC Research Analysts; and Mr. Michael A. Borst, SEWRPC Research Aide, for their contributions to the conduct of this study and the preparation of this report.

MEMORANDUM REPORT
NUMBER 176

A LAKE PROTECTION PLAN FOR UPPER NEMAHBIN LAKE WAUKESHA COUNTY, WISCONSIN

Prepared by the

Southeastern Wisconsin Regional Planning Commission
W239 N1812 Rockwood Drive
P.O. Box 1607
Waukesha, Wisconsin 53187-1607
www.sewrpc.org

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Chapter I

INTRODUCTION

Upper Nemahbin Lake, located in the Town of Summit, Waukesha County, Wisconsin, is a 283-acre drainage, or flow-through, lake located in the middle portion of the Bark River, a tributary stream system to the Rock River. Upper Nemahbin Lake is a valuable natural resource offering a variety of recreational and related opportunities to the resident community and its visitors. The Lake is situated entirely within U.S. Public Land Survey Township 7 North, Range 17 East, Sections 13 and 24, Town of Summit, in Waukesha County. In recent years, the recreational and aesthetic value of Upper Nemahbin Lake has been perceived to be adversely affected by various water quality and lake use management problems, including problems related to excessive sediment deposition in the area of the confluence of the Bark River and Upper Nemahbin Lake, the growth of Eurasian water milfoil in the Lake, and other environmental disturbances related to past failures of the Roller Mill Dam.[1] Additionally, the proposed abandonment of the Roller Mill Dam by the current owner poses both opportunities and risks for the downstream waterbodies, primarily for Upper Nemahbin Lake. Likewise, the proposed reconstruction of CTH P, which includes the low head weir impounding Lower Nemahbin Lake, and controlling the water level of Upper Nemahbin Lake, has implications for water level management in the two lakes, as well as Lower Nashotah Lake which drains into Upper Nemahbin Lake from the north, as shown on Map 1.

BACKGROUND

Seeking to improve the usability and prevent the deterioration of its natural assets and recreational potential, the Upper Nemahbin Lake community, formed the Upper Nemahbin Lake Management District (UNLMD), a Chapter 33, *Wisconsin Statutes*, public inland lake protection and rehabilitation district, in 1992. The UNMLD, in cooperation with the Town of Summit and the City of Delafield, continues to undertake an annual program of lake management in the middle portion of the Bark River basin, downstream of Nagawicka Lake. To this end, the District has established a dialogue with the City of Delafield Lake Welfare Committee with regard to the management of water quality and water flows between the upstream Nagawicka Lake and Upper Nemahbin Lake, and has initiated discussions with the Lower Nemahbin Lake Association with regard to lake management concerns in that Lake and downstream.

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[1]*SEWRPC Memorandum Report No. 101*, Upper Nemahbin Lake Watershed Inventory Findings, Waukesha County, Wisconsin, *May 1995*.

Map 1

LOCATION OF UPPER NEMAHBIN LAKE ON THE BARK RIVER BETWEEN NAGAWICKA LAKE AND CROOKED LAKE

UPPER NEMAHBIN LAKE

Source: SEWRPC.

Upper Nemahbin Lake has been the subject of previous lake management-related investigations, including reports produced by the private sector[2] and the Southeastern Wisconsin Regional Planning Commission (SEWRPC)[3].

This report sets forth updates and expands the watershed inventory previously completed by SEWRPC through the development of a lake protection plan for Upper Nemahbin Lake. This plan reports on the condition of the aquatic plant communities in Upper Nemahbin Lake during 2008, as well as relevant tributary area and waterbody data related to land use, water quality, hydrology, and ecology. The plan also provides recommendations for management of aquatic plants within Upper Nemahbin Lake, and for the management of water quality and recreational uses. In addition, this plan extends consideration of lake management issues of concern in both the upstream and downstream directions from Upper Nemahbin Lake, through consideration of the impacts of proposed changes to the water level control structures in the vicinities of Mill Road (Roller Mill Dam) and CTH P (Lower Nemahbin Lake Dam), respectively.

At the time of writing, both the Wisconsin Department of Natural Resources (WDNR) and Wisconsin Department of Transportation (WisDOT) are considering actions that could significantly modify the current status of the Lake and middle portion of the Bark River system within the Region. The WDNR has granted a request for abandonment of the Roller Mill Dam (Applebecker Millpond), situated downstream of Nagawicka Lake and upstream of Upper Nemahbin Lake, and the WisDOT is initiating planning activities for the reconstruction of CTH P which has the potential to modify the hydrologic control structure at the outlet of Lower Nemahbin Lake. This latter action would affect lake levels on Lower Nemahbin, Upper Nemahbin, and Lower Nashotah Lakes. For these reasons, the UNLMD requested the assistance of SEWRPC in preparing specific guidance with respect to the hydrology and hydrobiology of the Middle Bark River and to minimize the likely impacts on the fish, wildlife, and other aquatic biota within this critical stream reach.

Prior to initiating this planning program, the UNLMD had partnered with the City of Delafield in contracting with the U.S. Geological Survey (USGS) to acquire data on the hydrology and water quality of the Bark River at its outlet from Nagawicka Lake,[4] and had requested the assistance of the WDNR in securing cost-share grant funds under the Chapter NR 190 Lake Management Planning Grant Program to support the conduct of a planning program designed to guide the proposed management activities within the middle Bark River so as to protect water quantity and quality in the Lake. The outputs of these planning efforts are incorporated herein by reference.

Specifically, this report represents part of the ongoing commitment of the Upper Nemahbin Lake community, through the UNLMD, to sound planning with respect to the Lake. The report sets forth inventories of the aquatic plant communities present within Upper Nemahbin Lake, the aquatic life present in the stream system above and below the Lake, and related inventories necessary to protect and preserve the essential character, habitat and water quality of the middle Bark River. The aquatic plant inventories were prepared by SEWRPC in cooperation with the UNLMD based upon the results of field surveys conducted by the Commission staff using the modified Jesson

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[2]*Aqua-Tech, Inc., Report,* Limnological Survey of Upper Nemahbin Lake for the Determination of Water Quality, *s.d. See also TN & Associates,* Watershed Inventory of the Bark River between Nagawicka Lake and Upper Nemahbin Lake, Waukesha County, Wisconsin, *June 2001.*

[3]*SEWRPC Community Assistance Memorandum Report No. 101,* Upper Nemahbin Lake Watershed Inventory Findings, Waukesha County, Wisconsin, *May 1995.*

[4]*See U.S. Geological Survey Scientific Investigations Report No. 2006-5273,* Water Quality, Hydrology, and Response to Changes in Phosphorus Loading to Nagawicka Lake, a Calcareous Lake in Waukesha County, Wisconsin, *2006.*

and Lound transect method developed by the WDNR;[5] the benthological inventories were prepared by SEWRPC based upon the results of field surveys conducted by WDNR and Commission staff; the fisheries inventories were prepared by SEWRPC based upon field data acquired by WDNR, Medical College of Wisconsin, and SEWRPC staff; and, the stream inventories were prepared by SEWRPC based upon field inventories conducted by SEWRPC staff, all during 2008. This plan was funded in part by a grant through the Chapter NR 190 Lake Management Planning Grant Program.

LAKE PROTECTION OBJECTIVES

The objectives of this lake protection plan for Upper Nemahbin Lake were developed in consultation with the UNLMD. These objectives are as follows:

1. To protect and maintain public health, and promote public comfort, convenience, necessity and welfare, in concert with that of the natural resource, through the environmentally sound management of native vegetation, fishes and wildlife populations in and around Upper Nemahbin Lake;

2. To effectively maintain the water quality of Upper Nemahbin Lake so as 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;

3. To manage the inflowing and outflowing waters of the Middle Bark River so as to maintain effective public recreational boating access to both Upper and Lower Nemahbin Lakes, and to ensure continued navigability of the waterways; and,

4. To provide a high-quality, water-based experience for residents and visitors to Upper Nemahbin Lake and manage the Lake in an environmentally sound manner, consistent with the policies and objectives of the WDNR as set forth in the regional water quality management plan.[6]

This lake protection plan conforms to the requirements and standards set forth in the relevant *Wisconsin Administrative Codes.*[7] 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. The scope of this report is limited to a consideration of those management measures that are determined to be effective in the protection of lake water quality and lake use based upon data available through 2008.

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[5]*R. Jesson, and R. Lound, Minnesota Department of Conservation Game Investigational Report No. 6,* An Evaluation of a Survey Technique for Submerged Aquatic Plants, *1962.*

[6]*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.*

[7]*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 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."*

Chapter II

INVENTORY FINDINGS: UPPER NEMAHBIN LAKE

INTRODUCTION

The physical characteristics of a lake and its watershed are important factors in any evaluation of existing and likely future water quality conditions and lake uses, including recreational uses. Characteristics, such as watershed topography, lake morphometry, and local hydrology, ultimately influence water quality conditions and the composition of plant and fish communities within the lake. Therefore, these characteristics must be considered during the lake management planning process. Accordingly, this chapter provides pertinent information on the physical characteristics of Upper Nemahbin Lake and its tributary area, land use conditions, and the chemical and biological environments of the Lake, as well as past and present management practices and the recreational uses and facilities of Upper Nemahbin Lake. Subsequent chapters deal with the connected stream system draining to and from Upper Nemahbin Lake, issues of concern relative to Upper Nemahbin Lake, and alternative and recommended lake and stream protection practices.

BACKGROUND

Upper Nemahbin Lake is located immediately west of the City of Delafield, in the Town of Summit in the west central portion of Waukesha County, as shown on Map 1 in Chapter I of this report. The Lake is considered to be a drainage, or flow-through, lake, having a defined natural channel inflow and a defined outflow. The Bark River forms the major tributary stream flowing into Upper Nemahbin Lake from the east and out of the Lake to the south; additional inflow to the Lake arises from the tributary areas to Upper and Lower Nashotah Lakes, which drain directly to Upper Nemahbin Lake from the north.

Upper Nemahbin Lake discharges directly to Lower Nemahbin Lake, which is separated from Upper Nemahbin Lake by the CTH DR and IH 94 highway corridor. Upper Nemahbin Lake, Lower Nemahbin Lake, and Lower Nashotah Lake share a common surface elevation determined in part by the control structure that forms part of the CTH P bridge spanning the Bark River.[1] This control structure forms the southernmost “break point” in the hydrological system controlling water quality and quantity conditions within Upper Nemahbin Lake.

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[1]*The water surface elevations of Upper Nemahbin Lake and Lower Nemahbin Lake are nominally different due to the constriction of flow created by the CTH DR and IH 94 bridges that separate the Lakes. Under high flow conditions, these bridges may limit the passage of flood flows and create a slight difference in water surface elevation between Upper and Lower Nemahbin Lakes. The presence of a sand bar between Upper Nemahbin Lake and Lower Nashotah Lake may similarly restrict flows between these lakes under certain conditions.*

Upstream of Upper Nemahbin Lake, natural grade changes in the middle portion of the Bark River formed an ideal location for the Roller Mill Dam, an intermediate waterbody located downstream of Nagawicka Lake.[2] As of late-2009, this latter structure is being abandoned by the current owner, who applied to the Wisconsin Department of Natural Resources (WDNR) for an abandonment permit pursuant to the procedures set forth in Chapter 31 of the *Wisconsin Statutes*.

WATERBODY CHARACTERISTICS

Upper Nemahbin Lake is a 283-acre waterbody, the hydrographical characteristics of which are set forth in Table 1. As aforementioned, the Lake is a flow-through lake with a single deep basin. The Lake has a maximum depth of approximately 61 feet, a mean depth of about 30 feet, and a volume of 8,377 acre-feet. The general orientation of Upper Nemahbin Lake is north-south. The most steeply sloped bottom gradients are located along the eastern shore of the Lake adjacent to the deep hole. Elsewhere in the basin, there are extensive shallow water zones located near the Lake's northern extreme and southwestern corner. The general bathymetry of the Lake is shown on Map 2.

The Lake is approximately 1.1 miles long with a shoreline development factor (SDF) of 1.2, indicating that, while the shoreline is slightly longer that a perfectly circular lake of the same area, the Lake is largely circular in aspect. By comparison, the upstream Nagawicka Lake has a SDF of 1.65, reflecting the more elongate and irregular shoreline of that waterbody. The SDF is important because it is often related to the amount of littoral zone (the shallower, near-shore area of a lake usually rich in plant and animal life) in a lake. The greater a lake's shoreline factor, the more irregular its shoreline and, therefore, the greater the likelihood of its having more littoral zone area within which habitat suitable for plant and animal life is located. From a human perspective, higher SDF values provide a greater the length of shoreline available for development and lake access.

Other factors, such as lake bottom sediment composition and basin contours, also impact the amount of biological activity in a lake. Lake bottom sediment types in the near shore areas of Upper Nemahbin Lake, in depths of less than 3 feet, consist predominantly of rock and gravel along the western and northern shorelines, sand and gravel along the eastern shoreline, and silt in the area adjacent to where the Bark River flows into the Lake in the southeastern corner. As noted in the previously prepared lake and watershed inventory for Upper Nemahbin Lake,[3] this silt most likely reflects deposition of unconsolidated materials released from the upstream Roller Mill Dam.[4] This issue has become increasingly severe since mid-2008 when, during a flood event,[5] and pursuant to the WDNR order to protect human life, health, and property, appended hereto as Appendix A, the stop logs were removed from the spillway of the Roller Mill Dam. Although the stop logs were subsequently replaced temporarily during late-June 2008, the WDNR order further stipulated that the stop logs be again removed at a rate of one stop log every four days, commencing in early-July 2008 and continuing until all of the stop logs were removed. While the initial action undertaken during the flood event of mid-June 2008, successfully

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[2]*See SEWRPC Community Assistance Planning Report No. 262,* A Lake Management Plan for Nagawicka Lake, Waukesha County, Wisconsin, *March 2001.*

[3]*SEWRPC Memorandum Report No. 101,* Upper Nemahbin Lake Watershed Inventory Findings, Waukesha County, Wisconsin, *May 1995.*

[4]*Episodic deposition of unconsolidated materials at the confluence of the Bark River with Upper Nemahbin Lake is documented by the Wisconsin Department of Natural Resources in letters dated July 19, 1989, July 27, 1989, and February 12, 1990, File Ref: 3564; see also Lake Country Reporter, July 13, 1989, page 26.*

[5]*See U.S. Geological Survey News Release, "USGS Crews Dispatched to Measure Historic Wisconsin Floods," June 10, 2008.*

Table 1

HYDROLOGY AND MORPHOMETRY OF UPPER NEMAHBIN LAKE: 2008

Parameter	Upper Nemahbin Lake
Size	
Surface Area of Lake	283 acres
Total Tributary Area[a]	31,644 acres
Direct Tributary Area[a]	2,188 acres
Lake Volume	8,377 acre-feet
Residence Time[b]	0.55 years
Shape	
Length of Lake	1.1 mile
Width of Lake	0.6 mile
Length of Shoreline	2.9 miles
Shoreline Development Factor[c]	1.2
General Lake Orientation	N-S
Depth	
Mean Depth	29.6 feet
Maximum Depth	61.0 feet

[a]*The total and direct tributary areas for Upper Nemahbin Lake have been variously recorded in earlier reports as 25,585 and 1,734 acres, respectively. The current measurements are based on elevation refinements made possible through Commission digital terrain modeling analysis.*

[b]*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.*

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

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

minimized the risk of dam failure, the subsequent controlled drawdown led to significant sediment loss from the former lake basin (associated with "head cutting" as the historic channel seeks to reestablish itself) and high rates of deposition within the portion of the Bark River entering Upper Nemahbin Lake (see Chapter IV). Offshore, in water depths ranging from three feet to about 11 feet, the predominant sediment type throughout the Lake is a combination of silt and sand. A preponderance of soft bottom sediments and relatively flat bottom contours is often associated with lakes of high productivity; lakes containing greater percentages of rock and sand bottom materials with steep bottom contours, such as is generally the case in Upper Nemahbin Lake, are more likely to have lower productivity.

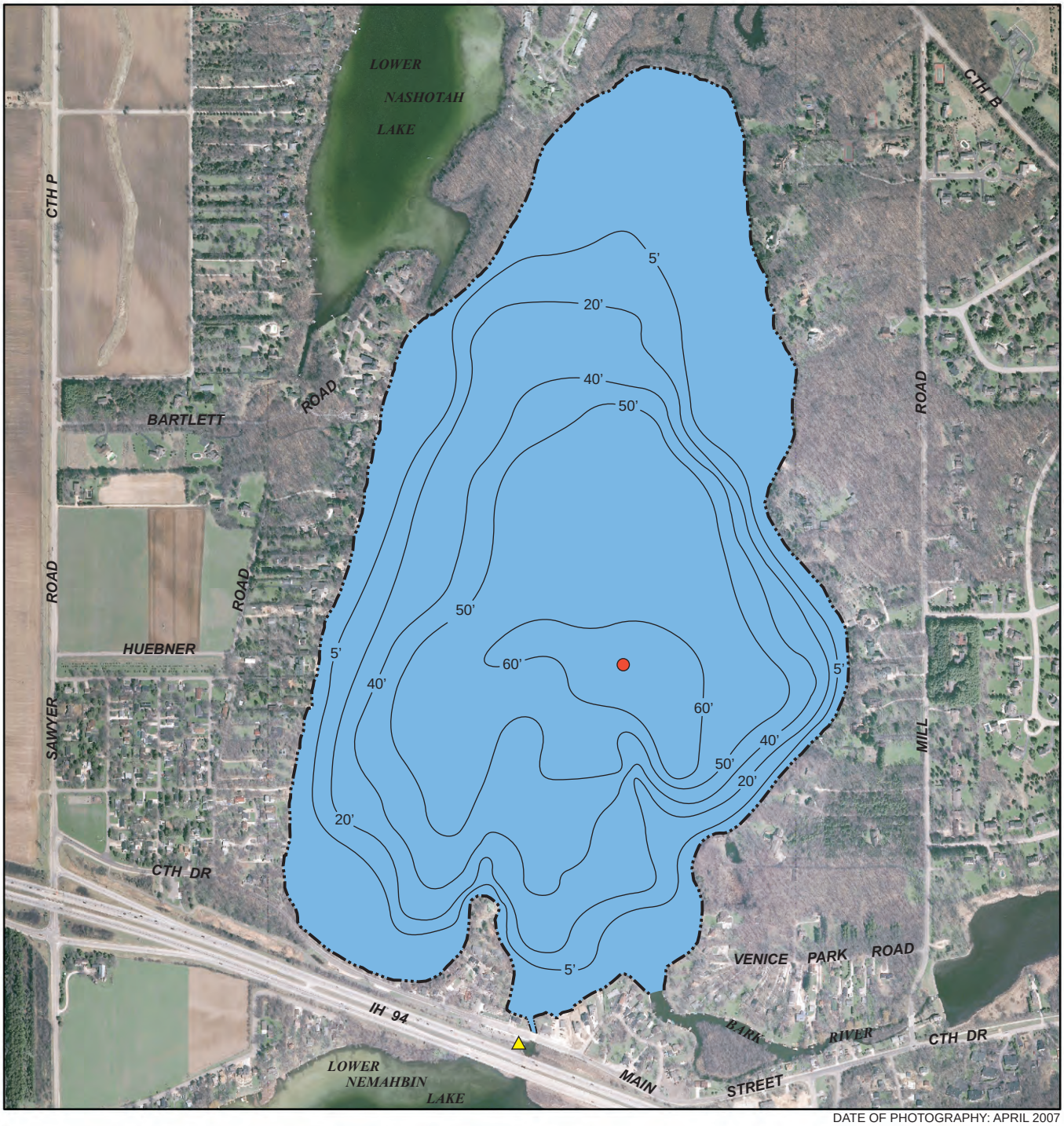
TRIBUTARY AREA AND LAND USE CHARACTERISTICS

The area directly tributary to Upper Nemahbin Lake is situated within the City of Delafield, the City of Oconomowoc and the Town of Summit, all in Waukesha County. This area, which drains directly to Upper Nemahbin Lake without passing through any upstream waterbody, is approximately 2,188 acres in areal extent. The total area tributary to the Lake extends over a significantly larger area, as shown on Map 3. The total area tributary to Upper Nemahbin Lake, which is approximately 31,644 acres in areal extent, includes portions of: the Cities of Delafield and Oconomowoc; the Villages of Chenequa, Hartland, Merton, Nashotah, Oconomowoc Lake, Sussex, and Richfield; and, the Towns of Delafield, Lisbon, Merton, and Summit, in Washington and Waukesha Counties. Of these communities, the Cities of Delafield and Oconomowoc, the Villages of Hartland, Merton, Nashotah and Richfield, and the Towns of Merton and Summit are designated as urbanized areas within the State of Wisconsin that are required to comply with federal Phase II Final Rules governing Municipal Separate Storm Sewer Systems (MS4s).[6]

[6]*The Phase II requirements build upon Phase I of the federal stormwater management rules governing the stormwater discharge permit system created within the National Pollutant Discharge Elimination System (NPDES), and promulgated in 1990. The Phase II requirements mandate the control of pollution generated by stormwater discharges from small municipal separate storm sewer systems (MS4s). MS4s include those stormwater management systems that serve communities of less than 100,000 people as well as construction sites that disturb one to five acres. Phase II allows exclusion of some facilities and inclusion of others based on the likelihood of adverse impacts to water quality. Chapter NR 216 of the* Wisconsin Administrative Code *contains six minimum measures for small MS4s that the US Environmental Protection Agency (US EPA) believes should significantly reduce pollutants in urban stormwater.*

Map 2

BATHYMETRIC MAP OF UPPER NEMAHBIN LAKE



DATE OF PHOTOGRAPHY: APRIL 2007

—20'— WATER DEPTH CONTOUR IN FEET

MONITORING SITE

PUBLIC ACCESS SITE

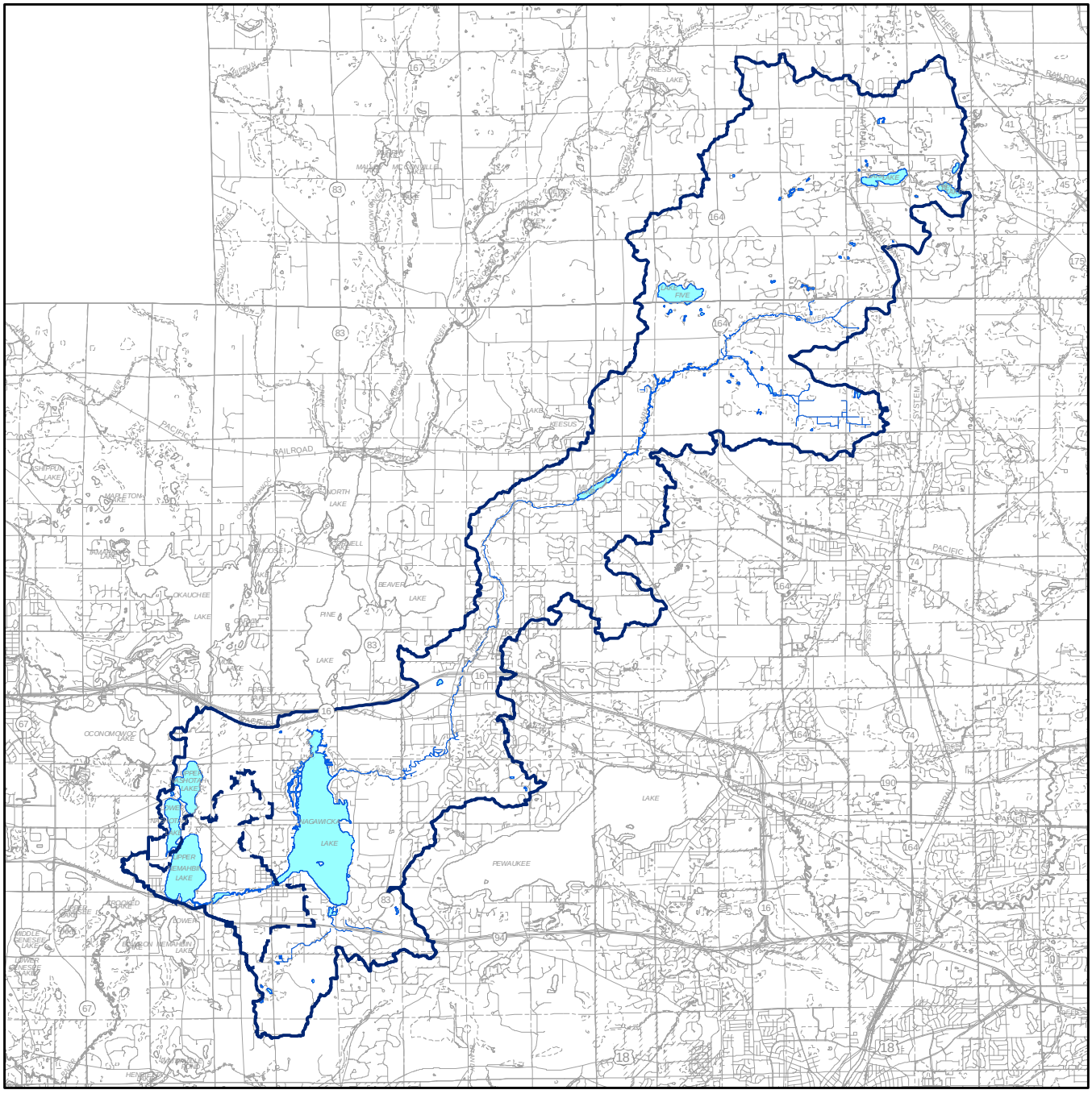
GRAPHIC SCALE

0 450 900 FEET

Source: U.S. Geological Survey and SEWRPC.

Map 3

UPPER NEMAHBIN LAKE TOTAL TRIBUTARY AREA



Source: SEWRPC.

Population
The population and the numbers of housing units within the drainage area directly tributary to Upper Nemahbin Lake have generally shown a steady increase, as summarized in Table 2. The greatest increase in population occurred between 1980 and 1990 when the numbers of people increased from 1,355 individuals to 1,814 individuals, or by about one-third. The numbers of housing units also increased during this same period. The numbers of houses increased during this decade from 446 to 681 units, an increase of over 52 percent.

In the total tributary area of Upper Nemahbin Lake, increases in population and number of households were fairly steady, as shown in Table 2. The largest increase in population within the total tributary area occurred during the period between 1970 and 1980, when the population increased by over 55 percent, from 11,238 individuals to 17,485 individuals. The greatest increase in the numbers of housing units also occurred during this same period.

Land Uses
The land uses within the portion of the area directly tributary to Upper Nemahbin Lake are primarily urban, with low- to medium-density single-family residential uses being the dominant urban land use. The shoreline of the Lake is mostly developed for residential uses, although some commercial development is located adjacent to the CTH DR corridor at the southern extreme of the Lake. These lake-oriented businesses offer a variety of services including private access opportunities, watercraft rentals, and bait and fishing supplies, among other services. As previously noted, the public recreational boating access site, deemed to provide adequate public recreational boating access pursuant to Chapter NR 1 of the *Wisconsin Administrative Code*, is located on the isthmus between Upper and Lower Nemahbin Lakes and between the CTH DR and IH 94 highway corridors. Access from this site to either lake is limited by the height of the bridges that cross the waterway linking the two lakes.

Map 4 shows existing land uses in the area directly tributary to Upper Nemahbin Lake as of 2000; these uses are summarized in Table 3. As shown in the table, as of the year 2000, the land uses in this area generally are fairly equally divided between rural and urban land uses, although this portion of the drainage area was somewhat more rural than urban. Future land uses within the area directly tributary to the Lake, however, are expected to include additional urban development, especially associated with the ongoing development of the Pabst Farm area in the City of Oconomowoc, infilling of already platted lots, and possible redevelopment of existing properties.

Under planned year 2035 conditions, as summarized in Table 3 and shown on Map 5, urban land uses in the area directly tributary to Upper Nemahbin Lake are expected to increase from about 43 percent of the land coverage in 2000, to about 72 percent in 2035. Rural land uses in the direct tributary area are anticipated to decrease from about 57 percent of the land coverage as of 2000, to about 28 percent of the land coverage under 2035 conditions. As shown on Map 5, these changes are predicted to occur mostly in the areas away from the immediate vicinity of the Lake, specifically in areas located to the north, west, and southeast of the Lake. These land use changes have the potential to modify the nature and delivery of nonpoint source contaminants to the Lake, with concomitant impacts on the aquatic plant communities within the waterbody.

For the total area tributary to Upper Nemahbin Lake, existing land uses are shown on Map 6 and are summarized in Table 4. As shown in the table, the land uses as of 2000 are significantly more rural than urban, with agriculture being the dominant rural land use and residential uses being the dominant urban land use. Future changes in land use within the total area tributary to Upper Nemahbin Lake are expected to be similar in nature to those anticipated within the area directly tributary to the Lake, albeit not as pronounced. Urban land uses are anticipated to increase from about 35 percent to 56 percent of the land cover within the total area tributary to Upper Nemahbin Lake, while rural land uses are expected to decrease from about 65 percent to 44 percent of the land cover. As shown on Map 7, the majority of these changes are expected to occur in the southern one-third and middle one-third of the total tributary area, in the vicinity of the City of Delafield and its environs.

Table 2

POPULATION AND HOUSEHOLDS WITHIN THE DIRECT AND TOTAL AREAS TRIBUTARY TO UPPER NEMAHBIN LAKE: 1960-2000[a]

Year	Direct Tributary Area		Total Tributary Area	
	Population	Households	Population	Households
1960	984	253	7,467	1,881
1970	1,239	375	11,238	3,071
1980	1,355	446	17,485	5,370
1990	1,814	681	21,159	7,034
2000	2,225	829	25,771	9,234

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

SHORELINE PROTECTION STRUCTURES

Erosion of shorelines results in the loss of land, damage to shoreline infrastructure, and interference with lake access and use. Wind-wave erosion, ice movement, and motorized boat traffic usually cause such erosion. A survey of the shoreline of Upper Nemahbin Lake, conducted by SEWRPC staff during the summer of 2008, showed natural shoreline along about 55 percent of the Lake perimeter, riprap along about 33 percent, bulkheads along about 8 percent, revetments along about 3 percent, and beaches along about 1 percent of the shoreline, as shown on Map 8. No erosion-related problems were observed within the lake basin during the 2008 survey that were considered to be severe or extreme.

WATER QUALITY

Water quality data on Upper Nemahbin Lake have been collected, intermittently, by the U.S. Geological Survey (USGS),[7] the Wisconsin Department of Natural Resources (WDNR), and private contractors since the 1970s.[8] A watershed inventory, compiled in 1995 by the Southeastern Wisconsin Regional Planning Commission (SEWRPC), summarized the water quality data collected in 1970 by Aqua-Tech, Inc., as well as the then-more current data gathered by USGS during 1993 and 1994.[9] Based on the analysis of wide array of parameters, SEWRPC staff documented significant improvement in overall water quality in Upper Nemahbin Lake between 1970 and 1994. This improvement in water conditions was likely to be the result of a combination of factors, including the abandonment of two sewage treatment facilities on the Bark River upstream of the Lake, application of land-based management strategies recommended in the regional water quality management plan,[10] and the installation of sanitary sewers in the area directly tributary to the Lake.[11]

The current study relies primarily on water quality data collected for Upper Nemahbin Lake by WDNR staff between 1995 and 2008, and is presented in Table 5.

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[7]*U.S. Geological Survey, Water-Data Report WI-94-2,* Water Resources Data - Wisconsin, Water Year 1994, Volume 2 - Upper Mississippi River Basin, *March 1995.*

[8]*Aqua-Tech, Inc.,* Limnological Survey of Upper Nemahbin Lake for the Determination of Water Quality, *s.d.*

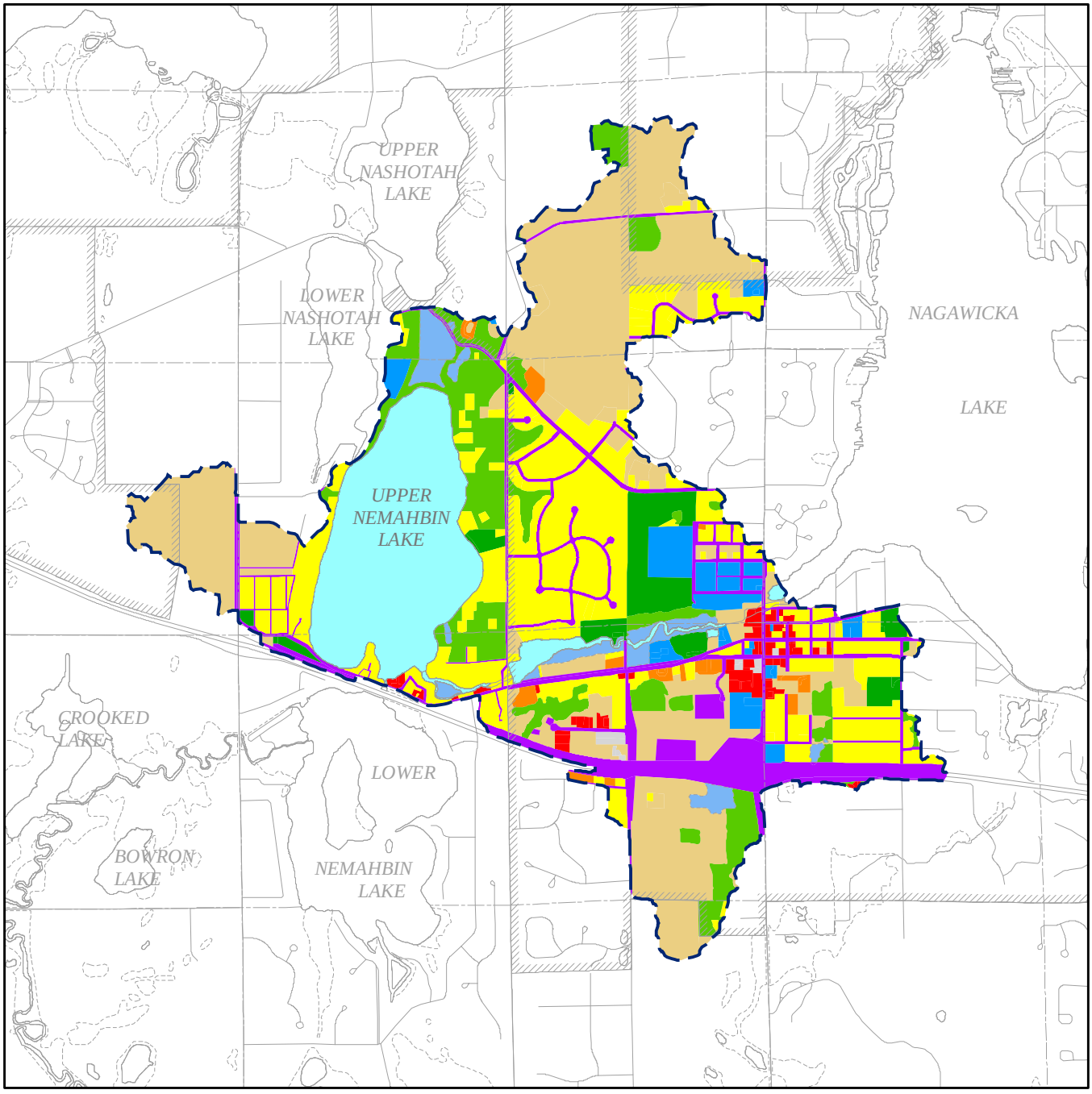
[9]*SEWRPC Memorandum Report No. 101,* op. cit.

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

[11]*See Community Assistance Planning Report No. 127,* Sanitary Sewer Service Area for the City of Delafield and the Village of Nashotah and Environs, Waukesha County, Wisconsin, *November 1992, as amended:* Amendment to Community Assistance Planning Report No. 127, Sanitary Sewer Service Area for the City of Delafield and the Village of Nashotah and Environs, Waukesha County, Wisconsin, *(Amendment to the Regional Water Quality Management Plan—2000, City of Delafield), December 1996.*

Map 4

EXISTING LAND USE WITHIN THE UPPER NEMAHBIN DIRECT TRIBUTARY AREA: 2000



Source: SEWRPC.

Table 3

EXISTING AND PLANNED LAND USE WITHIN THE AREA DIRECTLY TRIBUTARY TO UPPER NEMAHBIN LAKE: 2000 AND 2035

Land Use Categories[a]	2000		2035	
	Acres	Percent of Tributary Area	Acres	Percent of Tributary Area
Urban				
Residential	492	22.5	798	36.5
Commercial	34	1.6	62	2.8
Industrial	6	0.3	53	2.4
Governmental and Institutional	76	3.5	85	3.9
Transportation, Communication, and Utilities	252	11.5	396	18.1
Recreational	86	3.9	180	8.2
Subtotal	946	43.3	1,574	71.9
Rural				
Agricultural and Other Open Lands	661	30.2	43	2.0
Wetlands	54	2.5	54	2.5
Woodlands	220	10.0	210	9.6
Surface Water	307	14.0	307	14.0
Extractive	- -	- -	- -	- -
Landfill	- -	- -	- -	- -
Subtotal	1,242	56.7	614	28.1
Total	2,188	100.0	2,188	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

Water Clarity

Water clarity or transparency is often used as an indication of water quality. Transparency can be affected by physical factors such as water color (humic coloration or "tea" staining) and suspended particles, and by various biologic factors including seasonal variations in planktonic algae populations and activities of fish and other organisms living in the lake. Water clarity typically is 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 depth" or "Secchi-disk reading". Such measurements comprise an important part of the University of Wisconsin-Extension (UWEX) Citizen Lake Monitoring Network (CLMN) volunteer water quality monitoring program, formerly the WDNR Self-Help Monitoring Program.

Secchi-Disk Data

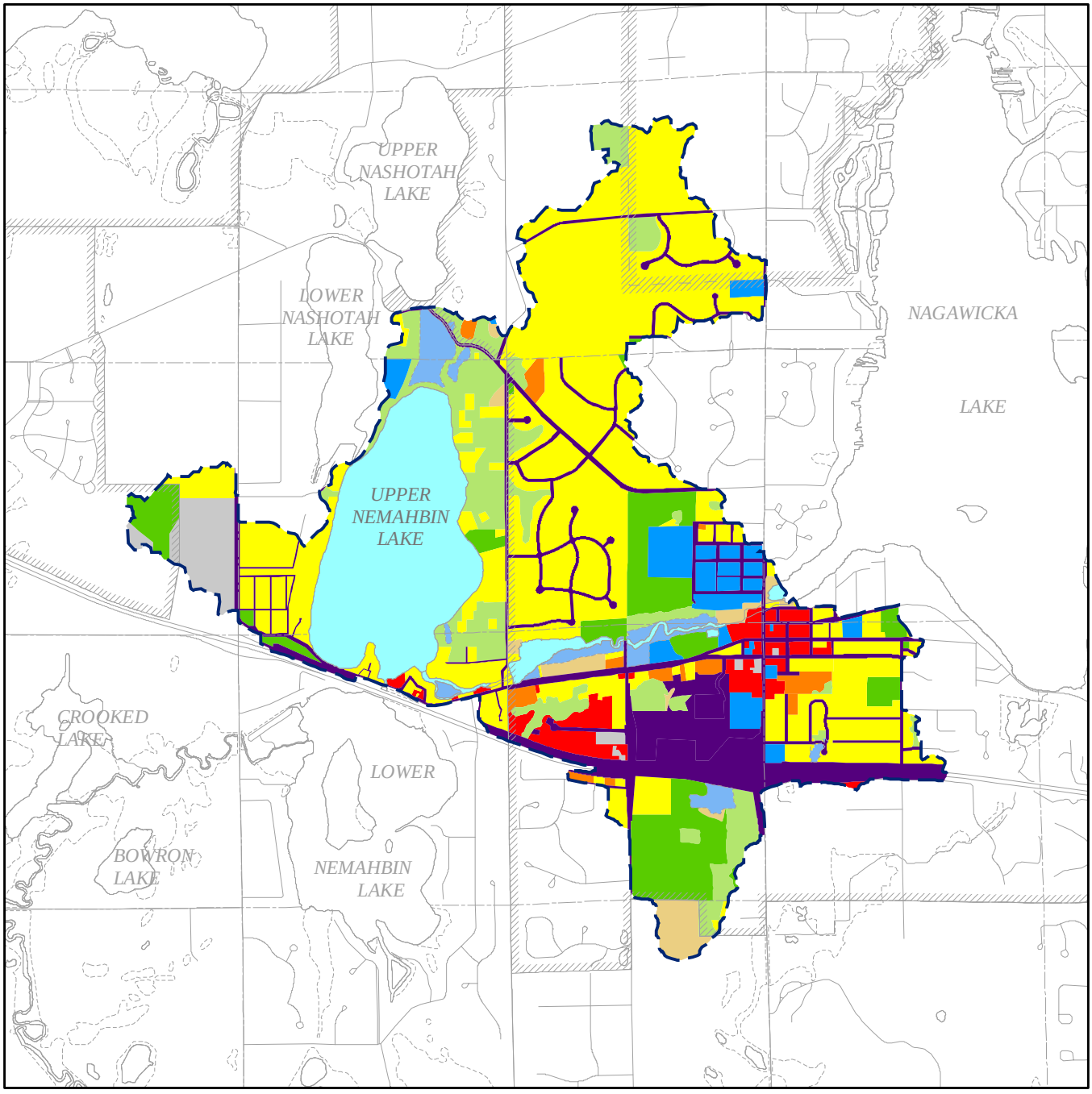
During the 1993-1994 study period, Secchi-disk measurements for Upper Nemahbin Lake were reported to be between about five and ten feet, with an average Secchi-disk reading of about six feet, indicating generally fair water quality. During the current period, transparency ranged from between six and 20 feet, with an average Secchi-disk depth of 12.5 feet, measurements indicative of very good water quality. It has been hypothesized that the increase in water clarity since the 1993-1994 study period may, in part, be the result of the development of a significant population of zebra mussels (*Dreissena polymorpha*) in the Lake, The WDNR lists Upper Nemahbin Lake as containing an established population of Zebra mussels since 1998. In 2000, WDNR staff recorded a Secchi depth of 5.3 meters (or greater than 17 feet).

Remote Sensing Data

In addition to in-lake direct measurements of water clarity using a Secchi disk, transparency of many Wisconsin lakes has been measured using remote sensing technology. The Environmental Remote Sensing Center (ERSC),

Map 5

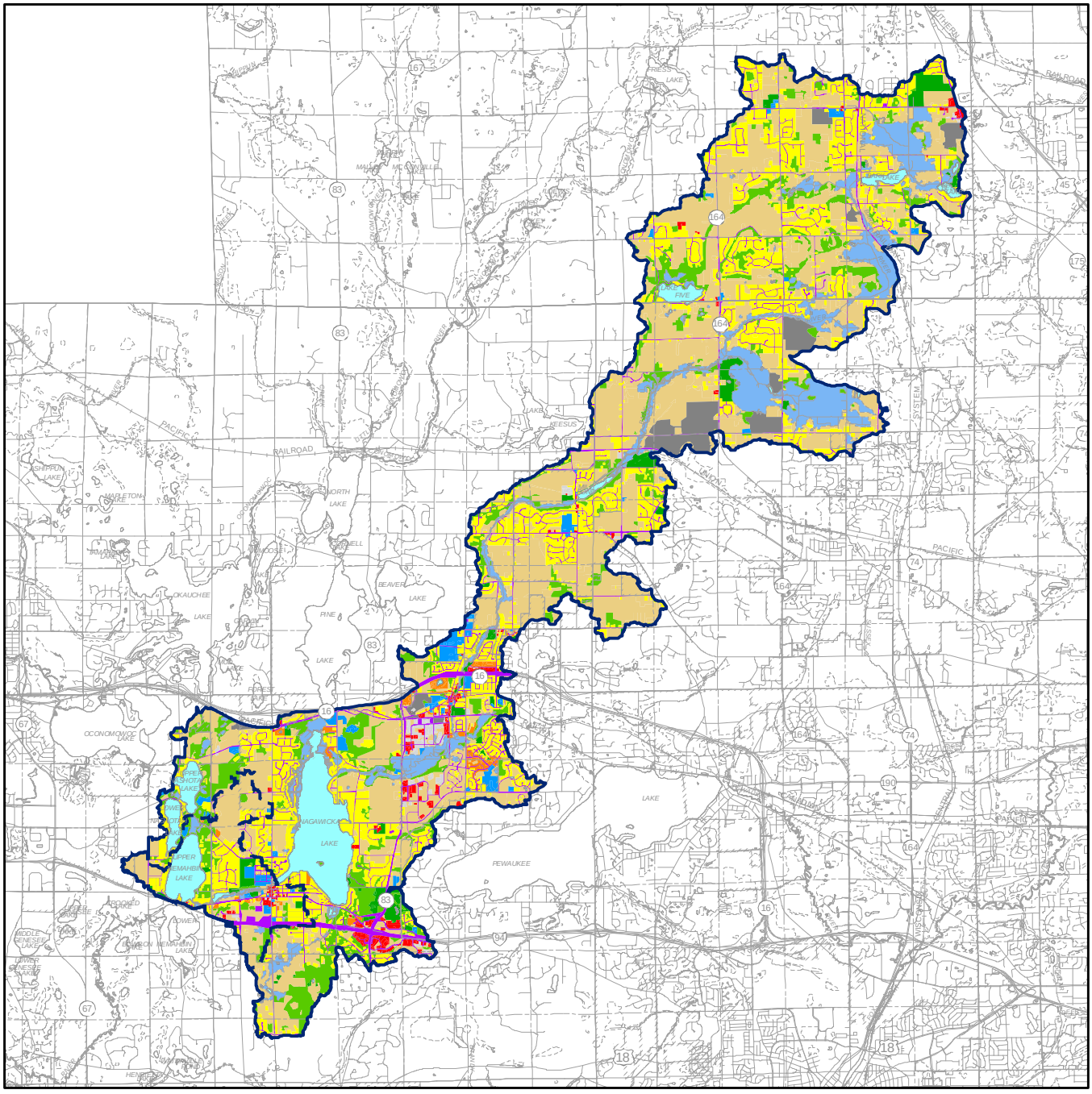
PLANNED LAND USE WITHIN THE UPPER NEMAHBIN DIRECT TRIBUTARY AREA: 2035



Source: SEWRPC.

Map 6

EXISTING LAND USE WITHIN THE UPPER NEMAHBIN LAKE TOTAL TRIBUTARY AREA: 2000



Source: SEWRPC.

Table 4

EXISTING AND PLANNED LAND USE WITHIN THE TOTAL AREA TRIBUTARY TO UPPER NEMAHBIN LAKE: 2000 AND 2035

Land Use Categories[a]	2000		2035	
	Acres	Percent of Tributary Area	Acres	Percent of Tributary Area
Urban				
Residential	6,903	21.8	10,932	34.5
Commercial	354	1.1	832	2.6
Industrial	183	0.6	337	1.1
Governmental and Institutional	525	1.7	825	2.6
Transportation, Communication, and Utilities	2,366	7.5	3,850	12.2
Recreational	667	2.1	990	3.1
Subtotal	10,998	34.8	17,766	56.1
Rural				
Agricultural and Other Open Lands	11,977	37.8	5,033	15.9
Wetlands	2,811	8.9	2,811	8.9
Woodlands	3,182	10.1	3,122	9.9
Surface Water	1,849	5.8	1,899	6.0
Extractive	827	2.6	1,013	3.2
Landfill	- -	- -	- -	- -
Subtotal	20,646	65.2	13,878	43.9
Total	31,644	100.0	31,644	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

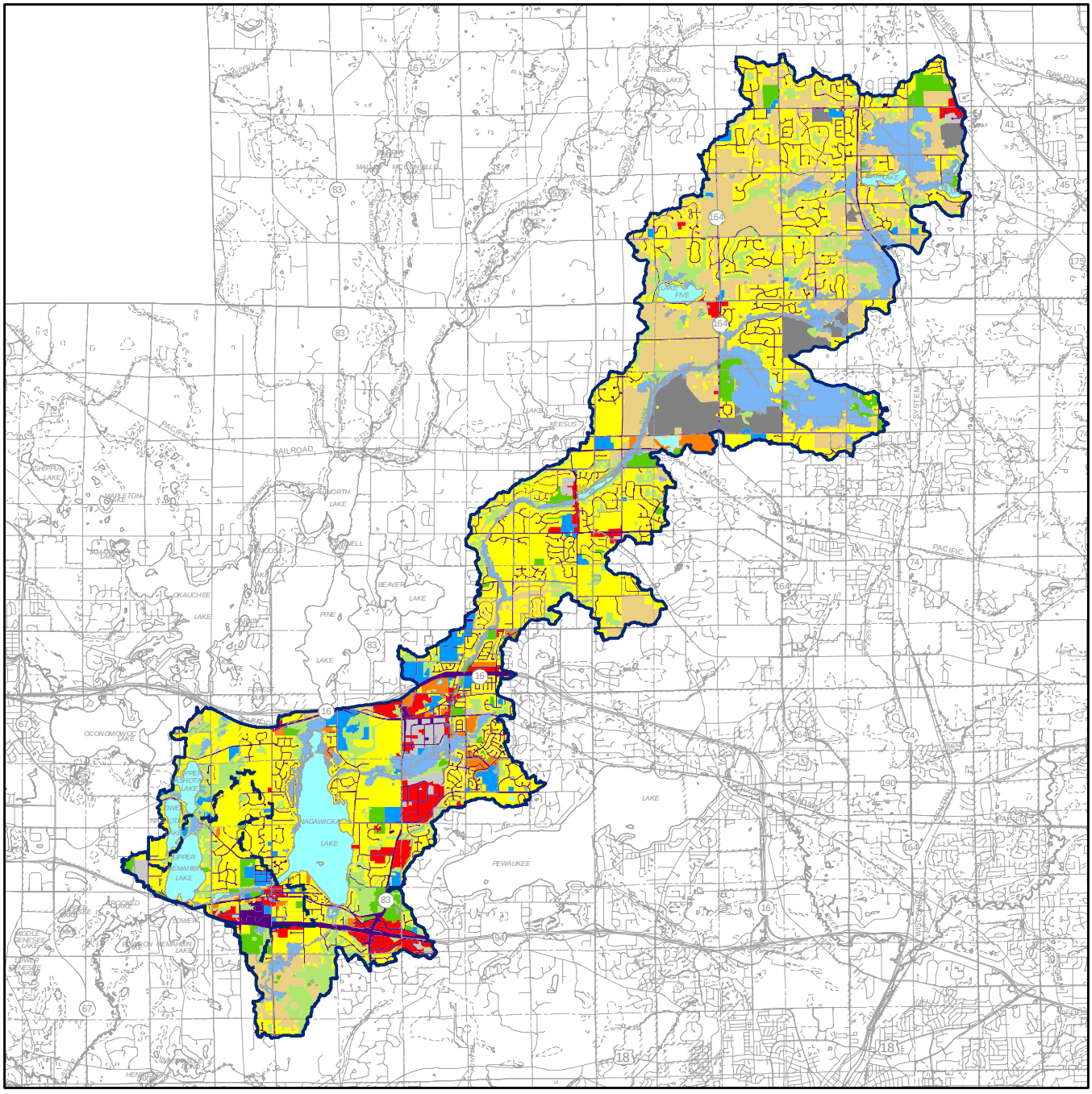
established in 1970 at the University of Wisconsin, Madison campus, was one of the first remote sensing facilities in the United States. Using data gathered by satellite remote sensing over a three year period, the ERSC generated a map based on a mosaic of satellite images showing the estimated water clarity of the largest 8,000 lakes in Wisconsin. The WDNR, through its volunteer Self-Help/CLMN Monitoring Program was able to gather clarity measurements from Secchi disk readings for about 800 lakes, or about 10 percent of Wisconsin's largest lakes; the satellite remote sensing technology utilized by ERSC is able to accurately estimate clarity for the remaining 90 percent. Measurements collected through ERSC remote sensing estimated average water clarity to be 11 feet for Upper Nemahbin Lake, a value indicative of generally very good water quality. This value is in good agreement with the average Secchi-disk reading reported by the WDNR staff.

Zebra Mussels Impacts

The zebra mussel is a nonnative species of shellfish with known negative impacts on native populations of benthic invertebrates, among other species. Impacts on lake fisheries also have been hypothesized. In the Upper Midwest, zebra mussels are having a varied impact on inland lakes. They disrupt the food chain by removing significant amounts of phytoplankton which serve as food not only for themselves but also for larval and juvenile fish and many forms of zooplankton. As a result of the filter feeding proclivities of these animals, many lakes experience improved water clarity which has led to increased growths of rooted aquatic plants, including Eurasian water milfoil. Curiously, within the Southeastern Wisconsin Region, zebra mussels have been observed attaching themselves to the stalks of the Eurasian water milfoil plants, dragging these stems out of the zone of light penetration due to the weight of the zebra mussel shells, and interfering with the competitive strategy of the Eurasian water milfoil plants. This, in turn, has contributed to improved growths of native aquatic plants in some cases, and to the growths of filamentous algae too large to be ingested by the zebra mussels in others. Because zebra mussels have become established in Upper Nemahbin Lake, their populations should be carefully

Map 7

PLANNED LAND USE WITHIN THE UPPER NEMAHBIN LAKE TOTAL TRIBUTARY AREA: 2035



- SINGLE-FAMILY RESIDENTIAL
- MULTI-FAMILY RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
- GOVERNMENT AND INSTITUTIONAL
- RECREATIONAL
- SURFACE WATER
- WETLANDS
- WOODLANDS
- AGRICULTURAL AND OTHER OPEN LANDS
- EXTRACTIVE AND LANDFILL

N

0 6,000 12,000 Feet

Source: SEWRPC.

Map 8

SHORELINE PROTECTION STRUCTURES ON UPPER NEMAHBIN LAKE: 2008

DATE OF PHOTOGRAPHY: APRIL 2007

RIPRAP
BULKHEAD
BEACH
REVETMENT
NATURAL

GRAPHIC SCALE
0 450 900 FEET

Source: SEWRPC.

Table 5

WATER QUALITY CONDITIONS FOR UPPER NEMAHBIN LAKE: 1995-2005

Parameter[a]	1995		2000		2005	
	Shallow[b]	Deep[c]	Shallow[b]	Deep[c]	Shallow[b]	Deep[c]
Specific Conductance (µS/cm)						
Range	549-634	617-681	- -	- -	635-690	712-757
Mean	603	648	- -	595	665	735
Standard Deviation	35	23	- -	- -	23	19
Number of Samples	5	5	- -	1	5	5
pH (units)						
Range	8.1-8.4	7.6-8.3	- -	- -	7.4-8.5	7.3-7.8
Mean	8.3	7.9	- -	8.5	8.2	7.5
Standard Deviation	0.1	0.3	- -	- -	0.5	0.2
Number of Samples	5	5	- -	1	5	5
Water Temperature (°F)						
Range	34.7-79.7	37.4-43.7	- -	- -	34.9-80.2	36.3-41.4
Mean	63.5	42.3	- -	70.5	62.5	39.4
Standard Deviation	21.4	2.7	- -	- -	20.0	2.1
Number of Samples	5	5	- -	1	5	5
Secchi Depth (feet)						
Range	10.5-18.4	- -	- -	- -	- -	- -
Mean	13	- -	- -	17.4	13.1	- -
Standard Deviation	3.6	- -	- -	- -	- -	- -
Number of Samples	4	- -	- -	1	1	- -
Dissolved Oxygen						
Range	8.4-14.0	0.4-11.5	- -	- -	3.9-14.4	0.1-10.1
Mean	10.6	3.5	- -	10.6	9.4	3.5
Standard Deviation	2.6	4.8	- -	- -	3.6	3.6
Number of Samples	5	5	- -	1	6	5
Total Phosphorus						
Range	0.004-0.011	0.012-0.033	- -	- -	0.011-0.023	0.020-0.076
Mean	0.008	0.022	- -	0.017	0.015	0.038
Standard Deviation	0.003	0.011	- -	- -	0.005	0.022
Number of Samples	4	4	- -	1	5	5
Chlorophyll-*a* (µg/l)						
Range	0.3-7.8	- -	- -	- -	1.5-3.1	- -
Mean	2.7	- -	- -	3	2.3	- -
Standard Deviation	3.5	- -	- -	- -	0.6	- -
Number of Samples	4	- -	- -	1	4	- -
Color						
Value	15	10	- -	5	15	- -
Number of Samples	1	1	- -	1	1	- -
Turbidity (NTU)						
Value	0.9	1.2	- -	3	2.3	- -
Number of Samples	1	1	- -	1	1	- -
Hardness, as $CaCO_3$						
Value	290	290	- -	- -	280	- -
Number of Samples	1	1	- -	- -	1	- -
Dissolved Calcium						
Value	55	56	- -	43	53	- -
Number of Samples	1	1	- -	1	1	- -
Dissolved Magnesium						
Value	37	37	- -	35	36	- -
Number of Samples	1	1	- -	1	1-	- -
Dissolved Sodium						
Value	23	23	- -	- -	33	- -
Number of Samples	1	1	- -	- -	1	- -
Dissolved Potassium						
Value	2	2	- -	- -	2	- -
Number of Samples	1	1	- -	- -	1	- -

Table 5 (continued)

Parameter[a]	1995		2000		2005	
	Shallow[b]	Deep[c]	Shallow[b]	Deep[c]	Shallow[b]	Deep[c]
Alkalinity, as $CaCO_3$						
Value			- -	198	- -	- -
Number of Samples	1	1	- -	1	- -	- -
Dissolved Sulfate SO_4						
Value	27	28	- -	- -	28	- -
Number of Samples	1	1	- -	- -	1	- -
Dissolved Chloride						
Value	51	51	- -	- -	74	- -
Number of Samples	1	1	- -	- -	1	- -
Dissolved Fluoride						
Value	0.05	0.05	- -	- -	- -	- -
Number of Samples	1	1	- -	- -	- -	- -
Dissolved Silica						
Value	1.7	2.1	- -	- -	4.5	- -
Number of Samples	1	1	- -	- -	1	- -
Dissolved Solids at 180º						
Value	356	354	- -	- -	386	- -
Number of Samples	1	1	- -	- -	1	- -
Dissolved Nitrogen, NO_2+NO_3						
Value	0.44	0.41	- -	0.407	0.752	- -
Number of Samples	1	1	- -	1	1	- -
Dissolved Nitrogen, Ammonia						
Value	0.13	0.16	- -	- -	0.03	- -
Number of Samples	1	1	- -	- -	1	- -
Nitrogen, Organic total						
Value	0.57	0.64	- -	- -	- -	- -
Number of Samples	1	1	- -	- -	- -	- -
Nitrogen, Amm + Org						
Value	0.7	0.8	- -	- -	0.4	- -
Number of Samples	1	1	- -	- -	1	- -
Nitrogen, Total						
Value	1.1	1.2	- -	- -	1.2	- -
Number of Samples	1	1	- -	- -	1	- -
Dissolved Orthophosphorus						
Value	<0.002	<0.002	- -	- -	0.003	- -
Number of Samples	1	1	- -	- -	1	- -
Dissolved Iron						
Value	<10	<10	- -	- -	<100	- -
Number of Samples	1	1	- -	- -	1	- -
Dissolved Manganese						
Value	<0.4	<0.4	- -	- -	<1	- -
Number of Samples	1	1	- -	- -	1	- -

NOTE: 1995 and 2005 data are from USGS; 2000 data is from WDNR.

[a] *Milligrams per liter unless otherwise indicated.*

[b] *Depth of sample approximately 1.5 feet.*

[c] *Depth of sample ranged from 56 to 64 feet for USGS in 1995 and 2005; depth of sample was 24 feet for WDNR in 2000.*

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

monitored. Regardless of the seeming beneficial impacts of these animals, the overall effect is that as zebra mussels and other invasive species spread to inland lakes and rivers, so do the environmental, aesthetic, and economic costs to water users.

Dissolved Oxygen

Dissolved oxygen levels are one of the most critical factors affecting the living organisms of a lake ecosystem. As was indicated by USGS data during both the previous and current study periods, dissolved oxygen levels are generally higher at the surface of Upper Nemahbin 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 lowest near the bottom of the Lake, where decomposer organisms and chemical oxidation processes utilize oxygen in the decay process. When any lake becomes stratified, that is, when a thermal or chemical gradient of sufficient intensity produces a barrier separating upper waters, called the epilimnion, from lower waters, known as the hypolimnion, the surface supply of oxygen to the hypolimnion is cut off. Eventually, if there is not enough dissolved oxygen to meet the demands from the bottom dwelling aquatic life and decaying organic material, the dissolved oxygen levels in the bottom waters may be reduced to zero, a condition known as anoxia or anaerobiasis.

During the abovementioned USGS study period of 1993 and 1994, by mid- to late-summer, Upper Nemahbin Lake thermally stratified at depths of between about 15 to 25 feet. The lower five feet of Upper Nemahbin Lake had become anoxic by June and the lower twenty feet by late August. During the current study period, WDNR data, obtained between 2002 and 2005, indicated that Upper Nemahbin Lake did not become completely anoxic, although levels of oxygen in the hypolimnion in late summer were significantly depressed far below the level of 5 milligrams of oxygen per liter (mg/l) which is considered to be the lowest level necessary to sustain fish.

Hypolimnetic anoxia is common in many of the lakes in southeastern Wisconsin during summer stratification. The depleted oxygen levels in the hypolimnion cause fish to move upward, nearer to the surface of the lakes, where higher dissolved oxygen concentrations exist. This migration, when combined with temperature, can select against some fish species that prefer the cooler water temperatures that generally prevail in the lower portions of the lakes. When there is insufficient oxygen at these depths, these fish are susceptible to summer-kills, or, alternatively, are driven into the warmer water portions of the lake where their condition and competitive success may be severely impaired.

In addition to these biological consequences, the lack of dissolved oxygen at depth can enhance the development of chemoclines, or chemical gradients, with an inverse relationship to the dissolved oxygen concentration. For example, the sediment-water exchange of elements such as phosphorus, iron, and manganese is increased under anaerobic conditions, resulting in higher hypolimnetic concentrations in these elements. Under anaerobic conditions, iron and manganese change oxidation states enabling the release of phosphorus from the iron and manganese complexes to which they are bound under aerobic conditions. This “internal loading” can affect water quality significantly if these nutrients and salts are mixed into the epilimnion, especially during early summer when these nutrients can become available for algal and rooted aquatic plant growth. Data for the previous study period indicated that the generally slight concentration gradients in phosphorus between surface and bottom waters was indicative of minor phosphorus release from bottom sediments during anoxic periods. Similar phosphorus gradients were observed during the current study period.

POLLUTION LOADINGS AND SOURCES

Pollutant loads 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 the lake through the atmosphere, across the land surface, and by way of inflowing streams. Pollutants transported by the atmosphere are deposited onto the surface of the lake as dry fallout and direct precipitation. Pollutants transported across the land surface enter the lake as direct runoff and, indirectly, as groundwater inflows, including drainage from onsite wastewater treatment systems. Pollutants transported by streams enter a lake as surface water inflows. In flow through lakes, like Upper Nemahbin Lake, pollutant loadings transported across land surfaces and inflowing streams comprise the principal routes by which

contaminants enter a waterbody.[12] Currently, there are no significant point source discharges of pollutants to Upper Nemahbin Lake or to the surface waters tributary to Upper Nemahbin Lake. For this reason, the discussion that follows is based upon nonpoint source pollutant loadings to the Lake. In this regard, it should be noted that the ongoing implementation of stormwater management measures, required in many communities within the area tributary to Upper Nemahbin Lake pursuant to the requirements of Chapter NR 216 of the *Wisconsin Administrative Code*, could significantly moderate the magnitude of nonpoint source pollutant loadings from urban areas.

Nonpoint sources of water pollution include urban sources, such as runoff from residential, commercial, transportation, construction, and recreational activities; and rural sources, such as runoff from agricultural lands and onsite sewage disposal systems.

For purposes of the previous SEWRPC watershed inventory, an assessment of the impact of watershed land use on the water quality of Upper Nemahbin Lake was obtained through the use of simple empirical water quality models, specifically through the use of Unit Area Loads and the OECD models,[13] as described by Ryding and Rast.[14] Unit Area Loads reflect the average amount of contaminant generated per unit area of tributary area surface under a particular land use. These land-use inputs, together with estimates of river flow, the other major transport mechanism moving contaminants into the Lake, were used to derive a range of estimated values for the contaminant loading rates used in the OECD water quality models presented in the initial report. In addition to the analyses conducted using the estimated average flow rate in the Bark River of 21 cubic feet per second (cfs), a second model run was made using a flow rate of 9.0 cfs to consider the impacts of extended low flow periods.

For the current study, nonpoint-source phosphorus, suspended solids, and urban-derived metals input to and output from Upper Nemahbin Lake were estimated using the Wisconsin Lake Model Spreadsheet (WILMS version 3.3.18.1),[15] and unit area load-based models developed for use within the Southeastern Wisconsin Region.[16]

Phosphorus Loadings

In the previous report, the phosphorus load to Upper Nemahbin Lake during 1990, the date of the land use inventory data used in the models, was estimated to be approximately 4,500 pounds. At that time, the data indicated that the majority of the contaminant loads, about 76 percent of the phosphorus load, entered Upper Nemahbin Lake from the Bark River. Under the then-planned 2010 conditions, assuming the installation of a

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[12]*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, 1989; 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.*

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

[14]Ibid.

[15]*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.*

[16]*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.*

public sanitary sewer system to serve urban development around the Lake,[17] the phosphorus load to Upper Nemahbin Lake was forecast to decrease to about 2,900 pounds, with the Bark River contributing about 72 percent of the total load of phosphorus to the Lake. Future loads of phosphorus were forecast to decline primarily as a result of reduced construction activity in the area, conversion of agricultural lands to low-density residential uses, and the anticipated installation of public sewer service in the Upper Nemahbin Lake direct tributary area. Such forecast suggested that the water quality of the Lake should stabilize and remain of relatively good quality.

During the current study, as shown in Table 6, existing year 2000 phosphorus loads from the total area tributary to Upper Nemahbin Lake were identified and quantified using Commission land use inventory data. It was estimated that, under year 2000 conditions, the total phosphorus load to Upper Nemahbin Lake was about 2,640 pounds. Of the annual total phosphorus load, it was estimated that about 2,025 pounds per year, or 77 percent of the total loading, were contributed by runoff from rural land, mostly agricultural sources, and about 570 pounds per year, or 21 percent, were contributed by runoff from urban land, mostly residential sources. About 43 pounds, or about 2 percent, were contributed by direct precipitation onto the lake surface.

The apparent decrease in phosphorus loading to the Lake from the time of the previous report to the time of the current report can likely be attributed to both environmental factors such as the implementation of the recommendations set forth in the regional water quality plan,[18] as well as nonenvironmental factors such as the refining of the Lake's tributary area boundary as a result of the application of the Commission digital terrain modeling (DTM) mapping system in the tributary area.

It should be noted that, while this load to Upper Nemahbin Lake is consistent with the forecast 2010 phosphorus load predicted in the previous report, the phosphorus loads to the upstream Nagawicka Lake, estimated utilizing this same modeling procedure and cited in the lake management plan for Nagawicka Lake,[19] were determined to have overestimated the actual phosphorus load to that Lake when compared with the phosphorus loads measured by the U.S. Geological Survey (USGS).[20] The USGS measured the mass of phosphorus discharged to the downstream portion of the Bark River, which forms the inflow to Upper Nemahbin Lake, at between 450 pounds and 800 pounds of phosphorus during the 2003 and 2004 monitoring years. As the Bark River inflow to Upper Nemahbin Lake was estimated to contribute about 85 percent of the phosphorus load to the Lake, these data suggest that: a) the total load to Upper Nemahbin Lake is likely to be lower than the approximately 2,240 pounds forecast by the models, and b) the ability of the upstream Nagawicka Lake to moderate phosphorus loads to the Middle Bark River, as noted in the SEWRPC plan, is significant.[21] The variation in the magnitude of the load, the USGS phosphorus loading data for Nagawicka Lake would support the assumed distribution of nutrient sources among land-use categories in the watershed.[22] Consequently, the recommended lake management actions for this reach of the Bark River would provide a valid basis for guiding watershed management actions.

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[17]*SEWRPC Community Assistance Planning Report No. 127,* Sanitary Sewer Service Area for the City of Delafield and the Village of Nashotah and Environs, Waukesha County, Wisconsin, *November 1992, as amended December 1996.*

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

[19]*SEWRPC Community Assistance Planning Report No. 262,* op. cit.

[20]*Herbert S. Garn, Dale M. Robertson, William J. Rose, Gerald L. Goddard, and Judy A. Horwatich, U.S. Geological Survey Scientific Investigations Report No. 2006-5273,* Water Quality, Hydrology, and Response to Changes in Phosphorus Loading of Nagawicka Lake, a Calcareous Lake in Waukesha County, Wisconsin, *2006.*

[21]*SEWRPC Community Assistance Planning Report No. 262,* loc. cit.

[22]*USGS Scientific Investigations Report No. 2006-5273,* loc. cit.

Table 6

ESTIMATED ANNUAL POLLUTANT LOADINGS FROM THE TOTAL AREA TRIBUTARY TO UPPER NEMAHBIN LAKE BY LAND USE CATEGORY: 2000

Land Use Category	Pollutant Loads			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential[a]	12.1	248.5	0.0	1.6
Commercial	25.0	76.5	14.0	3.0
Industrial	12.4	38.5	7.2	1.5
Governmental	2.0	46.8	0.0	0.0
Transportation	24.1	127.5	6.6	4.4
Recreational	1.4	32.4	0.0	0.0
Subtotal	77.0	570.2	27.8	10.5
Rural				
Agricultural	485.0	1,854.0	- -	- -
Wetlands	0.9	20.2	- -	- -
Woodlands	1.1	22.9	- -	- -
Water	31.3	43.3	- -	- -
Extractive	33.5	128.0	- -	- -
Subtotal	551.8	2,068.4	- -	- -
Total	628.8	2,638.6	27.8	10.5

[a]*Includes the contribution from onsite sewage disposal systems. The contribution from onsite sewage disposal systems, based upon the per capita phosphorus contribution contained within wastewater estimated within the WILMS model, could range from approximately 154.6 pounds per year to as much as about 4,123.4 pounds per year, depending upon soil type, system condition, and system locations. For purposes of this analysis, based upon the area of the drainage basin that is served by public sanitary sewerage services, the lower value of 154.6 pounds per year was used the most-likely contribution to the phosphorus load to Upper Nemahbin Lake from onsite sewage disposal systems.*

Source: SEWRPC.

Phosphorus release from the lake bottom sediments, or internal loading, as discussed above, does not appear to have been a contributing factor to the total phosphorus loading to the Lakes. The forecast year 2000 average annual in-lake phosphorus concentration of 16 micrograms per liter (µg/l) agrees well with the observed in-lake phosphorus concentration in the Lake of 14 µg/l reported by the WDNR.[23]

Under planned year 2035 conditions, as set forth in the adopted regional land use plan,[24] the annual total phosphorus load from the total area tributary to the Lake is anticipated to continue to diminish as agricultural activities within the area tributary to Upper Nemahbin Lake are replaced by urban residential land uses. The most likely annual total phosphorus load to the Lake under buildout conditions is estimated to be about 1,990 pounds.[25] Table 7 shows the estimated phosphorus loads to Upper Nemahbin Lake under 2035 conditions. Of the total

[23]*Forecast in-lake annual average phosphorus concentration was calculated using the OECD load-response relationship set forth in Organization for Economic Cooperation and Development, 1982,* op. cit.

[24]*SEWRPC Planning Report No. 48,* A Regional Land Use Plan for Southeastern Wisconsin: 2035, *June 2006.*

[25]*See USGS Scientific Investigations Report No. 2006-5273,* loc. cit., *which suggests that the total load to Upper Nemahbin Lake from the Bark River drainage area is likely to be lower than that forecast by the models.*

Table 7

ESTIMATED ANNUAL POLLUTANT LOADINGS FROM THE TOTAL AREA TRIBUTARY TO UPPER NEMAHBIN LAKE BY LAND USE CATEGORY: 2035

Land Use Category	Pollutant Loads			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential[a]	19.2	393.5	0.0	1.6
Commercial	58.7	179.7	32.9	3.0
Industrial	22.8	71.0	13.3	1.5
Governmental	3.3	76.2	0.0	0.0
Transportation	37.9	200.5	10.3	4.4
Recreational	2.1	48.1	0.0	0.0
Subtotal	144.0	969.0	56.5	10.5
Rural				
Agricultural	203.8	779.1	- -	- -
Wetlands	0.9	20.2	- -	- -
Woodlands	1.0	22.5	- -	- -
Water	32.1	44.4	- -	- -
Extractive	41.0	156.8	- -	- -
Subtotal	278.8	1,023.0	- -	- -
Total	422.8	1,992.0	56.5	10.5

[a]*Includes the contribution from onsite sewage disposal systems. The contribution from onsite sewage disposal systems, based upon the per capita phosphorus contribution contained within wastewater estimated within the WILMS model, could range from approximately 154.6 pounds per year to as much as about 4,123.4 pounds per year, depending upon soil type, system condition, and system locations. For purposes of this analysis, based upon the area of the drainage basin that is served by public sanitary sewerage services, the lower value of 154.6 pounds per year was used the most-likely contribution to the phosphorus load to Upper Nemahbin Lake from onsite sewage disposal systems.*

Source: SEWRPC.

annual forecast phosphorus load of about 1,990 pounds of phosphorus to Upper Nemahbin Lake, about 980 pounds per year, or 49 percent of the total loading, are estimated to be contributed by runoff from rural lands, mostly agricultural, while 970 pounds per year, or 49 percent, are estimated to be contributed by runoff from urban lands, mostly residential. It is anticipated that about 40 pounds, or about 2 percent, will be contributed by direct precipitation onto the lake surface. Thus, it may be anticipated that not only will the total phosphorus load to the Lake diminish, but also the distribution of the sources of the phosphorus load to the Lake will change, with the amount of phosphorus being contributed from urban sources increasing from about one-quarter of the total in 2000 to about one-half of the total in 2035. The mass of phosphorus contributed to the Lake from rural sources, conversely, is likely to decrease from about 77 percent of the total load in 2000 to about 49 percent of the total load in 2035. To this end, the stormwater management requirements set forth in Chapter NR 151 of the *Wisconsin Administrative Code*, and the limits established by the Wisconsin Legislature on the use and sale of fertilizer containing phosphorus in turf fertilizers to be used in urban areas pursuant to 2009 Wisconsin Act 9 and on the amount of phosphorus in certain cleaning agents pursuant to 2009 Wisconsin Act 63, may be expected to further decrease the phosphorus loads to the Bark River and its lakes.

Sediment Loadings

During the previous study, it was calculated that about 2,100 tons of sediment are delivered to the Lake each year with about 89 percent of this sediment loading being contributed by the Bark River, about 3 percent from urban sources, and about 7 percent from rural sources, mostly agricultural. It was forecast that the amount of sediment loading to the Lake would diminish by year 2010 for the same reasons described above with regard to phosphorus.

For the current study period, the estimated sediment load from the total area tributary to Upper Nemahbin Lake under then-existing year 2000 land use conditions are shown in Table 6. A total annual sediment load of about 630 tons was estimated to be contributed to Upper Nemahbin Lake. Of the likely annual sediment load, it was estimated that 520 tons per year, or 82 percent of the total load, were contributed by runoff from rural lands, mostly agricultural, with approximately 80 tons, or 13 percent, contributed by urban lands, mostly commercial and industrial sources. Approximately 30 tons, or 5 percent, were contributed by atmospheric deposition to the lake surface. The apparent decrease in sediment loading from the estimated 2,000 tons of sediment forecast as entering Upper Nemahbin Lake under 1990 land use conditions is likely to be the result, in part, of those same factors described above with respect to a similar decrease in the phosphorus load to the Lake.

As shown in Table 7, under planned year 2035 land use conditions, as set forth in the aforementioned regional land use plan, the annual sediment load from the total area tributary to the Lake is anticipated to diminish to be about 420 tons. As in the case of the forecast phosphorus load, the distribution of the sources of the sediment load to the Lake also may be expected to change, with an increased mass of sediment being contributed from urban sources, estimated to be 140 tons of sediment per year or about one-third of the total sediment load; and a decreased mass of sediment from rural sources, estimated to be 250 tons of sediment per year. The amount of sediment entering the Lake from deposition onto the lake surface should remain about the same as that forecast for year 2000, or about 30 tons per year.

Urban Heavy Metals Loadings

Urbanization brings with it increased use of metals and other materials that contribute pollutants to aquatic systems.[26] The majority of these metals is likely to become associated with sediment particles, and be encapsulated into the bottom sediments of the Lake.[27]

Heavy metal loadings likely to be contributed to Upper Nemahbin Lake under 1990 conditions were estimated in the previous SEWRPC report. At that time, about 520 pounds of zinc were estimated to be delivered to Upper Nemahbin Lake. Zinc was used in this analysis as a surrogate for a range of metals and other pollutants that were likely to be contributed to the Lake from urban sources. The more important sources of metals in urban runoff are from transportation and commercial land uses. These sources were of potential significance given the proximity of Upper Nemahbin Lake to the IH 94 corridor and other major roadways. It was forecast that loadings of zinc were likely to increase by year 2010 as a result of increased urbanization in the drainage area.

During the current study, the estimated loadings of copper and zinc from the total area tributary to Upper Nemahbin Lake under existing year 2000 and forecast year 2035 are shown in Tables 6 and 7, respectively. In 2000, it was estimated that about 30 pounds of copper and 10 pounds of zinc were estimated to be contributed annually to Upper Nemahbin Lake, all from urban lands. In estimating the zinc load, as well as the copper load, not previously reported, to Upper Nemahbin Lake for use in the current study, the Commission staff utilized a unit area load model developed for the Southeastern Wisconsin Region,[28] in contrast to the unit area load model utilized during the previous study which was derived from other, global sources.[29] Because of the more locally relevant nature of the coefficients employed in the Southeastern Wisconsin unit area load model, the present estimates of metals loadings to Upper Nemahbin Lake may be considered to be more representative of the actual loads to the Lake.

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

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

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

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

Under 2035 conditions, as set forth in the aforementioned regional land use plan, the annual heavy metal loads to the Lake are anticipated to increase. The most likely annual load of copper to the Lake under buildout conditions is estimated to increase to about 55 pounds, while the annual load of zinc is expected to remain at about 10 pounds of zinc, as shown in Table 7.

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 which 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 naturally fertile soils and the intensive land use activities, there are relatively few oligotrophic lakes in southeastern Wisconsin.

Mesotrophic lakes are moderately fertile lakes which 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, severely eutrophic or hypertrophic lakes are rare, especially since the regionwide implementation of recommendations put forth in the aforereferenced regional water quality management plan.

Several numeric "scales," based on one or more water quality indicators, 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 applies. In this case, two indices appropriate for Wisconsin lakes have been used; namely, the Vollenweider-OECD open-boundary trophic classification system,[30] and the Carlson Trophic State Index (TSI),[31] with a variation known as the Wisconsin Trophic State Index value (WTSI).[32] The WTSI is a refinement of the Carlson TSI 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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[30]*Organization for Economic Cooperation and Development (OECD),* op. cit.*; see also H. Olem and G. Flock, U.S. Environmental Protection Agency Report EPA-440/4-90-006,* The Lake and Reservoir Restoration Guidance Manual, Second Edition, *Washington, D.C., August 1990.*

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

[32]*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.*

In the aforereferenced Aqua-Tech report, Upper Nemahbin Lake was determined to be within the eutrophic category of enriched lakes based upon 1970 water quality data. That report noted that the southern portion of the Lake was considerably more enriched than the rest of the Lake, probably as a result of inflow from the Bark River. In a 1979, the WDNR, utilizing TSI values based on total phosphorus and chlorophyll-*a* measurements that ranged from 44 to 48, identified the Lake as mesotrophic.

In the aforereferenced Commission watershed inventory of 1995, water quality conditions in Upper Nemahbin Lake were reported to have improved significantly over the earlier 1970 survey. Phosphorus concentrations in the lake surface waters, reported by the USGS, indicated that the Lake was well within the mesotrophic range, bordering on meso-oligotrophic, as indicated by a WTSI value of about 40. As mentioned above, this improvement in water quality conditions was attributed, at least in part, to the result of implementation of point source recommendations set forth in the regional water quality management plan, including the installation of sanitary sewer systems and the elimination of upstream wastewater treatment plants.[33] This conclusion was consistent with the data gathered by the ERSC, which suggested that Upper Nemahbin Lake had a Trophic State Index (TSI) value of 42, a value that was well within the mesotrophic to oligo-mesotrophic range.

Based upon the WDNR data set for the period between 1995 and 2008, which resulted in a WTSI value of about 40, Upper Nemahbin Lake has remained in the mesotrophic range, bordering on meso-oligotrophic, as shown in Figure 1, despite the ongoing development in the drainage area tributary to the Lake. In part, this state has been maintained as a result of the retention of nutrients and other potential contaminants in the upstream Nagawicka Lake.

AQUATIC PLANTS: DISTRIBUTION AND MANAGEMENT AREAS

Aquatic plant surveys have been carried out on Upper Nemahbin Lake at intervals since the Aqua-Tech studies in 1970. More recently, Commission staff conducted an aquatic plant reconnaissance in August of 1993, as part of the planning program that resulted in the watershed inventory prepared by SEWRPC in 1995. Most recently, the Commission staff conducted a further survey during the summer of 2008, the results of which are shown in Table 8. Map 9 shows the distribution of aquatic plants in Upper Nemahbin Lake at the time of the 2008 survey. A species list, compiled from the results of this latest survey, is set forth in Table 9, along with comments on the ecological significance of each plant species. Representative illustrations of these aquatic plants can be found in Appendix B.

The 2008 survey was conducted using the modified Jesson and Lound transect method as adopted by the WDNR and previously used by the Commission staff during the 1993 aquatic plant reconnaissance of Upper Nemahbin Lake.[34] This methodology, when done in successive aquatic plant surveys, will allow the statistical evaluation of changes in the aquatic plant community within the Lake.[35]

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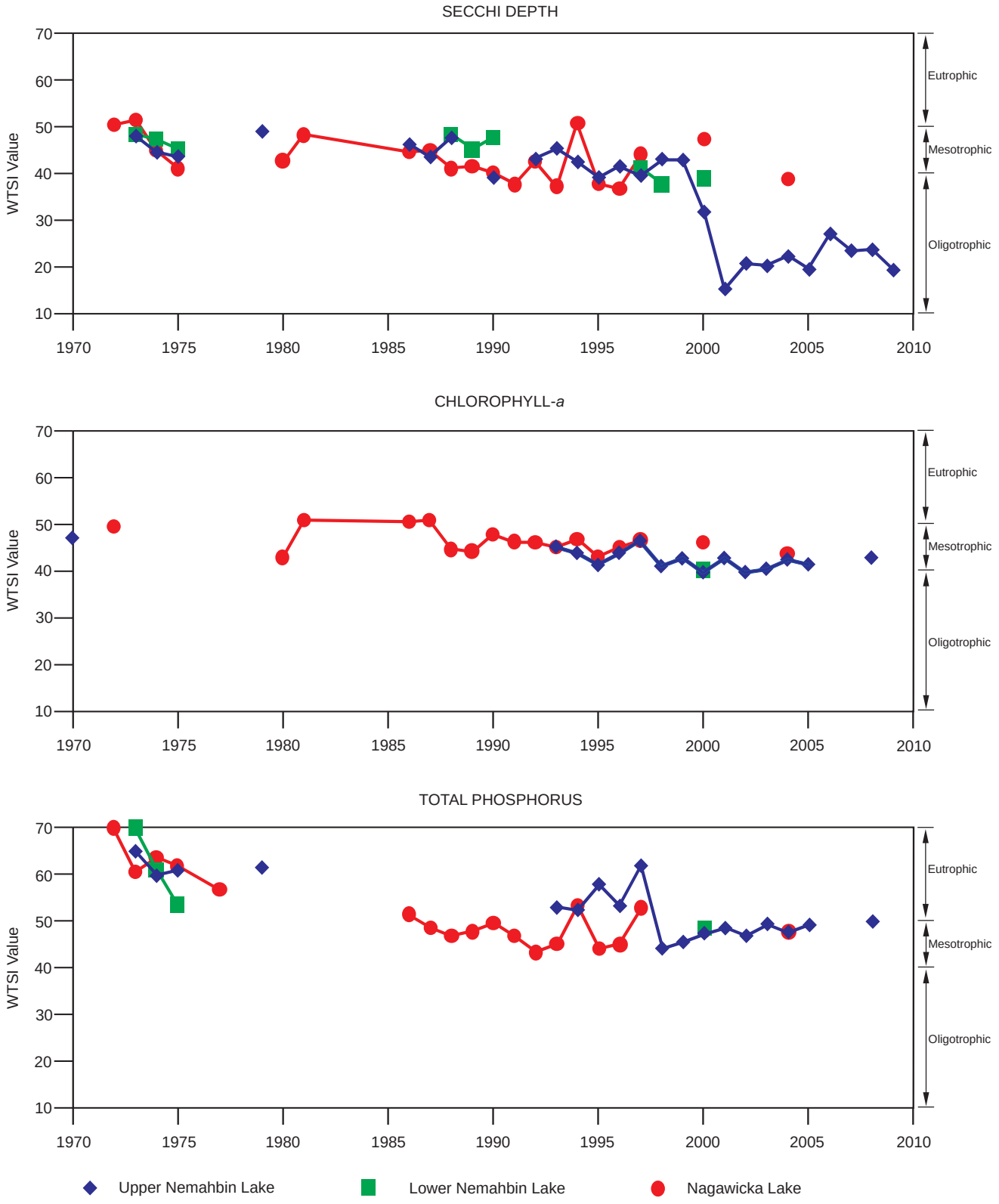
[33]*SEWRPC Memorandum Report No. 93,* op. cit.*; see also Community Assistance Planning Report No. 127, as amended,* op. cit.

[34]*R. Jesson and R. Lound, Minnesota Department of Conservation Game Investigational Report No. 6,* An Evaluation of a Survey Technique for Submerged Aquatic Plants, *1962.*

[35]*Memo from Stan Nichols, to J. Bode, J. Leverence, S. Borman, S. Engel, D., Helsel, entitled "Analysis of Macrophyte Data for Ambient Lakes-Dutch Hollow and Redstone Lakes example," Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension, February 4, 1994.*

Figure 1

WISCONSIN TROPHIC STATE INDICES FOR NAGAWICKA, UPPER NEMAHBIN, AND LOWER NEMAHBIN LAKES: 1970-2010



Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 8

SUBMERGED AQUATIC PLANT SPECIES OBSERVED IN UPPER NEMAHBIN LAKE: 2008

Aquatic Plant Species	Number of Sites Found	Frequency of Occurrence[a]	Relative Density[b]	Importance Value[c]
Ceratophyllum demersum (coontail)[d]	17	16.8	3.0	50.5
Chara vulgaris (muskgrass)[e]	81	80.2	3.5	277.2
Elodea canadensis (waterweed)	7	6.9	2.0	13.9
Myriophyllum sibiricum (northern water milfoil)[e]	1	1.0	3.0	3.0
Myriophyllum spicatum (Eurasian water milfoil)[e]	11	10.9	1.6	17.8
Najas flexilis (bushy pondweed)[d]	15	14.9	1.3	19.8
Najas marina (spiny naiad)	24	23.8	1.8	41.6
Potamogeton amplifolius (large-leaf pondweed)[e]	- -	- -	- -	- -
Potamogeton crispus (curly-leaf pondweed)[e]	3	3.0	1.7	5.0
Potamogeton gramineus (variable pondweed)	1	1.0	1.0	1.0
Potamogeton illinoensis (Illinois pondweed)	47	46.5	2.0	95.1
Potamogeton pectinatus (Sago pondweed)[e]	8	7.9	1.8	13.9
Potamogeton praelongus (white-stem pondweed)	1	1.0	1.0	1.0
Potamogeton richardsonii (clasping-leaf pondweed)	1	1.0	1.0	1.0
Potamogeton zosteriformis (flat-stem pondweed)	4	4.0	1.8	6.9
Utricularia spp. (bladderwort)	23	22.8	1.5	34.7
Vallisneria americana (water celery/eelgrass)[e]	73	72.3	3.2	227.7

NOTE: Sampling occurred at 101 sampling sites along 25 transects.

[a]*The percent frequency of occurrence is the number of occurrences of a species divided by the number of samplings with vegetation, expressed as a percentage. It is the percentage of times a particular species occurred when there was aquatic vegetation present, and is analogous to the Jesson and Lound point system.*

[b]*The average density is the sum of density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 4.0 is assigned to plants that occur at all four points sampled at a given depth and is an indication of how abundant a particular plant is throughout a lake.*

[c]*The importance value is the product of the relative frequency of occurrence and the average density, expressed as a percentage. This number provides an indication of the dominance of a species within a community.*

[d]*Species observed in the 1970 survey, but not in the 1993 reconnaissance.*

[e]*Species reported observed in the 1970 survey and in the 1993 reconnaissance.*

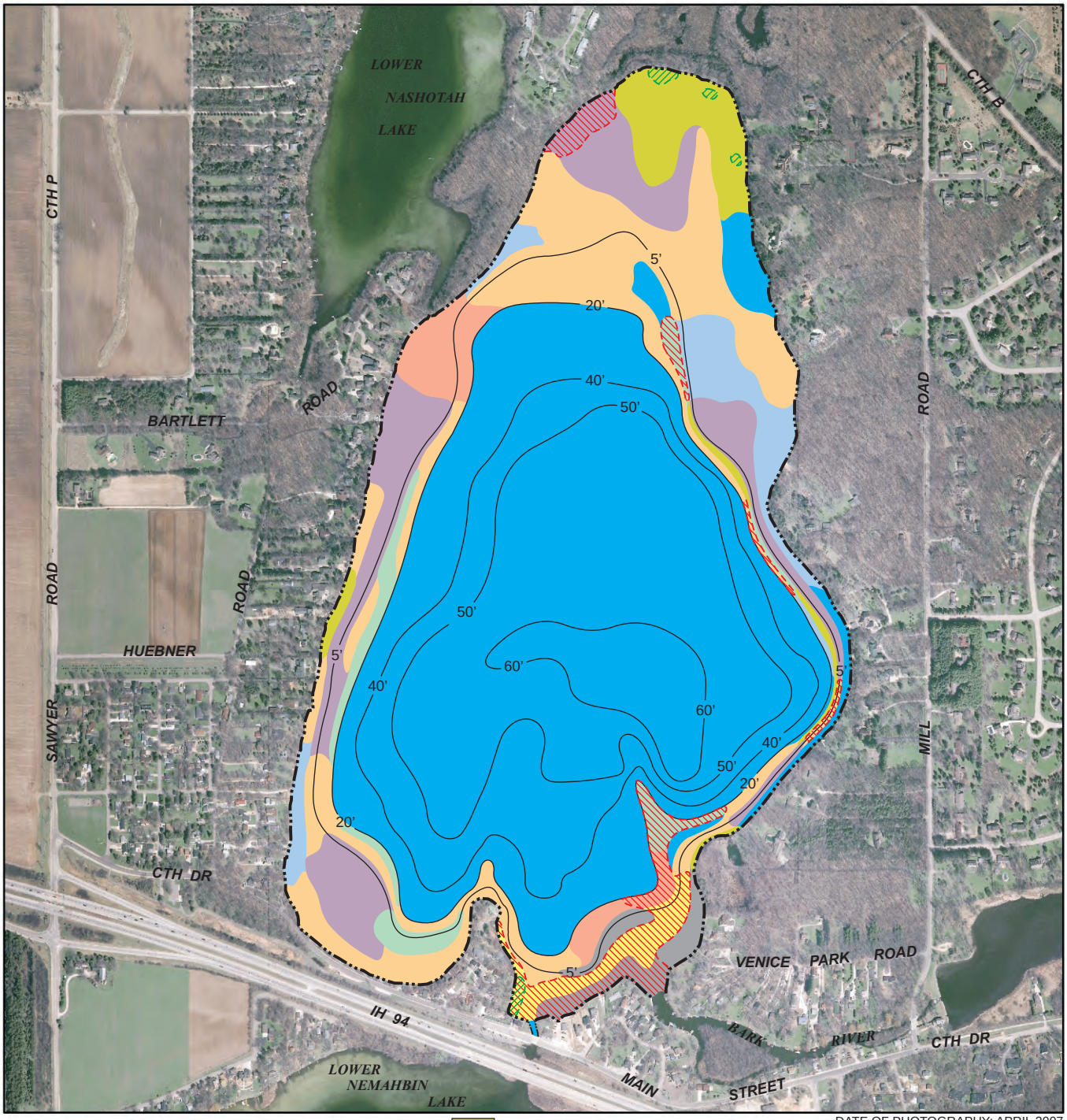
Source: SEWRPC.

Aquatic Plant Communities in Upper Nemahbin Lake

As set forth in the previous SEWRPC report, aquatic plants have historically occurred in Upper Nemahbin Lake in such abundance in and around the Bark River inflow and at the extreme northeastern corner of the Lake as to be perceived as a problem, interfering with recreational uses and aesthetic enjoyment of the Lake. At the time of the 1993 reconnaissance, abundant growths of aquatic plants were especially prevalent in the southeastern corner of the Lake in and around the Bark River inflow channel, as well as in the northeastern corner of the Lake. The dominant species of aquatic plant observed at that time was eelgrass (*Valisneria americana*), a native aquatic plant species in Southeastern Wisconsin lakes. Three nonnative species also were observed; namely, Eurasian water milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*) which formed part of the in-lake aquatic plant community, and purple loosestrife (*Lythrum salicaria*), which occurred around the shorelands of the Lake.

Map 9

AQUATIC PLANT COMMUNITY DISTRIBUTION IN UPPER NEMAHBIN LAKE: 2008



DATE OF PHOTOGRAPHY: APRIL 2007

—20'— WATER DEPTH CONTOUR IN FEET

OPEN WATER

WATER LILIES

EURASIAN WATER MILFOIL

MUSKGRASS, BUSHY PONDWEED, AND SAGO PONDWEED

MUSKGRASS, WILD CELERY, SPINY NAIAD, AND ILLINOIS PONDWEED

MUSKGRASS, WILD CELERY, ILLINOIS PONDWEED, COONTAIL, AND WATERWEED

MUSKGRASS, WILD CELERY, SPINY NAIAD, ILLINOIS PONDWEED, NATIVE WATER MILFOIL, AND BLADDERWORT

MUSKGRASS, WILD CELERY, ILLINOIS PONDWEED, SPINY NAIAD, BLADDERWORT, AND BUSHY PONDWEED

WILD CELERY, COONTAIL, WATERWEED, FLAT-STEM PONDWEED, VARIABLE PONDWEED, AND CURLY-LEAF PONDWEED

WILD CELERY, COONTAIL, ILLINOIS PONDWEED, BLADDERWORT, AND CURLY-LEAF PONDWEED

MUSKGRASS, WILD CELERY, ILLINOIS PONDWEED, BLADDERWORT, BUSHY PONDWEED, AND SAGO PONDWEED

GRAPHIC SCALE
0 450 900 FEET

Source: SEWRPC.

Table 9

POSITIVE ECOLOGICAL SIGNIFICANCE OF AQUATIC PLANT SPECIES PRESENT IN UPPER NEMAHBIN LAKE: 1970-2008

Aquatic Plant Species Present	Ecological Significance
Ceratophyllum demersum (coontail)	Provides good shelter for young fish and supports insects valuable as food for fish and ducklings
Chara vulgaris (muskgrass)	Excellent producer of fish food, especially for young trout, bluegills, small and largemouth bass, stabilizes bottom sediments, and has softening effect on the water by removing lime and carbon dioxide
Elodea canadensis (waterweed)	Provides shelter and support for insects which are valuable as fish food
Myriophyllum sibiricum (northern water milfoil)	Provides food for waterfowl, insect habitat and foraging opportunities for fish
Myriophyllum spicatum (Eurasian water milfoil)	None known
Najas flexilis (bushy pondweed)	Stems, foliage, and seeds important wildfowl food and produces good food and shelter for fish
Najas marina (spiny naiad)	One of our most important waterfowl plants since many species of ducks use its stems, leaves, and seeds as food; provides good shelter and food for fish
Nymphaea odorata (white water lily)	Waterfowl eat the seeds; deer, muskrat, and beaver eat the rhizomes; the leaves provide shade and shelter for fish
Potamogeton amplifolius (large-leaf pondweed)	Offers shade, shelter and foraging for fish; valuable food for waterfowl
Potamogeton crispus (curly-leaf pondweed)	Provides food , shelter and shade for some fish and food for waterfowl
Potamogeton gramineus (variable pondweed)	Provides habitat for fish and food for waterfowl, muskrat, beaver and deer
Potamogeton illinoensis (Illinois pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl
Potamogeton pectinatus (Sago pondweed)	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish
Potamogeton praelongus (white-stem pondweed)	Good food provider for waterfowl, muskrat, and some fish species; valuable habitat for musky. Considered an indicator species for water quality due to its intolerance of turbid water conditions.
Potamogeton richardsonii (clasping-leaf pondweed)	Provides food, shelter and shade for some fish, food for some wildfowl, and food for muskrat. Provides shelter and support for insects, which are valuable as fish food
Potamogeton zosteriformis (flat-stem pondweed)	Provides some food for ducks
Utricularia spp. (bladderwort)	Provides cover and foraging for fish
Vallisneria americana (water celery/eelgrass)	Provides good shade and shelter, supports insects, and is valuable fish food

NOTE: Information obtained from *A Manual of Aquatic Plants* by Norman C. Fassett, University of Wisconsin Press; *Guide to Wisconsin Aquatic Plants*, Wisconsin Department of Natural Resources; and, *Through the Looking Glass...A Field Guide to Aquatic Plants*, Wisconsin Lakes Partnership, University of Wisconsin-Extension.

Source: SEWRPC.

During the current study period, the dominant species were muskgrass (*Chara vulgaris*) and eelgrass (*Valisneria americana*). Other submergent species included coontail (*Ceratophyllum demersum*), waterweed (*Elodea canadensis*), northern water milfoil (*Myriophyllum sibiricum*, formerly known as *M. exalbescens*), Eurasian water milfoil (*Myriophyllum spicatum*), bushy pondweed (*Najas flexilis*), spiny naiad (*Najas marina*), curly-leaf pondweed (*Potamogeton crispus*), variable pondweed (*Potamogeton gramineus*), Illinois pondweed (*Potamogeton illinoensis*), Sago pondweed (*Potamogeton pectinatus*), white-stem pondweed (*Potamogeton praelongus*), clasping-leaf pondweed (*Potamogeton richardsonii*), flat-stem pondweed (*Potamogeton zosteriformis*), and bladderwort, (*Utricularia* spp).

Of particular interest was the distribution of Eurasian water milfoil in the Lake at the time of the 2008 study. Eurasian water milfoil is an invasive plant species capable of explosive growth, resulting in an ability to outcompete important native aquatic plant species. Abundant growths of Eurasian water milfoil can lead to significant ecological disruptions in the aquatic plant community of a lake, degrading water quality and habitat for fish, invertebrates and other wildlife. Eurasian water milfoil and curly-leaf pondweed, both of which have been recorded from Upper Nemahbin Lake, are declared nuisance species identified in Chapter NR 109 of the *Wisconsin Administrative Code.*

In 2008, Eurasian water milfoil had a limited distribution in the Lake with particularly abundant and extensive growths in the shallow southeastern end of the Lake adjacent to the confluence of the Bark River with Upper Nemahbin Lake. The distribution of Eurasian water milfoil observed during the 2008 survey was similar to that reported during 1993, although during the 2008 survey additional isolated stands of Eurasian water milfoil were observed at intervals along the eastern shore of the Lake, as shown on Map 9.

Aquatic plant communities do undergo cyclical and periodic changes, which reflect, in part, changing climatic conditions on an interannual scale, as well as, in part, the evolution of the aquatic plant community itself in response to changing hydroclimate conditions in the Lake. Interannular changes, brought about by such factors as changes in nutrient loading, sedimentation rates, and recreational usage patterns, occur over a period of three to seven years and may be temporary; other plant community changes may occur over a decadal period or longer and are longer-lasting. In addition, some changes in reported aquatic plant abundance may reflect seasonal variability associated with the timing of the various surveys. The pondweeds, in particular, are subject to greater seasonality than some of the other species. In such cases, the actual community composition may reflect changes associated with seasonal differences, such as water temperature and photoperiod, rather than actual changes in aquatic plant community composition. Due to the lack of empirical data regarding earlier aquatic plant surveys, it is difficult to accurately assess what changes may be occurring in the aquatic plant community in Upper Nemahbin Lake. Albeit, the introduction of Eurasian water milfoil to many lakes in the Region frequently leads to a more permanent alteration in the aquatic plant community composition. In some lakes in the Region, the variations in the abundance of Eurasian water milfoil may reflect a type of interannual periodicity in this species. Such periodicity 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 predator-prey cycles that include the plant and milfoil weevil (*Eurhychiopsis lecontei*), as well as climatic and limnological factors, such as insolation, water temperature, lake circulation patterns, and the relative severity of the winters during the intervening years.

Biodiversity

A critical key to the ability of an ecosystem, such as a lake, to maintain its ecological integrity is through biological diversity. Conserving the biological diversity, or *biodiversity*, of an ecosystem helps not only to sustain the system, but preserves a spectrum of options for future decisions regarding the management of that system. During the 2008 aquatic plant survey of Upper Nemahbin Lake, several aquatic plant communities in the Lake showed significant biodiversity, being comprised of at least ten different species. These highly diverse communities were distributed widely in most of the near shore areas of the Lake, but especially in the northern and southwestern portions of the lake basin. By contrast, only a few areas of the Lake contained plant communities with low diversity, communities with four or fewer species. Such areas included the near shore areas

along the northeastern shoreline of Upper Nemahbin Lake, as shown on Map 9. There were some areas of the Lake containing plant communities of moderate diversity, between six and seven species. Such moderate diversity communities were found generally equally distributed around the Lake, mostly in depths of 5 feet or less. In general, much of Upper Nemahbin Lake appears to have aquatic plant communities of moderate to good biodiversity.

Aquatic Plant Species of Special Significance

As previously mentioned, during the 2008 and earlier aquatic plant surveys on Upper Nemahbin Lake, several species of significance were observed. Two of these species, Eurasian water milfoil and curly-leaf pondweed, are considered to be invasive nonnative species and are considered detrimental to the ecological health of the Lake, while a number of other native aquatic plant species were considered to be high value plants that have significant habitat value.

Invasive Aquatic Plant Species

Eurasian water milfoil is one of eight milfoil species found in Wisconsin and the only one known to be exotic or nonnative. Because of its nonnative nature, Eurasian water milfoil has few natural enemies that can inhibit its often explosive growth. The plant exhibits this characteristic growth pattern in lakes with organic-rich sediments, or where the lake bottom has been disturbed. For example, it frequently has been reported as a colonizing species following dredging unless its growth is anticipated and controlled. Eurasian water milfoil populations can displace native plant species and interfere with the aesthetic and recreational use of the waterbodies. This plant has been known to cause severe recreational use problems in lakes within the Southeastern Wisconsin Region.

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, such as 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. To this end, as part of an ongoing commitment to the protection of Wisconsin waterways from the effects of harmful aquatic invasive species (AIS), the University of Wisconsin-Extension (UWEX), in cooperation with local lake management districts and related lake organizations, conduct Clean Boats, Clean Waters Programs that function to raise awareness of AIS and promote practices to help control the spread of nuisance species, including Eurasian water milfoil. The Program staff train volunteers and encourage them to provide informational programs at public recreational boating access sites throughout the State. Many lake organizations in the Region support these training programs and participate in the program.

Another detrimental aquatic invasive species is curly-leaf pondweed, a plant that thrives in cool water and exhibits a peculiar split-season growth cycle that helps give it a competitive advantage over native plants. 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; clearer waters in a Lake can help native plants compete more effectively with curly-leaf pondweed.

High-Value Native Aquatic Plant Species

There were several native plant species observed in the Lake during the 2008 aquatic plant survey, two of which are of exceptionally high ecological value; namely, muskgrass and white-stem pondweed, as shown in Table 8 and described in Table 9. Muskgrass is a favorite waterfowl food source and, as an effective bottom sediment

stabilizer, benefits water quality. Its prevalence in the plant communities of a lake may be a significant contributing factor to establishing and maintaining good water quality of a lake and, subsequently, in establishing water quality conditions that assist native plant species to successfully compete with curly-leaf pondweed, as described above. White-stem pondweed, because of its sensitivity to changes in water quality and intolerance of turbidity, is considered an excellent indicator species; its disappearance from water systems is an indication of declining water quality in disturbed systems. Although not observed during the 2008 aquatic plant survey, large-leaf pondweed, also known as musky weed or bass weed, which has been observed in the Lake enjoys a reputation as a highly valuable provider of fish habitat. The absence of any record of this plant during the 2008 aquatic plant survey may reflect the seasonality of the plant which, as noted above, tends to occur earlier in the year, prior to the August survey, when waters are cooler.

Past and Present Aquatic Plant Management Practices

All forms of aquatic plant management currently 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*. Aquatic plant management practices include manual and mechanical measures, chemical herbicides, physical barriers, and biological interventions. The use of chemicals to control aquatic plants and algae in Wisconsin has been regulated since 1941, even though records of aquatic herbicide applications have only been maintained by the WDNR since 1950. Prior to 1950, aquatic plant management interventions, while likely, were not recorded.

An aquatic plant management program has been carried out on Upper Nemahbin Lake in a documented manner since 1959. These aquatic plant management activities can be categorized as primarily chemical control, specifically targeting beds of Eurasian water milfoil. Recorded chemical herbicide treatments that have been applied to Upper Nemahbin Lake are summarized in Table 10. As shown in Table 10, between 1950 and 1967, a total of 900 pounds of sodium arsenite were applied to Upper Nemahbin Lake to control perceived nuisance growths of aquatic plants. When it became apparent that arsenic was accumulating in the sediments of treated lakes and that the accumulations of arsenic were found to present potential health hazards both to humans and aquatic life, the use of sodium arsenite was discontinued in the State in 1969.

A range of other aquatic herbicides have been used in Upper Nemahbin Lake at intervals through 2007. The types and quantities of these aquatic herbicides are summarized in Table 10. Since 2003, diquat and endothall (Aquathol®), contact herbicides that kill aquatic plant parts exposed to their active ingredient, have been utilized as the aquatic plant control agent of preference to control aquatic plant growths in Upper Nemahbin Lake.[36] Diquat use is restricted to the control of duckweed (*Lemna* sp.), milfoil (*Myriophyllum* spp.), and waterweed (*Elodea* sp.). However, this herbicide is nonselective and will kill many other aquatic plants, such as pondweeds (*Potamogeton* spp.), bladderwort (*Utricularia* sp.), and naiads (*Najas* spp.). Endothall primarily kills pondweeds, but does not control other potentially nuisance species, such as Eurasian water milfoil.

WDNR-Designated Sensitive Areas and SEWRPC-Designated Critical Species Habitat

Pursuant to authorities granted to the Department under Chapter NR 107 of the *Wisconsin Administrative Code*, the WDNR can identify sites within or around lakes that have special importance biologically, historically, geologically, ecologically, or even archaeologically. Such sites can be identified as Sensitive Areas after comprehensive examination and study is completed by WDNR staff from many different disciplines and fields of study. To protect aquatic life as well as the water quality of the lake itself, the WDNR places restrictions on specific activities within such Sensitive Areas. Restrictions for Sensitive Areas can include: limiting the use of aquatic herbicides to treatment of Eurasian water milfoil; prohibiting in-lake activities such as filling, placement of pea gravel/sand blankets, use of aquascreen, and construction of concrete, timber, or steel seawalls; limiting the

[36]*See Wisconsin Department of Natural Resources PUBL-WR-235 90,* Chemical Fact Sheet: Diquat, *May 1990; see also Wisconsin Department of Natural Resources PUBL-WR-237 90,* Chemical Fact Sheet: Endothall, *May 1990.*

Table 10

CHEMICAL CONTROL OF AQUATIC PLANTS IN UPPER NEMAHBIN LAKE: 1950-2008

Year	Total Acres Treated	Algal Control			Macrophyte Control				
		Copper Sulfate (pounds)	Blue Vitriol (pounds)	Cutrine or Cutrine Plus (pounds)	Sodium Arsenite (pounds)	2, 4-D (pounds)	Diquat (gallons)	Glyphosate (gallons)	Endothall/ Aquathol (gallons)
1950-1959	N/A	- -	- -	- -	900	- -	- -	- -	- -
1960	N/A	200.0 + 125.0 lbs cuprose	- -	- -	- -	- -	- -	- -	- -
1961-1967	- -	- -	- -	- -	- -	- -	- -	- -	- -
1968	N/A	42.0	- -	- -	- -	- -	- -	- -	- -
1969	N/A	50.0	- -	- -	- -	- -	- -	- -	- -
1970	13.08	159.0	- -	- -	- -	- -	1.5	- -	300 lbs
1971	8.80	100.0	- -	- -	- -	- -	- -	- -	7.0
1972	40.00	564.0	- -	- -	- -	- -	- -	- -	47.0
1973	6.90	85.0	- -	- -	- -	- -	- -	- -	35.0
1974	14.00	200.0	- -	- -	- -	- -	- -	- -	10.0
1975	22.90	156.3	- -	48.0	- -	- -	- -	- -	7.0
1976	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1977	29.00	- -	- -	52.0 gal	- -	- -	- -	- -	- -
1978	14.05	- -	- -	41.5 gal + 120 lbs	- -	7.3	- -	- -	15.0
1979	18.50	- -	- -	61.5 gal	- -	2.0	- -	- -	15.5
1980	24.00	- -	- -	59.0 gal	- -	5.0	- -	- -	14.0
1981	9.30	- -	- -	29.5 gal	- -	7.5	- -	- -	5.0
1982	8.70	- -	- -	17.0 gal	- -	19.0	- -	- -	3.0
1983	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1984	3.41	- -	- -	6.5 gal	- -	23.0	- -	- -	6.0
1985	2.75	- -	- -	- -	- -	8.0	- -	- -	1.5
1986	5.40	- -	- -	5.2 gal	- -	4.2	- -	- -	6.0
1987	2.90	- -	- -	4.0 gal	- -	4.0	- -	- -	60 lbs
1988	6.10	- -	- -	9.0 gal	- -	10.0	- -	- -	2.0
1989	3.20	- -	- -	4.1 gal	- -	- -	4.1	- -	- -
1990	1.50	- -	- -	2.5 gal	- -	- -	- -	- -	2.5 gal
1991	4.87	- -	- -	4.8 gal	- -	11.0	4.8	- -	- -
1992	3.59	- -	- -	4.0	- -	7.0	3.0	- -	- -
1993	3.15	- -	- -	2.3	- -	- -	4.0	- -	- -
1994	0.70	- -	- -	1.0	- -	- -	1.0	- -	- -
1995	0.75	- -	- -	0.4	- -	- -	0.4	- -	- -
1996	1.72	- -	- -	1.0 gal	- -	2.5	1.0	- -	1.0
1997	1.72	- -	- -	2.0 gal	- -	- -	2.0	- -	2.0
1998	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1999	1.38	- -	- -	1.0 gal	- -	- -	- -	- -	1.0
2000	1.30	- -	- -	1.3 gal	- -	- -	1.3	- -	- -
2001	0.70	- -	- -	0.8 gal	- -	- -	- -	- -	0.8
2002	2.76	- -	- -	- -	- -	6.0	2.5	- -	- -
2003	1.38	- -	- -	0.8 gal	- -	- -	0.8	- -	0.8
2004	1.38	- -	- -	-	- -	- -	0.8	- -	0.8
2005	0.15	- -	- -	0.3	- -	- -	0.3	- -	0.5
2006	0.70	- -	- -	0.5	- -	- -	1.5	- -	- -
2007	1.30	- -	- -	0.2	- -	- -	0.2	- -	0.2
2008	- -	- -	- -		- -	- -	- -	- -	- -
Total	- -	1,356.3	- -	175.7 + 304.5 gal	900	116.5	29.2	- -	183.6 + 360 lbs

Source: Wisconsin Department of Natural Resources and SEWRPC.

use of riprap to areas with erosion problems; minimizing the placement of individual and marina piers; prohibiting mechanical harvesting other than that associated with a research program to increase the diversity of aquatic plants, although small hand-cleared areas for swimming or navigation may be allowed; and, strictly enforcing construction site erosion controls, and shoreland and wetland ordinances. Currently, no Sensitive Areas have been designated by the WDNR in Upper Nemahbin Lake.

In addition to the foregoing WDNR actions, the SEWRPC regional natural areas and critical species habitat protection and management plan has identified Upper Nemahbin Lake as a Critical Lake of Southeastern Wisconsin.[37] The Lake has be given a designation of AQ-2 (RSH) identifying it as a lake of countywide or regional significance supporting endangered, threatened, or "special concern" species as identified by the WDNR. In this case, the Lake is known to contain a special concern species, the least darter (*Etheostoma microperca*). In addition, the Bark River, both upstream and downstream of Upper Nemahbin Lake, has been designated as AQ-1 (RSH), identifying these stream reaches as aquatic areas of statewide or greater significance supporting. Two State-listed endangered fish species, the slender madtom (*Notorus exilis*) and starhead topminnow (*Fundulus dispar*), are known to occur in these stream reaches, along with critical mussel species, as described further in Chapter III of this report.

FISHERIES

The WDNR reports that the fish population in Upper Nemahbin Lake is comprised of numerous different fish species, with panfish, northern pike and largemouth bass common and walleye and smallmouth bass present.[38] Currently, Upper Nemahbin Lake is managed for bluegill, largemouth bass, and northern pike. As shown in Table 11, WDNR stocking records for Upper Nemahbin Lake show the periodic stocking of walleye, northern pike and trout into Upper Nemahbin Lake since 1974.

In the fall of 1997, the WDNR conducted a single-night electrofishing survey of Upper Nemahbin Lake to assess the survival of 27,700 walleye fingerlings previously stocked into the Lake. The survey indicated that natural reproduction of walleye in Upper Nemahbin Lake was not significant and it was recommended that biennial stocking of walleyes be continued in order to sustain that fishery. Of the four species of gamefish captured during the survey, largemouth bass were the most abundant, walleye the next most abundant, smallmouth bass next and northern pike the least abundant. Forage fish, especially bluntnose minnows and brook silversides, were reported as abundant.

The WDNR staff conducted a further fisheries survey of Upper Nemahbin Lake during July 2000 using both mini-fyke nets and backpack-style electroshockers. The use of this latter gear did not result in any fishes being captured, but the mini-fyke net survey resulted in the capture of nine species of fishes: black bullhead, bluegill, green sunfish, Johnny darter, largemouth bass, longnose gar, mimic shiner, smallmouth bass, and yellow perch. Of these, largemouth bass were most abundant, and smallmouth bass and bluegill were common.

During 2004, the WDNR conducted a seining survey in Upper Nemahbin Lake at the same sites using the same gear and level of effort as used during an earlier survey in 1975. The purpose of this survey was to compare and document changes in fish populations over the intervening period. Using the same gear types eliminated the biases that can be created in fish surveys using differing gear types and survey methodologies. The 2004 comparison survey indicated twelve native species collected during 2004 compared to thirteen native species collected in the 1975 survey; nearly twice as many fish of all species were collected in the 2004 survey than in the previous survey. Species absent from the 2004 survey, that had been captured in 1975, included common carp, although this species was observed, white sucker, black bullhead, banded killifish, pumpkinseed, black crappie, and least darter (a State-designated species of special concern). Species that were captured in 2004, but not in 1975, included blackstripe topminnow, smallmouth bass, largemouth bass, fantail darter, and Johnny darter.

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

[38]*Wisconsin Department of Natural Resources Publication No. PUBL-FM-800-2005,* Wisconsin Lakes, *2005.*

Table 11

FISH STOCKED INTO UPPER NEMAHBIN LAKE

Year	Species Stocked	Number	Average Fish Length (inches)
1974	Walleye	7,500	5.00
1975	Walleye	22,820	5.00
1976	Walleye	3,870	N/A
1976	Walleye	13,300	3.00
1979	Brown trout	3,000	N/A
1979	Rainbow trout	5,300	N/A
1980	Walleye	1,100,000	N/A
1981	Walleye	15,000	3.00
1982	Walleye	40,080	3.00
1986	Walleye	32,299	2.63
1989	Walleye	37,225	2.20
1990	Walleye	22,280	2.00
1991	Walleye	15,045	4.00
1992	Walleye	89,280	2.00
1995	Walleye	27,700	2.10
2003	Walleye	57,624	2.20
2005	Walleye	27,821	1.50
2005	Northern pike	882	3.00
2006	Northern pike	1,028	3.00
2006	Northern pike	5,215	2.50
2008	Northern pike	529	3.00
2009	Walleye	9,905	2.00

Source: Wisconsin Department of Natural Resources and SEWRPC.

Most recently, the WDNR conducted mini-fyke net surveys of Upper Nemahbin Lake during August 2006. This survey resulted in the capture of six species: bluegill, largemouth bass, longnose gar, rock bass, smallmouth bass, and yellow perch. Bluegill were the most numerous fishes captured, followed by rock bass and smallmouth bass.

WILDLIFE

Given the land uses present around the shorelands of the Lake, generally only smaller animals and waterfowl can be expected to inhabit the Lakeshore. Muskrats, beaver, grey and fox squirrels, and cottontail rabbits are probably the most abundant and widely distributed fur-bearing mammals in the immediate riparian areas. Larger mammals, such as the whitetail deer, would generally be expected to be confined to the larger wooded areas and the open meadows found in the park and open space lands within the tributary areas of the Lake. The Upper Nemahbin Lake tributary areas support a significant population of waterfowl including mallards, wood duck, and blue-winged teal. During the migration seasons a greater variety of waterfowl may be present and in greater numbers.

Amphibians and reptiles are vital components of the Upper Nemahbin Lake ecosystem, and include frogs, toads, and salamanders, and turtles and snakes, respectively. About 14 species of amphibians and 16 species of reptiles would normally be expected to be present in the Upper Nemahbin Lake area.

RECREATIONAL FACILITIES AND ACTIVITIES

As set forth in the regional water quality management plan, Upper Nemahbin Lake is a multi-purpose waterbody serving a variety of recreational uses.[39] Active recreational uses include boating, waterskiing, swimming, and

[39]*SEWRPC Planning Report No. 30,* op. cit.*; see also SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995.*

fishing during the summer months, and cross-country skiing, and ice-fishing during the winter. The Lake is used year-round as a visual amenity. Walking, bird watching and picnicking are popular passive recreational uses of this waterbody, and it is heavily utilized during open water periods. Public access to the Lake is provided by a County-owned boat launch and access site located the channel between Upper and Lower Nemahbin Lakes, adjacent to the southern shore of Upper Nemahbin Lake, as shown on Map 2. The Lake is considered by the WDNR to have adequate public recreational boating access, as defined in Section NR 1 of the *Wisconsin Administrative Code.*

As shown in Table 12, a survey conducted on Upper Nemahbin Lake in 2008 indicated that about 302 boats were either moored in the water or stored on land in the shoreland areas around the Lake. Recreational boating is a popular active recreational use of the Lake, with more than half of all watercraft moored in the water or stored on land in the shoreline areas capable of high speed operation. Of the motorized watercraft observed moored or stored, pontoon boats represented the largest group, with power boats the next most common category. Of the nonmotorized watercraft observed, canoes and rowboats represented the most common types on the lake, with kayaks and paddleboats also observed in good numbers. The types of watercraft found on the Lake included powered or ski boats, fishing boats, pontoon boats, paddleboats, canoes, sailboats, kayaks, and personal watercraft ("jetskis"®).

The types of motorized watercraft docked or moored on a lake as well as the relative proportion of nonmotorized to motorized watercraft, often reflect the attitudes of the primary users of the lake, the residents. On Pewaukee Lake, for example, nearly 80 percent of all watercraft on the Lake are motorized compared to about 60 percent of the watercraft on Upper Nemahbin Lake. Additionally, of all watercraft on Pewaukee Lake, power boats make up the largest portion, almost 40 percent; on Upper Nemahbin Lake, the largest portion of all watercraft is pontoon boats, which represent about 23 percent of all watercraft docked or moored on the Lake.

To assess the degree of recreational boat use on a lake, it has been estimated that, in southeastern Wisconsin, the number of watercraft of all kinds operating at any given time is approximately 2 to 5 percent of the total number of watercraft docked and moored. On Upper Nemahbin Lake, this would amount to somewhere between six and 15 watercraft, about 60 percent of which would be motorized. There is a range of opinions on the issue of what constitutes optimal boating density, or the numbers of acres of open water necessary in which to operate a boat safely on a lake. In the mid-1980s, an average area of about 16 acres per power or sail boat was, at that time, considered suitable for the safe and enjoyable use of a boat on a lake. Over time, motorized watercraft of all kinds have steadily increased in power and speed. For safe waterskiing and fast boating, an area of 40 acres per boat was suggested in the aforementioned Regional guidelines as the minimum area necessary for safe operations. Chapter NR 1 of the *Wisconsin Administrative Code* has established recreational boating standards that suggest densities of between 15 and 30 acres per watercraft as being appropriate for lakes with a surface area equal to that of Upper Nemahbin Lake. Public recreational boating access opportunities on Upper Nemahbin Lake are consistent with these standards. Indirect estimates of boating densities of boats capable of high speeds on Upper Nemahbin Lake based on counts of watercraft docked or moored around the Lake, would produce boating densities of between 35 and 94 acres available per high-speed boat on Upper Nemahbin Lake.

Another way to assess the degree of recreational boat use on a lake is through direct counts of boats actually in use on a lake at a given time. During 2008, surveys to assess the types of watercraft in use on a typical summer weekday and a typical summer weekend day were conducted by Commission staff. The results of these surveys are shown in Table 13. As shown in Table 13, fishing boats and kayaks were the most popular watercraft in use during weekday mornings, while powerboats were slightly more commonly in use on weekday afternoons. Fishing boats and kayaks were the most popular watercraft in use on weekend mornings and afternoons.

Table 14 shows how people were using Upper Nemahbin Lake recreationally during a typical summer weekday and a typical summer weekend day in 2008. The most popular weekday recreational activities on Upper Nemahbin Lake included water skiing and tubing, swimming, fishing from boats, and pleasure boating. The most popular weekend recreational activities observed were fishing from boats, kayaking, and water skiing or tubing.

Table 12

WATERCRAFT DOCKED OR MOORED ON UPPER NEMAHBIN LAKE: 2008[a]

Type of Watercraft									
Powerboat	Fishing Boat	Pontoon Boat	Personal Watercraft	Canoe	Sailboat	Kayak	Paddleboat	Rowboat	Total
51	32	68	30	31	15	23	23	29	302

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

Source: SEWRPC.

Table 13

WATERCRAFT IN USE ON UPPER NEMAHBIN LAKE: 2008

Date and Time	Powerboat	Pontoon Boat	Fishing Boat	Personal Watercraft	Sailboat	Canoe/ Kayak	Rowboat	Paddle Boat	Total
Saturday, Sept 6									
9:30 a.m. to 10:30 a.m.	1	1	5	1	0	4	0	0	12
2:00 p.m. to 3:00 p.m.	1	0	6	0	1	3	0	0	11
Total for the Day	2	1	11	1	1	7	0	0	23
Percent	9	4	49	4	4	30	0	0	100

Thursday, August 14									
9:30 a.m. to 10:30 a.m.	0	0	0	0	0	2	1	0	3
2:00 p.m. to 3:00 p.m.	3	1	1	0	0	0	0	1	6
Wednesday, August 27									
9:30 a.m. to 10:30 a.m.	2	0	4	1	0	3	0	0	10
2:00 p.m. to 3:00 p.m.	1	0	2	1	0	2	0	0	6
Total for Both Days	6	1	7	2	0	7	1	1	25
Percent	24	4	28	8	0	28	4	4	100

Source: SEWRPC.

LOCAL ORDINANCES

Recreational boating activities on Upper Nemahbin Lake are subject to State of Wisconsin boating and water safety laws as set forth in Chapter 30, *Wisconsin Statutes*. Additionally, the Lake is subject to boating ordinances promulgated by the Town of Summit included herein as Appendix C. The Town of Summit has adopted general zoning, shoreland-wetland zoning, and subdivision control ordinances, and is subject to the Waukesha County floodland zoning ordinance and stormwater management and construction site erosion control ordinance, as shown in Table 15.

Table 14

RECREATIONAL ACTIVITIES IN/ON UPPER NEMAHBIN LAKE: 2008

Date and Time	Weekend Participants									
	Fishing from Shoreline	Pleasure Boating	Skiing/ Tubing	Sailing	Operating Personal Watercraft	Swimming	Fishing from Boats	Canoeing/ Paddle Boating	Park Goers	Total
Saturday, Sept 6										
9:30 a.m. to 10:30 a.m.	2	2	3	0	1	0	9	4	0	21
2:00 p.m. to 3:00 p.m.	0	0	3	2	0	0	10	3	0	18
Total for the Day	2	2	6	2	1	0	19	7	0	39
Percent	5	5	15	5	3	0	49	18	0	100

Date and Time	Weekday Participants									
	Fishing from Shoreline	Pleasure Boating	Skiing/ Tubing	Sailing	Operating Personal Watercraft	Swimming	Fishing from Boats	Canoeing/ Paddle Boating	Park Goers	Total
Thursday, August 14										
9:30 a.m. to 10:30 a.m.	1	0	0	0	0	2	0	3	0	6
2:00 p.m. to 3:00 p.m.	0	5	0	0	0	6	4	2	5	22
Total for the Day	1	5	0	0	0	8	4	5	5	28
Percent	4	18	0	0	0	29	15	17	17	100
Wednesday, August 27										
9:30 a.m. to 10:30 a.m.	0	1	7	0	2	0	8	4	0	22
2:00 p.m. to 3:00 p.m.	0	0	7	0	2	4	3	4	1	21
Total for the Day	0	1	14	0	4	4	11	8	1	43
Percent	0	2	34	0	9	9	26	18	2	100

Source: SEWRPC.

Table 15

LAND USE REGULATIONS WITHIN THE TOTAL AREA TRIBUTARY TO UPPER NEMAHBIN LAKE IN WAUKESHA COUNTY BY CIVIL DIVISION: 2007

Community	Type of Ordinance				
	General Zoning	Floodplain Zoning	Shoreland or Shoreland-Wetland Zoning	Subdivision Control	Construction Site Erosion Control and Stormwater Management
Waukesha County	Adopted	Adopted	Adopted and WDNR approved	Adopted: Floodland and shoreland only	Adopted
City of Delafield	Adopted	Adopted	Adopted	Adopted	Adopted
City of Oconomowoc	Adopted	Adopted	Adopted	Adopted	Adopted
Village of Chenequa	Adopted	None[a]	Adopted	None	Adopted[b]
Village of Hartland	Adopted	Adopted	Adopted	Adopted	Adopted
Village of Merton	Adopted	Adopted	Adopted	Adopted	None
Village of Nashotah	Adopted	None[a]	Adopted and WDNR approved	Adopted	Adopted
Village of Oconomowoc Lake	Adopted	Adopted	Adopted	Adopted	Adopted
Village of Sussex	Adopted	Adopted	Adopted and WDNR approved	Adopted	Adopted
Town of Delafield	Adopted	County ordinance	County ordinance	Adopted	County ordinance
Town of Lisbon	Adopted	County ordinance	County ordinance	Adopted	Adopted
Town of Merton	Adopted	County ordinance	County ordinance	Adopted	None
Town of Summit	Adopted	County ordinance	Adopted and WDNR approved	Adopted	None
Washington County[c]	Adopted	Adopted	Adopted and WDNR approved	Adopted: Floodland and shoreland only	Adopted
Village of Richfield	Adopted	Adopted	Adopted	Adopted	Adopted[d]

[a] *Flood hazard areas have been identified or mapped on year 2007 proposed FEMA floodplain maps.*

[b] *Erosion control ordinance only.*

[c] *In 1986, Washington County rescinded its general zoning ordinance, and all nine towns which were subject to the general County zoning ordinance have since adopted a town zoning ordinance.*

[d] *The Village of Richfield has adopted a Village Erosion Control and Stormwater Management Ordinance and has entered into an intergovernmental agreement with Washington County for County administration of the ordinance.*

Source: SEWRPC.

Chapter III

INVENTORY FINDINGS: BARK RIVER

INTRODUCTION

The physical characteristics of a stream network and its associated watershed are important factors in evaluating and managing the existing and likely future water quality conditions and uses of lakes into which these systems flow. Characteristics, such as watershed topography, stream channel morphometry, upstream impoundments and lakes, and local hydrology, ultimately influence water quality conditions and the composition of plant and fish communities within the stream system and its associated lakes. Therefore, these characteristics must be considered during the lake management planning process.

This chapter provides pertinent information on the physical and biological characteristics of the Middle Bark River—that portion of the Bark River system downstream of Nagawicka Lake and upstream of Crooked Lake.[1] Upper Nemahbin Lake forms an approximate midpoint within the Middle Bark River system, which extends both upstream and downstream of that Lake. It should be noted that aspects of the area tributary to the Middle Bark River area, its land use conditions, and past and present management practices have been summarized in Chapter II, although these data are included in this chapter to the extent necessary to characterize the stream system. Subsequently, Chapter IV will deal with issues of concern relative to Upper Nemahbin Lake and the Middle Bark River, and Chapter V will deal with alternative and recommended lake and stream protection practices.

BACKGROUND

The Upper Nemahbin Lake Management District (UNLMD) initiated a planning program during 2007 designed to provide specific guidance with respect to the hydrology of the Middle Bark River and its likely impacts on the fish, wildlife, and other aquatic biota within this critical stream reach. To this end, the District had previously contracted with the U.S. Geological Survey (USGS) to provide data on the hydrology and water quality of the Bark River at its outlet from Nagawicka Lake,[2] and had requested the assistance of the Southeastern Wisconsin

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[1]*The Regional Planning Commission has documented the conditions at both extremes of this River reach in SEWRPC Community Assistance Planning Report No. 262,* A Lake Management Plan for Nagawicka Lake, Waukesha County, Wisconsin, *March 2001; and, in SEWRPC Memorandum Report No. 112,* An Aquatic Plant Management Plan for Crooked Lake, Waukesha County, Wisconsin, *April 2000.*

[2]*See U.S. Geological Survey Scientific Investigations Report No. 2006-5273,* Water Quality, Hydrology, and Response to Changes in Phosphorus Loading to Nagawicka Lake, a Calcareous Lake in Waukesha County, Wisconsin, *2006.*

Regional Planning Commission (SEWRPC) in the conduct of a planning program designed to guide the proposed and planned activities within the Middle Bark River so as to protect water quantity and quality in the affected Lakes. The overall goal of the planning project, which is part of an ongoing program of lake-related management actions being undertaken by the UNLMD, was to produce an updated lake protection plan for the Upper Nemahbin Lake and its watershed that is consistent with the objectives of Chapter NR 190, *Wisconsin Administrative Code*.

One of the specific objectives of this planning project was to assess the degree and intensity of recreational water use in and around the Upper Nemahbin Lake relative to the management of water levels and operational strategies for the dams that augment or affect the natural water surface elevations of this Lake. The planning program was designed to include an evaluation of river regulation regime. In particular, this review was to consider proposed modifications to the control structures, including the reconstruction of the CTH P weir and removal of the Roller Mill Dam. Specific considerations included:

1. Assessment of potential risk of downstream movement of sediments currently impounded by the Roller Mill Dam as that dam is to be abandoned;

2. Potential channel design for a recreated streamcourse between Nagawicka Lake and Upper Nemahbin Lake when the Roller Mills Dam is abandoned;

3. Consideration of actions to restore fish and aquatic habitat within the recreated stream reach of the Middle Bark River;

4. Evaluation of the current water levels established by the CTH P weir at the outlet to Lower Nemahbin Lake;

5. Evaluation of fisheries aspects relating to possible water level fluctuations within the impounded portions of Upper and Lower Nemahbin and Lower Nashotah Lakes during and following the proposed reconstruction of the CTH P weir;

6. Recommendations regarding possible changes in elevation and/or operating regime of the CTH P weir; and

7. Review of the ownership and operation of the water level control structures.

During 2007, the Commission staff obtained cross-sectional data on stream morphology and biology within the project area. At the request of the UNLMD, Commission staff collected additional water and sediment depth data downstream of the Roller Mill Dam during October 2008 following action by the WDNR and the owner of the Roller Mill Dam that resulted in the drawdown of the impoundment pursuant to the drawdown order dated June 18, 2008 and appended hereto as Appendix A. This chapter, *inter alia*, summarizes the pre- versus post-drawdown condition of this portion of the Middle Bark River and the associated changes in water and sediment depths.

WATERBODY CHARACTERISTICS

The Bark River forms the major tributary stream flowing into Upper Nemahbin Lake from the east and out of the Lake to the south.[3] The Bark River is located in the south-central portion of Washington County, and the north-central, central, and west-central portions of Waukesha County, as shown on Map 3 in Chapter II of this report.

[3]*SEWRPC Memorandum Report No. 145*, Lake and Stream Resources Classification Project for Waukesha County, Wisconsin: 2000, *December 2005*.

The River flows south from Bark Lake through Waukesha County to the Rock River. Originating in southern Washington County, the Bark River is located in the southwestern portion of the Richfield area. Within Washington County, the River has a surface area of about four acres and extends over a linear distance of about 2.5 miles with a gradient of approximately two feet per mile. In Waukesha County, the River has a surface area of about 51 acres, a length of 24.6 miles, and a gradient of 5.1 feet per mile. The Bark River is a high gradient stream flowing from Washington County through Waukesha County, and then west into Jefferson County until its confluence with the Rock River. There are six lakes and impoundments on the course of the River within Waukesha County. The Bark River has limited navigability within Washington County, and is generally navigable only by canoe or similar watercraft. In Waukesha County, public recreational boating access is provided through public recreational boating access sites on some lakes and impoundments. The Bark River is included within the Lower Rock River basin areawide water quality management planning area.[4]

In 1963, the fishery of the Bark River was reported to consist largely of common lake species.[5] Forage fish, especially suckers, were the most common. The River was characterized as a dark-water, predominantly sandy-bottomed stream. Fish surveys were conducted in the Washington County portions of the stream during 1968, 1972, 1973, and 1975, and, in the Waukesha County portions, annually between 1972 and 1977, and in 1981, 1994, and 1995. These fish surveys reported the fishery to consist of channel catfish, black bullhead, brown bullhead, yellow bullhead, common carp, bluntnose minnow, fathead minnow, shorthead redhorse brassy minnow, spottail shiner, common shiner, emerald shiner, golden shiner, spotfin shiner, sand shiner, rosyface shiner, black crappie, white crappie, bowfin, buffalo, warmouth, white sucker, blackstripe topminnow, brook silverside, slenderhead darter, Iowa darter, rainbow darter, johnny darter, banded darter, least darter, fantail darter, central mudminnow, stonecat, creek chub, northern hog sucker, hornyhead chub, largescale stoneroller, central stoneroller, grass pickerel, logperch, slender madtom, tadpole madtom, lake chubsucker, banded killifish, largemouth bass, smallmouth bass, rock bass, white bass, northern pike, walleye, bluegill, green sunfish, orangespotted sunfish, and pumpkinseed.[6] The banded killifish and the least darter are listed as State species of special concern.[7] The slender madtom is listed as State endangered species.

Waterfowl and marsh fur bearers make migratory and resident use of the approximately 2,000 acres of wetlands that adjoin the River. Deer are also found in some of the larger wooded wetland areas.

As previously noted, Upper Nemahbin Lake, Lower Nemahbin Lake, and Lower Nashotah Lake share a common surface elevation determined in part by the control structure that forms part of the CTH P bridge spanning the Bark River.[8] This control structure forms the southernmost “break point” in the hydrological system controlling water quality and quantity conditions within Upper Nemahbin Lake. The CTH P-Nemahbin Lakes dam is in

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[4]*Wisconsin Department of Natural Resources Publication No. PUBL-* WR-280 98-REV, Lower Rock River Basin, Water Quality Management Plan, *October* 1998.

[5]*Wisconsin Conservation Department,* Surface Water Resources of Waukesha County*, 1963.*

[6]*D. Fago, Wisconsin Department of Natural Resources Research Report No. 148,* Retrieval and Analysis System Used in Wisconsin's Statewide Fish Distribution Survey, Second Edition*, December 1988.*

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

[8]*The water surface elevations of Upper Nemahbin Lake and Lower Nemahbin Lake are nominally different due to the constriction of flow created by the CTH DR and IH 94 bridges that separate the Lakes. Under high flow conditions, these bridges may limit the passage of flood flows and create a slight difference in water surface elevation between Upper and Lower Nemahbin Lakes. The presence of a sand bar between Upper Nemahbin Lake and Lower Nashotah Lake may similarly restrict flows between these lakes under certain conditions.*

private ownership, with the Nemahbin Advancement Association being noted by the WDNR as the owner of record.[9]

Upstream of Upper Nemahbin Lake, natural grade changes in the middle portion of the Bark River formed an ideal location for the Roller Mill Dam, an intermediate waterbody located downstream of Nagawicka Lake.[10] The Roller Mill Dam was in private ownerships, with Mrs. Margaret Zerwekh being noted by the WDNR as the owner of record.[11] This latter structure has been proposed to be abandoned by the owner, who has been granted an abandonment permit by the Wisconsin Department of Natural Resources (WDNR) pursuant to the procedures set forth in Chapter 31 of the *Wisconsin Statutes*.

TRIBUTARY AREA AND LAND USE CHARACTERISTICS

The area directly tributary to Upper Nemahbin Lake is situated within the City of Delafield, the City of Oconomowoc and the Town of Summit, all in Waukesha County. This area, which drains directly to Upper Nemahbin Lake without passing through any upstream waterbody, comprised largely of the Middle Bark River downstream of Nagawicka Lake and upstream of Upper Nemahbin Lake, is approximately 2,188 acres in areal extent. The total upstream area of the Bark River tributary to Upper Nemahbin Lake, as noted in Chapter II, extends over a significantly larger area, as shown on Map 3 in Chapter II of this report. This area tributary is approximately 31,644 acres in areal extent, and includes portions of: the Cities of Delafield and Oconomowoc; the Villages of Chenequa, Hartland, Merton, Nashotah, Oconomowoc Lake, Sussex, and Richfield; and, the Towns of Delafield, Lisbon, Merton, and Summit, in Washington and Waukesha Counties. As previously noted in Chapter II, a number of these communities are designated stormwater management areas under Chapter NR 216 of the *Wisconsin Administrative Code*.

As of 1995, land use within the Bark River drainage area within Washington County consisted largely of agricultural and open space uses, with agriculture comprising about 50 percent of the total land cover of the drainage area. Urban-density residential development comprised about 20 percent of the total land cover. The drainage area is partially located within an area planned for limited low density urban development in the regional land use plan. In Waukesha County, the land uses within the approximately 47-square-mile Bark River subwatershed consisted of about 30 percent urban land uses and about 70 percent rural land uses. Agricultural land uses comprised about one-half of the rural land cover in the subwatershed. Urban residential uses comprised about 55 percent of the urban land cover. The subwatershed is partially located within an area planned for urban development in the adopted Waukesha County development plan.[12]

Since 1995, in accordance with the regional land use plan and county development plan, significant urban density growth has occurred in the drainage basin. Within the total area tributary to Upper Nemahbin Lake, existing land uses are shown on Map 6 in Chapter II of this report and are summarized in Table 4 also in Chapter II of this report. As shown in the table, the land uses as of 2000 are significantly more rural than urban, with agriculture being the dominant rural land use and residential uses being the dominant urban land use. Future changes in land use within

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[9]http://dnrmaps.wisconsin.gov/imf/imf.jsp?site=SurfaceWaterViewer. *WDNR Key Sequence 1007, Waterbody Identification Code (WBIC) No. 813500.*

[10]*See SEWRPC Community Assistance Planning Report No. 262,* A Lake Management Plan for Nagawicka Lake, Waukesha County, Wisconsin, *March 2001.*

[11]http://dnrmaps.wisconsin.gov/imf/imf.jsp?site=SurfaceWaterViewer. *WDNR Key Sequence 1565, Waterbody Identification Code (WBIC) No. 827700.*

[12]*SEWRPC Community Assistance Planning Report No. 209,* A Development Plan for Waukesha County, Wisconsin, *August 199, as amended.*

the total area tributary to Upper Nemahbin Lake are expected to be similar in nature to those anticipated within the area directly tributary to the Lake, albeit not as pronounced. Urban land uses are anticipated to increase from about 35 percent to 56 percent of the land cover within the total area tributary to Upper Nemahbin Lake, while rural land uses are expected to decrease from about 65 percent to 44 percent of the land cover. As shown on Map 7 in Chapter II of this report, the majority of these changes are expected to occur in the southern one-third and middle one-third of the total tributary area, in the vicinity of the City of Delafield and its environs.

Nonpoint pollution within the Bark River subwatershed is generated primarily from both rural agricultural lands and urban residential lands which comprise about 55 percent of the land cover within the watershed, as documented in Chapter II of this plan.

PHYSICAL CONDITIONS IN THE MIDDLE BARK RIVER

Pre-Drawdown Conditions

The SEWRPC staff established a total of 74 transects along the mainstem of the Middle Bark River between Nagawicka Lake Dam and Upper Nemahbin Lake, which were sampled in June through August 2007. Transect locations were documented by geographic positioning system (GPS) location and Waukesha County 2007 digital, color orthophotography as shown on Map 10. At each transect, physical data on stream morphology were collected pursuant to a methodology adapted from the Wisconsin Department of Natural Resources, *Guidelines for Evaluating Habitat of Wadable Streams* (revised June 2000). Specifically, the following parameters were evaluated at each transect location: water depth, water width, including bankfull characteristics where possible, unconsolidated sediment depth, substrate type, bank height, bank slope, thalweg depth, habitat types, embeddedness of coarse gravel and rubble/cobble, percent substrate types, percent macrophytes, percent algae, percent woody debris, and extent of undercut banks. Photographs were also taken to further document channel conditions as shown in Figure 2.

As previously described, the Middle Bark River between Nagawicka Lake Dam and the confluence with Upper Nemahbin Lake has a total length of approximately 8,500 feet or 1.6 miles.[13] The river has a sinuosity of 1.2, which is indicative of modification or channel straightening. Overall, the average water depth was 1.7 feet and the depth ranged from 0.2 foot to 3.8 feet. Mean wet width ranged from 23 feet to 480 feet, with an overall average of 106.1 feet. These conditions are shown in Figure 3 and were consistent with characteristics found in the year 2000 report.[14]

Average channel width and water depth measurements demonstrated a general increase from the upstream to downstream direction, which is typical of stream systems, even though this trend is markedly interrupted by the Roller Mill Dam as shown in Figure 3. Mean sediment depths did not show any trend from upstream to downstream, which is not typical of stream systems. The backwater effect of Roller Mill Dam and Lower Nemahbin Lake causes an increase in channel width, water depth, and sediment accumulation as shown in Figure 3. As previously documented, these backwater effects were also associated with a decrease in water velocity in these areas of the Middle Bark River.[15] These decreases in water velocity have led to the deposition of an average sediment depth of 1.4 feet and a maximum sediment depth of four feet from Transect 1 through 8, as well as an average sediment depth 1.4 feet and a maximum sediment depth of more than five feet from Transects 14 through 52.

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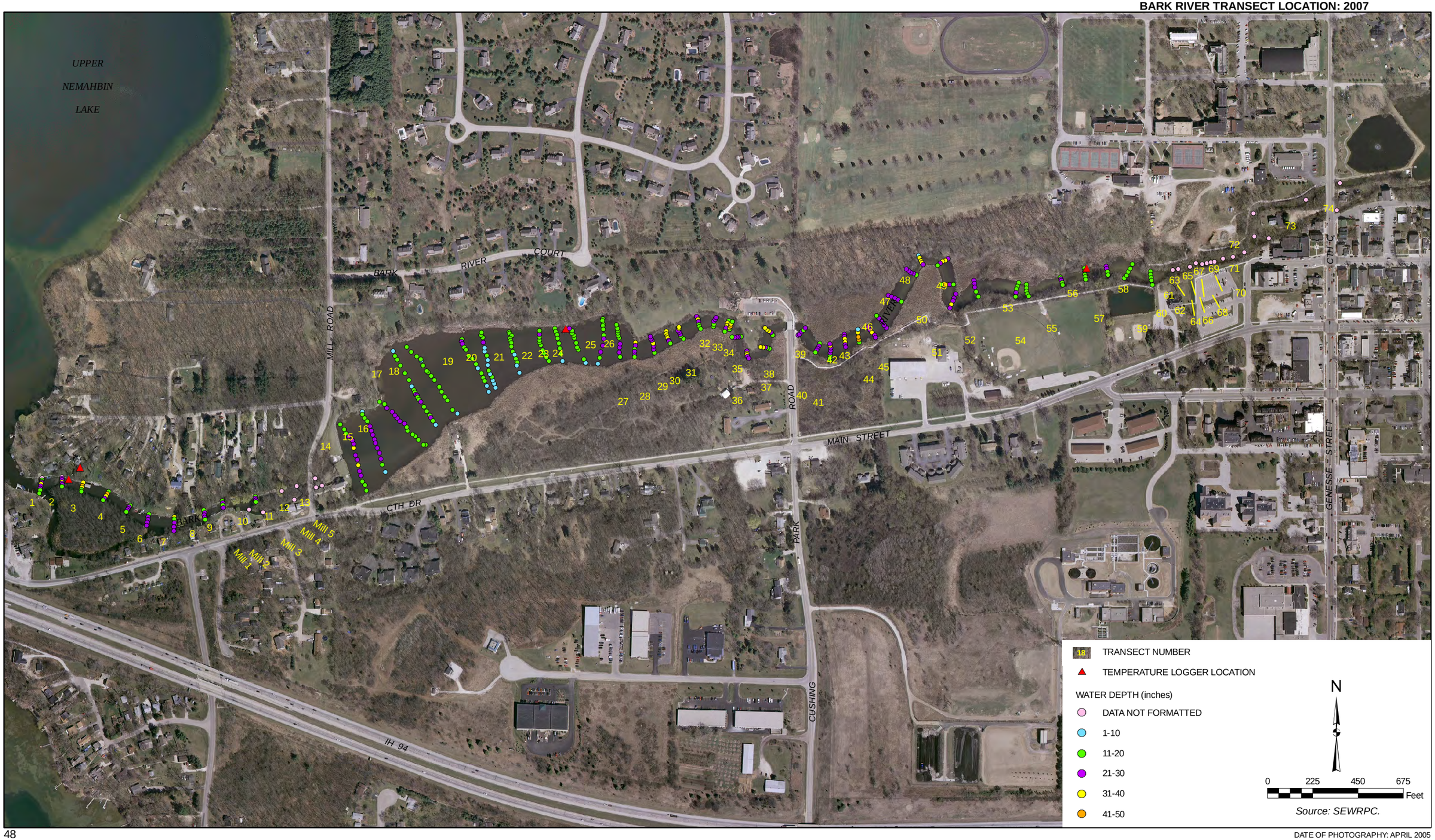
[13]*T N & Associates, Inc.*, Watershed Inventory of the Bark River Between Nagawicka Lake and Upper Nemahbin Lake, Waukesha County, Wisconsin, *prepared for the Upper Nemahbin Lake Management District, May 2001.*

[14]Ibid.

[15]Ibid.

Map 10

BARK RIVER TRANSECT LOCATION: 2007



DATE OF PHOTOGRAPHY: APRIL 2005

Figure 2

PHOTOGRAPHS OF THE MIDDLE BARK RIVER BETWEEN NAGAWICKA LAKE DAM AND THE CONFLUENCE OF THE MIDDLE BARK RIVER WITH UPPER NEMAHBIN LAKE: JUNE-OCTOBER 2007

NAGAWICKA LAKE DAM ON THE BARK RIVER LOOKING UPSTREAM

CTH C: BARK RIVER CROSSING LOOKING UPSTREAM

Figure 2 (continued)

MIDDLE BARK RIVER AT TRANSECT 71 LOOKING UPSTREAM

MIDDLE BARK RIVER AT TRANSECT 65 LOOKING UPSTREAM

Figure 2 (continued)

MIDDLE BARK RIVER AT TRANSECT 54 LOOKING UPSTREAM

APPLEBECKER MILLPOND AT TRANSECT 21 LOOKING SOUTH

Figure 2 (continued)

ROLLER MILL DAM LOOKING DOWNSTREAM FROM THE APPLEBECKER MILLPOND

MIDDLE BARK RIVER DOWNSTREAM OF THE ROLLER MILL DAM LOOKING UPSTREAM

Figure 2 (continued)

MILL ROAD: BARK RIVER BRIDGE CROSSING LOOKING UPSTREAM

MILL RACE DOWNSTREAM OF THE ROLLER MILL DAM
LOOKING UPSTREAM AT TRANSECT MILL 2

NOTE: Compare the photograph with that shown in Figure 12; note the loss of the cobble and gravel substrate in this reach.

Figure 2 (continued)

MIDDLE BARK RIVER DOWNSTREAM OF MILL ROAD LOOKING UPSTREAM AT TRANSECT 10

MIDDLE BARK RIVER DOWNSTREAM OF THE MILL RACE CONFLUENCE WITHIN
THE AREA OF BACKWATER EFFECT FROM UPPER NEMAHBIN LAKE AT TRANSECT 8

Figure 2 (continued)

MIDDLE BARK RIVER LOOKING UPSTREAM AT TRANSECT 2
ON AUGUST 28, 2007, FOLLOWING A HIGH FLOW EVENT

NOTE: Water spilling out over banks and into adjacent properties and the upstream Middle Bark River USGS gauge at the Nagawicka Lake Dam recorded a discharge of 62 cubic feet per second on August 28, 2007. This discharge event is four days after a recorded 95 cubic feet per second discharge at the Nagawicka Lake Dam on August 24, 2007.

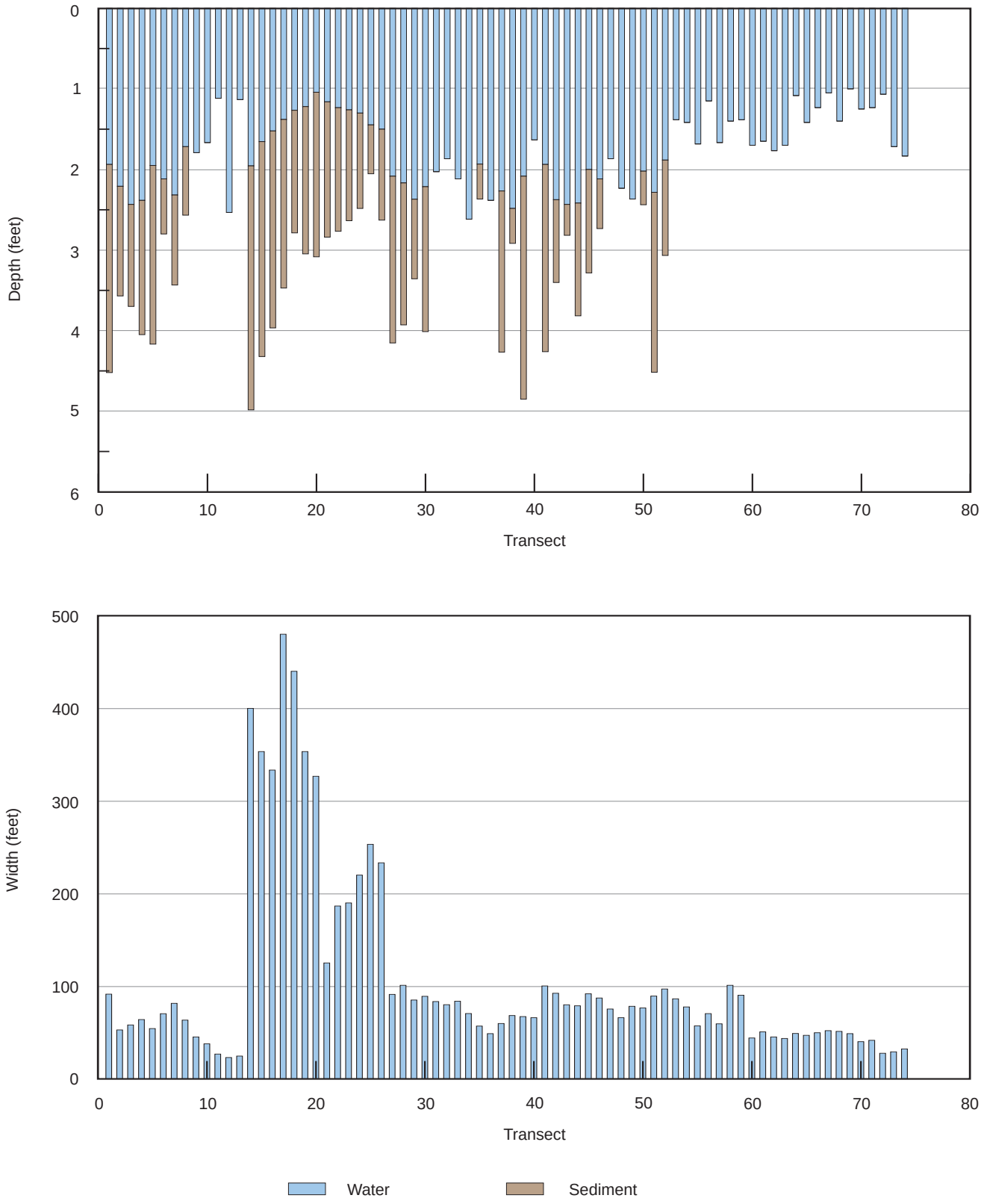
Source: SEWRPC.

The water surface elevation profile in Figure 4 shows that the backwater effect from Upper Nemahbin Lake extends nearly 2,000 lineal feet upstream of the confluence of the Bark River with Upper Nemahbin Lake, which affects more than 90 percent of the reach from the confluence to Roller Mill Dam. The backwater effect of the Roller Mill Dam extends approximately 4,000 feet upstream as shown in Figure 4, which is consistent with the only areas of sediment deposition within the Middle Bark River upstream of this dam. In the reaches downstream of both Nagawicka and Roller Mill dams there are relatively narrow channels, increases in water velocity, and exposure of larger substrates due to erosion of the smaller sediment particles. In fact, the approximately 200-foot-long section of stream immediately downstream of the Roller Mill Dam contains the steepest slope of the entire Middle Bark River as shown in Figure 4.

The deepest recorded areas of sediment deposition occurred behind Roller Mill Dam in the Middle Bark River, as shown in Figure 3. As shown in Figures 3, 4, and 5, sediment depths within this impoundment increased from east (upstream) to west (downstream) within the impoundment with the greatest sediment depths being found at cross-section 14. This pattern of deposition is consistent with the accreting nature of impoundments and reflects the filling of the pre-impoundment stream channel. The bed of the historical stream channel (shown in Figure 4), was identified during the sediment survey conducted by Commission staff in 2007. This pattern of deposition and the location of the historical stream channel are shown in Figure 5. Both the approximate historical bed profile and cross-sections indicate that the historical channel conditions approximate those observed downstream of the Roller Mill Dam. Both areas are steeply sloped.

Figure 3

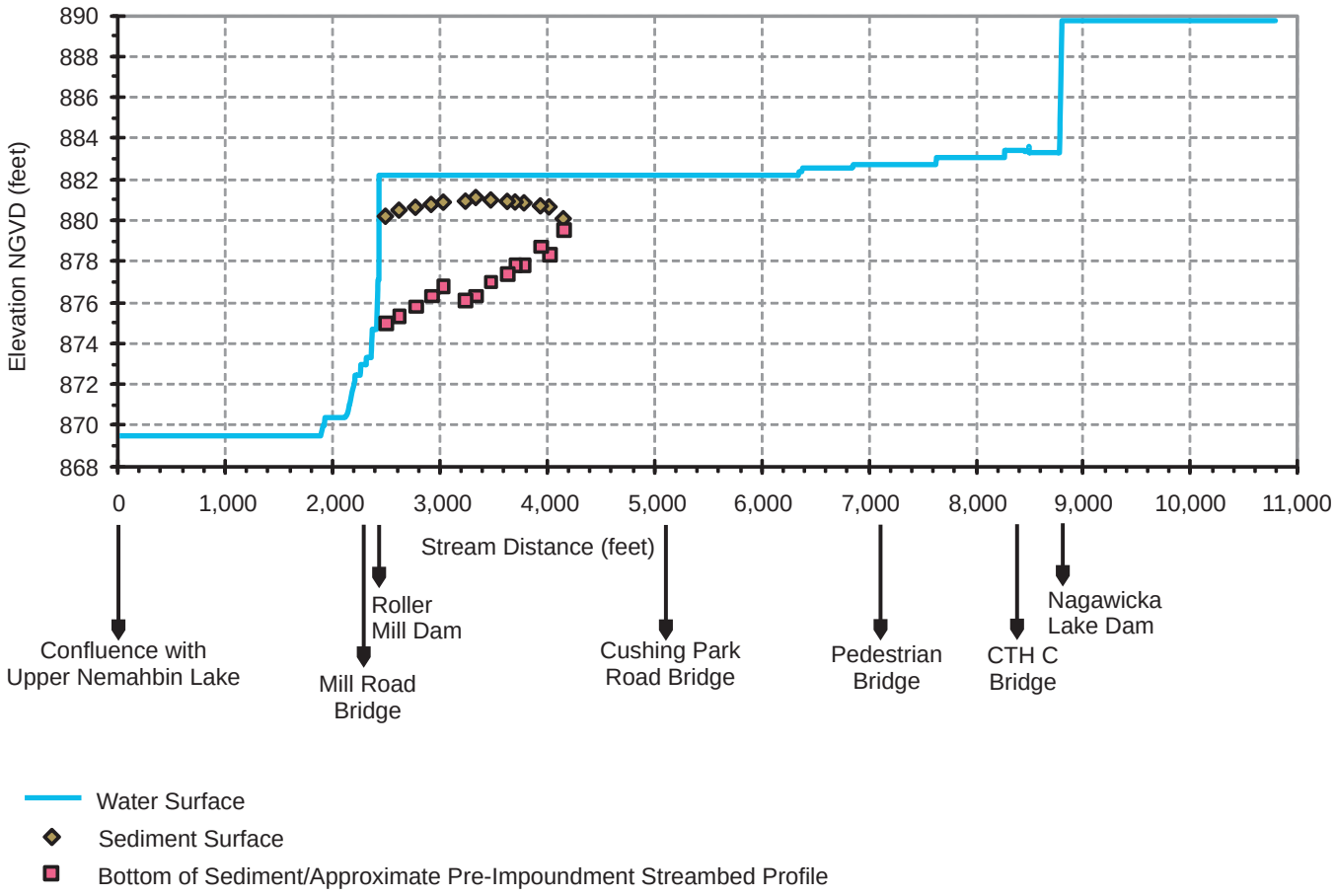
AVERAGE WATER DEPTH, SEDIMENT DEPTH, AND WIDTH WITHIN THE MIDDLE BARK RIVER BETWEEN NAGAWICKA DAM AND UPPER NEMAHBIN LAKE: 2007



Source: SEWRPC.

Figure 4

ELEVATION PROFILE OF THE BARK RIVER BETWEEN UPPER NEMAHBIN LAKE AND NAGAWICKA LAKE: 2009



Source: SEWRPC.

Post-Drawdown Conditions

In October 2008, Commission staff resampled the 18 transects along the Middle Bark River and Mill Race located between the Roller Mill Dam and Upper Nemahbin Lake over a total linear distance of 1,573 feet downstream of the Roller Mill Dam as shown on Map 11.[16] During this latter survey, Commission staff evaluated the following parameters at each transect location: water depth, water width, unconsolidated sediment depth, and substrate type.

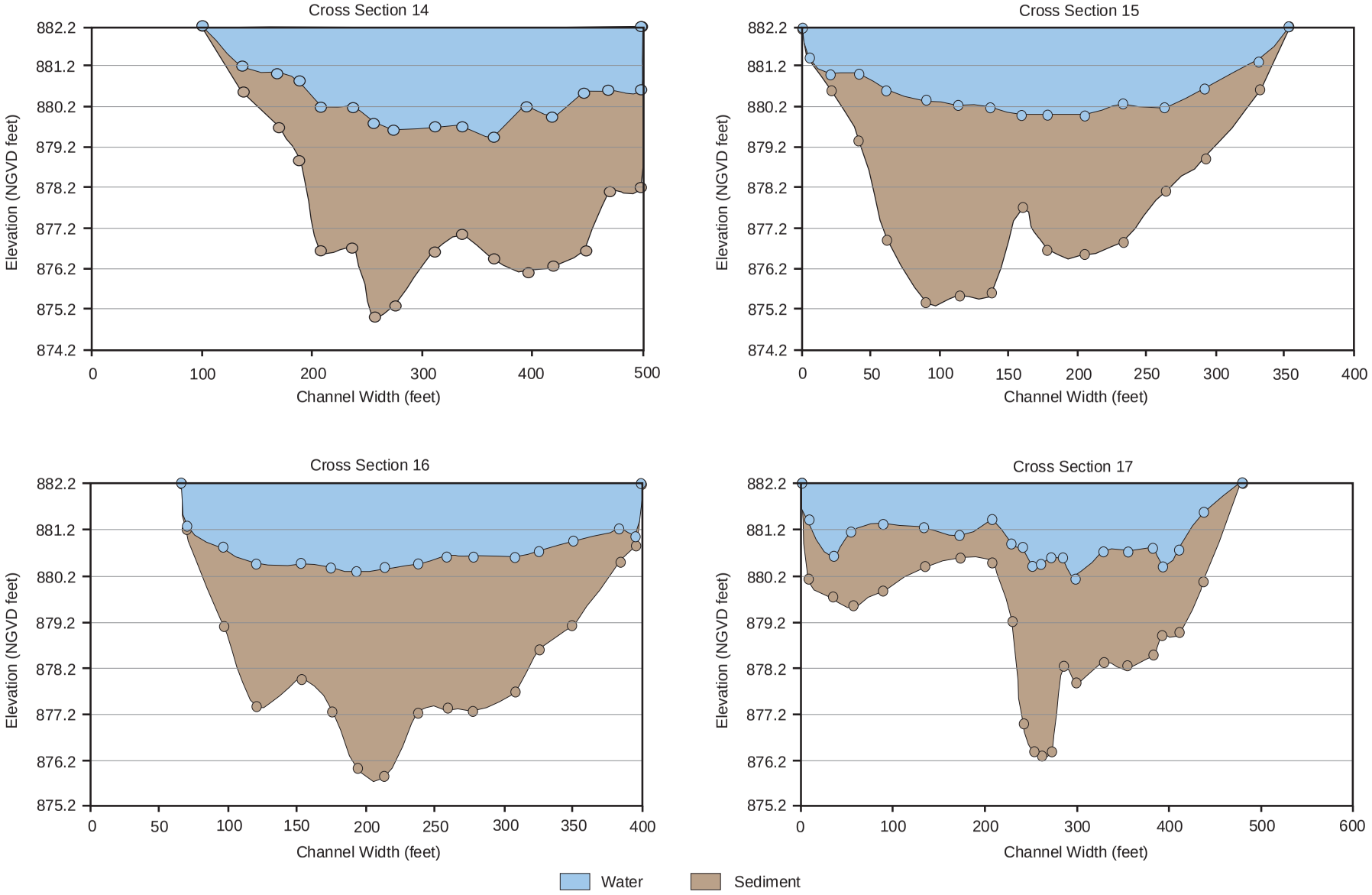
Sediment depths were calculated along each transect. These depths were used to generate a mean depth of sediment which was used to estimate the volume of sediment between transects in order to determine a total volume of unconsolidated sediment within the study reach in 2007 and 2008. Photographs were also taken to further document channel conditions.

An Analysis of Covariance (ANCOVA) statistical test was used to determine the difference in water depth, sediment depth, and total depth (water and sediment) among years (2007 versus 2008) and transects. Application

[16]*The 18 transects were renumbered based upon their distance from Roller Mill Dam to analyze longitudinal effects of sediment deposition downstream of Roller Mill dam and shown on Map 10.*

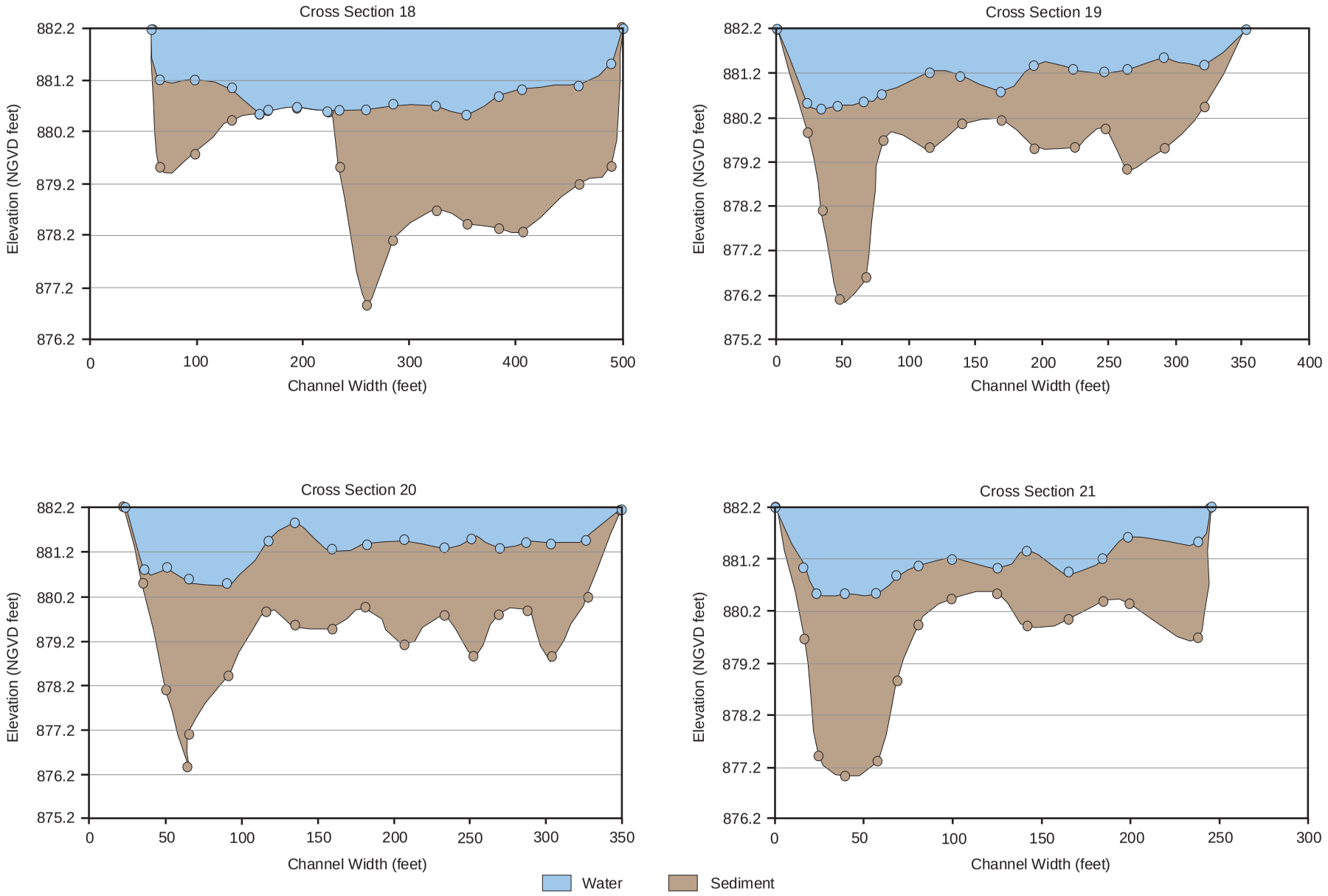
Figure 5

CROSS-SECTIONAL PROFILES OF WATER AND SEDIMENT DEPTH IN THE ROLLER MILL IMPOUNDMENT: 2007



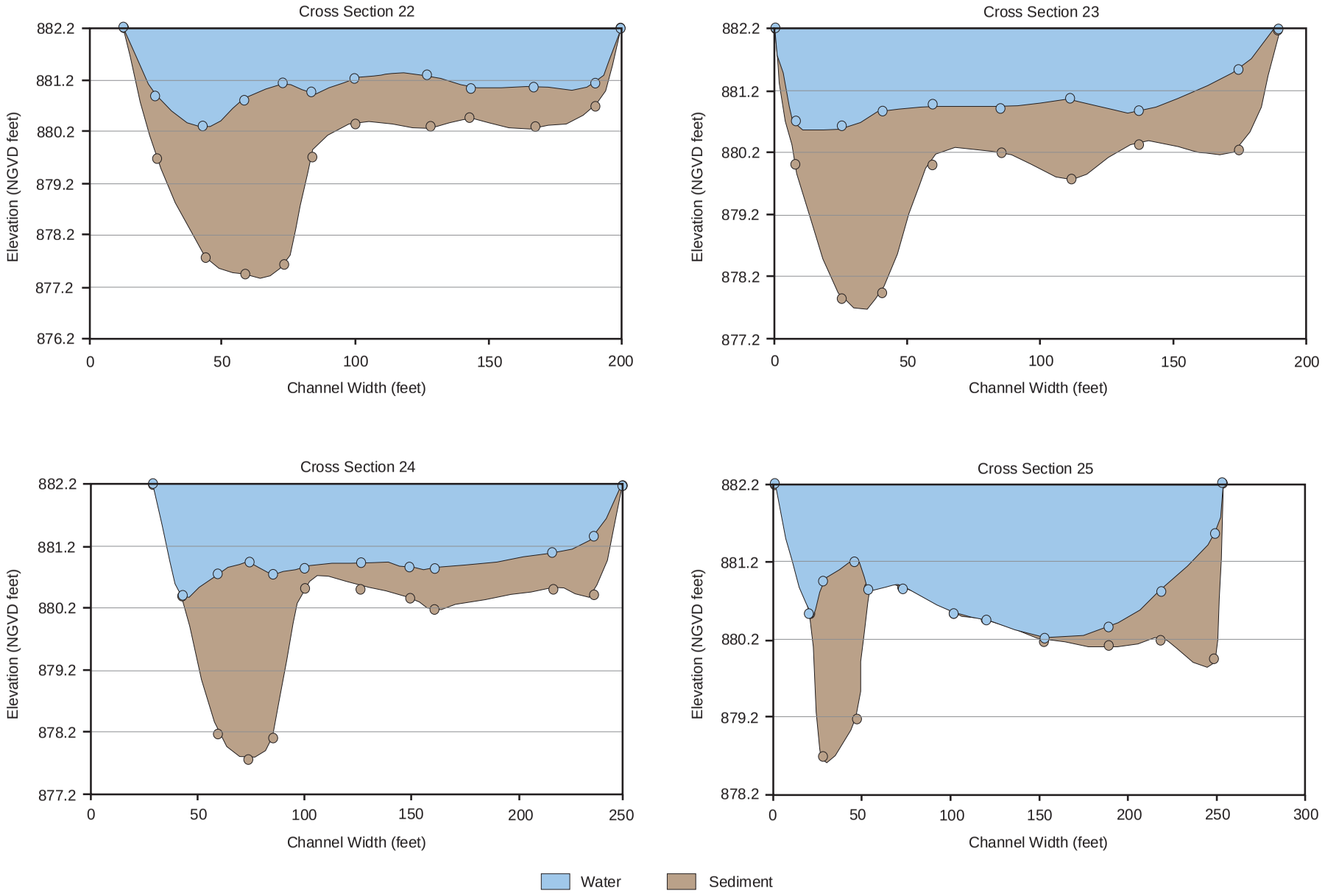
NOTE: Cross-section locations are shown on Map 10.

Figure 5 (continued)



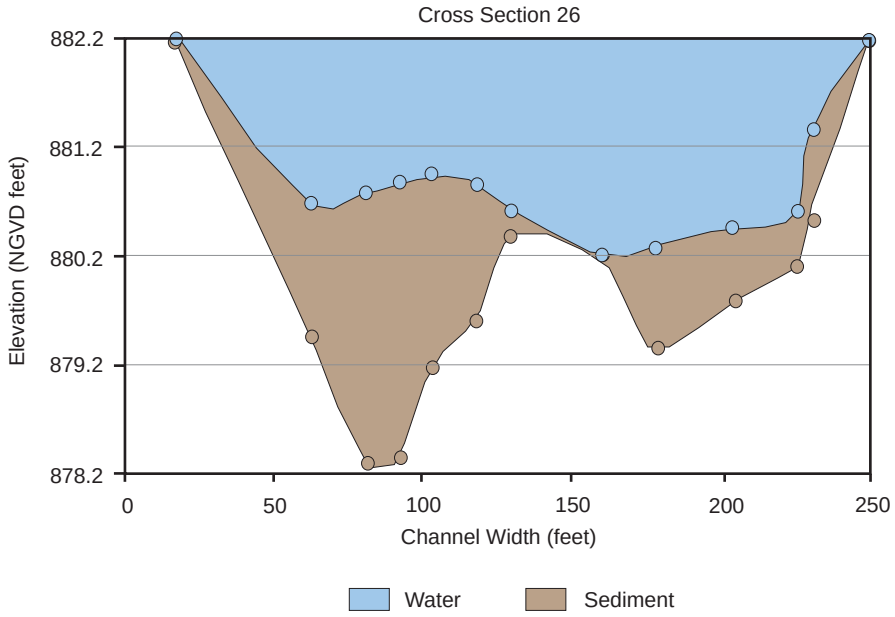
NOTE: Cross-section locations are shown on Map 10.

Figure 5 (continued)



NOTE: Cross-section locations are shown on Map 10.

Figure 5 (continued)



NOTE: Cross-section locations are shown on Map 10.

Source: SEWRPC.

of that statistical test generates a parameter, designated the "P-value," which relates to statistical significance. The Middle Bark River and the Mill Race reaches were analyzed separately. All statistical analyses were performed using SYSTAT.[17] A P-value less than 0.05 indicated a significant result.

Based upon photographic documentation of the Roller Mill Dam and its environs obtained by the Commission staff immediately following the implementation of the WDNR drawdown order in June 2008, and by Commission staff and WDNR staff at intervals between June and October 2008, shown in Figures 6 through 10, significant "head cutting" of unconsolidated sediments has occurred as a result of the change in water surface elevation arising from the removal of the stop logs from the Roller Mill Dam spillway. The chronology of these manipulations is set forth in Table 16.

The differences in water surface elevation within the basin of the former Applebecker Millpond have resulted in the mobilization of unconsolidated sediments from within the impoundment and the transport of the eroded sediment into the downstream reach of the Middle Bark River and the Mill Race. This head cutting is clearly visible in Figure 8, which shows the incision of the river channel into the unconsolidated sediments of the former Applebecker Millpond from vantage points at Mill Road (looking east) and at Cushing Memorial Park (looking west), both in the City of Delafield. There are several areas within the former Roller Mill Dam impoundment where Commission staff measured up to 24 inches of bank and bed erosion. Additionally, based upon measurements made by Commission staff during 2007, the fact that the elevation of the sediment surface within the impoundment was higher than the level of the concrete spillway sill is likely to have contributed additional

[17] *SYSTAT Software*, SYSTAT 10.2, *2002.*

Map 11

TRANSECT LOCATIONS DOWNSTREAM OF THE ROLLER MILL DAM: 2007 AND 2008

DATE OF PHOTOGRAPHY: APRIL 2005

Figure 6

TIME SERIES OF PHOTOGRAPHS OF THE ROLLER MILL DAM IMPOUNDMENT: JUNE-OCTOBER 2008

JUNE 19, 2008

JUNE 23, 2008

NOTE: Photographs taken from Mill Road looking east.

Figure 6 (continued)

JUNE 27, 2008

AUGUST 20, 2008

NOTE: Photographs taken from Mill Road looking east.

Figure 6 (continued)

OCTOBER 10, 2008

NOTE: Photograph taken from Mill Road looking east.

Source: SEWRPC.

sediment from within the Roller Mill Dam basin to the downstream segments of the Middle Bark River. The elevation of the unconsolidated sediments is documented in Figure 4, and the head cutting that occurred with the boards removed in 2008, as shown in the eastward view set forth in Figure 8, was a result of the difference in elevation between the sediment in the Roller Dam basin and the concrete spillway crest.

Such sediment loading is additional to the sediment loading generated from nonpoint sources in the tributary area upstream of Upper Nemahbin Lake, documented in Chapter II of this plan.

Water Width

Water width among transects did not change between 2007 and 2008. This is consistent with the anticipated characteristics of a waterbody regulated by a control structure (i.e., the outlet structure of Lower Nemahbin Lake at CTH P which regulates the levels of both Upper and Lower Nemahbin Lakes). This also is consistent with observations by the Commission staff and riparian residents living below the Roller Mill Dam. The backwater effect of the CTH P weir (Lower Nemahbin Lake Dam) extends upstream to Transect 457, as shown on Map 11.

Total Depth

Based upon the ANCOVA results, the total depth (sediment and water combined) among transects along the Middle Bark River did not change significantly between years 2007 and 2008 and there was no significant

Figure 7

SERIES OF PHOTOGRAPHS OF THE ROLLER MILL DAM IMPOUNDMENT: JUNE-NOVEMBER 2009

JUNE 15, 2009

OCTOBER 10, 2009

NOTE: Photographs taken from Mill Road looking east.

Source: Wisconsin Department of Natural Resources.

Figure 8

CHANNEL HEAD CUTTING AND STREAMBED AND STREAMBANK EROSION WITHIN THE ROLLER MILL DAM IMPOUNDMENT: OCTOBER 10, 2008

NOTE: Photograph taken at east end of impoundment looking west.

NOTE: Photograph taken at west end of impoundment looking east.

Source: SEWRPC.

Figure 9

STATUS OF THE DAM BOARDS IN THE SPILLWAY OF THE ROLLER MILL DAM: 2008

JUNE 8, 2008

JUNE 18, 2008

Figure 9 (continued)

JULY 10, 2008

JULY 16, 2008

Figure 9 (continued)

AUGUST 5, 2008

AUGUST 20, 2008

Figure 9 (continued)

AUGUST 25, 2008

NOTE: Photographs taken at west end of impoundment looking east.

Source: Wisconsin Department of Natural Resources.

interaction between years and transect, as shown in Table 17.[18] The total depth increases from upstream to downstream among transects with the deepest areas being closest to Upper Nemahbin Lake, which is why the ANCOVA analysis indicates that there is a significant relationship between total depth and transect number, which is an indicator of position along the stream. This also is consistent with the characteristics of a regulated stream,[19] such as that in the portions of the Middle Bark River influenced by the backwater of the CTH P weir.

In the Mill Race the ANCOVA results indicate that there was a significant decrease in total depth among transects and between years 2007 and 2008, as well as a significant interaction between transects and years, as shown in Table 18, which means that both year and transect can account for the change in total depth. This decrease is the result of sediment deposition arising from the partial failure of a portion of the channel wall downstream of the penstock, as noted in the findings of fact set forth in the WDNR order for dam drawdown appended hereto as

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[18]*The lack of significant interaction between years and transect implies that the total depth distribution was similar in 2007 and 2008. This means that the data can be compared directly between the two years.*

[19]*See T.D. Fontaine III and S.M. Bartell (editors),* Dynamics of Lotic Ecosystems. *Ann Arbor Science, Ann Arbor. 1983. ISBN 0-250-40612-8; see also James V. Ward and Jack A. Stanford (editors).* Ecology of Regulated Streams. *Plenum Press, New York. 1979. ISBN 030640317X; and, H.B.N. Hynes,* The Ecology of Running Waters. *University of Toronto Press, Toronto. 1972. ISBN 1930665334.*

Figure 10

STATUS OF THE DAM BOARDS IN THE SPILLWAY OF THE ROLLER MILL DAM: 2008

OCTOBER 10, 2008

NOTE: Photograph taken at west end of impoundment looking east.

Source: SEWRPC.

Appendix A. This latter action combined with removal of the stop logs from the main spillway effectively stopped flow within the Mill Race, although seepage from the mainstem of the Middle Bark River in the vicinity of the Mill Road Bridge did result in limited continued flow in the lower reaches of the Mill Race downstream of the bridge.

Sediment Depth

Based upon the ANCOVA results, the sediment depth was significantly different between years 2007 and 2008 and among transects, but there was no significant interaction between years and transect, as shown in Table 17 and Figure 11.[20] This difference reflects the episodic deposition of sediments eroded from behind the Roller Mill Dam within the portion of the Middle Bark River upstream of Upper Nemahbin Lake rather than the chronic sediment loading arising from the tributary area. The depth of sediment in the downstream portion of the Middle Bark River, which is subject to the backwater effect of the CTH P weir, increased by up to 2.0 feet after the drawdown of the Roller Mill Dam. It is possible that, if the dam had failed, the uncontrolled release of sediment and water from the Roller Mill impoundment could have resulted in even greater sediment deposition.

[20]*The lack of significant interaction between years and transect implies that the sediment depth distribution was similar in 2007 and 2008. This means that the data can be compared directly between the two years.*

Table 16

CHRONOLOGY OF STOP LOG REMOVAL AND REPLACEMENT AT THE ROLLER MILL DAM

Date	Action Taken	Figure
June 8, 2008	No action: all boards (stop logs) in place	9
June 11, 2008	Six boards were removed from the Roller Mill Dam spillway	- -
June 12, 2008	Unknown number of additional boards removed from the Roller Mill Dam spillway	- -
June 13, 2008	All remaining boards removed from the Roller Mill Dam spillway	- -
June 18, 2008	All boards removed from the Roller Mill Dam spillway	9
June 21, 2008	Pursuant to the WDNR Order,[a] three boards were replaced in each of the four bays: 12 boards in total were replaced	- -
July 7, 2008	Pursuant to the WDNR Order, one board was removed from one bay	- -
July 10, 2008	Pursuant to the WDNR Order, one further board was removed from one bay; 10 boards remain	9
July 14, 2008	Pursuant to the WDNR Order, one further board was removed from one bay	- -
July 16, 2008	Three boards appear to have been removed; nine boards remain	9
July 18, 2008	Pursuant to the WDNR Order, one further board was removed from one bay	- -
July 22, 2008	Pursuant to the WDNR Order, one further board was removed from one bay	- -
July 26, 2008	Pursuant to the WDNR Order, one further board was removed from one bay	- -
July 30, 2008	Pursuant to the WDNR Order, one further board was removed from one bay	- -
August 3, 2008	Pursuant to the WDNR Order, one further board was removed from one bay	- -
August 5, 2008	Eight boards appear to have been removed; four boards remain	9
August 7, 2008	Pursuant to the WDNR Order, one further board was removed from one bay	- -
August 22, 2008	Nine boards appear to have been removed; three boards remain	9
August 25, 2008	Ten boards appear to have been removed; two boards remain	9
September 1, 2008	Pursuant to the WDNR Order, all boards should have been removed from the Roller Mill Dam spillway	- -
October 10, 2008	All boards have been removed	10

[a]*Dates of placement and removal of boards (stop logs) pursuant to the WDNR Order are approximate, based upon the timeline established in the Order. In some instances, the WDNR staff adjusted the schedule set forth in the Order to accommodate requests from the dam owner. See Appendix A, "Wisconsin Department of Natural Resources Order to Drawdown Roller Mill Dam: June 2008."*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Based upon the 2007 survey, in the reach of the Middle Bark River between the Roller Mill Dam and Upper Nemahbin Lake the substrate could be characterized as a mixture of sand and gravel substrates. During the 2008 survey, the substrates observed along the transects were dominated by unconsolidated sediments, with an organic silty character that matches the organic silty sediments from the Roller Mill Dam impoundment. Such sediments are readily eroded and transported in flowing water systems even or especially at low velocities.[21] The accumulation of such sediments in the Middle Bark River downstream of Roller Mill Dam, shown in Figure 12, occurred concurrently with observed erosion from within the Dam impoundment which began in June 2008 with the removal of the stoplogs from the Roller Mill Dam spillway. In contrast, the first three transects immediately

[21]*See William C. Krumbein and L.L. Sloss,* Stratigraphy and Sedimentation, *W.H. Freeman Company, 1995. ISBN: 9780716702191.*

Table 17

MIDDLE BARK RIVER ANCOVA ANALYSES

TOTAL DEPTH (water and sediment)

Variable	Sum-of Square	Degrees of Freedom	Mean Square	F Statistic	Significance P-value
Year	0.448	1	0.448	1.465	0.229
Transect Number	65.453	12	5.454	17.823	**<0.001**
Year X Transect Number	3.396	12	0.283	0.925	0.525
Error	33.051	108	0.306		

NOTE: ANCOVA of total depth (water and sediment) values with respect to year (2007 versus 2008) with Transect number (142, 244, 322, 457, 621, 723, 876, 1007, 1117, 1244, 1369, 1473, and 1573) as a covariate. This analysis was based upon 134 sample points and yielded an R^2 of 0.68 and significant P-values less than 0.05 are shown in bold.

SEDIMENT DEPTH VALUES

Variable	Sum-of Square	Degrees of Freedom	Mean Square	F Statistic	Significance P-value
Year	9.754	1	9.754	22.104	**<0.001**
Transect Number	29.057	12	2.421	5.487	**<0.001**
Year X Transect Number	4.958	12	0.413	0.936	0.514
Error	47.657	108	0.441		

NOTE: ANCOVA of sediment depth values with respect to year (2007 versus 2008) with Transect number (142, 244, 322, 457, 621, 723, 876, 1007, 1117, 1244, 1369, 1473, and 1573) as a covariate. This analysis was based upon 134 sample points and yielded an R^2 of 0.48 and significant P-values less than 0.05 are shown in bold.

WATER DEPTH VALUES

Variable	Sum-of Square	Degrees of Freedom	Mean Square	F Statistic	Significance P-value
Year	14.386	1	14.386	41.213	**<0.001**
Transect Number	12.350	12	1.029	2.948	**0.001**
Year X Transect Number	2.679	12	0.223	0.640	0.804
Error	37.700	108	0.349		

NOTE: ANCOVA of water depth values with respect to year (2007 versus 2008) with Transect number (142, 244, 322, 457, 621, 723, 876, 1007, 1117, 1244, 1369, 1473, and 1573) as a covariate. This analysis was based upon 134 sample points and yielded an R^2 of 0.43 and significant P-values less than 0.05 are shown in bold.

Source: SEWRPC.

downstream of Roller Mill Dam (i.e., Transects 142, 244, 322) did not show evidence of deposition in 2007 or 2008, due to higher bed slopes and greater water velocities. This section of the Middle Bark River is characterized by large cobble and boulder substrates as shown in Figure 13. These substrates are associated with fast flowing water.

Table 18

MILL RACE ANCOVA ANALYSES

TOTAL DEPTH (water and sediment)

Variable	Sum-of Square	Degrees of Freedom	Mean Square	F Statistic	Significance P-value
Year	0.761	1	0.761	40.866	**<0.001**
Transect Number	6.826	4	1.706	91.690	**<0.001**
Year X Transect Number	0.332	4	0.083	4.466	**0.004**
Error	0.744	40	0.019		

NOTE: ANCOVA of total depth (water and sediment) values with respect to year (2007 versus 2008) with Transect number (111, 143, 267, 431, and 494) as a covariate. This analysis was based upon 50 sample points and yielded an R^2 of 0.91 and significant P-values less than 0.05 are shown in bold.

SEDIMENT DEPTH VALUES

Variable	Sum-of Square	Degrees of Freedom	Mean Square	F Statistic	Significance P-value
Year	1.805	1	1.805	74.690	**<0.001**
Transect Number	0.392	4	0.098	4.057	**0.007**
Year X Transect Number	0.392	4	0.098	4.057	**0.007**
Error	0.967	40	0.024		

NOTE: ANCOVA of sediment depth values with respect to year (2007 versus 2008) with Transect number (111, 143, 267, 431, and 494) as a covariate. This analysis was based upon 50 sample points and yielded an R^2 of 0.73 and significant P-values less than 0.05 are shown in bold.

WATER DEPTH VALUES

Variable	Sum-of Square	Degrees of Freedom	Mean Square	F Statistic	Significance P-value
Year	4.351	1	4.351	481.985	**<0.001**
Transect Number	4.050	4	1.012	112.154	**<0.001**
Year X Transect Number	0.574	4	0.144	15.908	**<0.001**
Error	0.361	40	0.009		

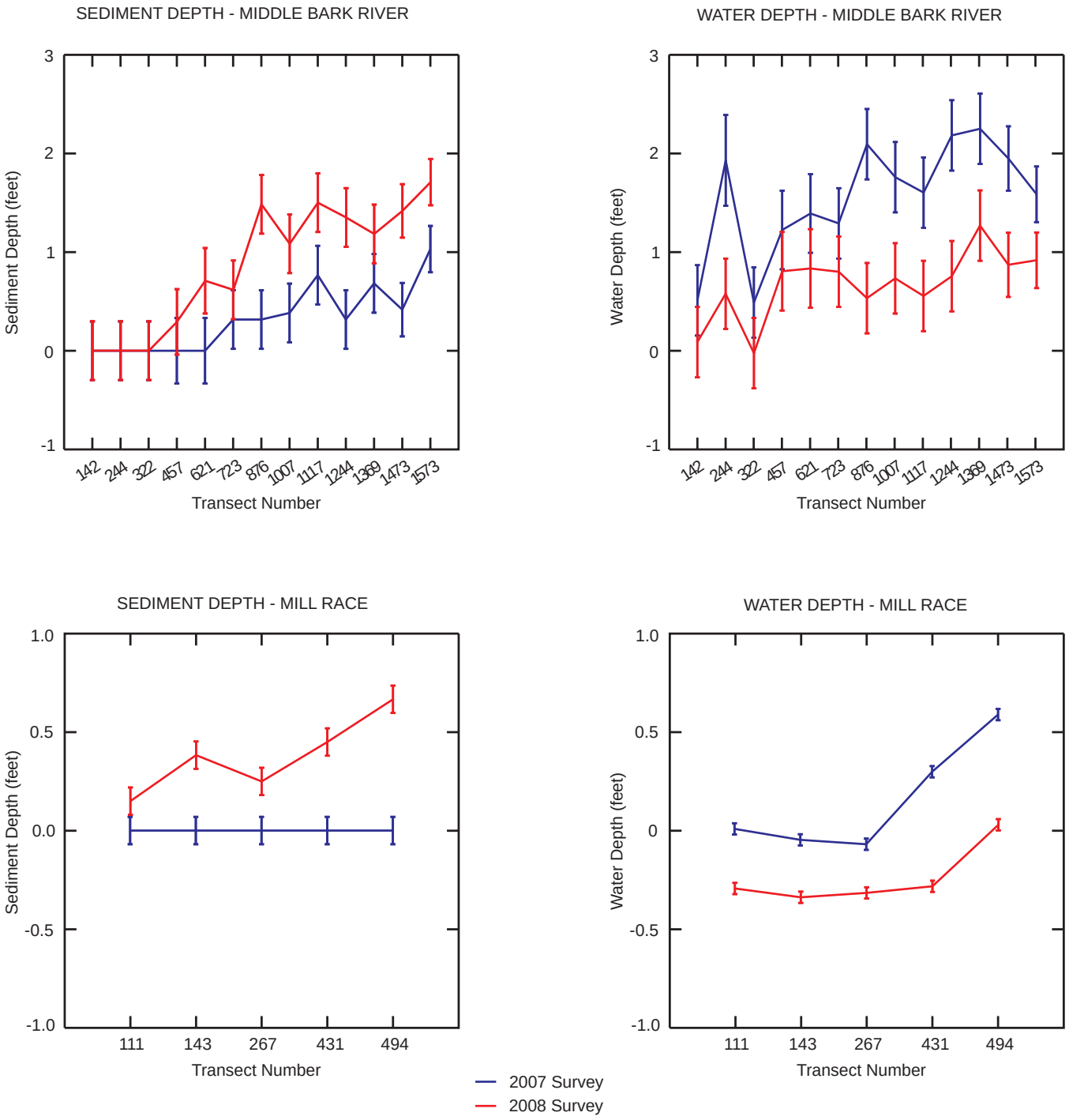
NOTE: ANCOVA of water depth values with respect to year (2007 versus 2008) with Transect number (111, 143, 267, 431, and 494) as a covariate. This analysis was based upon 50 sample points and yielded an R^2 of 0.96 and significant P-values less than 0.05 are shown in bold.

Source: SEWRPC.

In the Mill Race, the ANCOVA results of sediment depth indicated that there was a significant increase among transects and between years 2007 and 2008, as well as a significant interaction between transects and years, as shown in Table 18 and Figure 11, which means that both year and transect can account for the change in sediment depth. This increase is consistent with the partial failure of the Mill Race channel wall, which introduced berm materials into the channel, and with the transport of unconsolidated sediments from the Roller Mill Dam impoundment into the channel following removal of the stop logs as noted above. Prior to 2008, the sediments

Figure 11

SEDIMENT AND WATER DEPTHS BETWEEN YEARS: 2007-2008



NOTES: Each figure was generated from a separate ANCOVA test and represents the least square mean and standard deviation for either sediment depth or water depth values among Transect and Year of survey.

Transect numbers are measurements of the distance downstream of the Roller Mill Dam.

Source: SEWRPC.

Figure 12

SEDIMENT DEPOSITION IN THE MILL RACE BELOW THE ROLLER MILL DAM: OCTOBER 10, 2008

NEAR TRANSECT 431 LOOKING DOWNSTREAM

SEDIMENT DEPOSITION AT THE CONFLUENCE OF THE
MILL RACE WITH THE BARK RIVER LOOKING UPSTREAM

Source: SEWRPC.

Figure 13

TYPICAL FAST WATER REACH UPSTREAM OF TRANSECT 457: OCTOBER 10, 2008

Source: SEWRPC.

within the Mill Race were characterized as a mixture of sand and gravels for its entire length. In 2008, the transects contained from 0.25 to 0.75 foot of unconsolidated sediment with the deepest deposition in the downstream transects, as shown in Figure 11.

Water Depth

Based upon the ANCOVA results, the water depth was significantly different between years 2007 versus 2008 and among transects, but there was no significant interaction between years and transect, as shown in Table 17 and Figure 11.[22] This difference reflects a loss of water depth in the backwater portion of the Middle Bark River of up to 2.0 feet and is consistent with sediment deposition in this reach. A loss of depth in a former deep pool that provided habitat was noted immediately downstream of the Mill Road bridge at Transect 244, which most likely was a result of the redistribution of cobble and boulder substrates that occurred during the high flow events of June 2008.

In the Mill Race the ANCOVA results of water depth indicated that there was a significant decrease among transects and between years 2007 and 2008, as well as a significant interaction between transects and years, as shown in Table 18 and Figure 11, which means that both year and transect can account for the change in water depth. This reduction in water depth was the result of the reduction in flow through the mill race as the result of the emergency drawdown order. As noted above, in the lower reaches of the Mill Race, some flow was observed as the result of seepage from the mainstem of the Middle Bark River in the vicinity of the Mill Road Bridge.

[22]*The lack of significant interaction between years and transect implies that the water depth distribution was similar in 2007 and 2008. This means that the data can be compared directly between the two years.*

Volume of Sediment Deposition
Based upon the foregoing estimates of sediment deposition, the Commission staff calculated that there was an additional volume of 1,928 cubic yards of unconsolidated sediment present in the reach between Transects 621 to 1573 during 2008 compared to 2007, as shown in Table 19 and Figure 11. In contrast, there was a corresponding loss in water volume of 2,064 cubic yards in the same reaches and during the same period, as shown in Table 20 and Figure 11. These measured volumes in the downstream reach of the Middle Bark River, between the Roller Mill Dam and Upper Nemahbin Lake are consistent with the estimated loss of unconsolidated sediments from the basin of the former Applebecker Millpond, set forth in footnote 14, above, and are strongly suggestive of these sediments being the primary source of the deposited material. This volume of deposited unconsolidated sediment in the portion of the Bark River downstream of Roller Mill Dam and upstream of Upper Nemahbin Lake represents a significant potential loss in mussel and fishery habitat, as discussed in Chapter IV.

In addition, the Mill Race contained an increased volume of 71 cubic yards of unconsolidated sediment in the reach between Transects 111 to 494 during 2008 compared to 2007, as well as a loss of 111 cubic yards of water volume, as shown in Tables 19 and 20, and in Figure 11.

BIOLOGICAL CONDITIONS IN THE MIDDLE BARK RIVER

The SEWRPC staff established a total of 68 transects along the Middle Bark River between Nagawicka Lake Dam and Upper Nemahbin Lake, which were sampled in July and August 2007, with a subset of these transects being resampled during October 2008 following a regional flood event.[23] Transect locations were documented by geographic positioning system (GPS) location and Waukesha County 2007 digital, color orthophotography. At each transect, data on the biological conditions observed in the stream were collected pursuant to the same methodology, adapted from the WDNR stream sampling protocols, utilized during the inventory of the physical conditions in the stream. Photographs were taken to further document the biological conditions of the stream. SEWRPC staff conducted a further reconnaissance of the vegetation in the basin of the former Applebecker Millpond following the implementation of the WDNR draw down order.

Fishes of the Middle Bark River
Based upon the 2007 fish data, set forth in Table 21, there were a total of 26 native fish species observed within the reach of the Middle Bark River downstream of the Roller Mill Dam. This stream reach contained 14 and 12 more total native fish species, respectively, in 2007 than were reported from Upper and Lower Nemahbin Lakes during the 2004 WDNR littoral zone seining surveys, also shown in Table 21. Further comparison of these data sets indicates that there were 15 unique fish species in this affected stream reach compared to the littoral zone fish community in Upper Nemahbin Lake and 18 unique fish species compared to the littoral zone fish community in Lower Nemahbin Lake. Consequently, this stream reach was the most diverse section of the entire Upper Nemahbin and Lower Nemahbin Lakes system based upon the number fish species observed (i.e., fish species richness).

The fish species reported during 2007 included one endangered fish (slender madtom, shown in Figure 14) and two special concern fishes (least darter and weed shiner). It is important to note that, while slender madtom have been known to occur in the Bark River system,[24] this is the first record of a slender madtom being found within the portion of the Bark River that encompasses Upper Nemahbin and Lower Nemahbin Lakes. The Bark River is only one of four watersheds within the State of Wisconsin, which include the Oconomowoc River, Rock River, and Pecatonica River watersheds, where slender madtom have been observed since 1986.

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[23]*See U.S. Geological Survey News Release, "USGS Crews Dispatched to Measure Historic Wisconsin Floods," June 10, 2008.*

[24]*D. Fago, WDNR Technical Bulletin No. 175,* Distribution and Relative Abundance of Fishes in Wisconsin, VIII Summary Report, *Madison, Wisconsin, 1992.*

Table 19

CALCULATED TOTAL SEDIMENT VOLUME WITHIN THE MIDDLE BARK RIVER AND MILL RACE DOWNSTREAM OF THE ROLLER MILL DAM: 2007 AND 2008

Year	Waterbody	Transect	Water Width (feet)	Mean Sediment Depth (feet)	Mean Sediment Depth Between Transects (feet)[a]	Mean Water Width Between Transects (feet)[a]	Total Length Between Transects (feet)	Calculated Sediment Volume (width X depth X length) (cubic feet)	Calculated Sediment Volume (cubic yards)
2007	Middle Bark River	142	24.7	0.00					
					0.00	23.9	102	0	0
		244	23.1	0.00					
					0.00	25.0	78	0	0
		322	26.8	0.00					
					0.00	32.4	135	0	0
		457	37.9	0.00					
					0.00	41.6	164	0	0
		621	45.3	0.00					
					0.16	54.4	102	888	33
		723	63.5	0.32					
					0.32	72.6	153	3,554	132
		876	81.6	0.32					
					0.35	76.0	131	3,485	129
		1,007	70.4	0.38					
					0.58	62.4	110	3,981	147
		1,117	54.4	0.77					
					0.55	59.3	127	4,142	153
		1,244	64.1	0.32					
					0.50	61.2	125	3,825	142
		1,369	58.3	0.68					
					0.55	55.6	104	3,180	118
		1,473	52.9	0.42					
					0.73	72.2	100	5,271	195
		1,573	91.5	1.03					
		- -	- -	- -	- -	- -	**Subtotal**	**28,326**	**1,049**
	Mill Race	111	9.0	0.00					
					0.00	11.2	32	0	0
		143	13.3	0.00					
					0.00	13.3	124	0	0
		267	13.3	0.00					
					0.00	12.8	164	0	0
		431	12.3	0.00					
					0.00	13.3	63	0	0
		494	14.3	0.00					
					0.00	19.5	10	0	0
		- -	- -	- -	- -	- -	**Subtotal**	**0**	**0**
		- -	- -	- -	- -	- -	**Total**	**28,326**	**1,049**
2008	Middle Bark River	142	24.7	0.00					
					0.00	23.9	102	0	0
		244	23.1	0.00					
					0.00	25.0	78	0	0
		322	26.8	0.00					
					0.15	32.4	135	656	24
		457	37.9	0.29					
					0.50	41.6	164	3,411	126
		621	45.3	0.71					
					0.67	54.4	102	3,718	138
		723	63.5	0.62					
					1.05	72.6	153	11,663	432
		876	81.6	1.48					
					1.28	76.0	131	12,744	472
		1,007	70.4	1.08					
					1.29	62.4	110	8,855	328
		1,117	54.4	1.50					
					1.43	59.3	127	10,769	399
		1,244	64.1	1.35					
					1.27	61.2	125	9,716	360
		1,369	58.3	1.18					
					1.30	55.6	104	7,517	278
		1,473	52.9	1.42					
					1.57	72.2	100	11,335	420
		1,573	91.5	1.71					
		- -	- -	- -	- -	- -	**Subtotal**	**80,384**	**2,977**

Table 19 (continued)

Year	Waterbody	Transect	Water Width (feet)	Mean Sediment Depth (feet)	Mean Sediment Depth Between Transects (feet)[a]	Mean Water Width Between Transects (feet)[a]	Total Length Between Transects (feet)	Calculated Sediment Volume (width X depth X length) (cubic feet)	Calculated Sediment Volume (cubic yards)
2008	Mill Race	111	9.0	0.15					
					0.27	11.2	32	97	4
		143	13.3	0.38					
					0.32	13.3	124	528	20
		267	13.3	0.25					
					0.35	12.8	164	735	27
		431	12.3	0.45					
					0.56	13.3	63	469	17
		494	14.3	0.67					
					0.67	14.3	10	96	4
		- -	- -	- -	- -	- -	**Subtotal**	**1,924**	**71**
		- -	- -	- -	- -	- -	**Total**	**82,308**	**3,048**
							Middle Bark River Total Load (2008 - 2007)	**52,058**	**1,928**
							Mill Race Total Load (2008 - 2007)	**1,924**	**71**
							Total Volume	**53,982**	**1,999**

[a]*This was calculated by computing the mean sediment depth and water width of corresponding transects.*

Source: SEWRPC.

It has been well established that dams can significantly affect fish species richness and community structure,[25] which is probably why the reach downstream of Roller Mill Dam is much more diverse than the reach upstream of the Dam. The stream reach downstream of Roller Mill Dam has an unobstructed connection to both Upper and Lower Nemahbin Lakes, which is why the reach contained a mixture of both riverine specialist species (i.e., fishes generally found in lotic environments) and generalist species (i.e., fishes commonly found in both lentic and lotic environments). This connection with the lakes, combined with the high quality and diversity of habitats within the reach, were the most likely factors contributing to high number of fish species observed in 2007 within this reach downstream of the Roller Mill Dam, which is a designated fish refuge pursuant to Section 23.09 (2)(c) of the *Wisconsin Statutes* and Section NR 26.08 (68)(a)1 of the *Wisconsin Administrative Code*.

Many of the 26 species of fishes observed downstream of the Roller Mill Dam in 2007 were not found during a 2008 WDNR fisheries survey. As shown in Table 21, only 10 fish species were reported by WDNR staff during the 2008 survey. While some of these differences may be explained by differences in sampling gear and level of effort, the deposition of unconsolidated sediments that occurred during 2008, as documented above, is likely to have had a significant negative impact on the quality and availability of suitable habitat for fishes. Some of the fish species may have been able to migrate downstream, and would be available to recolonize the stream reach between the Roller Mill Dam and Upper Nemahbin Lake. However, in the near term, the fishes in the downstream area may be more susceptible to increased risk of predation and competition for available food, as well as being forced into marginal habitats. This would especially impact the riverine specialist fish species, such as the slender madtom, hornyhead chub, sand shiner, stonerollers, and darter species that are less well equipped to survive in a lake environment. The slender madtom is probably one of the most vulnerable fish species. This species is generally found in streams greater than about 30 feet in width, with clear water having moderate to swift water velocities sufficient to keep the bottom substrates free of silt and water depths of 0.4 to 12 inches over substrates of gravel and boulders interspersed with sand.[26] Further, research has shown that temporary decreases in fish

[25]*Thomas M. Slawski, Francis M. Veraldi, Stephen M. Pescitelli, and Michael J. Pauers, "Effects of Tributary Spatial Position, Urbanization, and Multiple Low-Head Dams on Warmwater Fish Community Structure in a Midwestern Stream,"* North American Journal of Fisheries Management, *Volume 28:1020–1035, 2008.*

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

Table 20

CALCULATED TOTAL WATER VOLUME WITHIN THE MIDDLE BARK RIVER AND MILL RACE DOWNSTREAM OF THE ROLLER MILL DAM: 2007 AND 2008

Year	Waterbody	Transect	Water Width (feet)	Mean Water Depth (feet)	Mean Water Width Between Transects (feet)[a]	Mean Water Depth Between Transects (feet)[a]	Total Length Between Transects (feet)	Calculated Sediment Volume (width X depth X length) (cubic feet)	Calculated Water Volume (cubic yards)
2007	Middle Bark River	142	24.7	1.13					
					23.9	1.70	102	4,144	153.0
		244	23.1	2.20					
					25.0	1.70	78	3,315	123.0
		322	26.8	1.12					
					32.4	1.40	135	6,124	227.0
		457	37.9	1.67					
					41.6	1.70	164	11,598	430.0
		621	45.3	1.79					
					54.4	1.80	102	9,988	370.0
		723	63.5	1.72					
					72.6	2.00	153	22,216	823.0
		876	81.6	2.32					
					76.0	2.20	131	21,903	811.0
		1,007	70.4	2.07					
					62.4	2.00	110	13,728	508.0
		1,117	54.4	1.95					
					59.3	2.20	127	16,568	614.0
		1,244	64.1	2.38					
					61.2	2.40	125	18,360	680.0
		1,369	58.3	2.43					
					55.6	2.30	104	13,300	493.0
		1,473	52.9	2.21					
					72.2	2.10	100	15,162	562.0
		1,573	91.5	1.94					
		- -	- -	- -	- -	- -	**Subtotal**	**156,406**	**5,794.0**
	Mill Race	111	9.0	0.52					
					11.2	0.50	32	179	7.0
		143	13.3	0.43					
					13.3	0.40	124	660	24.0
		267	13.3	0.40					
					12.8	0.70	164	1,469	54.0
		431	12.3	0.95					
					13.3	1.20	63	1,005	37.0
		494	14.3	1.38					
					19.5	1.10	10	215	8.0
		- -	- -	- -	- -	- -	**Subtotal**	**3,528**	**131.0**
		- -	- -	- -	- -	- -	**Total**	**159,934**	**5,924.0**
2008	Middle Bark River	142	24.7	0.82					
					23.9	1.00	102	2,438	90.0
		244	23.1	1.18					
					25.0	1.00	78	1,862	69.0
		322	26.8	0.73					
					32.4	1.00	135	4,549	168.0
		457	37.9	1.35					
					41.6	1.40	164	9,551	354.0
		621	45.3	1.38					
					54.4	1.40	102	7,768	288.0
		723	63.5	1.35					
					72.6	1.30	153	14,440	535.0
		876	81.6	1.15					
					76.0	1.20	131	11,947	442.0
		1,007	70.4	1.30					
					62.4	1.20	110	8,237	305.0
		1,117	54.4	1.17					
					59.3	1.20	127	9,037	335.0
		1,244	64.1	1.32					
					61.2	1.50	125	11,475	425.0
		1,369	58.3	1.70					
					55.6	1.60	104	9,252	343.0
		1,473	52.9	1.40					
					72.2	1.40	100	10,108	374.0
		1,573	91.5	1.44					
		- -	- -	- -	- -	- -	**Subtotal**	**100,665**	**3,728.0**

Table 20 (continued)

Year	Waterbody	Transect	Water Width (feet)	Mean Water Depth (feet)	Mean Water Width Between Transects (feet)[a]	Mean Water Depth Between Transects (feet)[a]	Total Length Between Transects (feet)	Calculated Sediment Volume (width X depth X length) (cubic feet)	Calculated Water Volume (cubic yards)
2008	Mill Race	111	9.0	0.07					
					11.2	0.04	32	14	0.5
		143	13.3	0.00					
					13.3	0.02	124	33	1.0
		267	13.3	0.03					
					12.8	0.06	164	126	5.0
		431	12.3	0.08					
					13.3	0.32	63	268	10.0
		494	14.3	0.55					
					14.3	0.55	10	79	3.0
		- -	- -	- -	- -	- -	**Subtotal**	**520**	**19.0**
		- -	- -	- -	- -	- -	**Total**	**101,185**	**3,747.0**
							Middle Bark River Total Volume (2008 - 2007)	**-55,741**	**-2,065.0**
							Mill Race Total Volume (2008 - 2007)	**-3,008**	**-112.0**
							Total Volume	**-58,749**	**-2,177.0**

[a]*This was calculated by computing the mean sediment depth and water width of corresponding transects.*

Source: SEWRPC.

species diversity in tail water reaches associated with dam removal may extend over a period of several years.[27] However, this same research also indicates that species diversity may never recover from sediment deposition in the downstream areas, particularly in low gradient reaches such as found in the downstream backwater areas.[28]

Mollusks of the Middle Bark River

During August of 2007, the SEWRPC and WDNR staff conducted a field survey of the Middle Bark River, upstream and downstream of the Roller Mill Dam site, to identify mussel populations present within this river reach. The results of this field investigation are set forth in Table 22. The survey was conducted using both quantitative survey techniques, based upon a known area of streambed as defined by a 0.25 square meter quadrat, and qualitative searches of the river reaches. Three sites—lower, middle, and upper sections—along the river reach downstream of Roller Mill Dam were sampled during this survey, as well as one site upstream of the Roller Mill Dam and downstream of Nagawicka Lake. At each site, the streambed substrates were described based upon the conditions prevailing at the time of the 2007 survey.

At the time of the 2007 survey, the SEWRPC and WDNR staff failed to find any mussels in the six quadrats sampled within the lower section of the Bark River, although a shell of a floater (*Pyganodon grandis*) was found outside of the quadrats together with numerous shell fragments. This section of the River is located adjacent to Upper Nemahbin Lake within are area of the River influenced by the backwater effect of the Lake. The substrate in this area at the time of the 2008 survey was comprised of a slightly silty sand and gravel with abundant aquatic vegetation.

Upstream of this area, but also within the area affected by the backwater effect of Upper Nemahbin Lake, in the middle section of the River downstream of Roller Mill Dam, a total of 26 quadrats were sampled, and the

[27]Matthew J. Catalano and others, "Effects of Dam Removal in Fish Assemblage Structure and Spatial Distributions in the Baraboo River, Wisconsin," *North American Journal of Fisheries Management,* Volume 27:519-530, 2007*;* Paul D. Kanehl, "Changes in the Habitat and Fish Community of the Milwaukee River, Wisconsin, Following Removal of the Woolen Mills Dam," *North American Journal of Fisheries Management,* Volume 17:387-400, 1997.

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

Table 21

FISH SPECIES AMONG SITES WITHIN AND ADJACENT TO UPPER AND LOWER NEMAHBIN LAKES: 1975-2008

Fish Species	Upstream of Roller Mill Dam		Downstream of Roller Mill Dam		Upper Nemahbin Lake				Lower Nemahbin Lake		
	2007[a]	2008[b]	2007[c]	2008[b]	1975[d]	2000[e]	2004[f]	2006[e]	1975[d]	2004[f]	2004 Additional Sites[f]
Banded Darter	- -	2	1	2	- -	- -	- -	- -	- -	- -	- -
Banded Killifish	1	- -	- -	- -	7	- -	- -	- -	16	18	8
Black Bullhead	- -	- -	- -	- -	1	1	- -	- -	- -	- -	- -
Black Crappie	- -	- -	- -	- -	1	- -	- -	- -	79	- -	- -
Blackchin Shiner	- -	- -	- -	- -	- -	- -	- -	- -	3	- -	- -
Blacknose Shiner	- -	- -	- -	- -	- -	- -	- -	- -	151	132	20
Blackstripe Topminnow	12	- -	4	- -	- -	- -	2	- -	3	2	- -
Bluegill	7	1	26	- -	10	106	82	97	61	28	75
Bluntnose Minnow	185	8	11	19	6	- -	141	- -	231	542	428
Bowfin	- -	- -	1	- -	- -	- -	- -	- -	- -	- -	- -
Brook Silverside	- -	- -	2	- -	- -	- -	- -	- -	- -	- -	1
Central Mudminnow	- -	- -	1	- -	- -	- -	- -	- -	1	- -	- -
Central Stoneroller	- -	- -	19	- -	- -	- -	- -	- -	- -	- -	- -
Common Carp	- -	- -	- -	- -	5	- -	- -	- -	- -	- -	- -
Common Shiner	177	6	48	6	- -	- -	- -	- -	- -	2	- -
Fantail Darter	- -	1	6	- -	- -	- -	1	- -	- -	- -	- -
Golden Shiner	- -	- -	1	- -	- -	- -	- -	- -	31	- -	- -
Goldfish	1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Grass Pickerel	- -	- -	1	- -	- -	- -	- -	- -	- -	- -	- -
Green Sunfish	15	- -	11	- -	18	1	1	- -	43	- -	- -
Hornyhead Chub	2	2	29	1	- -	- -	- -	- -	- -	- -	- -
Iowa Darter	- -	- -	- -	- -	32	- -	45	- -	13	1	1
Johnny Darter	28	9	4	1	- -	1	1	- -	- -	- -	- -
Lake Chubsucker	- -	- -	- -	- -	- -	- -	- -	- -	2	- -	- -
Largemouth Bass	6	- -	3	- -	- -	214	1	7	- -	14	9
Largescale Stoneroller	- -	- -	5	- -	- -	- -	- -	- -	- -	- -	- -
Least Darter[g]	- -	- -	1	- -	46	- -	- -	- -	144	- -	4
Longnose Gar	1	- -	- -	- -	- -	1	- -	3	2	- -	- -
Mimic Shiner	- -	- -	- -	- -	- -	42	- -	- -	8	178	19
Northern Pike	4	- -	- -	- -	- -	- -	- -	- -	2	- -	- -
Pugnose Shiner	- -	- -	- -	- -	- -	- -	- -	- -	21	- -	- -
Pumpkinseed	13	1	- -	- -	6	- -	- -	- -	85	1	1
Rainbow Darter	20	14	165	1	1	- -	6	- -	- -	- -	- -
Rock Bass	12	3	36	1	4	- -	10	28	42	1	1
Sand Shiner	- -	- -	4	- -	- -	- -	- -	- -	- -	- -	- -
Slender Madtom[g]	- -	- -	3	1	- -	- -	- -	- -	- -	- -	- -
Smallmouth Bass	13	7	16	1	- -	115	10	20	- -	- -	- -
Spotfin Shiner	- -	- -	1	- -	- -	- -	- -	- -	- -	- -	- -
Weed Shiner[g]	80	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
White Sucker	1	- -	- -	3	2	- -	- -	- -	- -	- -	- -
Yellow Bullhead	1	2	1	- -	- -	- -	- -	- -	1	- -	- -
Yellow Perch	3	1	12	- -	40	5	6	3	222	3	1
Total Native Species	19	13	26	10	13	9	12	6	21	12	12

[a] *These fishes were collected with a combination of fyke nets, seine nets, and backpack electrofishing gears.*

[b] *These fishes were collected by WDNR staff using electrofishing gear.*

[c] *These fishes were collected with a combination of seine nets, stream and backpack electrofishing gears.*

[d] *These fishes were collected with seine nets.*

[e] *These fishes were collected by WDNR staff using mini-fyke nets.*

[f] *These fishes were collected with a combination of seine nets and backpack electrofishing gears.*

[g] *This is the first record of a slender madtom, a State of Wisconsin-designated endangered fish species, to occur within this reach of the Bark River. The least darter and weed shiner are designated species of special concern in the State of Wisconsin.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 14

SLENDER MADTOM IDENTIFICATION PHOTOS ON THE MIDDLE BARK RIVER DOWNSTREAM OF THE ROLLER MILL DAM: 2007

Source: SEWRPC.

Table 22

MUSSELS IDENTIFIED FROM THE MIDDLE BARK RIVER UPSTREAM AND DOWNSTREAM OF THE ROLLER MILL DAM SITE: AUGUST 2007

Mussel Species	Bark River at Upper Nemahbin Lake (6 x 0.25 m^2 quadrats)	Bark River between Upper Nemahbin Lake and Roller Mill Dam (26 x 0.25 m^2 quadrats)	Bark River Downstream of Roller Mill Dam (12 x 0.25 m^2 quadrats)	Bark River Downstream of Nagawicka Lake (65 x 0.25 m^2 quadrats)Lake
Anodontoides ferrucianus (cylinder)	- -	1	- -	1
Carunculina parva (lilliput)	- -	1	- -	
Elliptio dilatata (spike)	- -	- -	- -	14
Fusconaia flava (Wabash pigtoe)	- -	- -	- -	2
Lampsilis cardium (pocketbook)	- -	8 (6 male, 5 female)	- -	1 (female)
Lampsilis siliquoidea (fat mucket)	- -	11 (3 male, 5 female)	1 (juvenile)	5 (3 male, 2 female)
Lasmigona complanata (white heelsplitter)	- -	- -	- -	1
Lasmigona compressa (creek heelsplitter)	- -	- -	- -	1
Pleurobema sintoxia (round pigtoe)	- -	- -	- -	2
Pyganodon grandis (floater)	Observed	2	- -	6
Strophitus undulates (creeper)	- -	2	- -	12
Venustaconcha ellipsiformis (ellipse)[a]	- -	1	- -	11

[a]*State-listed threatened species.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

SEWRPC and WDNR staff found a total of 29 mussels representing eight species, as noted in Table 22. Two specimens of the State-listed, threatened ellipse (*Venustaconcha ellipsiformis*) were identified. The fat mucket (*Lampsilis siliquoidea*) and the pocketbook (*Lampsilis cardium*) were noted as being common in this reach. At the time of the 2008 survey, the substrate within this reach was characterized as slightly silty, sandy gravel, and some aquatic vegetation was noted. There was noticeable flow in this section of the Bark River at the time of the survey.

Further upstream, and immediately downstream of the Roller Mill Dam, in a fast flowing portion of the Middle Bark River, only one mussel, a fat mucket, was reported from 12 quadrats sampled. The substrate in this portion of the River was described as a slightly sandy and gravelly cobble, and lacked aquatic vegetation.

As noted above, the substrate conditions in the lower and middle sections of the Middle Bark River influenced by the backwater effect of Upper Nemahbin Lake, downstream of the Roller Mill Dam, were significantly modified during 2008 by the deposition of unconsolidated sediments. Up to 2.0 feet of unconsolidated sediments have been deposited within these portions of the Middle Bark River, potentially inundating the mussel population in this area. Although a further quantitative survey of the mollusk population of the Middle Bark River was not

conducted during 2008, following the aforereferenced depositional event, SEWRPC staff did not observe any mussels within the depositional area during the October 2008 sediment survey.[29]

In the section of the Middle Bark River downstream of Nagawicka Lake, in the vicinity of the former WDNR fish hatchery and current City of Delafield Chentis/Krueger Senior Center, the SEWRPC and WDNR staff found a total of 56 mussels, representing 11 species, in a total of 65 quadrats, as set forth in Table 22. Eleven specimens of the State-listed, threatened ellipse (*Venustaconcha ellipsiformis*) were identified. This mussel was described as common within this section, as was the creeper (*Strophitus undulates*). The spike (*Elliptio dilatata*) was noted as being abundant in this reach. There was moderate flow in this section of the Middle Bark River, and the substrate was characterized as gravelly, grading from a slightly sandy gravelly cobble in the upper portions of the reach to a gravelly sand in the lower portions of the reach.

Vegetation Surveys of the Roller Mill Dam Basin

The SEWRPC staff conducted three vegetation surveys in the vicinity of the Roller Mill Dam. Two of these surveys were conducted prior to the drawdown of the impoundment in 2009, and one survey was conducted within the former lake basin following the 2009 drawdown. Unfortunately, the pre-drawdown surveys did not include a survey of the vegetation within and adjacent to the central portion of the then-Applebecker Millpond, which was surveyed during the 2009 post-drawdown plant survey. Consequently, it is not possible to directly compare or contrast the survey results, although it appears that the percentage of nonnative species within the communities increases from east to west across the basin of the Applebecker Millpond site, possibly reflecting the increasing degree of human activity between Cushing Memorial Park and Mill Road.

The first of the vegetation surveys in the vicinity of the then headwaters of the Applebecker Millpond was conducted during mid-September 2001, at the location of the Cushing Memorial Park bridge site.[30] This survey resulted in the identification of 48 species of terrestrial and wetland plants, characteristic of a floodplain wetland complex, and either a second-growth, southern wet to wet-mesic lowland hardwood wetland and shallow marsh or shallow marsh and shrub-carr, as set forth in Table 23. No Federal- or State-designated endangered, threatened, or special concern species were reported. The broad-leaf cat-tail (*Typha latifolia*) and nonnative purple loosestrife (*Lythrum salicaria*) were reported to be co-dominant in this portion of the now-former Applebecker Millpond basin. Of the 48 species reported, only seven were identified as nonnative species.

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[29]*Freshwater mussels have a unique life cycle. Mussels can live for between 10 years and 100 years, and most need a fish to complete their life cycle. Some mussels require a specific host fish to complete their reproductive cycle, while others can use a variety of fish species as a host for their larvae (glochidia). The duration of this parasitic phase varies, but typically ranges from two weeks to a few months, after which the metamorphosed juvenile mussels fall to the substrate and begin their benthic life. In this regard, the apparent loss of fish species from the Middle Bark River, noted herein, may negatively affect mussel reproductive success. Further, the limited mobility of mussels can make them very susceptible to increases in sediment deposition. While there are a few exceptions, like the floater (*Pyganodon grandis*), most freshwater mussels do not tolerate areas with high silt concentrations. Mussel beds located in slow flowing waters where unconsolidated sediments settle out often can be covered deep enough to suffocate the population: as little as one-quarter of an inch of sediment covering the substrate has been reported to cause death in about 90 percent of the mussel species examined. See National Native Mussel Conservation Committee, "National Strategy for the Conservation of Native Freshwater Mussels,"* Journal of Shellfish Research, *Volume 17, Number 5, 1999.*

[30]*See SEWRPC File No. SVY2487, "Preliminary Vegetation Survey: Cushing Park Road Bridge Replacement at the Bark River Wetlands," September 2001.*

Table 23

AQUATIC, WETLAND, AND TERRESTRIAL PLANT SPECIES PRESENT IN ROLLER MILL DAM BASIN PRIOR TO, AND FOLLOWING, DRAWDOWN: SEPTEMBER 2001-JUNE 2009

Plant Species	Plant Species Present[a] (September 2001)	Plant Species Present (June 2003)	Plant Species Present (June 2009)
Characeae			
Chara sp. (muskgrass)	- -	- -	X
Equisetaceae			
Equisetum arvense (common horsetail)	X	- -	- -
Pinaceae			
Larix laricina (tamarack)	- -	X	- -
Typhaceae			
Typha latifolia (broad-leaved cat-tail)	X	X	X
Typha angustifolia (narrow-leaved cat-tail)	X	X	- -
Najadaceae			
Potamogeton sp. (pondweed)	- -	- -	X
Alismataceae			
Alisma plantago-aquatica (water plantain)			X
Sparganiaceae			
Sparganium eurycarpum (common burred)	- -	X	- -
Gramineae			
Glyceria maxima (tall manna grass)[d]	- -	- -	X
Poa palustris (marsh bluegrass)	- -	- -	X
Triticum aestivum (annual wheat grass)[d]	- -	- -	X
Phragmites communis (tall reed grass)	X	- -	- -
Calamagrostos canadensis (Canada blue-joint)	X	X	
Muhlenbergia mexicana (leafy satin grass)	X	- -	- -
Phalaris arundinacea (reed canary grass)[d]	X	- -	X
Leersia oryzoides (rice cut grass)	X	- -	- -
Leersia virginica (white grass)	- -	X	X
Cyperaceae			
Eleocharis erythropoda (red-root spike-rush)	- -	- -	X
Scirpus validus (soft-stemmed bulrush)	- -	- -	X
Scirpus atrovirens (green bulrush)	- -	- -	X
Scirpus fluviatillus (river bulrush)	- -	X	- -
Carex bebbii (Bebb's oval sedge)	- -	- -	X
Carex blanda (wood sedge)	- -	X	
Carex hystericina (bottlebrush sedge)	- -	- -	X
Carex stricta (tussock sedge)	X	X	- -
Carex lacustris (lake sedge)	X	X	- -
Carex sp. (sedge)	- -	- -	X
Juncaceae			
Juncus nodosus (joint rush)	- -	- -	X
Liliaceae			
Hemerocallis fulva (day-lily)[d]	- -	X	- -
Iridaceae			
Iris virginica (Virginia blueflag)	X	X	- -
Fagaceae			
Quercus macrocarpa (bur oak)	X		
Araceae			
Arisaema triphyllum (Jack-in-the-pulpit)	- -	X	- -
Symplocarpus foetidus (skunk cabbage)	X	X	- -

Table 23 (continued)

Plant Species	Plant Species Present[a] (September 2001)	Plant Species Present (June 2003)	Plant Species Present (June 2009)
Salicaceae			
Populus deltoides (cottonwood)	- -	- -	X
Salix nigra (black willow)	X	- -	X
Betulaceae			
Betula sp. (birch)	- -	- -	X
Juglandaceae			
Juglans cinerea (butternut)	- -	X	- -
Ulmaceae			
Ulmus americana (American elm)	X	X	- -
Urticaceae			
Pilea pumila (clearweed)	X	- -	- -
Urtica dioica (stinging nettle)	- -	X	X
Boehmeria cylindrical (false nettle)	- -	- -	X
Polygonaceae			
Rumex crispus (curly dock)[d]	- -	- -	X
Rumex orbiculatus (great water dock)	X	X	- -
Polygonum pensylvanicum (pinkweed)	X	- -	X
Polygonum persicaria (lady's thumb)[d]	- -	- -	X
Polygonum scandens (climbing false buckwheat)	X	- -	
Polygonum sp. (smartweed)	- -	- -	X
Chenopodiaceae			
Chenopodium album (lambs quarters)[d]	- -	- -	X
Caryophyllaceae			
Lychnis alba (white campion)[d]	- -	- -	X
Nymphaeaceae			
Nymphaea odorata (white water lily)	- -	- -	X
Runnunculaceae			
Thalictrum dasycarpum (tall meadow rue)	X	X	- -
Caltha palustris (marsh marigold)	- -	X	- -
Ranunculus sceleratus (cursed crowfoot)	- -	- -	X
Saxifragaceae			
Ribes americanum (wild black currant)	X	X	
Cruciferae			
Thlaspi arvense (penny cress)[d]	- -	- -	X
Capsella bursa-pastoris (shepherds purse)[d]	- -	- -	X
Hesperis matronalis (dames rocket)[d]	- -	X	- -
Alliaria officinalis (garlic mustard)[d]	- -	X	- -
Rosaceae			
Geum canadense (white avens)	- -	X	- -
Prunus virginiana (chokecherry)	- -	X	- -
Rubus strigosus (red raspberry)	X	- -	- -
Rosa multiflora (multiflora rose)[d]	- -	X	- -
Potentilla sp. (cinquefoil)	- -	- -	X
Fabaceae			
Melilotus officinalis (yellow sweet clover)[d]	- -	- -	X
Aceraceae			
Acer saccharinum (silver maple)	- -	- -	X
Acer negundo (boxelder)	X	X	X
Anacardiaceae			
Rhus radicans (poison ivy)	- -	X	- -

Table 23 (continued)

Plant Species	Plant Species Present[a] (September 2001)	Plant Species Present (June 2003)	Plant Species Present (June 2009)
Balsaminaceae			
Impatiens capensis (jewelweed)	- -	- -	X
Impatiens biflora (jewelweed)	X	X	- -
Rhamnaceae			
Rhamnus cathartica (common buckthorn)[d]	X	X	- -
Rhamnus frangula (glossy buckthorn)[d]	X	X	- -
Vitaceae			
Vitis riparia (river-bank grape)	X	- -	- -
Parthenocissus quinquefolia (Virginia creeper)	X	X	- -
Tiliaceae			
Tilia americana (basswood)	- -	X	- -
Violaceae			
Viola sororia (woolly blue violet)	- -	X	- -
Lythraceae			
Lythrum salicaria (purple loosestrife)[e]	X	X	X
Onagraceae			
Epilobium coloratum (willow herb)	X	- -	- -
Circaeae quadrisulcata (enchanter's nightshade)	- -	X	- -
Umbelliferae			
Sanicula sp. (black snakeroot)	- -	X	- -
Angelica atropurpurea (angelica)	- -	X	- -
Cornaceae			
Cornus stolonifera (red-osier dogwood)	X	X	- -
Cornus amomum (silky dogwood)	- -	X	- -
Primulaceae			
Lysimachia nummularia (moneywort)[d]		X	
Oleaceae			
Fraxinus pennsylvanica (green ash)	X	X	X
Hydrophyllaceae			
Hydrophyllum virginianum (Virginia waterleaf)	- -	X	- -
Boraginaceae			
Hackelia virginiana (stickseed)	- -	X	- -
Bignoniaceae			
Catalpa speciosa (catalpa)	- -	X	- -
Solanaceae			
Solanum dulcamara (deadly nightshade)[d]	X	X	- -
Caprifoliaceae			
Viburnum lentago (nannyberry)	X	X	- -
Viburnum opulus (European high bush-cranberry)[d]	- -	X	- -
Sambucus Canadensis (elderberry)	X	- -	- -
Lonicera x bella (hybrid honeysuckle)[d]	X	X	- -
Asclepiadaceae			
Asclepias incarnate (marsh milkweed)	X	- -	X
Convolvulaceae			
Convolvus arvensis (field bindweed)[d]	X	- -	- -
Cuscuta gronovii (dodder)	X	- -	- -
Labiatae			
Lycopus americanus (cutleaf bugleweed)	X	- -	X
Glechoma hederacea (creeping Charlie)[d]	- -	X	- -

Table 23 (continued)

Plant Species	Plant Species Present[a] (September 2001)	Plant Species Present (June 2003)	Plant Species Present (June 2009)
Rubiaceae			
Galium asprellum (rough bedstraw)	X	- -	- -
Galium aparine (annual bedstraw)	- -	X	- -
Scrophulariaceae			
Verbascum thapsus (mullein)[d]	- -	- -	X
Compositae			
Bidens coronate (tall swamp-marigold)	X	- -	- -
Bidens sp. (beggars-ticks)	- -	X	X
Ambrosia artemisiifolia (common ragweed)	- -	- -	X
Solidago altissima (tall goldenrod)	X	- -	- -
Solidago graminifolia (grassleaf goldenrod)	X	- -	- -
Solidago gigantea (giant goldenrod)	X	X	X
Aster novae-angliae (New England aster)	X	- -	- -
Aster simplex (marsh aster)	X	- -	- -
Aster lucidulus (swamp aster)	X	- -	X
Aster lateriflorus (calico aster)	- -	X	- -
Erigeron philadelphicus (marsh fleabane)	- -	- -	X
Erigeron strigosus (daisy fleabane)	- -	- -	X
Conyza canadensis (horseweed)	- -	- -	X
Carduus nutans (nodding thistle)[d]	- -	- -	X
Circium arvense (Canada thistle)[d]	- -	X	X
Lactuca serriola (prickly wild lettuce)[d]	- -	X	- -
Sonchus arvensis (sow thistle)[d]	- -	- -	X
Total Number of Plant Species	48	56	51
Number of Nonnative Plant Species	7	15	15
Percent of Nonnative Plant Species	15	27	29

[a]*Survey conducted in the vicinity of the Cushing Memorial Park Road bridge over the Bark River near the former headwaters of the Applebecker Millpond.*

[b]*Survey conducted in the vicinity of the Mill Road bridge over the Bark River near the outlet of the Applebecker Millpond.*

[c]*Survey conducted in the former basin of the Applebecker Millpond following drawdown of the Roller Mill Dam.*

[d]*Nonnative species.*

[e]*Purple loosestrife is an invasive, nonnative species designated pursuant to Chapters NR 40 and NR 109 of the* Wisconsin Administrative Code*.*

Source: SEWRPC.

The SEWRPC staff conducted a further pre-drawdown vegetation survey in the vicinity of the outlet of the then-Applebecker Millpond, in the vicinity of the Roller Mill Dam, during late-June 2003.[31] This survey resulted in the identification of 56 species of terrestrial and wetland plants, characteristic of a floodplain wetland complex, and either a second-growth, southern wet lowland hardwood community or second growth southern wet- to wet-mesic lowland hardwood, shrub-carr, and southern wet meadow community, as set forth in Table 23. No Federal- or State-designated endangered, threatened, or special concern species were reported. Skunk cabbage (*Symplocarpus foetidus*) and jewelweed (*Impatiens biflora*) were reported as being co-dominant in this portion of the now-former Applebecker Millpond basin. Of the 56 species reported, 15 were identified as nonnative species.

[31]*See SEWRPC File No. SVY2749, "Preliminary Vegetation Survey: Mill Road Bridge Replacement at Bark River Wetlands," June 2003.*

During the autumn of 2008, the WDNR seeded the exposed lake sediments within the former basin of the Applebecker Millpond with a mixture of annual wheat and an unspecified mixture of native seed—comprised of water plantain (*Alisma plantago-aquatica*), common fox sedge (*Carex stipata*), bristly sedge (*Carex comosa*), green bulrush (*Scirpus atrovirens*), wool grass (*Scirpus cyperinus*), and Virginia wild rye (*Elymus virginicus*)—in order to stabilize the accumulated sediment present. The SEWRPC staff subsequently conducted a further vegetation survey of the Roller Mill Dam site during late-June 2009.[32] The emerging plant community was described as a fresh (wet) meadow and shallow marsh comprised of a total of 51 aquatic, wetland, and upland fringe plants within the area of the drawn down impoundment, tabulated in Table 23. Horseweed (*Conyza canadensis*) was reported to be the dominant plant in this emerging ecosystem. No Federal- or State-designated endangered, threatened, or special concern species were reported. Of the total number of plant species reported, three species were aquatic plants; namely, the macro-alga chara (*Chara* sp.), pondweeds (*Potamogeton* sp. [sic]), and the white water lily (*Nymphaea odorata*). Additionally, green ash (*Fraxinus pennsylvanica*) and nodding thistle (*Cardus nutans*) were noted as transitional plants growing along the wetland edge. Of the remaining 46 species, 15 were noted to be nonnative plant species.

Of the species reported as having been planted by the WDNR staff during the autumn of 2008, annual wheat grass (*Triticum aestivum*), water plantain, and green bulrush were reported as present in the SEWRPC vegetation survey. The SEWRPC staff note that this plant is one of the 15 nonnative species observed in the former dam basin. As might be expected following the drawdown of an impoundment, purple loosestrife (*Lythrum salicaria*), an invasive species pursuant to Chapter NR 109 of the *Wisconsin Administrative Code,* is a species of specific concern. This shoreland plant frequently occupies newly exposed lakebed areas, and is an aggressive colonizer. The presence of this, and other nonnative plant species reported in the pre-drawdown surveys—as well as in the post-drawdown survey in many cases—is a cause for concern as many of these nonnative species have the ability to outcompete native plant species in the absence of the implementation of active management measures.

There also was an increase in the number of woody and other terrestrial plant species observed. While black willow (*Salix nigra*), box elder (*Acer negundo*), and green ash (*Fraxinus pennsylvanica*) had been reported from the vicinity of the Roller Mill Dam prior to the drawdown, several other species not previously reported were observed by the SEWRPC staff as saplings or seedlings following the drawdown, including cottonwood (*Populus deltoides*) and silver maple (*Acer saccharinum*), as shown in Table 23. The tamarack (*Larix laricina*), previously reported from the vicinity of the Roller Mill Dam structure, was not reported during the 2009 survey.

HYDROLOGICAL AND THERMAL CONDITIONS IN THE MIDDLE BARK RIVER

The SEWRPC staff placed a total of five temperature-recording data-loggers along the Middle Bark River between Nagawicka Lake Dam and Upper Nemahbin Lake during 2007. These devices recorded water temperatures at hourly intervals throughout the period between June 28, 2007 and December 28, 2009. This period included the flood event of 2008,[33] as well as the periods during which the Applebecker Millpond was at its full supply level in 2007 and in a drawn down state in 2009.

Hydrological Observations on the Middle Bark River

As part of the work effort associated with the studies of phosphorus loading to the upstream Nagawicka Lake,[34] the USGS established a stream flow gauging station at the outlet to Nagawicka Lake. The City of Delafield, in cooperation with the UNLMD, maintained this station through the period of this planning project. The resultant hydrograph is shown in Figure 15 (note logarithmic scale for discharge). This figure clearly shows the impact of

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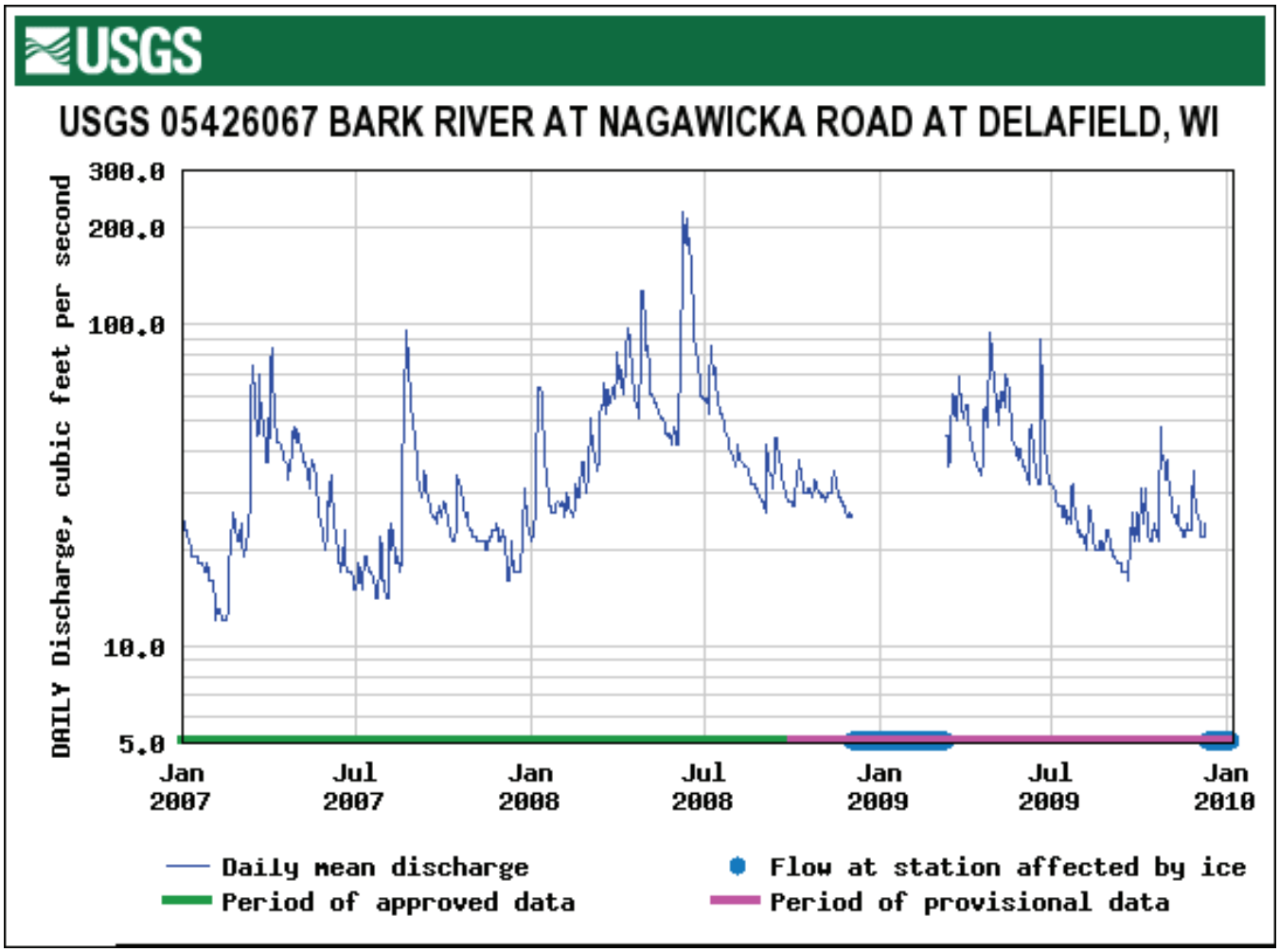
[32]*See SEWRPC File No. SVY3552, "Preliminary Vegetation Survey: Nemahbin* [sic] *Mill Dam Site," June 2009.*

[33]*U.S. Geological Survey News Release,* op. cit.

[34]*U.S. Geological Survey Scientific Investigations Report No. 2006-5273,* op. cit.

Figure 15

U.S. GEOLOGICAL SURVEY HYDROGRAPH FOR THE BARK RIVER AT NAGAWICKA LAKE OUTLET JANUARY 2007 THROUGH DECEMBER 2009



Source: U.S. Geological Survey and SEWRPC.

the Bark River floods during the summer of 2008, when peak flows in the River exceeded previous high flows during the 2007-2009 period by a factor of two. This high flow event coincided with the manipulations of the spillway at the Roller Mill Dam during 2008, and, during the period of the receding hydrograph following the June 2008 peak flows, provided the erosive power and transport mechanism associated with the loss of unconsolidated sediments from within the former Applebecker Millpond, as noted above.

For the study period from 2004 through 2008, excluding the 2008 water year, mean discharges ranged between 18.0 cubic feet per second (cfs) and 26.4 cfs, while the mean discharge during water year 2008 was reported as 45.8 cfs.[35] Within this period, water years 2005 and 2006 represented relatively low flow periods, with annual average discharges of 18.5 cfs and 18.0 cfs, respectively, while water years 2004 and 2007 represented somewhat higher flows, with annual average discharges of 24.9 cfs and 26.4 cfs, respectively.

[35]*The U.S. Geological Survey defines a water year or hydrological year as the period from October 1 to September 30.*

Based upon the full period of record from 2002 through 2008, the month of April generally has the greatest monthly mean discharge, with mean monthly stream flows between April and June—averaging 39 cfs—being higher than those reported during other months—which average 20 cfs.[36]

Flows in the Bark River downstream of Nagawicka Lake, during calendar years 2007 and 2009, appeared to reflect a more typical periodicity, with peak flows being recorded during spring and autumn of those years. Peak flows during calendar year 2007 approached 100 cfs during both seasons, while peak daily flows during calendar year 2009 only approached 100 cfs during the spring. Discharge during the autumn of 2009 was approximately one-half that of the 2007 season, with peak daily flows during the autumn approaching 50 cfs. Minimum daily flows during both water years were less than 20 cfs.

While the presence of Nagawicka Lake upstream of the Roller Mill Dam and the Nemahbin Lakes tends to dampen out the extreme fluctuations in stream flow that might otherwise occur in the absence of that large Lake, the total annual water outputs from that Lake were similar to the total inputs—with little change in storage from the beginning to the end of each study year, being reported by the USGS.[37]

Thermal Status of the Middle Bark River

The SEWRPC staff monitored air and water temperatures at three stations within, above, and below the Applebecker Millpond at hourly intervals from June 28, 2007 through December 28, 2009. These data are presented in Figure 16 and show that this is a warmwater stream system. The seasonality in the thermal data is clearly evident, with warmer water temperatures coinciding with the summer months and cooler water temperatures coinciding with the winter months. Water temperatures at each of the sites above, within the Applebecker Millpond, and below the Millpond regularly exceeded 29 degrees Celsius (°C). Water temperatures within the Applebecker Millpond, and below the Millpond also exceeded 30°C as shown in Figure 16.

As shown in Figure 17, data from each of these three water temperature monitoring points were subselected for the summer season, and further divided into pre-drawdown data—for calendar year 2007, drawdown data—for calendar year 2008, and post-drawdown data—for calendar year 2009, in an effort to identify the effect of the drawdown of the Applebecker Millpond on the thermal environment of the Bark River. The hypothesis that is tested is that the presence of the Applebecker Millpond acted to increase surface water temperatures relative to those likely to occur in the free-flowing stream, following the opening of the spillway.[38] Thus, it was assumed that the opening the spillway should contribute to reduced water temperatures within the former impoundment.

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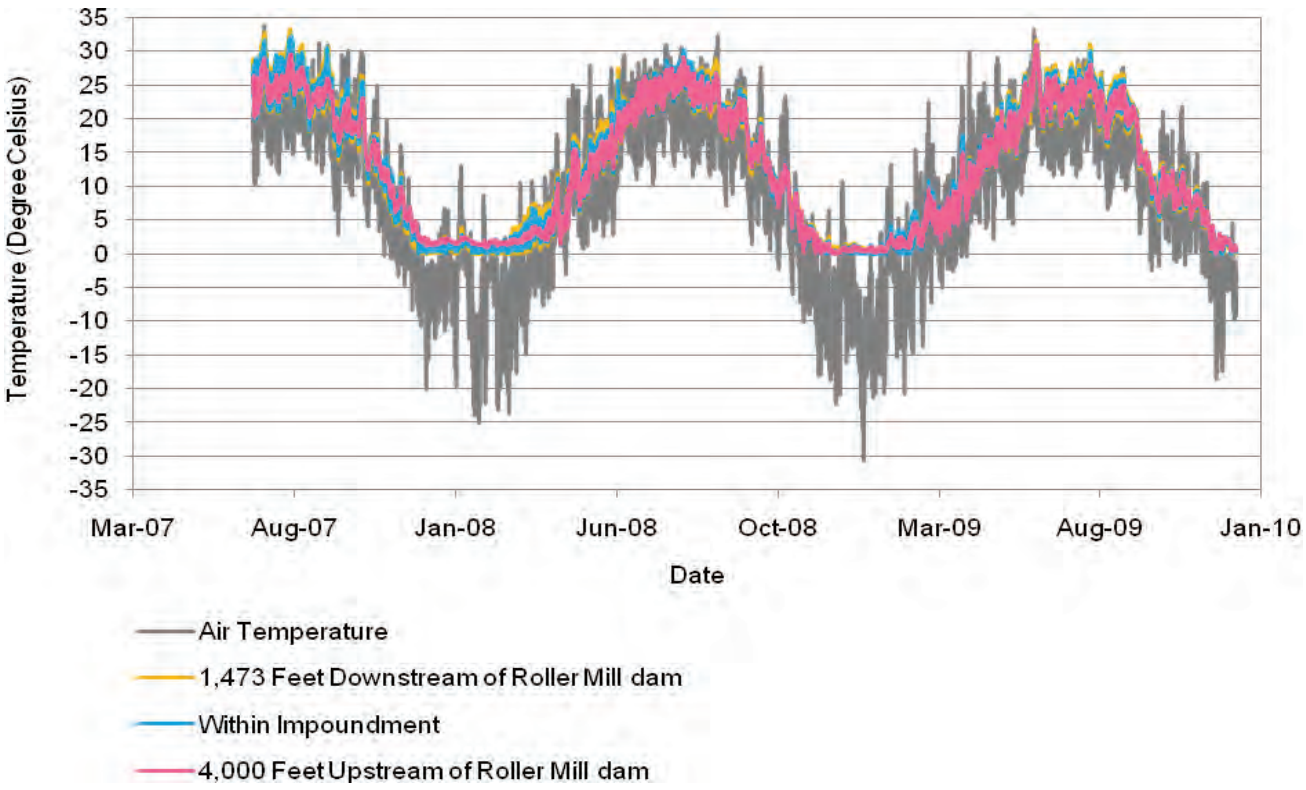
[36]*See U.S. Geological Survey Water-Data Report No. WI-02-1,* Water Resources Data - Wisconsin, Water Year 2002*, 2003, and similar for subsequent Water Years.*

[37]*U.S. Geological Survey Scientific Investigations Report No. 2006-5273,* op. cit.

[38]*See, for example, Michigan Department of Natural Resources, Fisheries Research Report No. 2058,* Temperature Effects of Dams on Coldwater Fish and Macroinvertebrate Communities in Michigan*, 2001, in which the impact of small dams on downstream thermal regimes was examined, and the effects of temperature increases due to impoundment on downstream fish and macroinvertebrate communities were assessed. The results of this assessment showed that small dams can increase downstream temperatures by more than 5°C, resulting in lower densities of coldwater fish species—specifically brown trout, brook trout, and slimy sculpin—and generally increasing fish species richness downstream. See also, World Commission on Dams,* Dams and Development: A New Framework for Decision-Making*, November 2000.*

Figure 16

HOURLY AIR AND WATER TEMPERATURE DATA FOR SITES DOWNSTREAM, UPSTREAM, AND WITHIN THE ROLLER MILL DAM IMPOUNDMENT: 2007-2009

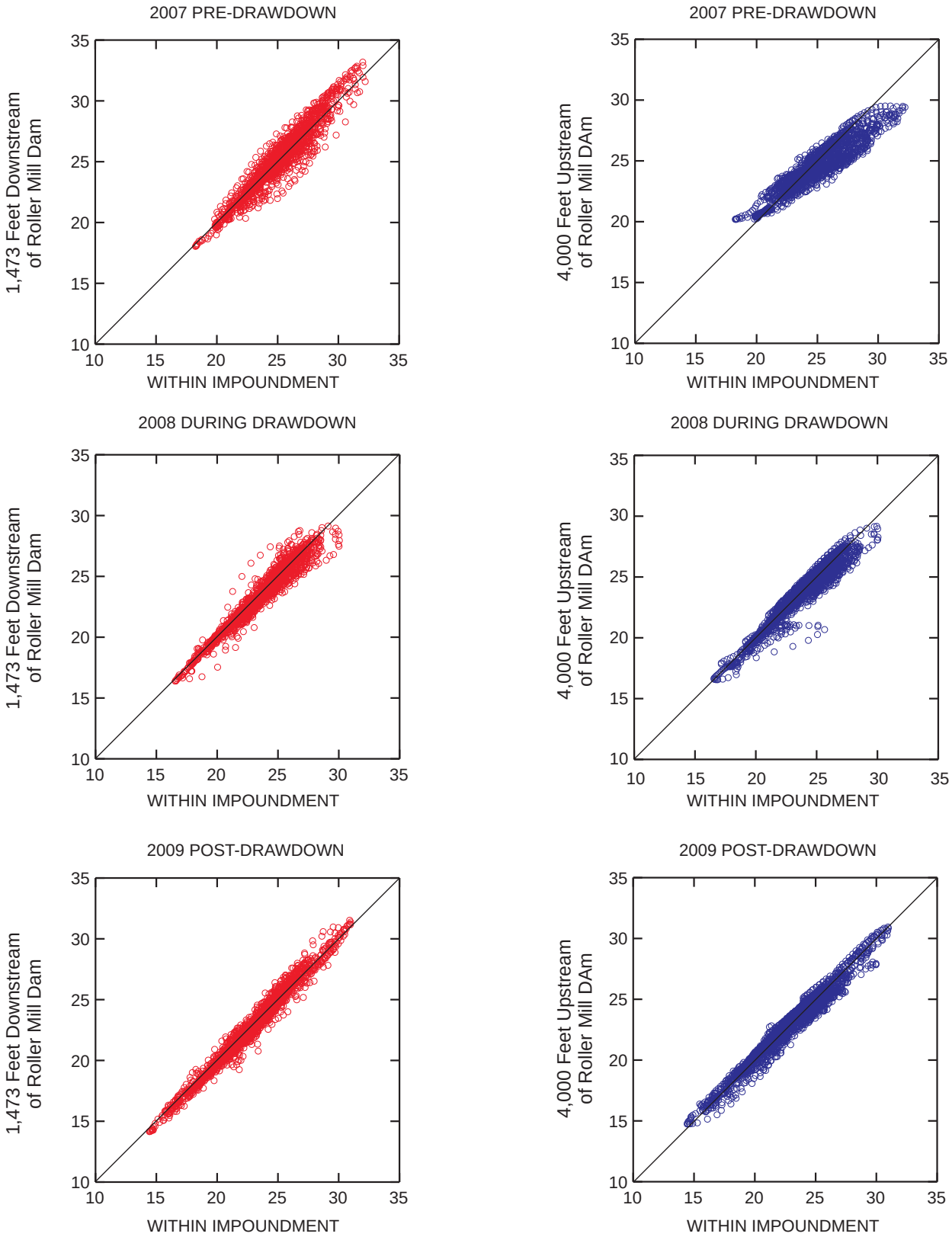


Source: SEWRPC.

Figure 17 shows real-time comparison of hourly summer temperatures of the Applebecker Millpond compared to the upstream site and the Applebecker Millpond compared to the downstream site, for each year. The diagonal line in each of the plots in Figure 17 indicates the point where the temperatures in the Applebecker Millpond and those of the upstream and downstream sites are the same. If the data fall above or below this line of equivalence, temperatures at the two sites are different. In 2007 under pre-drawdown conditions water temperatures within the Applebecker Millpond were warmer (more points to the right of the diagonal line) than both the upstream and downstream Bark River sites. During 2008 conditions were similar. In 2009 under post-drawdown conditions, water temperatures within the Applebecker Millpond were reduced and more similar to the upstream and downstream sites (data points more tightly clustered around the diagonal line) as shown in Figure 17. This reduction in temperature is consistent with the observations where dam removal has consolidated flows within a newly forming channel that is much less exposed to solar irradiation.

Figure 17

HOURLY SUMMER (JUNE, JULY, AUGUST) TEMPERATURE DATA COMPARISONS FOR SITES DOWNSTREAM, UPSTREAM, AND WITHIN THE ROLLER MILL DAM IMPOUNDMENT: 2007-2009



Source: SEWRPC.

Chapter IV

ISSUES AND CONCERNS

INTRODUCTION

Upper Nemahbin Lake is capable of supporting a variety of recreational water uses. However, some of these recreational uses are currently at risk of being curtailed or eliminated as a result of current and possible future threats facing the Middle Bark River. These concerns relate to the regulation of water flows and lake levels within this combined lake and river system.

In addition to the issues relating to the hydrology of the Middle Bark River, there are other concerns facing the Lake community, including potential deleterious changes in: aquatic plant communities and ecologically valuable areas; land use and water quality; and, the recreational use of the Lake and its environs.

Consequently, there are a number of existing and potential future problems and issues of concern that should be addressed in this protection plan. This chapter presents a summary of the major issues and concerns facing the Upper Nemahbin Lake community and their associated community resident along the Middle Bark River. The next chapter sets forth alternative and recommended management measures to mitigate, moderate, or otherwise manage these concerns.

ISSUES AND CONCERNS RELATING TO THE MIDDLE BARK RIVER

Water Flow Control and Hydrology

In response to resident concerns expressed over proposed abandonment of the Roller Mills Dam and the reconstruction of the CTH P weir at the outlet of Lower Nemahbin Lake, water flow control is an important issue to be considered.

The owner of the Roller Mill Dam, which impounded the 12-acre Applebecker Millpond, has been granted an abandonment permit by the Wisconsin Department of Natural Resources (WDNR), pursuant to Section 31.187 of the *Wisconsin Statutes*. The abandonment process requires the conduct of an Environment Assessment by the Wisconsin Department of Natural Resources (WDNR), pursuant to requirements set forth in Chapter NR 150 of the *Wisconsin Administrative Code*. The WDNR completed this Environmental Assessment during 2008. The assessment is appended hereto as Appendix D. The Environmental Assessment identified a number of issues of concern that were required to be addressed by the owner of the dam prior to the granting of the abandonment permit by the WDNR. One of these issues included stabilization and management of the accumulated sediment present within the basin of the Applebecker Millpond.[1]

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[1]*This requirement was affirmed by the Wisconsin Department of Hearings and Appeals Administrative Law Judge in his April 2009 Findings of Fact, Conclusions of Law, Orders and Permit, appended hereto as Appendix E.*

Based on concerns regarding dam stability and safety, and to protect human life, health, and property, the WDNR subsequently issued a drawdown order during and following the regional flood in mid-2008,[2] set forth in Appendix A. This order required the removal of the stop logs from the spillway of the Roller Mill Dam. This action has resulted in the erosion of unconsolidated sediments from within the basin of the former Applebecker Millpond, and the deposition of significant volumes of these sediments within the Bark River between the Millpond and Upper Nemahbin Lake, as documented by Commission staff during late-2008 and summarized in Chapter III.[3] This deposition may be considered to be episodic, and is additional to the chronic deposition of sediment throughout the Middle Bark River that arises from nonpoint sources within the tributary area.

Consequences of Sediment Deposition

Habitat Loss

Based upon a comparison of the 2007 versus 2008 surveys of the reach of the Middle Bark River between the Roller Mill Dam and Upper Nemahbin Lake, summarized in Chapter III, there was a significant loss of sand and gravel substrates associated with the deposition of unconsolidated sediments. The inundation of the sand and gravel substrates represents a significant loss of habitat for fish and other aquatic organisms. This effective loss of sand and gravel substrates is particularly detrimental to fish spawning habitats. Species such as sunfishes (e.g., largemouth bass, bluegill, green sunfish), darters, and minnows (i.e., common shiner, sand shiner, spotfin shiner) depend upon the sand and gravel substrates for feeding, nesting, and rearing of juveniles. Loss of substrate has direct and indirect impacts on gamefish species through reduction of breeding success as well as numbers of forage fishes upon which these species depend. In addition, the loss of water volume directly limits the total biomass of fishes able to reside in this reach. The quality of deep water habitat has also been reduced in this reach.

Based upon the 2007 fish data, summarized in Table 21 in Chapter III of this report, there were a total of 26 native fish species that included one endangered (slender madtom), and two special concern (least darter and weed shiner) fish species observed within the affected stream reach that was covered with sediment during 2008. It is important to note that, while slender madtom have been reported to occur in the Bark River system,[4] the current record is the only record of a slender madtom found within the Upper Nemahbin and Lower Nemahbin Lakes portion of the River. Figure 14 in Chapter III of this report illustrates this species of special concern. The Bark River is only one of four watersheds within the State of Wisconsin, which include the Oconomowoc River, Rock River, and Pecatonica River watersheds, where the slender madtom have been observed since 1986.

In addition, the Middle Bark River contained 14 and 12 more total native fish species in 2007 than either the Upper Nemahbin Lake or Lower Nemahbin Lake, respectively, compared to the WDNR littoral zone seining surveys in 2004 by Dr. John Lyons. Further comparison of these data sets indicated that there were 15 unique fish species in this affected stream reach compared to the littoral zone fish community in Upper Nemahbin Lake and 18 unique fish species compared to the littoral zone in Lower Nemahbin Lake. This indicates that the Middle Bark River was the most diverse section of the entire Upper Nemahbin and Lower Nemahbin Lakes system based upon the number fish species (i.e., fish species richness).

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[2]*See U.S. Geological Survey News Release, "USGS Crews Dispatched to Measure Historic Wisconsin Floods," June 10, 2008.*

[3]*This drawdown was undertaken pursuant to authorities granted the WDNR in Chapter 31 of the* Wisconsin Statutes, *and was ordered because the impoundment was deemed to be unsafe. A catastrophic failure of the structure potentially would have contributed a much larger volume of unconsolidated material as well as concrete and earthen fill from a failed impoundment, endangering not only the ecosystem structure and function but also human life and property. See Appendix A.*

[4]*D. Fago, WDNR Technical Bulletin No. 175,* Distribution and Relative Abundance of Fishes in Wisconsin, VIII Summary Report, *Madison, Wisconsin, 1992.*

It has been well established that dams can significantly affect fish species richness and community structure,[5] which is probably why the reach downstream of the Roller Mill Dam is much more diverse than the reach upstream of the Dam. The stream reach downstream of the Roller Mill Dam has an unobstructed connection to both Upper and Lower Nemahbin Lakes, which is why this reach contains a mixture of both riverine specialist species (i.e., fishes generally found in lotic environments) and generalist species (i.e., fishes commonly found in both lentic and lotic environments). This connection with the lakes, combined with the high quality and diversity of habitats within this reach, are the most likely factors contributing to high number of fish species observed in 2007 within this reach downstream of the Roller Mill Dam.

The reach of the Bark River between Upper Nemahbin Lake and the Roller Mill Dam was designated as a fish refuge pursuant to Section 23.09 (2)(c) of the *Wisconsin Statutes* and Section NR 26.08 (68)(a)1 of the *Wisconsin Administrative Code*. According to Section NR 26.08, "…it shall be unlawful for any person or persons to take, catch, disturb, capture, kill, or fish for fish in any manner from March 1 of each year to the date immediately preceding the opening date of the general fishing season, both dates inclusive, in, on or along [this designated fish refuge]…." The designated reach provides protection for the fishes from human predation. Coincident with, but incidental to,[6] such protection is the provision of refuge, habitat and protection for spawning and rearing for developing juveniles of a variety of fish species, including gamefish such as largemouth bass, smallmouth bass, and northern pike. As indicated above, the sediment deposition that occurred within this reach during 2008 has significantly degraded the overall quality and quantity of high quality fishery habitat that was previously available for feeding, shelter, spawning, and juvenile rearing within this designated fish refuge.

Many of the species observed downstream of the Roller Mill Dam in 2007 may have been compromised due to the deposition of sediment in 2008. In particular, the slender madtom is probably one of the most vulnerable fish species, since this species is generally found in streams greater than about 30 feet in width, in clear water with moderate to swift water velocities sufficient to keep the bottom substrates free of silt, and in water depths of 0.4 to 12 inches over substrates of gravel and boulders interspersed with sand.[7] Consequently, the deposition of sediments that occurred in 2008 is likely to have had a significant negative impact on the quality and availability of suitable habitat for slender madtom in this reach. Some of these fishes may have been able to migrate upstream or downstream,[8] but this concentration of fishes in a limited area increases their risk of predation, limits availability of food due to increased competition, creates an increased potential for disease and parasite transmission, and forces them into marginal habitats.

In addition, this reach contained eight mussel species including one threatened species (e.g., the ellipse). These organisms are likely to have been smothered by the deposited sediment. These organisms are filter feeders and require sand and gravel substrates. Although these organisms have some ability to move, the rate of deposition of the sediments was likely to have been such that their ability to escape inundation was minimal.

In the absence of adequate erosion controls in the former lake basin, additional sediment erosion from the Roller Mill Dam impoundment and deposition within the Middle Bark River upstream of Upper Nemahbin Lake can be anticipated, with concomitant negative biological impacts. Measures to remove and stabilize the sediments within

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[5]*Thomas M. Slawski, Francis M. Veraldi, Stephen M. Pescitelli, and Michael J. Pauers, "Effects of Tributary Spatial Position, Urbanization, and Multiple Low-Head Dams on Warmwater Fish Community Structure in a Midwestern Stream,"* North American Journal of Fisheries Management, *Volume 28:1020–1035, 2008.*

[6]*Susan Beyler, WDNR South East Region Fisheries Team Supervisor, personal communication.*

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

[8]*An October 2009 fisheries survey of this reach conducted by the WDNR reported a representative of this species as being present. Benjamin Heussner, WDNR Fisheries Biologist, personal communication.*

the Roller Mill Dam impoundment and restore a functional stream system both upstream and downstream of the Roller Mill Dam are important issues to be considered.

Loss of Navigability and Threat to Public Safety

In addition to the ecological value of this portion of the Bark River system, the Middle Bark River and associated lake systems provide a variety of recreational, residential, and commercial uses that benefit both riparian residents and the wider community. Specifically, the presence of a boat livery and privately owned recreational boating access sites along this stretch of the River represent significant economic opportunities within this community that are being impaired by sediment deposition. Several riparian property owners also have indicated that their use of these public waters has been impaired as a consequence of sediment deposition. These impairments were reported to include restricted boat access to Upper Nemahbin Lake; damage to boat motors as a result of cooling systems clogged by muck and debris; loss of aesthetic value; fear that swimmers, fishers, and boaters could become mired in unconsolidated sediment; and related concerns such as the inability to operate boat lifts at piers as well as pier access. Additionally, it was noted that the Summit Fire District, which provides fire protection services to the Town of Summit and Village of Oconomowoc Lake, utilizes the waters of the Bark River and Upper Nemahbin Lake as a water supply. The potential impact of unconsolidated sediments on their ability to obtain water from the area of the River and Lake adjacent to CTH DR also was identified as a cause of concern to this mixed land use neighborhood. During the 2008 reconnaissance by the Commission staff, a canoe from which the survey was being conducted frequently became mired in recently deposited sediments, an experience that substantiated the concerns voiced by the community. In order to maintain navigability and protect public safety in this portion of the Bark River, removal of unconsolidated sediments is an important issue to be considered.

Consequences of Lake Surface Elevation Changes

Loss of Navigability

The weir structure located on CTH P controls water flow out of Lower Nemahbin Lake, thereby regulating water levels in Lower and Upper Nemahbin Lakes and in Lower Nashotah Lake. This structure is an integral part of the CTH P bridge over the Bark River. As of 2009, CTH P was scheduled for reconstruction during the planning period, although the date for the reconstruction project has been postponed from 2010 to 2011 or beyond. Nevertheless, the proposed reconstruction of this weir has generated concern among the residents of the affected lakes in regards to potential harmful effects on Lake water levels that could result if the weir was to be removed. In addition to ecological impacts on the Lakes, from the viewpoint of the riparian owners, the potential fluctuations in water levels would affect shoreline erosion, interfere with proper pier height and placement, as well as correct placement of shoreline protection structures. It is also likely that removal of the weir could restrict or even eliminate navigation between the Upper and Lower Nemahbin Lakes and between Upper Nemahbin Lake and Lower Nashotah Lake, possibly severely affecting public recreational boating access to these lakes—as noted in Chapter II of this report, the public recreational boating access site serving both Upper and Lower Nemahbin Lakes is located on the channel linking these two waterbodies, between CTH DR and IH 94.

Floodland Zoning

In contrast to the potential impact of the proposed reconstruction or removal of the weir at CTH P on recreational boating activities, reducing the lake surface elevation of Upper Nemahbin Lake, in particular, could benefit the businesses and homes located within the floodlands along the Bark River and southern shoreline of Upper Nemahbin Lake. A number of structures have been observed to be at risk in this area of CTH DR during periods of high water level. While the several residences built in this area in recent years appear to have been built on fill, a number of businesses in this area have been flooded or threatened by flood waters at intervals during the last 20 years. At issue currently is the revised Federal Emergency Management Agency (FEMA) digital flood insurance rate maps (DFIRM) that have placed structures in the vicinity of the outlet to Upper Nemahbin Lake into a flood risk category. A request for a letter of map revision (LOMR) that would revise the floodplain as shown on the

FEMA DFIRM has been submitted by Waukesha County, the City of Delafield, the Village of Hartland, and the Upper Nemahbin Lake Management District.[9]

Section 87.30 of the *Wisconsin Statutes* requires that cities, 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 of the *Wisconsin Administrative Code*. The required regulations govern filling and development within a regulatory floodplain, which is defined as the area subject to inundation by the one-percent-annual-probability (100-year recurrence interval) flood event. Under Chapter NR 116, local floodland zoning regulations must prohibit nearly all forms of development within the floodway, which is that portion of the floodplain required to convey the 100-year recurrence peak flood flow. Local regulations set forth requirements governing filling and development within the flood fringe, which is that portion of the floodplain located outside the floodway that would be covered by floodwater during the one-percent-annual probability peak flood flow. Permitting the filling and development of the flood fringe area, however, reduces the floodwater storage capacity of the natural floodplain, and may thereby increase downstream flood flows and stages. It should be noted that towns may enact floodland zoning regulations which may be more restrictive than those in the county shoreland and floodland zoning ordinances.

ISSUES AND CONCERNS RELATING TO UPPER NEMAHBIN LAKE

Aquatic Plant Communities and Ecologically Valuable Areas

Concerns Related to Aquatic Plant Communities

Localized recreational use problems have been reported to be experienced in various portions of Upper Nemahbin Lake. The nature and extent of those problems depend on the specific uses desired of the Lake. The presence of Eurasian water milfoil, albeit not in dominant numbers, is, nevertheless, perceived as a nuisance and issue of concern by lake users. This species often grows to the surface of lakes, limiting certain recreational uses in specific areas and impairs not only the aesthetic quality of the lake, but also limits the habitat for fish and other aquatic life within and adjacent to the lake. These characteristics interfere with recreational uses, aesthetic enjoyment, and the ecological health of the waterbody.

Recreational boating activities, for example, are impaired by entanglement of propellers and clogging of cooling water intakes, slowing boating activities, and limiting the ability of lake users to navigate in certain areas of the lake. Without control measures, these areas could become impassable for recreational navigation. In addition, fishing and swimming activities on a lake also are adversely affected by excessive aquatic plant growth, especially in those areas of the lake where Eurasian water milfoil occurs at swimming depths. Fishing is affected by the growths of Eurasian water milfoil entangling lines, and by the poor quality habitat and food stocks provided within the stands of Eurasian water milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*), both designated aquatic invasive plants pursuant to Section NR 109.07 of the *Wisconsin Administrative Code*. Native aquatic plants pose less severe potential problems for swimming and provide positive ecological benefits to a lake, as noted in Table 9 in Chapter II of this report. Consequently, the management of aquatic plant communities in Upper Nemahbin Lake, and the presence of Eurasian water milfoil and curly-leaf pondweed in particular, is an important issue to be considered.

Concerns Related to Ecologically Valuable Areas

Upper Nemahbin Lake and its tributary drainage area contain ecologically valuable areas, including significant areas of diverse, native aquatic vegetation suitable for fish spawning and high quality wildlife habitat, which are located within and immediately adjacent to the Lake. The Upper Nemahbin Lake community has expressed

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[9]*Bark River LOMR, prepared by Yaggy Colby Associates, Inc., for Waukesha County, the City of Delafield, the Village of Hartland, and the Upper Nemahbin Lake Management District, March 2009.*

concern over the perceived degradation of these resources. Two potential concerns associated with ecologically valuable areas in and near Upper Nemahbin Lake have been identified. These include: the potential loss of wetlands and other ecologically valuable areas due to urbanization or other encroachments; and the degradation of wetlands and aquatic habitat due to the presence of invasive species, primarily Eurasian water milfoil, curly-leaf pondweed and purple loosestrife (*Lythrum salicaria*). The currently undeveloped areas of the Lake, generally lying along the northern and northeastern shorelines of the Lake, contain significant stands of native aquatic and wetland plants and shoreland woodlands that add aesthetic value to the community and provide good quality wildlife habitat. Consequently, management of ecologically valuable areas in and adjacent to the Lake is an important issue to be considered.

Environmentally Sensitive Areas

Within the lake basin, riparian wetland areas and aquatic macrophyte beds may be included within environmentally sensitive areas delineated by the Wisconsin Department of Natural Resources pursuant to authorities set forth in Chapter NR 107 of the *Wisconsin Administrative Code*. These areas include prime fish spawning habitat and macrophyte beds containing a diverse native flora within the Lake, as well as shoreline areas supporting this productive aquatic and wetland habitat. To date, the Wisconsin Department of Natural Resources has not designated any sensitive areas within Upper Nemahbin Lake, pursuant to their Chapter NR 107 authority.

Natural Areas and Critical Species Habitat

As described in Chapter II, the Upper Nemahbin Lake area is of ecological importance due its physical features and the richness and diversity of its biota. Upper Nemahbin Lake is identified as a Critical Lake of Southeastern Wisconsin[10] with a rating of AQ-2 (RSH), designating it as a lake of countywide or regional significance supporting endangered, threatened, or "special concern" species as identified by the WDNR, in this case "special concern" species the least darter (*Etheostoma microperca*). In addition, the Bark River, upstream and downstream of Upper Nemahbin Lake, is designated as AQ-1 (RSH), identifying it as an aquatic area of statewide or greater significance supporting, in this case, two endangered fish species, the slender madtom (*Notorus exilis*) and starhead topminnow (*Fundulus dispar*), with critical mussel species also present. Maintaining the ecological integrity of these areas is an important issue to be considered.

Land Use and Water Quality

Concerns Related to Water Quality

As of 1995, as described in Chapter II, Upper Nemahbin Lake was within the mesotrophic range, indicating that few water quality problems could be expected in the Lake. Citizens within the Upper Nemahbin Lake community have expressed concerns regarding surface water quality over the longer term, especially if urban density development occurs within the groundwatershed tributary to Upper Nemahbin Lake as is foreseen in the relevant regional and local land use plans. Because domestic water supplies to households within the Upper Nemahbin Lake community are drawn from the Regional groundwater aquifer system, contamination of this aquifer by pollutants leaching into the groundwater from the land surface is an issue of widespread concern within the Upper Nemahbin Lake community. This concern is shared throughout the Southeastern Wisconsin Region by communities who are dependent upon private wells for their water supply even though they may utilize a public sewage disposal system.[11] Measures taken to minimize water quality degradation in the surface drainage area tributary to Upper Nemahbin Lake should also serve to protect the groundwater resources of the watershed from contamination. Consequently, water quality is an important issue to be considered.

As described in Chapter II, according to the previous report, the majority of phosphorus loading to Upper Nemahbin Lake occurred as the result of inflow from the Bark River. In addition, excessive sediment deposition

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

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

in the confluence of the Bark River and Upper Nemahbin Lake that may be related to environmental disturbances and the input of particulate materials from past failures of the Roller Mill Dam,[12] which is situated on the Bark River between Nagawicka and Upper Nemahbin Lakes, is an issue of concern to residents in the area. As a consequence, the Upper Nemahbin Lake Management District has undertaken a planning program that has included in-lake water quality monitoring and a watershed inventory, including an aquatic plant survey,[13] and an environmental assessment of the Bark River between Nagawicka Lake and the confluence of the Bark River with Upper Nemahbin Lake.[14] During this latter study, sediment deposition at the inlet of the Bark River to Upper Nemahbin Lake was reported to be "greater than five feet…in depth [in 2001]." Elements of this proposed planning program will contribute directly to the conduct of a future hydrologic and hydraulic study of the Bark River system as recommended by the Southeastern Wisconsin Regional Planning Commission (SEWRPC).[15] The abandonment of this dam and the potential resultant deleterious effects on the ecosystem of the Lake is an important issue to be considered.

Concerns Related to Nonpoint Source Pollution

Nonpoint source pollutants in the surface water drainage area tributary to Upper Nemahbin Lake affect the Lake's water quality. Based upon recommendations set forth in the regional land use plan,[16] only limited future development of open lands within the drainage area tributary to Upper Nemahbin Lake is expected to occur. Such development is anticipated to take the form of residential development on existing platted lots or the redevelopment of existing sites within the drainage area that could have some impact on lake water quality, primarily as a result of erosion during construction and secondarily due to limited increased in impervious surfaces.

Construction activities within the watershed have the potential to mobilize significant quantities of soil from the land surface unless mitigation measures are applied and maintained. The control of construction site erosion and of stormwater-borne, nonpoint-sourced pollutants remains an important issue to be considered.

Concerns Related to Shorelands

As mentioned earlier, portions of the shoreline of Upper Nemahbin Lake remain in a natural state, especially along the northern and northeastern shores of the Lake. As such, these areas are likely to be potentially susceptible to wind, wave, and wake erosion should such vegetative protections be removed or modified. Wherever practical, vegetated buffer strips should be maintained along the lakeshore in order not only to protect these areas from wind and wave erosion, both shoreward and lakeward of the ordinary high-water mark, which mark generally defines the point at which the Lake and shore meet, but also to maintain habitat value and the natural ambience of the shoreland area. During the previous study period, the Commission staff examined existing shoreline protection structures and shoreland areas for signs of erosion. These shoreland protection structures,

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[12]*Episodic deposition of unconsolidated materials at the confluence of the Bark River with Upper Nemahbin Lake is documented by the Wisconsin Department of Natural Resources in letters dated July 19, 1989, July 27, 1989, and February 12, 1990, File Ref: 3564; see also Lake Country Reporter, July 13, 1989, page 26.*

[13]*SEWRPC Memorandum Report No. 101,* Upper Nemahbin Lake Watershed Inventory Findings, Waukesha County, Wisconsin, *May 1995.*

[14]*TN & Associates,* Watershed Inventory of the Bark River between Nagawicka Lake and Upper Nemahbin Lake, Waukesha County, *June 2001.*

[15]*SEWRPC Memorandum Report No. 112,* An Aquatic Plant Management Plan for Crooked Lake, Waukesha County, Wisconsin, *draft, May 1999.*

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

mainly comprised of riprap and bulkheads, were deemed by Commission staff to be in a relatively good state of repair. Nevertheless, because of the extensive amount of natural shoreline on Upper Nemahbin Lake, shoreland erosion is a potential issue of concern to be considered.

Recreational Usage

Concerns Related to Recreational Boating

The residents of the Upper Nemahbin Lake community have expressed concerns over the increased operations of power boats and personal watercraft on the Lake in recent years, especially with regard to the shoreline damage associated with boat wakes and aesthetic impacts resulting from these activities. In addition, the community has expressed concerns over other potential ecosystem level impacts associated with recreational watercraft usage. These include potential recreational boating impacts on the growth and nature of the aquatic plant community in Upper Nemahbin Lake; for example, spreading Eurasian water milfoil as a result of fragmentation of the plant by boating traffic and the potential impacts of recreational boating in the shallow areas of the Lake, including those areas of the Lake with less than five feet of water depth. Such concerns suggest that public recreational boating and the regulation of boating activities is an important issue to be considered.

Concerns Related to Recreational Opportunities within the Watershed

In addition to the water-oriented recreational opportunities offered by Upper Nemahbin Lake, the Lake provides numerous views and aesthetic aspects that are favored by the Upper Nemahbin Lake community. In large part, these aspects relate to the woodland areas of the northern and northeastern shorelands of the Lake. Recent urban-density residential developments in parts of the Lake's tributary area have the potential for changing the landscape within and adjacent to the area tributary to Upper Nemahbin Lake. Such development has the potential to significantly alter the viewshed tributary to Upper Nemahbin Lake, the intensity of the demands for water-based recreational opportunities, and the nature and delivery of nonpoint-sourced contaminants to the Lake. Consequently, preserving the natural aesthetics offered by the Lake is an issue to be considered.

Chapter V

ALTERNATIVE AND RECOMMENDED MANAGEMENT MEASURES

INTRODUCTION

Chapter IV described a number of lake and watershed management issues and issues of concern facing the Upper Nemahbin Lake community. These issues included both concerns that stemmed from perceived problems noted within the Lake basin, and from perceived problems noted both upstream and downstream of Upper Nemahbin Lake. Specifically, issues of concern to the Upper Nemahbin Lake community related to water flow control and hydrology associated with the proposed removal of the Roller Mill Dam upstream of Upper Nemahbin Lake, and with the proposed reconstruction of CTH P and its potential impact on the weir at the outlet of Lower Nemahbin Lake, which would affect the surface water elevations of both Upper and Lower Nemahbin Lake and Lower Nashotah Lake, all of which are hydrologically linked as a result of the current crest elevation of the CTH P weir.

In addition to these water quantity-related issues of concern, Chapter IV highlighted a number of water quality-related issues of concern. These included the presence of nonnative aquatic plant species within the basin of Upper Nemahbin Lake, ongoing development and nonpoint source pollution concerns in the drainage basin tributary to Upper Nemahbin Lake, and recreational use concerns. All of these concerns are current concerns facing Upper Nemahbin Lake, its resident community, and visitors.

Consequently, this chapter sets forth a range of measures to mitigate, moderate, and manage the concerns identified in Chapter IV. In addition, this chapter sets forth a recommended approach to managing the Lake and its watershed so as to achieve a range of desired lake and stream uses consistent with the expectations of the community and with the vision set forth in the *Wisconsin Statutes*, as elaborated in the *Wisconsin Administrative Code*. Specifically, the recommended lake management strategy is designed to promote fishable and swimmable conditions within Upper Nemahbin Lake. Such conditions will sustain a healthy lake ecosystem and full body contact recreational uses of the Lake. The recommended lake management measures set forth below are intended to be implemented by the Upper Nemahbin Lake Management District (UNLMD) in partnership with local and State government agencies and private landowners, as noted in Table 24.

MANAGEMENT MEASURES RELATING TO THE MIDDLE BARK RIVER

Roller Mill Dam

The owner of the Roller Mill Dam, which impounded the 12-acre Applebecker Millpond, was granted an abandonment permit by the Wisconsin Department of Natural Resources (WDNR) during 2009, pursuant to

Table 24

RECOMMENDED PROTECTION PLAN ELEMENTS FOR UPPER NEMAHBIN LAKE

Plan Element	Subelement	Management Measures	Management Responsibility
Water Flow Control Structures	Roller Mill Dam	Stabilize and control flocculent sediments within the former basin of the Applebecker Millpond; restore the historic channel of the Middle Bark River through the former impoundment site	Private owner and WDNR
	Middle Bark River	Remove flocculent sediments deposited within the reach of the Middle Bark River downstream of Roller Mill Dam and upstream of the Bark River confluence with Upper Nemahbin Lake; restore to the extent possible habitat inundated by flocculent sediment	WDNR
	Lower Nemahbin Lake-CTH P dam	At the time of reconstruction of the CTH P bridge over the Bark River, replace the existing weir that maintains the water levels of Upper and Lower Nemahbin and Lower Nashotah Lakes with a comparable structure	WisDOT, WDNR, and Waukesha County
Aquatic Plant Communities and Ecologically Valuable Areas	Aquatic Plants	Conduct periodic in-lake reconnaissance surveys of aquatic plant communities and update aquatic plant management plan every three to five years	UNLMD
		Limit use of aquatic herbicides for control of nuisance nonnative aquatic plant growth where necessary; specifically target Eurasian water milfoil, curly-leaf pondweed, and purple loosestrife, as necessary[a] Encourage growth of native plants in through use of vegetated buffer strips and control of Eurasian water milfoil	WDNR and UNLMD
		Conduct periodic monitoring of the aquatic plant community for the early detection and control of future-designated nonnative species that may occur Monitor invasive species populations where they occur	WDNR, UNLMD, and private landowners
		Manually harvest around piers and docks as necessary[b] Collect floating plant fragments from shoreland areas to minimize rooting of Eurasian water milfoil and deposition of organic materials in Lake	Private landowners
	Ecologically Valuable Areas	Support the preservation and rehabilitation of primary and secondary environmental corridors and isolated natural resource features in tributary area	UNLMD, Waukesha and Washington Counties, and relevant municipalities within total tributary area
Land Use and Water Quality	Tributary Area Development	Implement development guidelines set forth in the regional land use plan and county development plan	Waukesha and Washington Counties, and relevant municipalities within total tributary area
	Shoreline Protection Management	Maintain existing shoreline structures and repair as necessary using vegetative means insofar as practicable; reconstruction may require WDNR Chapter 30 permits	Waukesha County, Town of Summit, WDNR, and private landowners
	Water Quality Management	Continue participation in UWEX CLMN program and consider participation in the Expanded program, U.S. Geological Survey TSI program, or equivalent	WDNR, UWEX, USGS, and UNLMD
Recreational Use	Recreational Use Management	Maintain recreational boating access from the public access site pursuant to Chapter NR 7 guidelines Maintain signage at public access sites regarding invasive species and UWEX Clean Boats-Clean Waters Program; provide disposal containers for disposal of plant material removed from watercraft	WDNR, UWEX, and Town of Summit
	Public informational and educational programming	Continue to provide informational material and pamphlets on lake-related topics, especially the importance of aquatic plants and the protection of ecologically significant areas; consider offering public informational programming on topics of lake-oriented interest and education	WDNR, UWEX, and UNLMD
		Encourage inclusion of lake studies in environmental curricula (e.g., Pontoon Classroom, Project WET, Adopt-A-Lake)	Area school districts, UWEX, WDNR, and UNLMD

Table 24 (continued)

Plan Element	Subelement	Management Measures	Management Responsibility
Recreational Use (continued)	Public informational and educational programming (continued)	Encourage riparian owners to monitor their shoreline areas as well as open-water areas of the Lake for new growths of nonnative plants and report same immediately to the UNLMD	Private landowners and UNLMD
	Lake district board continuing education	Maintain awareness of current developments in the area of lake management through informative publications such as "Lake Tides" (available free through the Wisconsin Lakes Partnership) and attendance at lake education conventions, workshops, and seminars	UNLMD

NOTE: The following abbreviations were used:

UNLMD = Upper Nemahbin Lake Management District
WDNR = Wisconsin Department of Natural Resources
WisDOT = Wisconsin Department of Transportation
UWEX = University of Wisconsin-Extension
UWSP = University of Wisconsin-Steven Point
CLMN = Citizen Lake Monitoring Network
USGS = U.S. Geological Survey

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

[b]*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.

Source: SEWRPC.

Section 31.187 of the *Wisconsin Statutes*.[1] Abandonment requires the conduct of an Environmental Assessment by the WDNR pursuant to Chapter NR 150 of the *Wisconsin Administrative Code*. The WDNR completed the draft Environmental Assessment during 2008. This assessment, appended hereto as Appendix D, identified a number of issues of concern that were required to be addressed by the owner of the dam prior to executing the abandonment permit; namely, the owner was to be required to provide a drawdown plan, material removal plan, erosion control plan, sediment stabilization plan, planting plan, floodplain analysis, stream bank stabilization plan, existing and proposed grades, construction sequencing, and site specific analysis.[2]

During June 2008, the WDNR ordered the drawdown of the Millpond, initially as an emergency action to protect human life, health, and property as a result of high flows experienced at that time and concerns about the stability and safety of the dam. Subsequently, pursuant to the WDNR order, appended hereto as Appendix A, the stop logs

[1]*A Wisconsin Department of Hearings and Appeals Administrative Law Judge granted the abandonment request on April 21, 2009, subject to the completion of the "final dam removal plans." See Appendix E.*

[2]*Of these requirements set forth in the WDNR Environmental Analysis appended hereto as Appendix D, the drawdown plan has been obviated by the June 18, 2008 WDNR order to drawdown Roller Mill Dam. The Administrative Law Judge, in his order of April 21, 2009, affirmed that the owner "develop the required plans and specifications for the removal of the dam and restoration of the Bark River….[including]…best management practices and techniques to remove or stabilize existing sediment deposits and control transportation of material to the maximum extent practicable…complete removal of all concrete, metal and wood portions of the dam and removal of the earthen embankment to the extent necessary to pass the regulatory flood…on-site monitoring plans for invasive species [and] control of sediments…a planting plan that emphasizes native species with habitat value and that includes objective standards of re-vegetation performance…[and] construction and post-construction sequencing and final plans."*

were replaced and the pool level subsequently drawn down in a controlled fashion during July and August 2008. Further, in order to stabilize and manage the accumulated sediment present within the former basin of the Applebecker Millpond, the WDNR seeded the exposed lake sediments with a mixture of winter wheat and native seed during the autumn of 2008.[3] The former lake basin has not been refilled.

Three alternative concepts could be considered as the basis for managing the abandonment process. These are discussed below, and include: Alternative 1, limited action to restore the upstream reach of the Bark River formerly inundated by the Millpond; Alternative 2, management of stream flows during a stream reconstruction process—either by construction of a temporary bypass channel to pass river flows or management of discharge from the upstream Nagawicka Lake dam or both; and Alternative 3, creation of a sediment retention basin within the former lake basin upstream of the existing spillway to retain sediments mobilized during the abandonment process—with either the accumulated sediments being excavated and disposed of offsite or disposed onsite in geo-tubes. Alternative 4 considers the granting of a new dam operating permit to a municipal governmental unit. All four Alternatives are predicated upon the current—as of 2009—drawn-down state of the impoundment, and the granting, during early-2009, of an abandonment permit to the owner of record of the Roller Mill Dam.

Array of Management Measures

Alternatives Associated with the Removal of the Roller Mill Dam

Alternative 1 involves the progressive removal of stop logs, which was completed during October 2008, and notching of the spillway structure, allowing water to pass downstream with minimal hindrance under most flow conditions. This Alternative provides limited protection from soil mobilization and transport (erosion) in upstream portions of the basin and no protection from sediment deposition in the downstream portions of the river. Based upon previous experiences, such as those in the Baraboo River,[4] this Alternative could result in significant mobilization of unconsolidated sediments present within the former lakebed, with the consequence that downstream plant and animal communities could be inundated by sediment deposition, to the detriment of these communities. While this approach to dam removal is cost-effective for the dam owner and relatively easy to implement as it requires little preparatory work other than a progressive removal of the dam stop logs and notching of the spillway, it does pose significant risk of erosion within the lake basin and of deposition downstream. The consequences of downstream deposition include loss of State-listed threatened and endangered species of fish and mollusks, as well as other riverine species resident within the reach of the Bark River upstream of Upper Nemahbin Lake. Sediment deposition within this stream reach also would potentially impair navigation and create a possible economic hardship for boat liveries and property owners resident along the River. This Alternative could pose a risk of further failure of the raceway, either of the raceway wall due to the difference in water elevations (and, therefore, water pressure) between the River and raceway or of the berm in the vicinity of the former penstock and inlet to the millrace, an issue identified and documented by the WDNR in their order of July 2008. Because of the risks posed to downstream property owners, properties, and critical ecological elements, this Alternative is not considered to be a feasible approach to the abandonment of the Roller Mill Dam.

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[3]*See SEWRPC "Preliminary Vegetation Survey: Nemahbin* [sic] *Mill Dam Site," June 2009: 48 species of wetland plants were recorded during this survey, 14 of which were noted to be nonnative plant species. Three species of submergent and floating-leaved aquatic plants also were reported, including* Chara *sp.,* Potamogeton *spp., and* Nymphaea odorata.

[4]*See Jeffrey A. Thornton, Discussion: "Geomorphic Analogies for Assessing Probable Channel Response to Dam Removal, by Martin W. Doyle, Emily H. Stanley, and Jon M. Harbor,"* Journal of the American Water Resources Association, *Volume 39, Issue 5, Pages 1309-1310, October 2003; Martin W. Doyle, Emily H. Stanley, and Jon M. Harbor, "Geomorphic Analogies for Assessing Probable Channel Response to Dam Removal,"* Journal of the American Water Resources Association, *Volume 38, Issue 6, Pages 1567-1579, December 2002; Martin W. Doyle, Emily H. Stanley, and Jon M. Harbor, "Reply to Discussion by Jeffrey A. Thornton,"* Journal of the American Water Resources Association, *Volume 39, Issue 5, pages 1311-1312, October 2003.*

Alternative 2 would bypass Bark River flows through the dam structure, most likely at a point along the earthen embankment, while in-basin rehabilitation works were undertaken. This Alternative would be designed to pass the nominal base flow of the River through a constructed bypass channel. In a variation of this Alternative, reconstruction of a new stream channel could potentially be coordinated with operations at the upstream Nagawicka Lake Dam to minimize flows in the Middle Bark River during construction. This variant may not require construction of a bypass channel if construction can be completed in a period of days and flow from Nagawicka Lake Dam is closed down, but may require a (temporary) modification of the operating permit for the Nagawicka Lake Dam. While this Alternative has the benefit of potentially allowing construction to be undertaken under essentially "no-flow" conditions, it would require careful coordination with the City of Delafield—owner and operator of the Nagawicka Lake Dam—and with the National Weather Service to minimize risk of flooding from storm-related high flow events. This risk is further exacerbated by the high rate of groundwater flow in this area, which would suggest that, even if a bypass channel was in place and operating to design specifications, the current lake basin may not be able to be dewatered sufficiently to allow in-basin construction to occur, although an over-winter construction sub-Alternative or the creation of a temporary sump to allow seepage to be pumped downstream might overcome this possible limitation. The provision of a bypass channel would have the benefit of continuing to allow stream flow to pass through the dam structure, thereby allowing in-basin stabilization work to proceed with reduced risk from flood events. Nevertheless, there are potential negative aspects which outweigh the positive aspects of this Alternative. The primary risks associated with this Alternative are the risk that the proposed bypass channel and/or pumped sump may not be able to accommodate flood flows, and the high costs of construction likely to be associated with a bypass channel or operation association with a pumped option. This Alternative alone is not considered to be a feasible approach to the abandonment of the Roller Mill Dam, although as recommended below aspects of this Alternative should be considered for implementation.

Alternative 3 would create a sediment retention basin in the vicinity of the "deep hole" of the former Applebecker Millpond. Because this deep hole is currently inundated with unconsolidated sediment, removal of the accumulated sediment would be required for this basin to be effective in retaining unconsolidated sediments likely to be eroded from the upstream portions of the Basin or likely to be mobilized during the process of stream recreation within the Basin. Because "head cutting" (erosion) of the unconsolidated sediment currently contained within the former lake basin is a major threat to the downstream reach of the Bark River, noted under Alternative 1 above, this Alternative would provide a mechanism for the capture and containment of the mobilized sediment. Sediments mobilized by head cutting or by the construction of the stream channel would have to be removed from the sedimentation basin periodically to ensure adequate capacity within the sedimentation basin to capture and retain any eroded or mobilized sediments. This Alternative would provide a significant degree of protection for the downstream reach of the Bark River and for Upper Nemahbin Lake during the period of stream re-creation and dam removal. Once the stream is re-created, the basin and the remaining dam structure could be removed with reduced risk to the downstream reach of the Bark River. The cost of retaining the mobilized sediments onsite is expected to be relatively low; however, under this Alternative, materials captured in the instream sedimentation basin would need to be periodically removed from the basin either to an offsite disposal location to be determined or pumped as slurry into geo-tubes or other onsite containment system. The additional cost of transporting retained materials could be significant. Disposal within the former lake basin would greatly reduce the transportation costs associated with spoil disposal. From a conceptual perspective, placement of these geo-tubes or similar containment structures along the southern shoreline of the current lake basin and outside of the existing wetlands would provide protection of this shoreline from erosion and provide the basis for the protection of the wetlands that currently exist along this shoreline. Management of the sediments contained in the geo-tubes would be an issue; however, these sediments could be buried in place or distributed elsewhere within the former lakebed once the abandonment was underway. The geo-tubes, for example, could be used to create wetland cells within the basin that would create a variety of wildlife habitat within the restored stream corridor. Given the protections which this Alternative would provide for the downstream segment of the Bark River and for Upper Nemahbin Lake, this Alternative is a feasible approach to the abandonment of the Roller Mill Dam.

Under Alternative 3, it is recommended that the existing millrace be isolated from the remainder of the dam structure of the Roller Mill Dam by means of a cofferdam or other structural mechanism to ensure that this southern portion of the dam wall remains stable.

Alternatives Associated with the Issuance of a New Operating Permit for the Roller Mill Dam[5]
Alternative 4 would be to issue a new operating permit for the Roller Mill Dam to a third party, who would then be responsible for the execution of the maintenance program being required in order to maintain the structural integrity of the dam. In this regard, Chapter 31 of the *Wisconsin Statutes* gives priority to a municipal form of government, which would include a public inland lake protection and rehabilitation district constituted under Chapter 33 of the *Wisconsin Statutes*. Issue of a new dam operating permit would obligate the permitee to comply with any outstanding remedial actions being required of the former dam owner. Acquisition of a dam subject to an abandonment proceeding by a municipal governmental entity is a potential outcome of the abandonment process, as noted in Section 31.185(4) of the *Wisconsin Statutes*. This alternative was actively debated by the City of Delafield, with the determination that the City did not wish to proceed with seeking an operating permit. Because of the absence of an eligible municipal sponsor, this Alternative is not considered to offer a feasible alternative to the abandonment of the Roller Mill Dam.

Recommended Management Measures
Regardless of the final disposition of the Roller Mill Dam, it is recommended that the unconsolidated sediments remaining in the former lake basin of the Applebecker Millpond be stabilized and actively managed to limit further impacts to the downstream portion of the Middle Bark River and its confluence with Upper Nemahbin Lake. To this end, implementation of the sediment management measures summarized as Alternative 3 is recommended. Alternative 3 provides mechanisms for the capture and containment of the mobilized sediment. This Alternative would provide a significant degree of protection for the downstream reach of the Bark River and for Upper Nemahbin Lake during the period of stream recreation and dam removal. Once the stream is re-created, the basin and the remaining dam structure could be removed with reduced risk to the downstream reach of the Bark River.

It also is recommended that the dam owner, in partnership with the WDNR—and with the possible participation of other interested parties, such as land conservancies—recreate the original stream that historically formed the bed of Applebecker Millpond. This stream alignment is shown on Map 12. Recreation of this stream channel will rehabilitate the habitat, recreate the hydrological integrity of the Middle Bark River between Upper Nemahbin Lake and the upstream Nagawicka Lake, and restore the ambience and visual amenity value of this historically disturbed ecosystem.[6]

Consideration of reconstructing the stream through the basin of the former Applebecker Millpond in association with the stream regulation element of Alternative 2, which would reduce or temporarily stop flows from the upstream Nagawicka Lake, potentially would have the advantage of minimizing the need for a bypass channel, although concerns relating to groundwater flows into the former Millpond would remain. In this regard, the timing of construction—with construction potentially taking place during winter—could be an important consideration during the engineering design phase of the (abandonment) process.

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[5]*On April 9, 2009, a Wisconsin Department of Administration Administrative Law Judge ruled that "the dam be declared abandoned" and that the owner of the Roller Mill Dam "develop final plans and specifications for the removal of the dam…". This decision reaffirmed the drawdown order, authorized the removal of the structure, and effectively precluded Alternative 4 as a viable Alternative. See Wisconsin Division of Hearings and Appeals Case No.: IP-SE-2008-68-67868 and Case No.: IP-SE-2008-68-67870, April 21, 2009. See Appendix E.*

[6]*It should be noted that the site attributes that made this site a desirable location for an impoundment, namely the steepness of the grade change, could continue to pose limitations on the ability of fishes and other organisms to colonize a recreated stream channel by upstream migration from the lower reaches of the Middle Bark River.*

Map 12

HISTORICAL ALIGNMENT OF THE MIDDLE BARK RIVER THROUGH THE APPLEBECKER MILLPOND BASIN

DATE OF PHOTOGRAPHY: APRIL 2005

In addition, it is recommended that the WDNR implement remedial in-stream measures to reduce the volume of unconsolidated sediment deposited in the reach of the Middle Bark River downstream of the Roller Mill Dam extending to the confluence with Upper Nemahbin Lake. While it is unlikely that such measures can recover the extent of the biological diversity previously recorded from this River reach, especially among less mobile organisms like the mussels which may take a significant time to recover, there is a high likelihood of such actions benefiting the fisheries community that was formerly resident in this area. Because of their greater mobility in the face of such extreme river pollution, fishes are potentially more resilient when conditions are recovered. The use of a small suction dredge is recommended as a management measure likely to result in the least additional disturbance to this River reach during the remediation project.

Lower Nemahbin Lake-CTH P Dam

As of 2009, the Waukesha County Department of Public Works, Highway Operations Division, and Wisconsin Department of Transportation (WisDOT) had placed the reconstruction of CTH P on their schedule for possible action within the next several years. Because the existing water level control structure is fully integrated into the existing bridge abutment and structure, it is likely that portions of the weir will have to be rebuilt as a consequence of the road work.

Array of Management Measures

Alternatives Associated with the Reconstruction of the Lower Nemahbin Lake-CTH P Dam

Alternative 1 maintains the current structure and elevations associated with the CTH P weir. This Alternative would preserve the connectivity of the public recreational boating access site located between IH 94 and the CTH DR corridors, and ensure continuity of recreational opportunities and hydrological functions currently associated with Upper and Lower Nemahbin Lakes.

Alternative 2, proposed by the UNLMD, would provide for an inflatable weir crest system, which could allow limited manipulation of the lake levels in the conjoined Upper and Lower Nemahbin and Lower Nashotah Lake system, that could be installed at the time the CTH P weir is rebuilt or repaired.[7] Under this alternative, the UNLMD has suggested that provision be made to raise the surface elevation of the Lakes by approximately 0.5 feet from the current surface elevation so as to enhance navigability, especially during dry periods. Operation of such a system would require active management of the weir by staff, potentially the dam owner or staff from the Town of Summit or UNLMD, as well as coordination with the gate operations at Nagawicka Lake. In this regard, the U.S. Army Corps of Engineers notes that the use of inflatable weirs has been associated with reduced structural longevity relative to other types of structures, increased vulnerability to vandalism, and potentially higher associated maintenance costs. Additionally, permitting requirements pursuant to Chapter 31 of the *Wisconsin Statutes*, relating to the change of dam design and potentially of water surface elevation, would have to be addressed. Because there is a significant flooding risk to homes and businesses along the Middle Bark River, especially along the CTH DR corridor adjacent to the lake outlet, and because this risk would extend to other low lying areas of the three Lakes, this alternative is not recommended.

Alternative 3, that of providing a means to lower water levels, which could moderate flood risks along CTH DR, among others, is not considered a desirable alternative by lake residents. However, should the weir at the CTH P site be reconstructed with a gate system (for example), it would be possible to potentially manage the flooding risks affecting the three Lakes—Upper and Lower Nemahbin Lakes and Lower Nashotah Lake—while maintaining navigability during droughts. While this alternative is not recommended at this time, it is recommended that this Alternative be explored further at such time as the redesign of the weir at CTH P is undertaken. As in the case of Alternative 2, issues to be considered would be associated with the operation of this gated structure, assignment of responsibilities for such operation, and allocation of resources to cover these operational costs.

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[7]*See U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, "Performance Survey of Inflatable Dams in Ice-Affected Waters,"* Ice Engineering*, No. 30, October 2001.*

In a variation of Alternative 3, a limited drawdown, including any changes in water surface elevations likely to be experienced during road construction, may have implications for sediment transport within that portion of the Middle Bark River where deposition of unconsolidated sediments eroded from the Roller Mill Dam basin has occurred. A reduced water surface elevation may cause such sediments to be, in part, partially consolidated within the stream channel or partially remobilized and transferred into the depositional areas of Upper Nemahbin Lake, both with concomitant negative impacts on navigation and in-stream/in-lake ecology. Should the community wish to explore these issues, however, it is further recommended that the WDNR, WisDOT, Town of Summit, Upper Nemahbin Lake Management District, and owner of the impoundment—the Nemahbin Advancement Association—participate in the discussions.

Both Alternative 2 and Alternative 3 also would require action to modify the dam operating permit issued by the WDNR pursuant to authorities granted under Chapter 31 of the *Wisconsin Statutes*.

Recommended Management Measures

At such time as the CTH P bridge over the Bark River at the outlet of Lower Nemahbin Lake is reconstructed, it is recommended that any future design include provision for the replacement of the current water level control structure with a control structure of similar capacity and design, with the same design water surface elevation as at present. This structure could be modified so as to provide for additional drawdown to minimize flood risks upstream, particularly in the vicinity of the Upper Nemahbin Lake outlet and the associated infrastructure and development adjacent to CTH DR to further minimize flood risks in that area, but the design and operation of such modifications would have to be accomplished in a way that would avoid downstream flooding because of increased discharges from Lower Nemahbin Lake. Increasing the surface elevations of the Upper and Lower Nemahbin and Lower Nashotah Lakes is not recommended due to the fact that such actions would increase the existing flood risks to infrastructure adjacent to CTH DR, at other locations along the shorelines of Upper and Lower Nemahbin Lakes and downstream of Lower Nemahbin Lake due to alteration in floodwater storage capacity. This alternative also would limit access to the Lakes by decreasing clearances between the lake water surface and the bridges. Likewise, decreasing the surface elevations of the Upper and Lower Nemahbin and Lower Nashotah Lakes is not recommended due to the fact that such actions possibly would reduce the ability of recreational watercraft launched at the public recreational boating access site located between the IH 94 and CTH DR corridors to access either or both of the Nemahbin Lakes due to limited water depths.

MANAGEMENT MEASURES RELATING TO UPPER NEMAHBIN LAKE

Aquatic Plant Communities and Ecologically Valuable Areas

As stated in Chapter II of this report, recent aquatic plant management activities in Upper Nemahbin Lake can be categorized as primarily based upon chemical herbicide treatment to manage nuisance levels of aquatic plant growth in the Lake. In addition, individual householders on Upper Nemahbin Lake are known to have engaged in manual harvesting in the vicinities of their piers and docks.

The shoreland and aquatic macrophyte management elements of this plan 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* governing recreational boating facilities, and with the public recreational boating access requirements set forth under Chapter NR 1 of the *Wisconsin Administrative Code*.

Array of Management Measures

Aquatic plant management measures can be classed into four groups: ***physical measures***, which include lake bottom coverings and water level management; ***biological measures***, which include the use of various organisms, including herbivorous insects and plantings of aquatic plants; ***manual*** and ***mechanical measures***, which include harvesting and removal of aquatic plants; and, ***chemical measures***, which include the use of aquatic herbicides. All control measures are stringently regulated and require a State of Wisconsin permit; chemical controls are regulated under Chapter NR 107 of the *Wisconsin Administrative Code,* and all other aquatic plant management practices are regulated under Chapter NR 109 of the *Wisconsin Administrative Code*. Placement of bottom covers,

a physical measure, also requires a WDNR permit under Chapter 30 of the *Wisconsin Statutes*. Costs range from minimal for manual removal of plants using rakes and hand-pulling, to upwards of $75,000 for the purchase of a mechanical plant harvester, for which the operational costs can approach $2,500 to $25,000 per year depending on staffing and operation policies.

Physical Measures

Lake bottom covers and light screens provide limited control of rooted plants by creating a physical barrier which reduces or eliminates the sunlight available to the plants. Sand and gravel are usually widely available and relatively inexpensive to use as cover materials, but plants readily recolonize areas so covered in about a year. Synthetic materials, such as polyethylene, polypropylene, fiberglass, and nylon, can provide relief from rooted plants for several years. However, such materials, known as bottom screens or barriers, generally have to be placed and removed annually. Such barriers also are susceptible to disturbance by watercraft propellers or the buildup of gasses from decaying plant biomass trapped under the barriers. In the case of Upper Nemahbin Lake, the need to encourage native aquatic plant growth while simultaneously controlling the growth of Eurasian water milfoil, suggests that the placement of lake bottom covers as a method to control aquatic plant growth does not appear to be warranted. Thus, such measures are not considered viable for Upper Nemahbin Lake.

Biological Measures

Biological controls offer an alternative approach to controlling nuisance plants, particularly purple loosestrife (*Lythrum salicaria*), an invasive shoreland wetland plant, and Eurasian water milfoil. Classical biological control techniques have been successfully used to control both nuisance plants with herbivorous insects.[8] Recent evidence shows that *Galerucella pucilla* and *Galerucella calmariensis*, beetle species, and *Hylobius transversovittatus* and *Nanophyes brevis*, weevil species, have potential as biological control agents for purple loosestrife.[9] Extensive field trials conducted by the WDNR in the Southeastern Wisconsin Region since 1999 have indicated that these insects can provide effective management of large infestations of purple loosestrife. In contrast, the few studies of Eurasian water milfoil control utilizing *Eurhychiopsis lecontei*, an aquatic weevil species, have resulted in variable levels of control, with little control being achieved, especially on those lakes having extensive motorized boating traffic. Thus, while the use of insects as a means of shoreland wetland plant management is considered to be viable, the use of *Eurhychiopsis lecontei* as a means of aquatic plant management control is not considered a viable option for use on Upper Nemahbin Lake at this time.

The use of grass carp, *Ctenopharyngodon idella*, an alternative biological control used elsewhere in the United States, is not permitted in Wisconsin. This voracious herbivore has been shown to denude lakes and ponds of aquatic vegetation, exposing lake bottom sediments to wind erosion and increasing turbidity in lakes and ponds, and enhancing the likelihood of occurrence of nuisance algal blooms.[10]

A variation on the theme of biological control is the introduction of aquatic plants into a waterbody as a means of encouraging or stimulating the growth of desirable native aquatic plant species in a lake. While few projects of this nature have been undertaken in the Southeastern Wisconsin Region, the Lac La Belle Management District, in partnership with the WDNR and University of Wisconsin-Milwaukee, did attempt to supplement the aquatic

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[8]*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.*

[9]*Sally P. Sheldon, "The Potential for Biological Control of Eurasian Water Milfoil (*Myriophyllum spicatum*) 1990-1995 Final Report," Department of Biology Middlebury College, February 1995.*

[10]*C. Holdren, W. Jones and J. Taggart,* Managing Lakes and Reservoirs, *Third Edition, North American Lake Management Society, Terrene Institute, and U.S. Environmental Protection Agency, 2001.*

plant community of that Lake by selectively planting pondweeds (*Potamogeton* spp.).[11] Several hundred pondweeds were transplanted into Lac La Belle, and, while there is some evidence that a few of these transplants were successful, the net outcome of the project was disappointing. Few of the introduced plants were observed in subsequent years.[12] Given the apparent low success rate, supplemental plantings are not considered to be a viable aquatic plant management option for Upper Nemahbin Lake at this time.

Manual and Mechanical Measures

The physical removal of specific types of vegetation by selective harvesting of plants provides a highly selective means of controlling the growths of nuisance aquatic plant species, including purple loosestrife and Eurasian water milfoil. Pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, manual harvesting of aquatic plants within a 30-foot-wide corridor along a 100-foot length of shoreline would be allowed without a WDNR permit, provided the plant material is removed from the 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.

Aquatic macrophytes also may be harvested mechanically with specialized equipment consisting 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 plant growth as it removes the plant biomass and nutrients from a lake. Mechanical harvesting is particularly effective as a measure to control large-scale growths of aquatic plants. Narrow channels can be harvested to provide navigational access and "cruising lanes" for predator fish to migrate into the macrophyte beds to feed on smaller fish. The harvesting of water lilies and other emergent native plants should be avoided.

"Clear cutting" aquatic plants and denuding the lake bottom of flora, using either manual or mechanical harvesting, should be avoided. However, top cutting of plants, such as Eurasian water milfoil, using mechanical harvesters, as shown in Figure 18, has proven to be beneficial in some lakes as a means of minimizing the competitive advantage of the Eurasian water milfoil plant and encouraging native aquatic plant growths.[13]

In the shoreland area, where purple loosestrife may be expected to occur, bagging and cutting loosestrife plants prior to the application of chemical herbicides to the cut ends of the stems, can be an effective control measure for small infestations of this plant. Loosestrife management programs, however, should be followed by an annual monitoring and control program for up to 10 years following the initial control program to manage the regrowth of the plant from seeds. Manual removal of such plants is recommended for isolated stands of purple loosestrife when and where they occur.

In the nearshore area, specially designed rakes are available to assist in the manual removal of nuisance aquatic plants, such as Eurasian water milfoil. The use of such rakes also provides a safe and convenient method of

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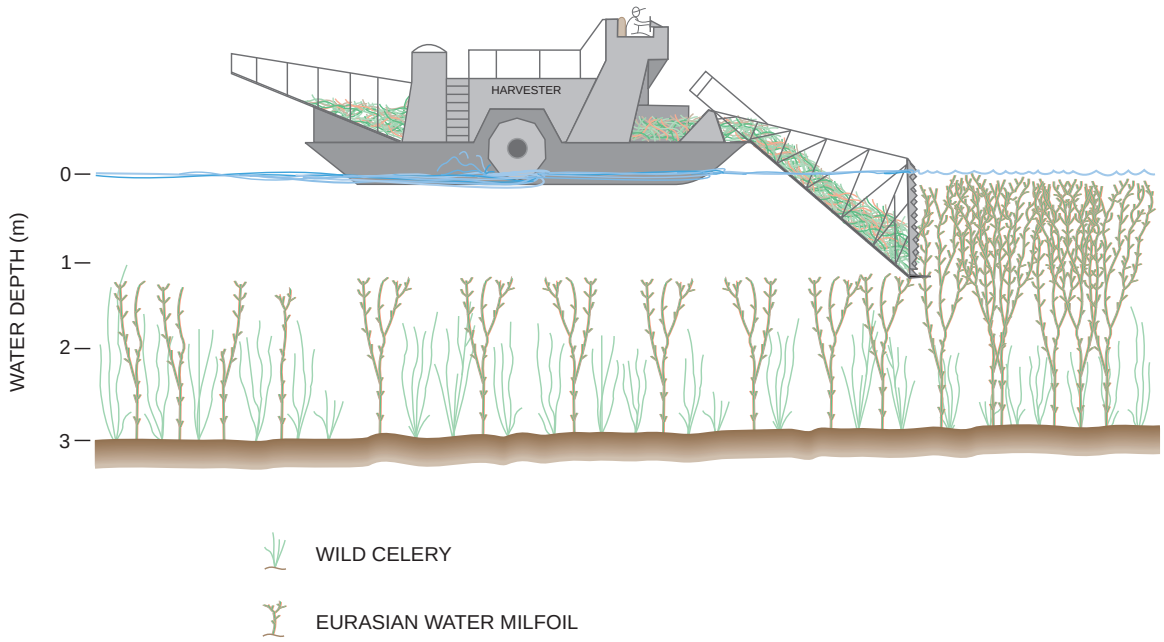
[11]*Donald H. Les and Glenn Guntenpergen, "Laboratory Growth Experiments for Selected Aquatic Plants, Final Report, July 1989–June 1990 (Year 1)," Report to the Wisconsin Department of Natural Resources, June 1990;Wisconsin Department of Natural Resources, Environmental Assessment: Improvement of the Water Quality and Fisheries Habitat of LacLaBelle [sic] and the Lower Oconomowoc River, s.d.*

[12]*At the 2003 annual meeting of the Lac La Belle Management District, a citizen reported observing a herbicide application in the vicinity of the planted area of the Lake. Such an application might explain the observed lack of success of this management measure. See SEWRPC Community Assistance Planning Report No. 47, 2nd Edition,* A Water Quality Management Plan for Lac La Belle, Waukesha County, Wisconsin, *May 2007.*

[13]*See SEWRPC Memorandum Report No. 143,* An Aquatic Plant Management Plan for the Lauderdale Lakes, Walworth County, Wisconsin, *August 2001.*

Figure 18

PLANT CANOPY REMOVAL 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.

controlling aquatic plants in deeper nearshore waters around piers and docks. The advantage of the rakes is that they are relatively inexpensive, easy and quick to use, and immediately remove the plant material from the lake, without a waiting period. Removal of the plants from the lake avoids the accumulation of organic matter on the lake bottom, which adds to the nutrient pool that favors further plant growth. State permitting requirements for manual aquatic plant harvesting mandate that the harvested material be removed from the lake. Should the UNLMD acquire a number of these specially designed rakes, they could be made available for the riparian owners to use on a trial basis to test their operability before purchasing them.

Hand-pulling of stems, where they occur in isolated stands, provides an alternative means of controlling plants, such as Eurasian water milfoil, in the Lake, and purple loosestrife, on the lakeshore. Because this is a more selective measure, the rakes being nonselective in their harvesting, manual removal of Eurasian water milfoil is considered a viable option in Upper Nemahbin Lake, where practicable and feasible.

An advantage of mechanical aquatic plant harvesting is that the harvester typically leaves enough plant material in the lake to provide shelter for fish and other aquatic organisms, and to stabilize the lake bottom sediments. Aquatic plant harvesting also has been shown to facilitate the growth of native aquatic plants in harvested areas by allowing light penetration to the lakebed. Many native aquatic plants are low-growing species that are less likely to interfere with human recreational and aesthetic uses of a lake. A disadvantage of mechanical harvesting is that the harvesting operation may cause fragmentation of plants and, thus, unintentionally facilitate the spread of some plants that utilize fragmentation as a means of propagation, namely Eurasian water milfoil. Harvesting may also disturb bottom sediments in shallower areas where such sediments are only loosely consolidated,

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 that an exotic species, such as Eurasian water milfoil, may colonize the disturbed area since this is a species that tends 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. 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 shallow water areas, the loosely consolidated nature of the bottom sediments, and the species composition, mechanical harvesting is not considered a viable management option as a control of aquatic plants in much of Upper Nemahbin Lake.

Chemical Measures

Chemical treatment with herbicides is a short-term method of controlling heavy growths of nuisance aquatic plants. Chemicals are generally applied to the growing plants in either a liquid or granular form. The advantages of using chemical herbicides to control aquatic macrophytes growth are the relatively low-cost and the ease, speed, and convenience of application. The disadvantages associated with chemical control include unknown long-term effects on fish, fish food sources, and humans; a risk of increased algal blooms due to the eradication of macrophyte competitors; an increase in organic matter in the sediments, possibly leading to increased plant growth, as well as anoxic conditions which can cause fish kills; adverse effects on desirable aquatic organisms; loss of desirable fish habitat and food sources; and, finally, a need to repeat the treatment the following summer due to existing seed banks and/or plant fragments. Widespread chemical treatments can also provide an advantage to less desirable, invasive, introduced plant species to the extent that such treatments may produce conditions in which nonnative species can outcompete the more beneficial, native aquatic plant species. Hence, this is seldom a feasible management option to be used on a large scale. Widespread chemical treatment, therefore, is not considered a viable option for Upper Nemahbin Lake, although limited chemical control is often a viable technique for the control of the relatively small-scale infestations of aquatic plants, such as Eurasian water milfoil, or shoreland plants, such as purple loosestrife.

To minimize the possible impacts of deoxygenation, loss of desirable plant species, and contribution of organic matter to the sediments, early spring or late fall applications should be considered. Such applications also minimize the concentration and amount of chemicals used due to the facts that colder water temperatures enhance the herbicidal effects, while the application of chemical herbicides during periods when most native aquatic plants species are dormant limits the potential for non-target species impacts. 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 or late fall chemical controls,[14] especially in those shoreline areas where mechanical harvesting would not be deemed viable, targeting growths of Eurasian water milfoil or other invasive nuisance aquatic plants and purple loosestrife in and around the Lake, is considered a viable option for Upper Nemahbin Lake.

[14]*It should be noted that, at the time of writing, late fall herbicide treatments are considered to be experimental in Wisconsin and will not typically be permitted by the WDNR at this time, pending further research into the use of such treatments. It also is noted that many aquatic plants become dormant during the late fall and winter, die back, and do not meet the nuisance standards established pursuant to Chapter NR 107 of the* Wisconsin Administrative Code *as the basis for the application of aquatic herbicides. Consequently, late fall applications of herbicides are not recommended.*

Protection of Natural Areas and Ecologically Valuable Areas

Ecological balance and natural beauty are important determinants of the ability of an area to provide a pleasant and habitable environment for all forms of life and to maintain its social and economic well being. Preservation of the most significant aspects of the natural resource base is therefore essential to the well being of an area. One of the most important tasks completed under the regional planning program for southeastern Wisconsin has been the identification and delineation of those areas in the Region in which concentrations of the best remaining elements of the natural resource base occur. The protection and preservation of such areas in essentially natural, open uses is crucial in maintaining both the ecological balance and natural beauty of the Region and the planning area. The delineation of these natural resource and resource-related elements on a map results in an essentially linear pattern of relatively narrow, elongated areas which have been termed "environmental corridors" by the Regional Planning Commission. Primary environmental corridors include a wide variety of the important natural resource and resource-related elements.

In any consideration of environmental corridors, it is important to note that the preservation of such resources can assist in flood flow attenuation, water pollution abatement, and favorable climate modification. In addition, because of the many interacting relationships between living organisms and their environment, the destruction or deterioration of any one element of the natural resource base may lead to a chain reaction of deterioration and destruction of other elements. The draining and filling of wetlands, for example, may destroy fish spawning grounds, wildlife habitat, groundwater recharge areas, and the natural filtration action and flood water storage functions of interconnecting stream systems. The resulting deterioration of surface water quality may, in turn, lead to deterioration of the quality of groundwater, which serves as a source of domestic, municipal, and industrial water supply and on which low flows in rivers and streams may depend. Similarly, the destruction of woodland cover may result in soil erosion and stream siltation, more rapid stormwater runoff and attendant increased flood flows and stages, and destruction of wildlife habitat.

Although the effects of any one of these environmental changes may not in and of itself be overwhelming, the combined effects will eventually create serious environmental and developmental problems. These problems include flooding, water pollution, deterioration and destruction of wildlife habitat, loss of groundwater recharge areas, and destruction of the unique natural beauty of the area. The need to maintain the integrity of the remaining environmental corridors thus becomes apparent.

Recommended Management Measures

The most-effective plans for managing aquatic plants rely on a combination of methods and techniques, such as those described above. Therefore, to enhance the recreational uses of Upper Nemahbin Lake, while maintaining the quality and diversity of the biological communities, the following recommendations are made:

- Manual harvesting around piers and docks is recommended as a means of controlling growths of nonnative nuisance species of plants in these areas. In this regard, the UNLMD could consider purchasing several specialty rakes designed for the removal of vegetation from shoreline property and make these available to riparian owners. This would allow the riparian owners to use the rakes on a trial basis before purchasing their own. Although the rakes do not require a permit for use along a 30-foot-wide length of shoreline, State requirements for manual aquatic plant harvesting mandate that the harvested material be removed from the lake. Where feasible and practicable, hand-pulling of stems, where they occur in isolated stands, is also recommended as an alternative means of controlling Eurasian water milfoil and purple loosestrife. Manual control should target nonnative species.

- It is recommended that the use of chemical herbicides be limited to controlling nuisance growths of exotic species, particularly Eurasian water milfoil and purple loosestrife; chemical control of curly-leaf pondweed could be considered in cases where the growths of this plant extend into the recreational boating season.

- It is recommended that chemical applications be made by licensed applicators in early spring, subject to State permitting requirements, to maximize their effectiveness on nonnative plant species while minimizing impacts on native plant species and acting as a preventative measure to reduce the development of nuisance conditions. Such use should be evaluated annually and the herbicide applied only on an as-needed basis. Only herbicides that target Eurasian water milfoil and curly-leaf pondweed, such as 2,4-D and endothall, should be used;[15] for the control of purple loosestrife, the use of glyphosate could be considered for application to the cut stems of the plants after the seed heads have been bagged and cut.[16] If necessary, diquat also could be considered for use to control growths of curly-leaf pondweed.[17]

- The use of algicides, such as Cutrine Plus, is not generally recommended; however, should algicides be used to control filamentous algal growths in the nearshore area, the use of such chemical control agents should be minimized to avoid loss of valuable macroscopic algae, such as *Chara* spp., which also can be killed by these products.[18] Maintenance of shoreland areas around docks and piers remains the responsibility of individual property owners.

- Informational programming is recommended to encourage riparian owners to monitor their shoreline areas, as well as open-water areas of the Lake, for new growths of nonnative nuisance plants and report such growths immediately to the UNLMD so that a timely and effective response can be executed.

- It is recommended that the UNLMD consider the conduct of in-lake aquatic plant surveys at about three- to five-year intervals, depending upon the observed degree of change in the aquatic plant communities. In addition, information on the aquatic plant control program should be recorded and should include descriptions of major areas of nuisance plant growth and areas chemically treated.

- Additional periodic monitoring of the aquatic plant community is recommended for the early detection and control of future-designated nonnative species that may occur. Such control could be effected with the assistance of funds provided under the Chapter NR 198, aquatic invasive species control grant program, and should be undertaken as soon as possible once the presence of a nonnative, invasive species is observed and confirmed, reducing the risk of spread from waters where they are present and restoring native aquatic communities. Control of currently designated invasive

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[15]*2,4-D also will control desirable species, such as* Nymphaea *sp. and* Utricularia *spp., known to occur in Upper Nemahbin Lake; see Wisconsin Department of Natural Resources PUBL-WR-236 90,* Chemical Fact Sheet: 2,4-D, *May 1990. Endothall also will control desirable species, such as* Valisneria americana *and* Chara *spp., known to occur in Upper Nemahbin Lake; see Wisconsin Department of Natural Resources PUBL-WR-237 90,* Chemical Fact Sheet: Endothall, *May 1990.*

[16]*See Wisconsin Department of Natural Resources PUBL-WR-239 90,* Chemical Fact Sheet: Glyphosate, *May 1990.*

[17]*See Wisconsin Department of Natural Resources PUBL-WR-237 90,* Chemical Fact Sheet: Endothall, op. cit.*; diquat also will control desirable species, such as* Elodea *spp.; see Wisconsin Department of Natural Resources PUBL-WR-235 90,* Chemical Fact Sheet: Diquat, *May 1990.*

[18]*See Wisconsin Department of Natural Resources PUBL-WR-238 90,* Chemical Fact Sheet: Copper Compounds, *May 1990.*

species, designated pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, using appropriate control measures,[19] is recommended throughout the Lake.

- The primary environmental corridors include the best remaining woodlands, wetlands, and wildlife habitat areas, and are, in effect, composites of the best remaining residual elements of the natural resource base of the planning area. These corridors have truly immeasurable environmental and recreational value. The protection of the primary environmental corridors from intrusion by incompatible rural and urban uses, and thereby from degradation and destruction, will serve to maintain a high level of environmental quality in the planning area, protect its natural beauty, and provide valuable recreation opportunities and is, therefore, recommended.

Land Use and Water Quality

Water quality is one of the key parameters used to determine the overall health of a waterbody. Water quality, in turn, is the net result of the delivery of a range of substances to the aquatic environment through direct discharges to the water, atmospheric deposition onto the water surface, and runoff into the water from the land surface. Human activities on the landscape mobilize increased numbers and masses of contaminants, which can adversely affect the aquatic environment. Consequently, interventions are required to minimize this impact. The importance of good water quality can hardly be underestimated, as it affects nearly every facet of the natural balances and relationships that exist in a lake between the myriad of abiotic and biotic elements present. Because of the importance water quality plays in the functioning of a lake ecosystem, careful monitoring of this lake element represents a fundamental management tool.

Array of Management Measures

The University of Wisconsin-Extension (UWEX) operates the Citizen Lake Monitoring Network (CLMN), formerly the WDNR Self-Help Monitoring Program. Volunteers enrolled in this program gather data at regular intervals on water clarity through the use of a Secchi disk. Because water quality degradation tends to reduce water clarity, Secchi-disk measurements are generally considered one of the key parameters in determining the overall quality of a lake's water, as well as a lake's trophic status. Secchi-disk measurement data are added to the WDNR-sponsored data base containing lake water quality information for most of the lakes in Wisconsin and is accessible on-line through the WDNR website. An Expanded Self-Help Monitoring Program that involves collecting data on several key physical and chemical parameters in addition to the Secchi-disk measurements also is offered. Under this program, samples of lake water are collected by volunteers at regular intervals and analyzed by the State Laboratory of Hygiene (SLOH). Data collection is more extensive and, consequently, places more of a burden on volunteers. In the recent past, members of the LSWHA have taken part in the abovedescribed programs, collecting water quality data on an intermittent basis.

In addition to the UWEX volunteer-based CLMN program, the University of Wisconsin-Stevens Point (UWSP) offers several volunteer-conducted water quality sampling programs. Under these latter programs, volunteers collect water samples and send them to the UWSP Water and Environmental Analysis Laboratory (WEAL) for analysis. The U.S. Geological Survey (USGS) also offers an extensive water quality monitoring program under their Trophic State Index monitoring program. USGS field personnel conduct a series of approximately five monthly samplings beginning with the spring turnover. Samples are analyzed by the SLOH for an extensive array of physical and chemical parameters. Either of these programs will provide the community with a more detailed analysis of the conditions of the Lakes and form an important baseline from which changes in lake trophic state

[19] *Appropriate control measures include, but are not limited to, any permitted aquatic plant management measure, placement of signage, and use of buoys to isolate affected areas of the Lake. Such measures as may be appropriate should be determined in consultation with WDNR staff and conducted in accordance with required permits under Chapters NR 107, NR 109, and NR 198, among others, of the* Wisconsin Administrative Code.

can be assessed. Such periodic assessments are an important element of tracking the success of lake management measures, and for identifying future issues of concern prior to such issues becoming major problems within the Lakes.

The basic UWEX CLMN program is available at no charge, but does require volunteers to be committed to taking Secchi disk measurements at regular intervals throughout the spring, summer, and fall. The Expanded Self-Help Program requires additional commitment by volunteers to take a more-extensive array of measurements and samples for analysis, also on a regular basis. As with any volunteer-collected data, despite the implementation of standardized field protocols, individual variations in levels of expertise due to background and experiential differences, can lead to variations in data and measurements from lake-to-lake and from year-to-year for the same lake, especially when volunteer participation changes.

The UWSP turnover sampling program requires only a once-a-year sampling, thereby requiring a smaller time commitment by the volunteers, but, there is a modest charge for the laboratory analysis, and, because sampling is performed by volunteers, is subject to those variations identified above. Additionally, since samples need to be taken as closely as possible to the actual turnover period, which occurs only during a relatively short window of time, volunteers need to monitor lake conditions as closely as possible to be able to determine when the turnover period is occurring. This sampling program forms a good complement to the UWEX CLMN volunteer monitoring program.

The USGS program does not require volunteer sampling. All sampling and analysis is provided by USGS personnel using standardized field techniques and protocols. As a result, a more standardized set of data and measurements may be expected. However, the cost of the USGS program is significantly higher than the UWSP program, even with State cost-share availability.

Recommended Management Measures

The WDNR offers Small Grant cost-share funding within the Chapter NR 190 Lake Management Planning Grant Program that can be applied for to defray the costs of laboratory analysis and sampling equipment. It is recommended that the UNLMD continue regular participation in the CLMN program sponsored by the UWEX. Data gathered as part of this program should be presented annually by the volunteers at the annual meeting of the UNLMD, where the citizen monitors could be given some recognition for their work. The Lake Coordinator of the WDNR, South East Region, could assist in enlisting more volunteers in this program. The information gained at first-hand by the public from participation in this program can increase the credibility of the proposed changes in the nature and intensity of use to which the Lake is subjected.

It is further recommended that the UNLMD participate in one of the more comprehensive water quality programs on a periodic basis every three to five years: either the UWSP WEAL lake sampling program or USGS program. The use of either the UWSP or USGS programs would be especially valuable as a means to attain a comprehensive water quality determination on a periodic basis while maintaining yearly CLMN data.

Insofar as future land usage affects water quality, it is recommended that development around Upper Nemahbin Lake proceed with due regard for the management of stormwater and other urban runoff so as not to impair the water quality of the Lake. To wit, it is recommended that:

- Development within the area tributary to Upper Nemahbin Lake should occur at densities consistent with those set forth in the adopted regional land use and county development plans;

- Land use development, or redevelopment, proposals around the shoreline of the Lake be carefully reviewed for potential impacts on the Lake;

- Residential developments be placed in conservation developments on smaller lots, while preserving portions of the open space on each property or group of properties considered for development and preserving the natural and cultural resources to the extent practicable;

- Urban pollution control measures, including wet detention basins, infiltration basins, grassed swales, and good urban "housekeeping" practices, be encouraged to minimize pollutant loadings to the Lakes;

- Where new development or redevelopment is proposed, the provisions of the relevant local government land division and construction site erosion control ordinances be strictly enforced within the area tributary to the Lake; and,

- Sound rural land management practices be implemented to reduce soil loss and contaminant loadings through preparation of farm conservation plans and other rural practices adopted in accordance with the county land and water resource management plan.

Implementation of the management measures required to comply with Federal Phase II Final Rules governing Municipal Separate Storm Sewer Systems (MS4s) within the urban areas of the Cities of Delafield and Oconomowoc, the Villages of Hartland, Merton, Nashotah and Richfield, and the Towns of Merton and Summit—designated as urbanized areas within the State of Wisconsin—should contribute to the mitigation of urban sourced pollutants currently being delivered to the Bark River.

Recreational Use

Current public recreational boating standards as set forth in Sections NR 1.91(4) and NR 1.91(5) of the *Wisconsin Administrative Code*, establish minimum and maximum standards for public boating access development, respectively, to qualify waters for resource enhancement services provided by the WDNR. As noted in Chapter II, public recreational boating access opportunities on Upper Nemahbin Lake conform to the current State public recreational boating access standards.[20] Periodic review of these standards is recommended in order to ensure continuing eligibility for future grants from the WDNR for lake enhancement services.

In addition to provision of adequate public recreational boating access, it is recommended that appropriate signage at the public recreational boating access site be provided to alert users of Eurasian water milfoil, zebra mussels, and other nonnative invasive species. Such information should also be included in the Association's informational programming, consistent with the aquatic plant management measures set forth in this plan. The District should also consider participating in the UWEX Clean Boats-Clean Waters Program.

Public Informational and Educational Programming

As part of the overall citizen informational and educational programming to be conducted in the Upper Nemahbin Lake community, residents and visitors in the vicinity of the Lakes should be made aware of the value of the ecologically significant areas in the overall structure and functioning of the ecosystems of the Lakes. Specifically, informational programming related to the protection of ecologically valuable areas in and around the Lake should focus on the need to minimize the spread of nuisance aquatic invasive species, such as purple loosestrife and Eurasian water milfoil. As set forth in Appendix F, such informational programming has been part of the "Water Quality Report" presented at the District's annual meetings in recent years, and it is proposed that such programming will be continued.

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[20]*Chapter NR1 of the* Wisconsin Administrative Code *requires that public inland lakes have adequate public recreational boating access in order for the lake to be eligible for financial and/or technical assistance from the Wisconsin Department of Natural Resources. Such assistance includes the ability to access State lake rehabilitation, nonpoint source water pollution control, fish management, and/or water safety aides, including access to State cost-share funding for enhancement services.*

With respect to aquatic plants, distribution of posters and pamphlets, available from the UWEX and the WDNR, that provide information and illustrations of aquatic plants, their importance in providing habitat and food resources in aquatic environments, and the need to control the spread of undesirable and nuisance plant species is recommended. Currently, many lake residents seem to view all aquatic plants as "weeds" and residents often spend considerable time and money removing desirable plant species from a lake without considering their environmental impact. Inclusion of specific public informational and educational programming within the activities of the UNLMD is recommended. These programs should focus on the value and impacts of these plants on water quality, fish, and on wildlife, and on alternative methods for controlling existing nuisance plants, including the positive and negative aspects of each method. These programs can be incorporated into the comprehensive informational and educational programs that also would include information on related topics, such as water quality, recreational use, fisheries, and onsite sewage disposal systems.

Educational and informational brochures and pamphlets, of interest to homeowners and supportive of the lake management program, are available from the UWEX, the WDNR, the Waukesha County Offices, and many Federal government agencies. These brochures could be provided to homeowners through local media, direct distribution, or targeted library/civic center displays. Alternately, they could be incorporated into the newsletters produced and distributed by the UNLMD. Many of the ideas contained in these publications can be integrated into ongoing, larger-scale activities, such as anti-littering campaigns, recycling drives, and similar pro-environment activities.

Other informational programming offered by the WDNR, Waukesha County, and the UWEX Lakes Program, such as the Adopt-A-Lake program and Project WET (Water Education Training) curriculum, can contribute to an informed public, actively involved in the protection of ecologically valuable areas within the area tributary to Upper Nemahbin Lake. Citizen monitoring and awareness of the positive value of native aquatic plant communities are important opportunities for public informational programming and participation that are recommended for the Lake.

SUMMARY

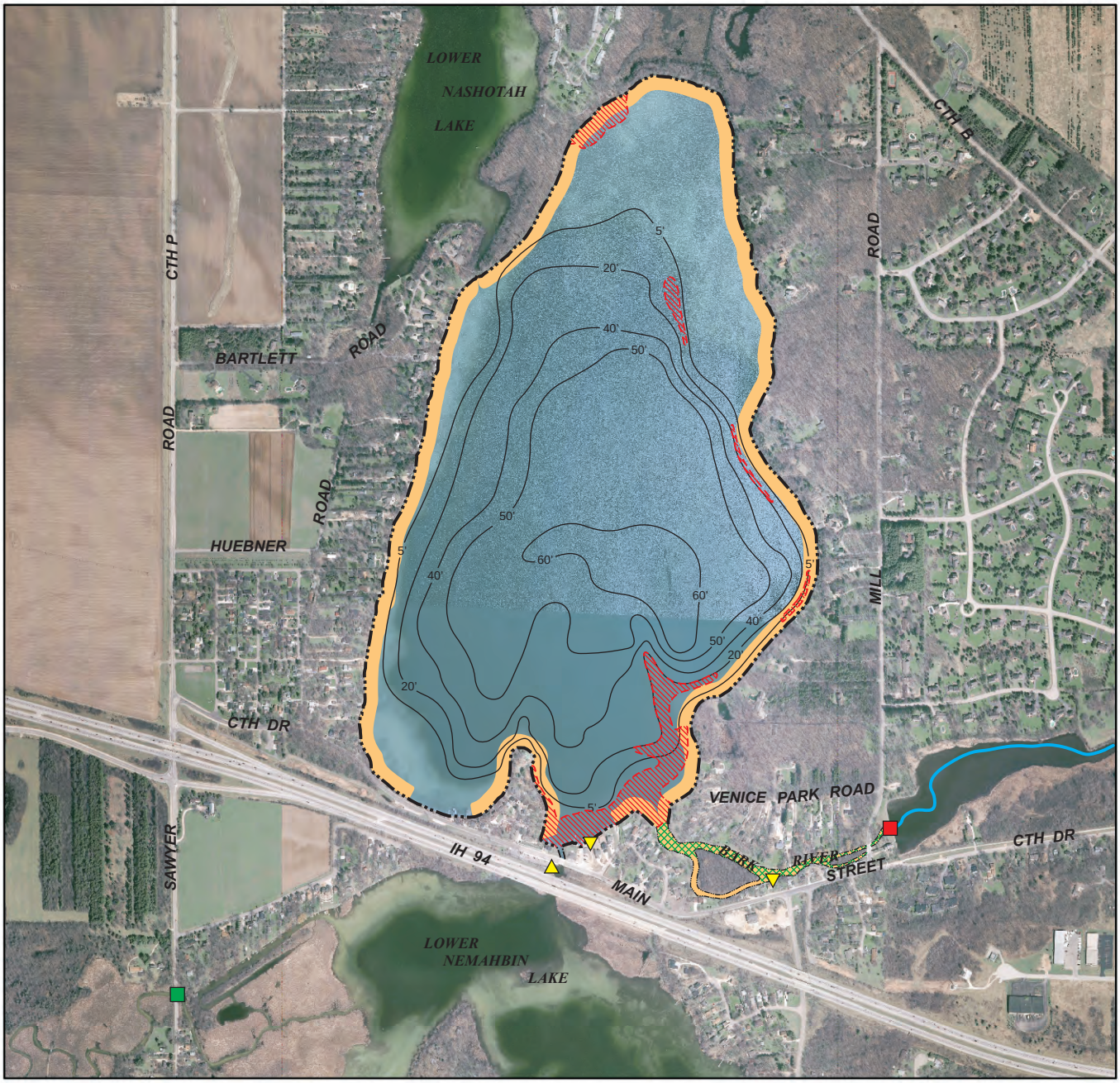
This plan documents the findings and recommendations of a study of Upper Nemahbin Lake and the associated reaches of the Middle Bark River both upstream and downstream of the Lake, requested by the UNLMD. This plan examines existing and anticipated water quantity and water quality conditions associated with proposed changes to the Roller Mill Dam and Lower Nemahbin Lake-CTH P dam, existing and anticipated water quality conditions associated with ongoing development in the drainage basin, potential aquatic plant management problems, and recreational use problems on the Lake. The plan sets forth recommended actions and management measures for the resolution of those problems. The recommended plan is summarized in Table 24 and shown on Map 13.

Upper Nemahbin Lake was found to be was well within the mesotrophic range, bordering on meso-oligotrophic, as indicated by a WTSI value of about 40, with above average water quality for lakes in the Region. This improvement in water quality conditions from those reported during the late 1970s was attributed, at least in part, to the result of implementation of point source recommendations set forth in the regional water quality management plan, including the installation of sanitary sewer systems and the elimination of upstream wastewater treatment plants. Further improvement in water quality may be anticipated as the designated MS4 communities within the tributary area progressively implement stormwater management measures.

Preservation of environmental corridor lands, and especially within the shoreland areas situated immediately adjacent to the Lakes, is recommended. To this end, the UNLMD should support appropriate land management practices designed to reduce nonpoint source pollutant discharges in stormwater runoff into the Lake, and promote appropriate shoreline management practices, including the use of riprap and vegetative buffer strips, where applicable.

Map 13

RECOMMENDED PROTECTION PLAN FOR UPPER NEMAHBIN LAKE



— 20' — WATER DEPTH CONTOUR IN FEET

△ PUBLIC ACCESS SITE - MAINTAIN PURSUANT TO CHAPTER NR 1

▽ PRIVATE ACCESS SITE

■ REPAIR/RESTORE CTH P WEIR, MAINTAIN CURRENT CREST ELEVATION

■ REMOVE/REPAIR ROLLER MILL DAM FOLLOWING RESTORATION OF HISTORIC STREAM CHANNEL

IMPOUNDMENTS MANAGEMENT

RESTORE HISTORIC STREAM CHANNEL THROUGH THE APPLEBECKER MILLPOND PRIOR TO REMOVAL OF ROLLER MILL DAM

RESTORE NAVIGABILITY AND HABITAT OF MIDDLE BARK RIVER AND MAINTAIN

AQUATIC PLANT MANAGEMENT

EURASIAN WATER MILFOIL CONTROL AREA CHEMICAL: HIGH PRIORITY

- CONDUCT PERIODIC SURVEYS OF AQUATIC PLANT COMMUNITIES, MONITOR FOR INVASIVE SPECIES

WATER QUALITY MANAGEMENT

- CONTINUE PARTICIPATION IN UWEX CLMN PROGRAM
- CONSIDER PERIODIC DETAILED WATER QUALITY ASSESSMENT USING USGS TSI PROGRAM OR EQUIVALENT

LAND MANAGEMENT

- ENCOURAGE LAND USE DEVELOPMENT CONSISTENT WITH COUNTY DEVELOPMENT PLAN

PROMOTE AND MAINTAIN VEGETATED SHORELAND BUFFERS, MAINTAIN SHORELAND PROTECTION STRUCTURES

INFORMATIONAL PROGRAMMING

- CONTINUE EDUCATIONAL AND INFORMATIONAL PROGRAMMING

GRAPHIC SCALE

0 600 1200 FEET

Source: SEWRPC.

The plan recommends limited use of chemical herbicides mainly in areas where nuisance levels of nonnative invasive species—Eurasian water milfoil, curly-leaf pondweed, and purple loosestrife—are present, manual harvesting aquatic plants around piers and docks with subsequent removal of cut material from the Lakes, and monitoring of invasive species populations. The plan further recommends periodic in-lake aquatic plant surveys every three to five years to monitor changes in the aquatic plant community and assess effectiveness of aquatic plant management techniques.

The plan recommends regular participation in the UWEX CLMN volunteer water quality monitoring program with consideration of participation in the Expanded Self-Help Program, and periodic conduct of USGS, or equivalent, comprehensive water quality surveys.

With regard to recreational uses of Upper Nemahbin Lake, the plan recommends maintaining public recreational boating access consistent with Chapter NR 1 standards and Chapter NR 7 guidelines, as well as erecting and maintaining signage regarding aquatic and other invasive species.

Finally, the recommended plan includes continuation of an ongoing program of public information and education, focusing on providing riparian residents and lake users with an improved understanding of the lake ecosystem. For example, additional options regarding household chemical use, lawn and garden care, shoreland protection and maintenance, and recreational use of the Lake should be made available to riparian property owners, thereby providing riparian residents with alternatives to traditional activities.

Adherence to the recommendations contained in this plan should provide the basis for a set of management actions that are: aligned with the goals and objectives set forth in Chapter I of this report; reflective of the ongoing commitment by the Upper Nemahbin Lake community, through the UNLMD and the Town of Summit, to sound planning with respect to the Lake; and, sensitive to current needs, as well as those in the immediate future.

APPENDICES

Appendix A

WISCONSIN DEPARTMENT OF NATURAL RESOURCES ORDER TO DRAW DOWN ROLLER MILL DAM: JUNE 2008

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Matthew J. Frank, Secretary
Gloria L. McCutcheon, Regional Director

Waukesha Service Center
141 NW Barstow St. Room 180
Waukesha, Wisconsin 53188
Telephone 262-574-2100
FAX 262-574-2117
TTY Access via relay - 711

June 18, 2008

Mrs. Margaret Zerwekh
500 Mill Road
Delafield, WI 53018

Subject: Order to Draw Down the Nemahbin Roller Mill Dam, Field File #67.27

Dear Margaret:

Thank you for your cooperation last week during the rain events. We appreciate your efforts to keep the dam safe during the high flows.

Enclosed with this letter please find an Order to Draw Down the Nemahbin Roller Mill Dam. As we discussed earlier this week, I have included the most current copy of the Department's list of engineers and contractors. The Department does not certify or recommend any of these engineers but is providing the list as a resource for your use. Please note that prior to performing any work on the dam the Department must approve the plans and specifications.

If you have any questions regarding this order, or are unsure on how to proceed, please contact me at (608) 628-2870.

Again, thank you for your cooperation.

Sincerely,

Michelle Schneider
Water Management Engineer

CC: Meg Galloway, P.E. Dam Safety & Floodplain Section Chief, WDNR – GEF II, WT/3
Warden Mitch Groenier

BEFORE THE
DEPARTMENT OF NATURAL RESOURCES

IN THE MATTER of the Unsafe Condition of the Nemahbin Roller Mill Dam, Located on the Bark River, Waukesha County.

ORDER FOR DAM DRAW DOWN

FINDINGS OF FACT

The Department finds that:

1. The Nemahbin Roller Mill Dam is located on the Bark River in the NW Quarter of the NW Quarter of Sec. 19, T7N, R18E, in the City of Delafield, Waukesha County. The Nemahbin Roller Mill Dam impounds the Applebecker Millpond.
2. The Nemahbin Roller Mill Dam is currently owned by Margaret Zerwekh, 500 Mill Road, Delafield, WI, 53018.
3. On June 11-13, 2008, Department personnel investigated the Nemahbin Roller Mill Dam to assess possible damage from the high water conditions.
   a. On Wednesday, June 11, one of the abandoned mill race gates broke open, allowing water to flow through the penstock. On Thursday, June 12, the mill race was partially blocked by inserting a metal plate in the penstock.
   b. The I-beams that support the stoplog structure in the principal spillway are deteriorated.
   c. The concrete in the mill race has degraded significantly.
4. During the course of the week, all of the stoplogs were removed from the principal spillway.
5. The dam is currently under an order to reconstruct or abandon and remove by December 1, 2008.
6. The dam in its present condition is not sufficiently strong, and is unsafe, and dangerous to life, health and property.

CONCLUSIONS OF LAW

The Department concludes that:

1. The Department of Natural Resources has authority pursuant to sections 31.02 and 31.19, Wisconsin Statutes to inspect or cause an inspection to be made of any dam or reservoir.
2. The Department of Natural Resources has authority pursuant to sections 31.02 and 31.19, Wisconsin Statutes to order alterations and repairs to any dam that is not sufficiently strong or is unsafe, and that is dangerous to life, health and property.
3. The Department of Natural Resources has authority pursuant to sections 31.02 and 31.19, Wisconsin Statutes to order the draw down of the impoundment above a dam that is not sufficiently strong or is unsafe, and that is dangerous to life, health and property.

ORDER

It is therefore ordered that:

1. The owner of the Nemahbin Roller Mill Dam shall replace three stoplogs in each of the four bays by June 21, 2008.
2. The owner of the Nemahbin Roller Mill Dam shall draw down the Applebecker Millpond to the elevation maintained by keeping all stoplogs removed from the spillway of the dam and securing the stoplogs away from the dam site by September 1, 2008. The owner shall begin removing stoplogs at a rate of approximately one stoplog every four days on July 7, 2008 until all stoplogs have been removed.
3. The impoundment shall remain drawn down until reconstruction or removal of the dam is completed. The owner shall inspect the dam on a daily basis to ensure that no additional obstruction to flow is placed in the structure, and shall promptly remove any such obstructions found.

NOTICE OF APPEAL RIGHTS

If you believe that you have the right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed.

To request a contested case hearing pursuant to s.227.42, Wis. Stats., you have 30 days after the decision is mailed or otherwise served by the Department of Natural Resources. The filing of a request for a contested case hearing is not a prerequisite for judicial review and does not extend the 30-day period for filing a petition for judicial review.

This decision was hand delivered on June 18, 2008.

STATE OF WISCONSIN DEPARTMENT OF NATURAL RESOURCES
For the Secretary

By Michelle Schneider 6-18-2008

Michelle Schneider
Water Management Engineer

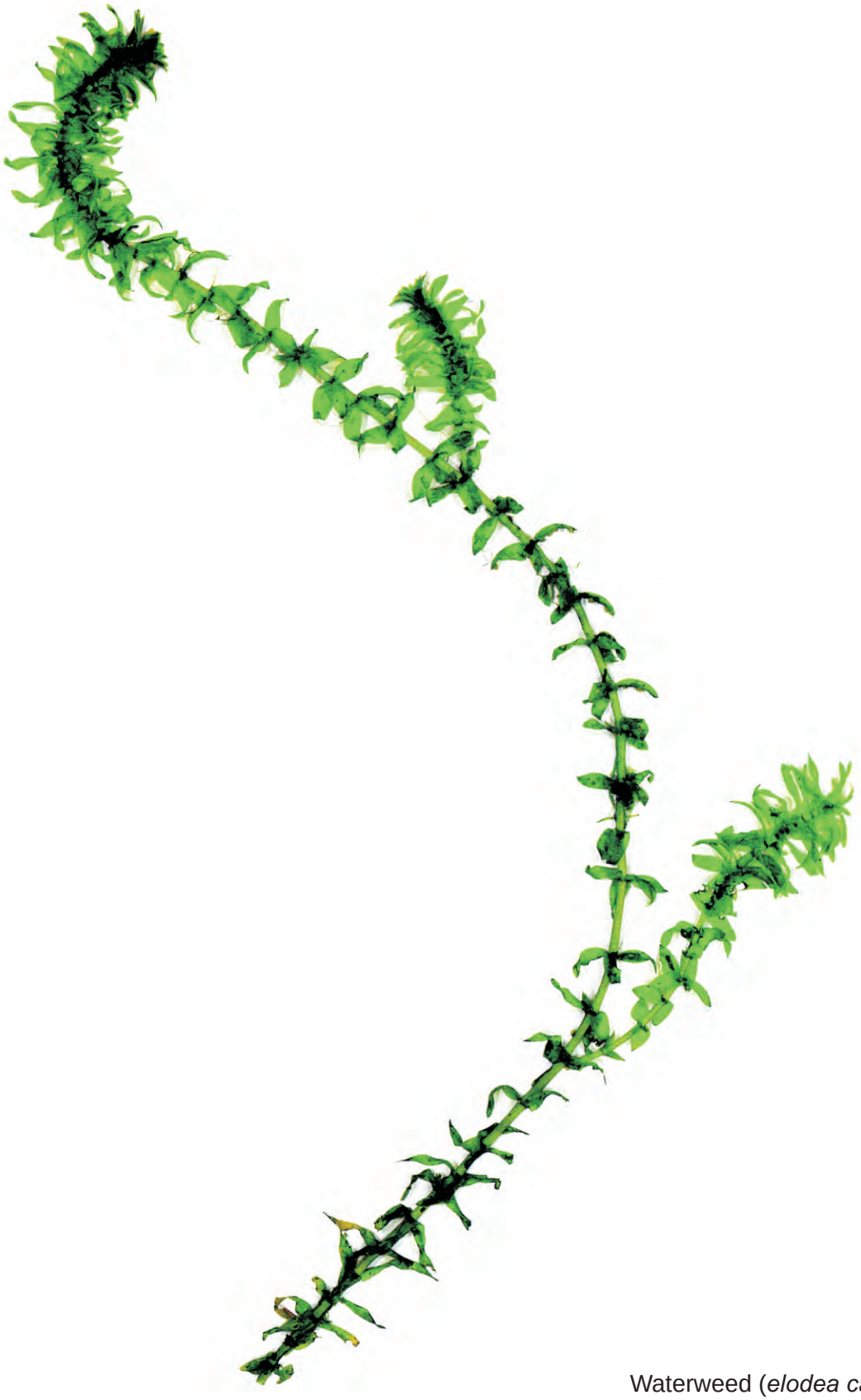
Date

Appendix B

REPRESENTATIVE ILLUSTRATIONS OF AQUATIC PLANTS FOUND IN UPPER NEMAHBIN LAKE

Coontail (*ceratophyllum demersum*)

Muskgrass (*chara vulgaris*)



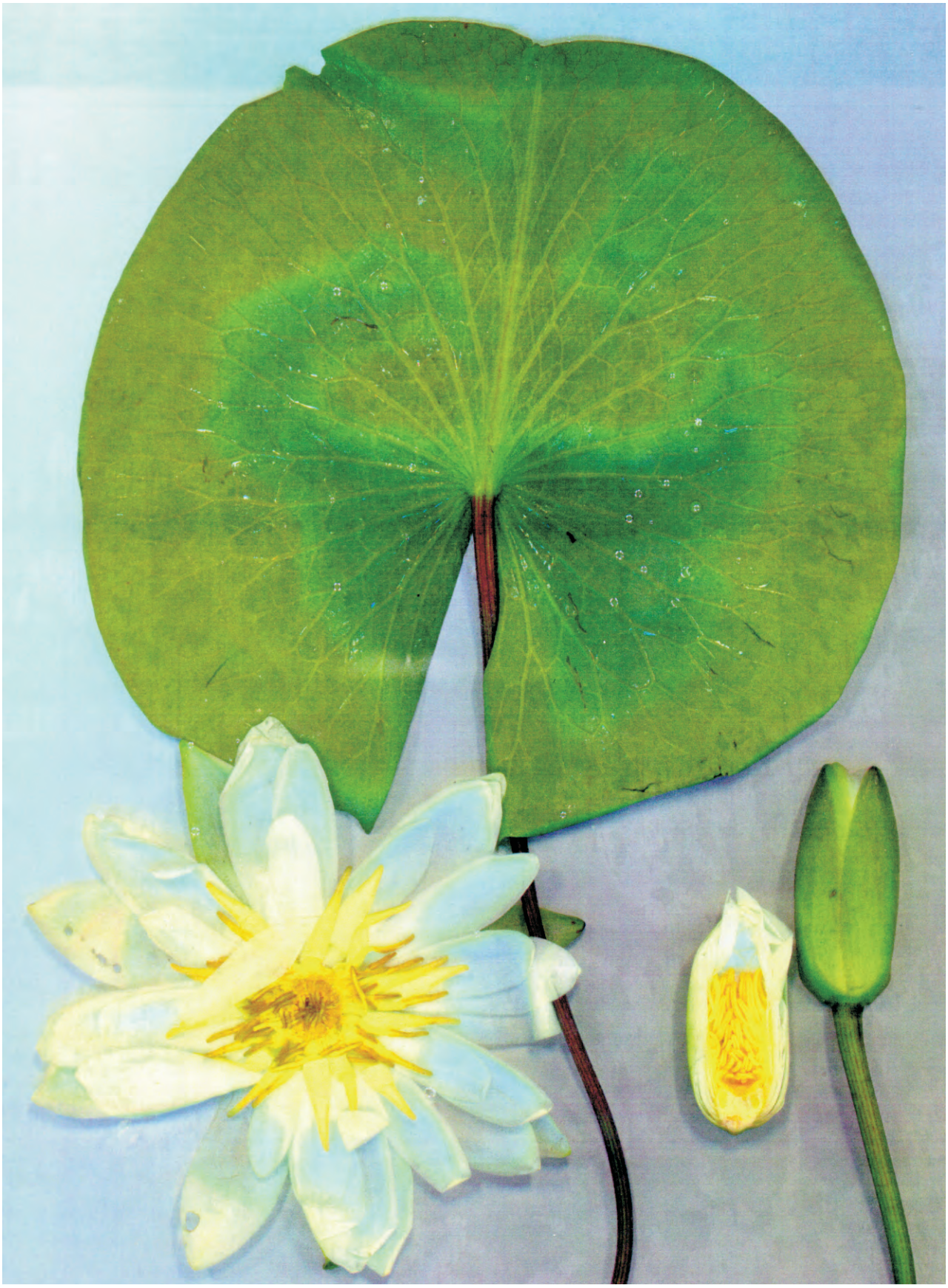
Waterweed (*elodea canadensis*)

Native Water Milfoil (*myriophyllum* sp.)

Eurasian Water Milfoil (*myriophyllum spicatum*)
Exotic Species (nonnative)

Bushy Pondweed (*najas flexilis*)

Spiny Naiad (*najas marina*)



White Water Lily (*nymphaea odorata*)

Large-Leaf Pondweed (*potamogeton amplifolius*)

Curly-Leaf Pondweed (*potamogeton crispus*)
Exotic Species (nonnative)

Variable Pondweed (*potamogeton gramineus*)

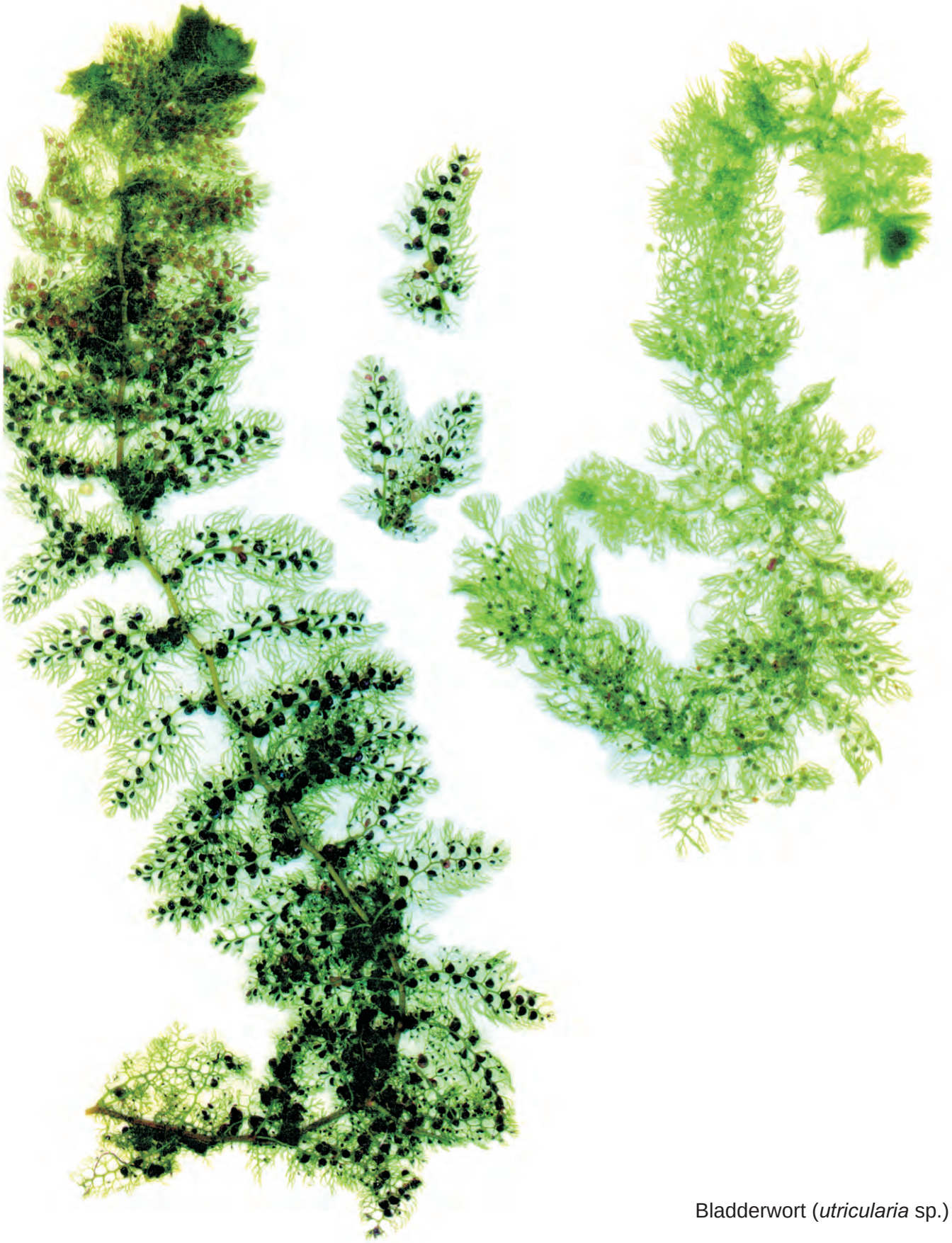
Illinois Pondweed (*potamogeton illinoensis*)

Sago Pondweed (*potamogeton pectinatus*)

White-Stem Pondweed (*potamogeton praelongus*)

Clasping-Leaf Pondweed
(*potamogeton richardsonii*)

Flat-Stem Pondweed (*potamogeton zosteriformis*)



Bladderwort (*utricularia* sp.)

Eel-Grass / Wild Celery (*valisneria americana*)

Appendix C

RECREATIONAL BOATING ORDINANCE APPLICABLE TO UPPER NEMAHBIN LAKE

Chapter 82

BOATING

[HISTORY: Adopted by the Town Board of the Town of Summit as indicated in article histories. Amendments noted where applicable.]

GENERAL REFERENCES

Parks — See Ch. 174.

ARTICLE I
Use and Operation of Motor Boats
[Adopted 12-3-1992 by Ord. No. 182]

§ 82-1. Applicability; enforcement officers. [Amended 4-1-1993 by Ord. No. 181]

A. The provisions of this article shall apply to the waters of Lower Nemahbin, Lower Genesee, Middle Genesee, Crooked Lake, Duck Lake, Waterville Lake, Lake Laura, Bowron Lake and Egg Lake, within the jurisdiction of the Town of Summit.

B. The provisions of this article shall be enforced by the officers of the Water Safety Patrol Unit and police of the jurisdiction of the Town of Summit.

§ 82-2. State boating and water safety laws adopted.

A. Except as otherwise specifically provided in this article, the current and future statutory provisions describing and defining regulations with respect to water traffic, boats, boating, and related water activities in §§ 30.50 up to and including 30.71, Wis. Stats., 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 article 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 article. Any further additions, amendments, revisions or modifications of the statute incorporated herein are intended to be made part of this article in order to secure uniform statewide 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 article by deferring to the same as if they are or were to be set out herein verbatim.

§ 82-3. Speed restrictions.

A. No motor boat shall be operated on Lake Laura, Egg Lake, or Duck Lake at any time at a speed in excess of slow — no-wake.

B. No motor boat shall be operated on Lower Nemahbin, Lower Genesee, Middle Genesee, Crooked Lake, Waterville Lake or Bowron Lake from sunset until sunrise at a speed in excess of slow — no-wake. [Amended 4-1-1993 by Ord. No. 181]

§ 82-4. Swimming regulations.

No person, unless said person is engaging in activities and subject to the provisions of § 30.70, Wis. Stats., 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 in 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.

§ 82-5. Local regulation on icebound inland waters.

A. No person shall operate or park or permit, authorize, direct or control the operation or parking of or ride as a passenger on any motorized vehicle or motor-driven vehicle, including but not limited to motor vehicles, snowmobiles, or all-terrain vehicles, on the ice on any portion of the aforementioned lakes.

B. The Chief of Police of the Town of Summit, upon application to him and payment of a license fee established by the Town Board, being satisfied that ice conditions do and will permit operation of a motorized vehicle or motor-driven vehicle upon a designated portion of the lake without material risk or hazard, may issue a written permit expiring within 24 hours after issuance authorizing operation of a motorized vehicle or motor-driven vehicle on the lake for particular purposes to be specified in such permit. Said particular purposes shall be limited to snowplowing of a portion of the lake for an ice skating rink, transporting of property to an island or conducting official lake studies. No such permit shall authorize speed or acrobatic contests, exhibitions or performances; racing; fishing; nor shall any such permit authorize joyriding, sightseeing or any other activity not deemed necessary by the Chief of Police.

§ 82-6. Violations and penalties.

A. State boating and water safety laws and all other violations as set forth in § 82-2 of this article. Any forfeiture for violation of the state statute, rule or order adopted by reference in § 82-2 of this article 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. Violation of local boating laws as set forth in §§ 82-3, 82-4 and 82-5 of this article shall be subject to the penalties set forth in Chapter 1, General Provisions, Article I, Penalties, of the Code of the Town of Summit.[1]

§ 82-7. Enforcement.

A. Enforcement procedure. The statutory provisions of §§ 66.0109, 66.0113, 66.0114, 30.29, 30.50 to 30.71, and Ch. 799, Wis. Stats., are adopted and by reference made a part of this article 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 article. Any future additions, amendments, revisions or modifications of the statutes incorporated herein are intended to be made part of this article in order to secure uniform statewide regulation and enforcement of boating ordinance violations. Further, the Town of Summit specifically elects to use the citation method of enforcement.

B. Deposits.

(1) Schedule of deposits. The schedule of cash deposits shall be as follows:

(a) § 82-2: 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.

(b) §§ 82-3, 82-4 and 82-5: $50 plus court costs and assessments plus current assessment fees and current court costs if applicable.

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1. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

(2) Deposit for repeat offenses. Any person found guilty of violating this article or any part thereof who was previously convicted of violating the same section within the last year shall forfeit twice the deposit delineated above plus court costs and penalty assessment.[2]

(3) Nonscheduled 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 therefor 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 article does not preclude the Town Board 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 Board 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.

ARTICLE II
Upper Nashotah Lake
[Adopted 12-3-1992 by Ord. No. 180]

§ 82-8. Applicability; enforcement officers.

A. The provisions of this article shall apply to the waters of Upper Nashotah Lake, within the jurisdiction of the Town of Summit and the City of Delafield.

B. The provisions of this article shall be enforced by the officers of the Water Safety Patrol Unit and police of the jurisdiction of the Town of Summit.

§ 82-9. State boating and water safety laws adopted.

A. Except as otherwise specifically provided in this article, the current and future statutory provisions describing and defining regulations with respect to water traffic, boats, boating, and related water activities in §§ 30.50 up to and including 30.71, Wis. Stats., 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 article 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 article. Any further additions, amendments, revisions or modifications of the statute incorporated herein are intended to be made part of this article in order to secure uniform statewide 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 article by deferring to the same as if they are or were to be set out herein verbatim.

§ 82-10. Speed restrictions.

No motor boat shall be operated on Upper Nashotah Lake from sunset until sunrise at a speed in excess of slow — no-wake.

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2. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

§ 82-11. Swimming regulations.

No person, unless said person is engaging in activities and subject to the provisions of § 30.70, Wis. Stats., 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 in 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.

§ 82-12. Local regulation on icebound inland waters.

A. No person shall operate or park or permit, authorize, direct or control the operation or parking of or ride as a passenger on any motorized vehicle or motor-driven vehicle, including but not limited to motor vehicles, snowmobiles, or all-terrain vehicles, on the ice on any portion of Upper Nashotah Lake.

B. The Chief of Police of the Town of Summit, upon application to him and payment of a license fee established by the Town Board, being satisfied that ice conditions do and will permit operation of a motorized vehicle or motor-driven vehicle upon a designated portion of the lake without material risk or hazard, may issue a written permit expiring within 24 hours after issuance authorizing operation of a motorized vehicle or motor-driven vehicle on the lake for particular purposes to be specified in such permit. Said particular purposes shall be limited to snowplowing of a portion of the lake for an ice skating rink, transporting of property to an island or conducting official lake studies. No such permit shall authorize speed or acrobatic contests, exhibitions or performances; racing; fishing; nor shall any such permit authorize joyriding, sightseeing or any other activity not deemed necessary by the Chief of Police.

§ 82-13. Violations and penalties.

A. State Boating and Water Safety Laws and all other violations as set forth in § 82-9 of this article. Any forfeiture for violation of the State statute, rule or order adopted by reference in § 82-9 of this article 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. Violation of local boating laws as set forth in §§ 82-10, 82-11 and 82-12 of this article shall be subject to the penalties set forth in Chapter 1, General Provisions, Article I, Penalties, of the Code of the Town of Summit.[3]

§ 82-14. Enforcement.

A. Enforcement procedure. The statutory provisions of §§ 66.0109, 66.0113, 66.0114, 30.29, 30.50 to 30.71, and Ch. 799, Wis. Stats., are adopted and by reference made a part of this article 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 article. Any future additions, amendments, revisions or modifications of the statutes incorporated herein are intended to be made part of this article in order to secure uniform statewide regulation and enforcement of boating ordinance violations. Further, the Town of Summit and the City of Delafield specifically elect to use the citation method of enforcement.

B. Deposits.

(1) Schedule of deposits. The schedule of cash deposits shall be as follows:

3. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

(a) § 82-9: 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.

(b) §§ 82-10, 82-11 and 82-12: $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 article or any part thereof who was previously convicted of violating the same section within the last year shall forfeit twice the deposit delineated above plus court costs and penalty assessment.[4]

(3) Nonscheduled 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 therefor 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 article does not preclude the Town Board or Common Council 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 Board or Common Council 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.

ARTICLE III
Golden Lake
[Adopted 12-3-1992 by Ord. No. 183]

§ 82-15. Applicability; enforcement officers.

A. The provisions of this article shall apply to the waters of Golden Lake, within the jurisdiction of the Town of Summit and the Town of Concord.

B. The provisions of this article shall be enforced by the officers of the Water Safety Patrol Unit and police of the jurisdiction of the Town of Summit.

§ 82-16. State boating and water safety laws adopted.

A. Except as otherwise specifically provided in this article, the current and future statutory provisions describing and defining regulations with respect to water traffic, boats, boating, and related water activities in §§ 30.50 up to and including 30.71, Wis. Stats., 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 article 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 article. Any further additions, amendments, revisions or modifications of the statute incorporated herein are intended to be made part of this article in order to secure uniform statewide 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

4. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

hereby incorporated in and made a part of this article by deferring to the same as if they are or were to be set out herein verbatim.

§ 82-17. Speed restrictions.

No motor boat shall be operated on Golden Lake from sunset until sunrise at a speed in excess of slow — no-wake.

§ 82-18. Swimming regulations.

No person, unless said person is engaging in activities and subject to the provisions of § 30.70, Wis. Stats., 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 in 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.

§ 82-19. No-wake requirement.

A No-Wake Law shall be in effect on Golden Lake on Saturdays, Sundays and all legal holidays between 12:00 noon and 4:00 p.m.

§ 82-20. Motor vehicles on Golden Lake when icebound.

No person shall operate or park or permit to be operated or parked any motorized vehicle as defined by Ch. 340, Wis. Stats., excluding snowmobiles or all-terrain vehicles (ATV) as defined by state statute, on the ice of Golden Lake.

§ 82-21. Violations and penalties.

A. State boating and water safety laws and all other violations as set forth in § 82-16 of this article. Any forfeiture for violation of the state statute, rule or order adopted by reference in § 82-16 of this article 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. Violation of local boating laws as set forth in §§ 82-17, 82-18, 82-19 and 82-20 of this article shall be subject to the penalties set forth in Chapter 1, General Provisions, Article I, Penalties, of the Code of the Town of Summit.[5]

§ 82-22. Enforcement.

A. Enforcement procedure. The statutory provisions of §§ 66.0109, 66.0113, 66.0114, 30.29, 30.50 to 30.71, and Ch. 799, Wis. Stats., are adopted and by reference made a part of this article 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 article. Any future additions, amendments, revisions or modifications of the statutes incorporated herein are intended to be made part of this article in order to secure uniform statewide regulation and enforcement of boating ordinance violations. Further, the Town of Summit and the Town of Concord specifically elect to use the citation method of enforcement.

B. Deposits.

(1) Schedule of deposits. The schedule of cash deposits shall be as follows:

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5. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

(a) § 82-16: 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.

(b) §§ 82-17, 82-18, 82-19 and 82-20: $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 article or any part thereof who was previously convicted of violating the same section within the last year shall forfeit twice the deposit delineated above plus court costs and penalty assessment.[6]

(3) Nonscheduled 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 therefor 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 article 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.

ARTICLE IV
Upper Genesee Lake
[Adopted 12-3-1992 by Ord. No. 184]

§ 82-23. Applicability; enforcement officers.

A. The provisions of this article shall apply to the waters of Upper Genesee Lake, within the jurisdiction of the Town of Summit.

B. The provisions of this article shall be enforced by the officers of the Water Safety Patrol Unit and police of the jurisdiction of the Town of Summit.

§ 82-24. State boating and water safety laws adopted.

A. Except as otherwise specifically provided in this article, the current and future statutory provisions describing and defining regulations with respect to water traffic, boats, boating, and related water activities in §§ 30.50 up to and including 30.71, Wis. Stats., 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 article 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 article. Any further additions, amendments, revisions or modifications of the statute incorporated herein are intended to be made part of this article in order to secure uniform statewide 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

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6. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

hereby incorporated in and made a part of this article by deferring to the same as if they are or were to be set out herein verbatim.

§ 82-25. Speed restrictions.

No motor boat shall be operated on Upper Genesee Lake at any time at a speed in excess of slow — no-wake.

§ 82-26. Swimming regulations.

No person, unless said person is engaging in activities and subject to the provisions of § 30.70, Wis. Stats., 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 in 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.

§ 82-27. Gasoline-powered motors prohibited.

No gasoline-powered motors shall be operated on Upper Genesee Lake.

§ 82-28. Local regulation on icebound inland waters.

A. No person shall operate or park or permit, authorize, direct or control the operation or parking of or ride as a passenger on any motorized vehicle or motor-driven vehicle, including but not limited to motor vehicles, snowmobiles, or all-terrain vehicles, on the ice on any portion of Upper Genesee Lake.

B. The Chief of Police of the Town of Summit, upon application to him and payment of a license fee established by the Town Board, being satisfied that ice conditions do and will permit operation of a motorized vehicle or motor-driven vehicle upon a designated portion of the lake without material risk or hazard, may issue a written permit expiring within 24 hours after issuance authorizing operation of a motorized vehicle or motor-driven vehicle on the lake for particular purposes to be specified in such permit. Said particular purposes shall be limited to snowplowing of a portion of the lake for an ice skating rink, transporting of property to an island or conducting official lake studies. No such permit shall authorize speed or acrobatic contests, exhibitions or performances; racing; fishing; nor shall any such permit authorize joyriding, sightseeing or any other activity not deemed necessary by the Chief of Police.

§ 82-29. Violations and penalties.

A. State boating and water safety laws and all other violations as set forth in § 82-24 of this article. Any forfeiture for violation of the State statute, rule or order adopted by reference in § 82-24 of this article 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. Violation of local boating laws as set forth in §§ 82-25, 82-26, 82-27 and 82-28 of this article shall be subject to the penalties set forth in Chapter 1, General Provisions, Article I, Penalties, of the Code of the Town of Summit.[7]

§ 82-30. Enforcement.

A. Enforcement procedure. The statutory provisions of §§ 66.0109, 66.0113, 66.0114, 30.29, 30.50 to 30.71, and Ch. 799, Wis. Stats., are adopted and by reference made a part of this article as if fully set herein. Any act required to be performed or prohibited by any statute incorporated herein by reference is required or

7. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

prohibited by this article. Any future additions, amendments, revisions or modifications of the statutes incorporated herein are intended to be made part of this article in order to secure uniform statewide regulation and enforcement of boating ordinance violations. Further, the Town of Summit specifically elects to use the citation method of enforcement.

B. Deposits.

(1) Schedule of deposits. The schedule of cash deposits shall be as follows:

(a) § 82-24: 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.

(b) §§ 82-25, 82-26, 82-27 and 82-28: $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 article or any part thereof who was previously convicted of violating the same section within the last year shall forfeit twice the deposit delineated above plus court costs and penalty assessment.[8]

(3) Nonscheduled 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 therefor 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 article does not preclude the Town Board 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 Board 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.

ARTICLE V
Lower Nashotah Lake
[Adopted 12-3-1992 by Ord. No. 185]

§ 82-31. Applicability; enforcement officers.

A. The provisions of this article shall apply to the waters of Lower Nashotah Lake, within the jurisdiction of the Town of Summit.

B. The provisions of this article shall be enforced by the officers of the Water Safety Patrol Unit and police of the jurisdiction of the Town of Summit.

§ 82-32. State boating and water safety laws adopted.

A. Except as otherwise specifically provided in this article, the current and future statutory provisions describing and defining regulations with respect to water traffic, boats, boating, and related water activities in §§ 30.50 up to and including 30.71, Wis. Stats., exclusive of any provisions therein relating to the

8. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

penalties to be imposed or the punishment for violation of said statutes, are hereby adopted and by reference made a part of this article 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 article. Any further additions, amendments, revisions or modifications of the statute incorporated herein are intended to be made part of this article in order to secure uniform statewide 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 article by deferring to the same as if they are or were to be set out herein verbatim.

§ 82-33. Speed restrictions.

No motor boat shall be operated on Lower Nashotah Lake from sunset until sunrise at a speed in excess of slow — no-wake.

§ 82-34. Swimming regulations.

No person, unless said person is engaging in activities and subject to the provisions of § 30.70, Wis. Stats., 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 in 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.

§ 82-35. Water skiing hours.

Water skiing shall be prohibited on the waters of Lower Nashotah Lake between the hours of 2:00 p.m. and 5:00 p.m. on Saturdays, Sundays and all legal holidays.

§ 82-36. No-wake requirement.

A No Wake Law shall be in effect on Lower Nashotah Lake on Saturdays, Sundays and all legal holidays between 2:00 p.m. and 5:00 p.m.

§ 82-37. Local regulation on icebound inland waters.

A. No person shall operate or park or permit, authorize, direct or control the operation or parking of or ride as a passenger on any motorized vehicle or motor-driven vehicle, including but not limited to motor vehicles, snowmobiles, or all-terrain vehicles, on the ice on any portion of Lower Nashotah Lake.

B. The Chief of Police of the Town of Summit, upon application to him and payment of a license fee established by the Town Board, being satisfied that ice conditions do and will permit operation of a motorized vehicle or motor-driven vehicle upon a designated portion of the lake without material risk or hazard, may issue a written permit expiring within 24 hours after issuance authorizing operation of a motorized vehicle or motor-driven vehicle on the lake for particular purposes to be specified in such permit. Said particular purposes shall be limited to snowplowing of a portion of the lake for an ice skating rink, transporting of property to an island or conducting official lake studies. No such permit shall authorize speed or acrobatic contests, exhibitions or performances; racing; fishing; nor shall any such permit authorize joyriding, sightseeing or any other activity not deemed necessary by the Chief of Police.

§ 82-38. Violations and penalties.

A. State boating and water safety laws and all other violations as set forth in § 82-32 of this article. Any forfeiture for violation of the state statute, rule or order adopted by reference in § 82-32 of this article 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. Violation of local boating laws as set forth in §§ 82-33, 82-34, 82-35, 82-36 and 82-37 of this article shall be subject to the penalties set forth in Chapter 1, General Provisions, Article I, Penalties, of the Code of the Town of Summit.[9]

§ 82-39. Enforcement.

A. Enforcement procedure. The statutory provisions of §§ 66.0109, 66.0113, 66.0114, 30.29, 30.50 to 30.71, and Ch. 799, Wis. Stats., are adopted and by reference made a part of this article 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 article. Any future additions, amendments, revisions or modifications of the statutes incorporated herein are intended to be made part of this article in order to secure uniform statewide regulation and enforcement of boating ordinance violations. Further, the Town of Summit specifically elects to use the citation method of enforcement.

B. Deposits.

(1) Schedule of deposits. The schedule of cash deposits shall be as follows:

(a) § 82-32: 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.

(b) §§ 82-33, 82-34, 82-35, 82-36 and 82-37: $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 article or any part thereof who was previously convicted of violating the same section within the last year shall forfeit twice the deposit delineated above plus court costs and penalty assessment.[10]

(3) Nonscheduled 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 therefor 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 article does not preclude the Town Board 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 Board 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.

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9. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

10. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

ARTICLE VI

Silver Lake
[Adopted 12-3-1992 by Ord. No. 186]

§ 82-40. Applicability; enforcement officers.

A. The provisions of this article shall apply to the waters of Silver Lake, within the jurisdiction of the Town of Summit and the City of Oconomowoc.

B. The provisions of this article shall be enforced by the officers of the Water Safety Patrol Unit and police of the jurisdiction of the Town of Summit.

§ 82-41. State boating and water safety laws adopted.

A. Except as otherwise specifically provided in this article, the current and future statutory provisions describing and defining regulations with respect to water traffic, boats, boating, and related water activities in §§ 30.50 up to and including 30.71, Wis. Stats., 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 article 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 article. Any further additions, amendments, revisions or modifications of the statute incorporated herein are intended to be made part of this article in order to secure uniform statewide 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 article by deferring to the same as if they are or were to be set out herein verbatim.

§ 82-42. Speed restrictions.

No motor boat shall be operated on Silver Lake from sunset until sunrise at a speed in excess of slow — no-wake.

§ 82-43. Swimming regulations.

No person, unless said person is engaging in activities and subject to the provisions of § 30.70, Wis. Stats., 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 in 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.

§ 82-44. Violations and penalties.

A. State boating and water safety laws and all other violations as set forth in § 82-41 of this article. Any forfeiture for violation of the State statute, rule or order adopted by reference in § 82-41 of this article 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. Violation of local boating laws as set forth in §§ 82-42 and 82-43 of this article shall be subject to the penalties set forth in Chapter 1, General Provisions, Article I, Penalties, of the Code of the Town of Summit.[11]

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11. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

§ 82-45. Enforcement.

A. Enforcement procedure. The statutory provisions of §§ 66.0109, 66.0113, 66.0114, 30.29, 30.50 to 30.71, and Ch. 799, Wis. Stats., are adopted and by reference made a part of this article 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 article. Any future additions, amendments, revisions or modifications of the statutes incorporated herein are intended to be made part of this article in order to secure uniform statewide regulation and enforcement of boating ordinance violations. Further, the Town of Summit and the City of Oconomowoc specifically elect to use the citation method of enforcement.

B. Deposits.

(1) Schedule of deposits. The schedule of cash deposits shall be as follows:

(a) § 82-41: 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.

(b) §§ 82-42 and 82-43: $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 article or any part thereof who was previously convicted of violating the same section within the last year shall forfeit twice the deposit delineated above plus court costs and penalty assessment.[12]

(3) Nonscheduled 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 therefor 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 article does not preclude the Town Board or Common Council 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 Board or Common Council 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.

ARTICLE VII
Upper Nemahbin Lake
[Adopted 4-1-1993 by Ord. No. 181]

§ 82-46. Applicability; enforcement officers; intent.

A. The provisions of this article shall apply to the waters of Upper Nemahbin Lake within the jurisdiction of the Town of Summit.

B. The provisions of this article shall be enforced by the officers of the Water Safety Patrol Unit and police of the jurisdiction of the Town of Summit.

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12. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

C. The intent of this article is to provide safe and healthful conditions for the enjoyment of aquatic recreation consistent with public rights and interest, and the capability of the water resources.

§ 82-47. State boating and water safety laws adopted.

A. Except as otherwise specifically provided in this article, the current and future statutory provisions describing and defining regulations with respect to water traffic, boats, boating, and related water activities in §§ 30.50 up to and including 30.71, Wis. Stats., 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 article 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 article. Any further additions, amendments, revisions or modifications of the statute incorporated herein are intended to be made part of this article in order to secure uniform statewide 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 article by deferring to the same as if they are or were to be set out herein verbatim.

§ 82-48. Speed restrictions.

A. No motorboat shall be operated on Upper Nemahbin Lake from sunrise until sunset at a speed in excess of 45 miles per hour unless otherwise further restricted by this article or state statute.

B. No motorboat shall be operated on Upper Nemahbin Lake on Sundays and Wisconsin statutory legal holidays between the hours of 12:00 noon and 3:00 p.m. local time, at a speed in excess of slow — no-wake. "Slow — no-wake" means operating a motorboat at a speed no faster than needed to maintain steerage.

C. No motorboat shall be operated on Upper Nemahbin Lake from sunset until sunrise at a speed in excess of slow — no-wake.

§ 82-49. Swimming regulations.

No person, unless said person is engaging in activities and subject to the provisions of § 30.70, Wis. Stats., 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 it 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.

§ 82-50. Local regulation on icebound inland waters.

A. No person shall operate or park or permit, authorize, direct or control the operation or parking of or ride as a passenger on any motorized vehicle or motor-driven vehicle, including but not limited to motor vehicles, snowmobiles, or all-terrain vehicles, on the ice on any portion of Upper Nemahbin Lake.

B. The Chief of Police of the Town of Summit, upon application to him and payment of a license fee established by the Town Board, being satisfied that ice conditions do and will permit operation of a motorized vehicle or motor-driven vehicle upon a designated potion of the lake without material risk or hazard, may issue a written permit expiring within 24 hours after issuance authorizing operation of a motorized vehicle or motor-driven vehicle on the lake for particular purposes to be specified in such permit. Said particular purposes shall be limited to snowplowing of a portion of the lake for an ice skating rink, transporting of property to an island or conducting official lake studies. No such permit shall authorize speed or acrobatic contests, exhibitions or performances; racing; fishing; nor shall any such permit authorize joyriding, sightseeing or any other activity not deemed necessary by the Chief of Police.

§ 82-51. Violations and penalties.

A. State boating and water safety laws and all other violations as set forth in § 82-47 of this article. Any forfeiture for violation of the State statute, rule or order adopted by reference in § 82-47 of this article 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. Violation of local boating laws as set forth in §§ 82-48, 82-49 and 82-50 of this article shall be subject to the penalties set forth in Chapter 1, General Provisions, Article I, Penalties, of the Code of the Town of Summit.[13]

§ 82-52. Enforcement.

A. Enforcement procedure. The statute provisions of §§ 66.0109, 66.0113, 66.0114, and 30.50 to 30.71, Wis. Stats., are adopted and by reference made a part of this article 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 article. Any future additions, amendments, revisions or modifications of the statutes incorporated herein are intended to be made part of this article in order to secure uniform statewide regulation and enforcement of boating ordinance violations. Further, the Town of Summit specifically elects to use the citation method of enforcement.

B. Deposits.

(1) Schedule of deposits. The schedule of cash deposits shall be as follows:

(a) § 82-47: 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.

(b) §§ 82-48, 82-49 and 82-50: $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 article or any part thereof who was previously convicted of violating the same section within the last year shall forfeit twice the deposit delineated above plus court costs and penalty assessment.[14]

(3) Nonscheduled 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 therefor 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 article does not preclude the Town Board 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 Board 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.

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13. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

14. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

ARTICLE VIII
Henrietta Lake and Utica Lake
[Adopted 7-1-1993 by Ord. No. 187]

§ 82-53. Applicability; enforcement officers.

A. The provisions of this article shall apply to the waters of Henrietta Lake and Utica Lake, within the jurisdiction of the Town of Summit and the Town of Ottawa.

B. The provisions of this article shall be enforced by the officers of the Water Safety Patrol Unit and police of the jurisdiction of the Town of Summit.

§ 82-54. State boating and water safety laws adopted.

A. Except as otherwise specifically provided in this article, the current and future statutory provisions describing and defining regulations with respect to water traffic, boats, boating, and related water activities in §§ 30.50 up to and including 30.71, Wis. Stats., 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 article 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 article. Any further additions, amendments, revisions or modifications of the statute incorporated herein are intended to be made part of this article in order to secure uniform statewide 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 article by deferring to the same as if they are or were to be set out herein verbatim.

§ 82-55. Speed restrictions.

No motor boat shall be operated on Henrietta Lake and Utica Lake at any time at a speed in excess of slow — no-wake.

§ 82-56. Swimming regulations.

No person, unless said person is engaging in activities and subject to the provisions of § 30.70, Wis. Stats., 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 in 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.

§ 82-57. Violations and penalties.

A. State boating and water safety laws and all other violations as set forth in § 82-54 of this article. Any forfeiture for violation of the State statute, rule or order adopted by reference in 82-54 of this article 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. Violation of local boating laws as set forth in §§ 82-55 and 82-56 of this article shall be subject to the penalties set forth in Chapter 1, General Provisions, Article I, Penalties, of the Code of the Town of Summit.[15]

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15. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

§ 82-58. Enforcement.

A. Enforcement procedure. The statutory provisions of §§ 66.0109, 66.0113, 66.0114, 30.29, 30.50 to 30.71, and Ch. 799, Wis. Stats., are adopted and by reference made a part of this article 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 article. Any future additions, amendments, revisions or modifications of the statutes incorporated herein are intended to be made part of this article in order to secure uniform statewide 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:

(a) § 82-54: 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.

(b) §§ 82-55 and 82-56: $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 article or any part thereof who was previously convicted of violating the same section within the last year shall forfeit twice the deposit delineated above plus court costs and penalty assessment.[16]

(3) Nonscheduled 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 therefor 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 article 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.

ARTICLE IX
Slow — No-Wake Restrictions
[Adopted 3-1-2001 by Ord. No. 01-235]

§ 82-59. Applicability; enforcement officers.

A. The provisions of this article shall apply to the waters of Lower Nashotah Lake, Upper Nemahbin Lake, Lower Nemahbin Lake, and Crooked Lake in the Town of Summit, Waukesha County.

B. This article shall be enforced by the Town Police Chief of the Town of Summit, Waukesha County, or his or her designee.

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16. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

§ 82-60. Speed restrictions.

"Slow — no-wake" restriction during high-water periods. When the waters of Lower Nashotah Lake, Upper Nemahbin Lake, Lower Nemahbin Lake and/or Crooked Lake reach the level of 871.3 as posted on the Interstate 94 bridge pier west of the water channel between Upper and Lower Nemahbin Lakes, the lakes are considered to be at flood stage. No person may operate a boat at a greater speed than "slow — no-wake" until such time as the water level declines to a point below the level of 871.3 as posted on the Interstate 94 bridge pier west of the water channel between Upper and Lower Nemahbin Lakes.

§ 82-61. Posting requirements.

The Town of Summit shall place and maintain a copy of this article at all public access points on Lower Nashotah Lake, Upper Nemahbin Lake, Lower Nemahbin Lake, and Crooked Lake. The posted ordinance shall be in compliance with the size requirements listed in § NR 5.15, Wis. Adm. Code.

§ 82-62. Violations and penalties.[17]

Any person violating any provision of this article shall be subject to the penalties set forth in Chapter 1, General Provisions, Article I, Penalties, of the Code of the Town of Summit.

17. **Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. II).**

Appendix D

WISCONSIN DEPARTMENT OF NATURAL RESOURCES ENVIRONMENTAL ANALYSIS OF THE PROPOSED ABANDONMENT OF THE ROLLER MILL DAM: JUNE 2008

ENVIRONMENTAL ANALYSIS AND DECISION ON THE NEED FOR AN ENVIRONMENTAL IMPACT STATEMENT (EIS) Department of Natural Resources (DNR)

Form 1600-1 Rev. 6-2001

Region or Bureau
Southeast Region
Type List Designation
Type List Designation II

NOTE TO REVIEWERS: This document is a DNR environmental analysis that evaluates probable environmental effects and decides on the need for an EIS. The attached analysis includes a description of the proposal and the affected environment. The DNR has reviewed the attachments and, upon certification, accepts responsibility for their scope and content to fulfill requirements in s. NR 150.22, Wis. Adm. Code. Your comments should address completeness, accuracy or the EIS decision. For your comments to be considered, they must be received by the contact person before 4:30 p.m., 07/03/2008.

Contact Person:
Michelle Schneider
Michelle.Schneider@Wisconsin.gov

Title: Water Management Engineer

Address: 141 NW Barstow St. Rom 180

Waukesha, WI 53188

Telephone Number
262-574-2117

Applicant: Margaret Zerwekh

Address: 500 Mill Road, Delafield, WI 53018

Title of Proposal: Nemahbin Roller Mill Dam Abandonment

Location: Waukesha County, City of Delafield
Township Range Section(s): NW ¼ NW ¼ Section 19, Township 7 North, Range 18 East

PROJECT SUMMARY

1. Brief overview of the proposal including the DNR action (include cost and funding source if public funds involved)

Mrs. Margaret Zerwekh has requested to abandon the Nemahbin Roller Mill Dam which impounds the Nemahbin Roller Dam Millpond (hereafter “Millpond”) located on the property located at 500 Mill Road,

on the Bark River in the City of Delafield, Waukesha County. Abandonment of this dam would include a drawdown of the 12-acre Millpond adjacent to the dam.

The application for abandonment did not include a site specific dam removal and river restoration plan. The Department will require that a full engineering document for removal of the structure be submitted and approved before any work begins. The project may require additional permits/approvals from the Department and local units of government depending on the scope of work proposed in the removal plans. Examples of the elements needed for the Department to proceed with Mrs. Zerwekh's application include but are not limited to:

- Drawdown Plan
- Material Removal Plan
- Erosion Control Plan
- Sediment Stabilization Plan,
- Planting Plan
- Floodplain Analysis
- Stream bank Stabilization Plan
- Existing and Proposed Grades
- Construction Sequencing
- Site specific analysis.

2. Purpose and Need (include history and background as appropriate)

The Nemahbin Roller Mill Dam (hereafter "the dam") was originally an earthen and brush dam constructed around 1839. George Applebecker was the owner of the dam around the first half of the 20th century. The dam used to power a saw mill, and later a feed and flour mill. According to an early inspection report dated September 10, 1919 by the Railway Commission of Wisconsin, this was a concrete wasteway dam, constructed of reinforced concrete 3 feet into the river bed. The berms were constructed of earth and gravel. A 5-foot concrete plank apron was installed below the dam to prevent scouring. The spillway was recorded as 21.3 feet long and 7 feet high from the top of the spillway to the low point in the retaining wall. The flashboards (stoplogs) had a height of 5 feet. A 7-foot wide flume (spillway) constructed of reinforced concrete was 38 feet long and 9 feet deep. The dam was operated 6 days per week (approximately 300 days per year) as part of a feed mill in 1919. The report states the water level had never risen above the dikes. At that time, the millpond was estimated to cover approximately 25 acres and the maximum depth was recorded at 8 feet. Department records show the Millpond currently covers approximately 12 acres and has a maximum depth of 5 feet. (Wisconsin Lakes, PUB-FH-800 2001) The Public Service Commission established ordered water levels for the Millpond. The minimum water level was set at 97.5 feet (880.36 feet Mean Sea Level (MSL)) and the maximum at 99.0 feet (881.86 MSL). (Order No. 2-WP-868-51)

By 1948, Ken and Margaret Zerwekh were the owners of the Nemahbin Roller Mill Dam. Mrs. Zerwekh is still the owner of the dam at this time. A dam inspection report from 1980 states the power house had been "newly rebuilt", and the dam was being used to produce electricity.

On March 29, 1994, Department staff conducted an inspection of the Nemahbin Roller Mill Dam. As a result of the numerous deficiencies found during that inspection, a number of corrective measures were required of the owner. One of these items was a dam failure analysis, compiled by Rust Environment and Infrastructure, Inc. in 1998. Subsequent to review of the hydraulic and hydrologic analyses included in this report, the Department assigned a preliminary hazard rating of Class III, High Hazard. In this preliminary hazard rating, the Department required the spillway to be upgraded in compliance with Chapter NR 333.07, Wisconsin Administrative Code, by December 1, 2008. After consideration of the high cost of repairing the

dam and citing her desire to return the Bark River to a free-flowing waterway, Mrs. Zerwekh submitted a dam abandonment request to the Department on October 3, 2004.

City of Delafield officials had expressed a desire to evaluate the alternatives for retaining the Millpond. Subsequently, the City has chosen to not initiate the steps necessary to obtain the property from Mrs. Zerwekh. The City of Delafield is the current owner of the Fish Hatchery Dam, located approximately 6,000 feet upstream of the Nemahbin Roller Mill Dam. The Fish Hatchery Dam creates Nagawicka Lake, a 917 acre body of water, the majority of which is located in the city of Delafield. The City was instructed by the Department in 1997 to make repairs on this dam. An order was issued in 2006 to the City to repair the dam by September 15, 2007. The City has completed the repairs to the dam.

3. Authorities and Approvals (list local, state and federal permits or approvals required)

Wisconsin Statutes 31.02, 31.19
Wisconsin Administrative Code NR 102, NR 104, NR 116, NR 150, NR 195, NR 333
Waukesha County/City of Delafield Conditional Use Permit
Army Corps of Engineers Permit under Section 404 of the Clean Water Act

PROPOSED PHYSICAL CHANGES (more fully describe the proposal)

4. Manipulation of Terrestrial Resources (include relevant quantities - sq. ft., cu. yard, etc.)

Removing the dam structure will result in a portion of the 12-acre Millpond being converted from a shallow pond to a terrestrial environment dominated by wetland vegetation. The resulting width of the river channel, consisting of the remaining portion of the Millpond, will be similar to upstream and downstream sections. Removal of the dam proposes to eliminate the continual concentration of sediment within the millpond that is released annually downstream during spring and high water flows. The project proposes to restore the natural fluctuations in sediment translocation to improve aquatic habitat and sediment stabilization.

The dam removal project would include a gradual draw down of the impounded water. This process will result in limiting mobilization of trapped sediment, however some movement of material is inevitable as the river channel recreates itself. After the millpond is drawn down, the exposed mudflats typically would be planted with a rapid-growing ground cover such as rye grass. This stabilization will subsequently ensure that less sediment will travel downstream upon removal of the dam structure.

The objectives of a typical dam removal/restoration project include enhancing the water quality and biotic integrity of the river (Bark River) by:

a) Restoring the original banks and bed of this portion of the Bark River
b) Eliminating the thermal impacts of the shallow Millpond
c) Restoring fish migration (passage) to upper and lower portions of the river
d) Eliminating spawning habitat for undesirable, non-native fish species such as common carp

5. Manipulation of Aquatic Resources (include relevant quantities - cfs, acre feet, MGD, etc.)

The dam and Millpond have altered, homogenized, and decreased the quality of aquatic habitat within this section of the Bark River. The dam removal will allow the river to return to its natural, pre-dam state,

improving water quality, conditions for native aquatic species, aquatic habitat, and increasing biodiversity.

The dam removal process will be conducted in two stages. The first stage involves the gradual draw down of the Millpond which will allow the flow and turbidity of the water to gradually return to previous conditions. The exposed mudflats will be stabilized in order to prevent erosion and lessen the amount of sediment that could flow downstream.

The second stage involves the actual removal of the dam structure and portions of the embankment. The entire concrete and wood portion of the dam will be removed. Portions of the embankment will be removed in order to alleviate the backwater created by high flows during the 100-year flood event.

The Department has not received full engineering plans for this project. As a result, the Department evaluation of the "Manipulation of Aquatic Resources" section will need to take into account the following (this list is not all inclusive):

- Plan to stabilize approximately 52,000 cubic yards of sediment currently estimated to exist in the millpond
- Plan for drawdown rate (rate per day, total volume to be released)
- Water diversion plan
- Construction staging plan (removal of structure, embankment, stabilization of banks, etc.) and timeline
- Sediment and Erosion Control plans during removal
- Planting plan
- Site specific analysis

6. Buildings, Treatment Units, Roads and Other Structures (include size of facilities, road miles, etc.)

No buildings or other permanent structures will be created or destroyed as part of this project. The area in which the dam is located will be restored to natural conditions once the dam is removed.

7. Emissions and Discharges (include relevant characteristics and quantities)

No negative long-term effects from emissions or discharges are expected. During and following removal of the dam, turbidity and sediment transport typically increase due to the in-water construction and the natural restoration of the river bed. Sediment discharge from the Millpond area will increase as the stream scours through its new channel. Furthermore, rainstorm events will cause turbidity to increase during and after construction until the stream channel and flowage bed become reestablished. Sediment management practices will be in used during construction to limit sediment transport. At a future time, it is expected that the Bark River will act like a natural stream system and effectively transport sediment based on standard fluvial geomorphic principles.

Typically, air emissions, including dust and exhaust, from dam demolition equipment and activities will increase temporarily in the local area during the work period.

8. Identify the maps, plans and other descriptive material attached

Attachment 1 County map showing the general area of the project

Attachment 2 USGS topographic map

Attachment 3 Plat map

Attachment 4 Riparian Parcel boundaries

Attachment 5 Aerial Photo of site

Attachment 6 DNR county wetlands map

Attachment 7 Zoning map

Attachment 8 List of wetland plants

Attachment 9 Sediment survey data – organic

Attachment 10 Sediment survey data – inorganic

Attachment 11 Sediment and Water Cross Section Data and Calculations

Attachment 12 DNR Fact Sheet – Basic Nomenclature of a Dam

AFFECTED ENVIRONMENT (describe existing features that may be affected by proposal)

9. Information Based On (check all that apply):

X Literature/correspondence (specify major sources)

Correspondence contained within the WDNR Dam Safety file

X Personal Contacts (list in item 25)

Field Analysis By: ☐ Author **X** Other (list in item 25)

Past Experience with Site By: **X** Other (list in item 25)

10. Physical Environment (topography, soils, water, air)

The Bark River is located within the Rock River Watershed. The river originates in the Southwest ¼ of the Southwest ¼ of Section 4, Township 8 North, Range 19 East, Town of Lisbon, Waukesha County, and flows in a southwesterly direction. The Nemahbin Roller Mill Dam lies on a short stretch of the Bark River between Nagawicka Lake and Upper Nemahbin Lake. The dam elevation is 884 ft MSL and impounds the Bark River to form the approximately 12 acre shallow Millpond.

The Millpond ranges in depth from 0.5 feet to 5 feet, with the water being deepest near the dam spillway. The average depth is 1 to 2 feet. The Millpond substrate materials transition from firm sands and gravels at the eastern end to mucky, unconsolidated silts near the dam spillway. The total sediment volume contained by the Millpond is approximately 52,000 cubic yards. These figures were compiled utilizing cross sectional data collected in the summer of 2007 by the Southeast Regional Planning Commission. Eighteen transects were completed; water and sediment depth were determined at 10 to 20 points along each transect.

The soils adjacent to the Millpond are classified as Fox, Matherton, and Sebewa silt loams. On June 14th, 2006, sediment cores from three different sample locations were extracted from the accumulated sediment within the Millpond created by the Nemahbin Roller Mill Dam. Each core contained organic plant detritus

in the upper core, changing to a uniform fine silt texture in the lower portions of the cores. Sediment analysis revealed the presence of Polycyclic Aromatic Hydrocarbons (PAHs) in each core, although all at levels below the Threshold Effect Concentration (TEC). The TEC (Threshold Effect Concentration) is the level at which a contaminant first starts to negatively impact aquatic organisms. The PEC (Probable Effect Concentration) is the level at which a contaminant will almost always negatively impact aquatic organisms. Similarly, while PCBs (Polychlorinated biphenyls), DDE (Dichlorodiphenyldichloroethylene), and DDD (Dichlorodiphenyldichloroethane) were detected in core samples A. and B., each was at levels below TEC concentrations. Arsenic is present in samples A. and B. at levels higher than are typically found in the Southeast Region waterways, but below the Probable Effect Concentration (PEC). The organic and inorganic test results are listed in Attachments 9 and 10 respectively.

The qualities of the sediments within the Millpond are at levels that would not preclude active management such as dredging, capping, etc. The presence of Arsenic is of the greatest concern, as it is present in levels that are likely impacting resident aquatic macroinvertebrate populations. There is a history of herbicides containing Arsenic used on Nagawicka Lake (located upstream) to control aquatic plants. Any management activities of the millpond sediment would need to minimize sediment release downstream. These activities could, in the event of dam removal, include a slow drawdown, with on-going stabilization of exposed material; use of bio-engineering, turbidity barriers or sediment traps where appropriate; or mechanical removal. Sediment management practices will be in place during construction to minimize sediment transport downstream.

11. Biological Environment (dominant aquatic and terrestrial plant and animal species and habitats including threatened/endangered resources; wetland amounts, types and hydraulic value)

The quantitative analyses and observations of the Bark River and Nemahbin Roller Mill Dam Millpond that are referenced in this document were conducted by the Wisconsin DNR and SEWRPC between 1999 and 2007. The Millpond is a shallow, warm water body with limited diversity of aquatic plants and animals. The mill pond provides (list values). In 2000, SEWRPC designated approximately three-quarters of the Millpond shoreline as Primary Environmental Corridor. Environmental Corridors are defined as linear areas in the landscape containing concentrations of natural resource amenities, as well as scenic, recreational, and historic resource amenities. Much of the Millpond Environmental Corridor is dominated by Cattails (*Typhus sp.*) which form a stand wider than 50 yards along the southern edge of the Millpond. The cattails begin in standing water and gradually transition to palustrine wetlands populated with deciduous shrubs and trees. Along the northern edge of the Millpond the bank rise is steeper, containing the cattail stand in standing water.

According to the Natural Heritage Inventory Program Database, one State of Wisconsin listed endangered species, Slender Madtom (*Notorus exilis*), is located within the project area. Two species of Special Concern, Black-crowned Night Heron (*Nycticorax nycticorax*) and Glade Fern (*Diplazium pycnocarpon*) are also located within the project area. State designated threatened or special concern species found within one mile of the project area include Ellipse mussel (*Venustaconcha ellipsiformis*), Mottled Darner (*Aeshna clepsudra*), Lake Chubsucker (*Erimyzon sucetta*), Least Darter (*Etheostoma microperca*), Banded Killfish (*Fundulus diaphanous*) and Pugnose Shiner (*Notrois anogenus*). Of these species, the Slender Madtom (endangered) and the Pugnose Shiner (threatened) are both found in the Bark River system and the connecting lakes. One State of Wisconsin threatened mussel species, Ellipse (*Venustachoncha ellipsiformis*), was found both upstream and downstream of the dam. Three uncommon species were found upstream of the Nemahbin Roller Mill Dam: Creek heelsplitter (*Lasmigona compressa*), Round pigtoe (*Pleurobema sintoxia*) and Spike (*Elliptio dilatata*) Spike). Dam removal will increase the riverine, cobble-

bottomed habitat that these species require and will remove the obstruction to upstream passage of their host fish species. Temporary, low levels of silt migration will not have any lasting impact on these species.

a. Fish

Fish species observed in the Millpond in September, 2007 were primarily tolerant species including several large carp and a school of darters. In 1999, Department staff conducted a fish population assessment of the Merton Millpond, a comparable dam impoundment located on the Bark River upstream of Nagawicka Lake. The following table lists the fish species found.

Common Name	**Scientific Name**
Black Bullhead	*Ictalurus melas*
Bluntnose Minnow	*Pimephales notatus*
Brook Stickleback	*Culaea inconstans*
Central Mudminnow	*Umbra limi*
Central Stoneroller	*Campostoma anomalum*
Common Carp	*Cyprinus carpio*
Common Shiner	*Notropis cornutus*
Creek Chub	*Semotilus atromaculatus*
Fantail Darter	*Etheostoma flabellare*
Fathead Minnow	*Pimephales promelas*
Hornyhead Chub	*Nocomis biguttatus*
Largemouth Bass	*Micropterus salmoides*
Northern Pike	*Esox lucius*
Rainbow Darter	*Etheostoma caeruleum*
Rock Bass	*Ambloplites rupestris*
Slender Madtom	*Noturus exilis*
White Sucker	*Catostomus commersoni*
Yellow Bullhead	*Ictalurus natalis*
Yellow Perch	*Perca flavescens*

A fish reconnaissance on the stretch of the Bark River from Nagawicka Lake to Upper Nemahbin Lake was conducted by the University of Wisconsin – Milwaukee, and Wisconsin Lutheran College in conjunction with SEWRPC staff between 26 June, 2007 and 24 July, 2007. The reconnaissance identified the following species:

Banded Darter	*Etheostoma zonale*
Banded Killifish	*Fundulus diaphanus*
Blackstripe Topminnow	*Fundulus notatus*
Bluegill	*Lepomis macrochirus*
Bluntnose Minnow	*Pimephales notatus*
Bowfin	*Amia calva*
Brook Silverside	*Labidesthes sicculus*
Central Mudminnow	*Umbra limi*
Central Stoneroller	*Campostoma anomalum*
Common Shiner*	*Notropis cornutus*
Fantail Darter	*Etheostoma flabellare*
Golden Shiner	*Notemigonus crysoleucas*

Goldfish	*Carassius auratus*
Grass Pickerel	*Esox americanus*
Green Sunfish**	*Lepomis cyanellus*
Hornyhead Chub	*Nocomis biguttatus*
Johnny Darter	*Etheostoma nigrum*
Largemouth Bass	*Micropterus salmoides*
Largescale Stoneroller	*Campostoma oligolepis*
Least Darter	*Etheostoma microperca*
Longnose Gar*	*Lepisosteus osseus*
Northern Pike*	*Esox lucius*
Pumpkinseed*	*Lepomis gibbosus*
Rainbow Darter	*Etheostoma caeruleum*
Rock Bass*	*Ambloplites rupestris*
Sand Shiner	*Notropis stramineus*
Slender Madtom	*Noturus exilis*
Smallmouth Bass	*Micropterus dolomieu*
Spotfin Shiner	*Cyprinella spiloptera*
Weed Shiner	*Notropis texanus*
White Sucker	*Catostomus commersoni*
Yellow Bullhead*	*Ictalurus natalis*
Yellow Perch*	*Perca flavescens*

Only 24% of the total species were found within the Millpond (denoted by *).

b. Mussel Species

Two sites were sampled along the Bark River between Upper Nemahbin Lake and Nagawicka Lake. One State of Wisconsin threatened species, Ellipse (*Venustachoncha ellipsiformis*), was found in both sample sites. Three uncommon species were found upstream from the dam; *Lasmigona compressa* (Creek heelsplitter), Round pigtoe (*Pleurobema sintoxia*) and Spike (*Elliptio dilatata*). Mussel species which were found as live samples are listed below.

Site #1 – Bark River below Roller Mill Dam (sampled 13 August, 2007)

Creeper	*Strophitus undulates*
Cylinder	*Anodontoides ferrucianus*
Ellipse	*Venustachoncha ellipsiformis*
Fat Mucket	*Lampsilis siliquoidea*
Floater	*Pyganodon grandis*
Lilliput	*Carunculina parva*
Pocketbook	*Lampsilis cardium*
White heelsplitter	*Lasmigona complanata*

Site #2 – Bark River below Nagawicka Dam – August 13, 2007

Creek heelsplitter	*Lasmigona compressa*
Creeper	*Strophitus undulates*
Cylinder	*Anodontoides ferrucianus*

Ellipse	*Venustachoncha ellipsiformis*
Fat Mucket	*Lampsilis siliquoidea*
Floater	*Pyganodon grandis*
Pocketbook	*Lampsilis cardium*
Round Pigtoe	*Pleurobema sintoxia*
Spike	*Elliptio dilatata*
Wabash Pigtoe	*Fusconaia flava*

c. Wildlife

The Millpond in its existing condition provides herptile, furbearer, and waterfowl habitat. Turtles and frogs using this pond should easily adapt to a riverine system if the dam were removed. No significant adverse impact would be expected. Muskrats (*Ondatra zibethicus*) would be the primary furbearer using the pond; mink (*Mustela vison*) and otter (*Lutra canadensis*) may also be present in this area, but at very low levels. A decrease in muskrat population would be expected if the dam is removed, however there is adequate habitat nearby and healthy muskrat populations exist in the region. Waterfowl populations in the Millpond such as Canada goose (*Branta canadensis*), Mallard (*Anas platyrhynchos*) and Wood Duck (*Aix sponsa*) would be expected to decline with removal of the dam. There are limited forage and roosting sites on the pond. While waterfowl would still use the river system, an overall reduction of numbers is anticipated, but no overall adverse impact is expected due to the close proximity of other open water habitats. Wading birds such as Great Blue Heron (*Ardea herodias*) would also be expected to temporarily decline but would adapt well to the riverine system well. A naturally fluctuating river system would also provide habitat for shorebirds. Overall, no significant adverse impact to wildlife is anticipated from the removal of the dam. There is adequate habitat nearby for any displaced wildlife, and the riverine system will provide other niche habitats for a more diversified wildlife population.

d. Aquatic Plants

Aquatic plant surveys conducted by SEWRPC within the Bark River between Nagawicka Lake and Upper Nemahbin Lake in August 2000 identified the following plant species:

Common Name	**Scientific Name**
Eurasian Water Milfoil	*Myriophyllum spicatum*
Coontail	*Ceratophyllum demersum*
Flatstem pondweed	*Potamogeton zosteriformus*
Common Water-weed	*Elodea Canadensis*
Curly leaf pondweed	*Potomogeton crispus*
Water Crowfoot	*Ranunculus sp.*
Water Celery	*Vallisneria Americana*
Milfoil species	*Myriophyllum sp.*
Sago pondweed	*Stuckenia pectinata*
Musk grass	*Chara vulgaris*
Yellow water lily	*Nuphar variegata*
White water lily	*Nymphaea tuberosa*

Within the Millpond, aquatic plant diversity was determined to be low to moderate. Downstream of the dam, plant diversity in the river increased as it approached Upper Nemahbin Lake, especially along the river banks. A plant reconnaissance survey conducted on the Millpond by WDNR in September 2007 identified the following plants in addition to the species listed by the SEWRPC study:

Common Name	Scientific Name
Water star grass	*Zostarella dubia*
Slender naiad	*Najas flexilis*

e. Wetlands

Between Nagawicka Lake and Upper Nemahbin Lake the Bark River is a slow moving, low gradient meandering stream through emergent and wet meadow wetland complexes. According to the Wisconsin Wetland inventory classification system, the wetland areas adjacent to the Millpond were classified as broadleaf persistent wet meadow and non-persistent wet meadow. An inventory of the area conducted in 2000 identified three dominant wetland communities surrounding the Millpond; broadleaf deciduous forest/deciduous shrub, deep/shallow marsh, and deep/shallow marsh and wet meadow. Much of the wetland area adjacent to the river above the Millpond is also classified as broadleaf persistent wet meadow, while downstream of the dam lie two small islands that are broadleaf deciduous forest/deciduous shrub palustrine wetlands. The area along the dam embankment is not classified as wetland.

Wetland functional values throughout the immediate Millpond fringe wetlands suggest a low functional value rating for floral diversity, fishery habitat, flood attenuation, shoreline protection and groundwater discharge. These wetlands provide a moderate functional value for wildlife habitat and water quality protection.

f. Wetland Plants

Surveys conducted by SEWRPC in 2000 and 2003, found that the dominant species in the areas adjacent to the millpond to be cattails (*Typha sp.)* and purple loosestrife (*Lythrum salicaria)*. A complete list of plants found in the wetlands surrounding the Millpond is detailed in Attachment 8.

12. Cultural Environment

a. Land use (dominant features and uses including zoning if applicable)

The 2010 recommended land use plan prepared by SEWRPC allocates three zoning types for the areas adjacent to the Nemahbin Roller Mill Dam. Approximately 2700 ft of dam frontage was zoned Primary Environmental Corridor, 1100ft was zoned Low-Density Residential, and 300 ft was zoned Medium-Density Residential. The eastern section of the Primary Environmental Corridor forms the western edge of Cushing Memorial Park. These zoning allocations have been adopted by the City of Delafield.

b. Social/Economic (including ethnic and cultural groups)

The Roller Mill Dam was originally constructed in 1842 to power a saw mill, and later a feed and flour mill. In the mid-1970s, electrical power generation was added and ran continuously except in times of inadequate flow or when the structure was being repaired or maintained. Generation of electricity was ceased in the late 1990s and the turbine and penstock was abandoned and removed in 2006. It is possible that some of the properties which currently abut the Millpond will not be immediately adjacent to the new river channel formed after removal of the dam. Recreation opportunities are expected to change from flat water paddling to a riverine paddling system.

c. Archaeological/Historical

According to Mark Dudzik, DNR Archaeologist, no significant historical or archeological sites are known to exist in the project area.

13. Other Special Resources (e.g., State Natural Areas, prime agricultural lands)

Kettle Moraine State Forest—Lapham Peak Unit, and Lower Nemahbin State Natural Area are within a one mile buffer of the project area. The Ice Age Trail passes within a quarter mile to the east of the millpond.

ENVIRONMENTAL CONSEQUENCES (probable adverse and beneficial impacts including indirect and secondary impacts)

14. Physical (include visual if applicable)

The drawdown of the Millpond for dam removal will result in the exposure of approximately 12 acres of substrate. An undetermined amount of this exposed area will become the restored river channel. The sand and cobbles of the natural river bed will constitute most of the exposed area, however there are areas closer to the dam structure that contain deep, silty sediments. These soil materials will require seeding and may need to be mechanically stabilized after drawdown to minimize the transport of sediment downstream after the dam removal is complete. Once the exposed soils have dewatered and become vegetated, they should not be a source of noxious odors.

The scour of anoxic sediment increases the potential for toxic un-ionized ammonia releases during drawdown. Completing the drawdown during the spring/early summer and fall of the year can minimize the potential for toxic effects. Cool water temperatures and lower water pH will mitigate the effects of un-ionized ammonia.

Removal of the dam and the resulting Millpond will restore an approximately 0.5 mile long, free-flowing reach of the Bark River. Average water depths will decrease within the Millpond and millrace. Following dam removal, water depths will likely mimic water depths that currently exist upstream and downstream of the dam. Water velocities will increase after the free-flowing river channel is restored due to a narrower channel and restored historical hydraulic gradient. The elevation of the millpond is approximately 10 feet higher than that of the Bark River just downstream of the dam. The construction plans will need to address the elevation differences to prevent erosion and to enhance fish passage.

The wetlands adjacent to the pond are identified as a broadleaf persistent wet meadow and non-persistent wet meadow with moderate functional values. After dam removal it is anticipated that the former impoundment wetland areas will revert to similar broadleaf persistent wet meadow.

Negative impacts to downstream water quality will be minimized due to the drawdown and stabilization of sediments prior to dam removal. Once the area is stable, water quality is expected to increase. Higher dissolved oxygen levels and lower algal levels will encourage the expansion of native aquatic plant and animal communities.

15. Biological (including impacts to threatened/endangered resources)

The transition from Millpond to river channel will have a variety of biological impacts on the impounded area, as well as the upstream and downstream reaches of the Bark River. Currently, the Millpond supports vegetation and wildlife that is associated with shallow aquatic environments, including turtles, warmwater

fish species, and exotic invasive plant species. A gradual drawdown of the dam over spring/summer will allow the migration of amphibians and turtles, and avoid the stranding of mussel species. A mussel and fish relocation may be needed for animals stranded in isolated pools of water during the drawdown.

The potential for aquatic plants and algae to reach nuisance levels will be reduced by removal of the dam and impounded water. The impoundment of water creates a thermal impact to the Bark River. The removal of the dam will eliminate the warming of the impounded water. The ecosystem that is currently supported by the Millpond will change significantly when the river channel is restored. A faster, continuously flowing stream will allow fish migration and colder water will encourage a greater diversity of fish species. Faster flow will also extend and gradually restore the gravelly or sandy substrate favored by the majority of mussel species and lithophilic (fish that spawn on gravel and small stones) fish species for spawning.

The wetlands adjacent to the pond are identified as a broadleaf persistent wet meadow and non-persistent wet meadow with moderate functional values. After dam removal it is anticipated that the former impoundment wetland areas will revert to similar broadleaf persistent wet meadow

Biological impacts due to this project can be better assessed once the Department receives full engineering plans from the applicant as described previously in sections 1 and 5.

16. Cultural

a. Land Use (including indirect and secondary impacts)

Removal of the dam and will expose approximately 12 acres of land. The 12 acres of exposed land that was under water with the former impoundment consists of accumulated soft organic sediment. Over time this sediment will be capable of supporting wetland plant species and be converted from former open water to a riverine wetland complex. According to the Waukesha County Register of Deeds Office most of the parcels are established through meets and bounds descriptions. The majority of the newly exposed land will continue to be under the ownership of Mrs. Zerwekh and the City of Delafield as per the original subdivision plat and certified survey maps obtained through the Deeds office. The quantity of exposed land gained by all owners will be dictated by those records however, no property owner will lose any land as a result of removing the dam. Due to the nature of the sediments, the likelihood of wetland characteristics, and the existence of floodplain it is unlikely that any land gained will be suitable for development. Future development will be governed by the City of Delafield's Zoning Ordinance and any necessary analyses will be the responsibility of the land owner and developer.

b. Social/Economic (including ethnic and cultural groups, and zoning if applicable)

There are no expected consequences or impacts to any ethnic or cultural groups or social impacts resulting from the removal of the dam. The Department of Natural Resources has not conducted any studies regarding economic impacts with dam removal projects.

c. Archaeological/Historical

According to WDNR Archaeologist Mark Dudzik, there are no known archaeological or historical impacts that will result from removal of the dam.

17. Other Special Resources (e.g., State Natural Areas, prime agricultural lands)

There are no special resources in the general area of the Millpond that should be affected by dam removal activities. Lapham Peak State Forest, Lower Nemahbin State Natural Area, and the Ice Age Trail are all within a one-mile radius of the dam.

18. Summary of Adverse Impacts That Cannot Be Avoided (more fully discussed in 14 through 17)

Negative impacts that cannot be avoided include temporary noise and emissions from earthmoving equipment, and temporarily high turbidity around the dam and downstream areas associated with dam removal activities. Fish and wildlife may be temporarily displaced. Suitable habitat for fish and mussel species downstream from the dam removal may experience temporary or permanent sedimentation from dam removal. Non-vegetated areas of sediment will be exposed prior to seeding, planting, and sediment stabilizing activities. Positive impacts will be reflected in the improvement of water quality and aquatic habitat over time, as the barrier to migrating and spawning fish will be removed and a free-flowing stream restored. It is expected that the long-term benefits of removing the high-hazard, structurally unsound dam will outweigh the temporary inconveniences and negative impacts.

DNR EVALUATION OF PROJECT SIGNIFICANCE (complete each item)

19. Environmental Effects and Their Significance

a. Discuss which of the primary and secondary environmental effects listed in the environmental consequences section are long-term or short-term.

There exists a possibility that isolated communities of aquatic organisms and fish species are present in the impoundment. Populations of the same species and individual species populations have been physically segregated for a substantial length of time. This means that small populations of fish communities exist that have not intermingled or bred with larger populations. The extent to which such fragmentation has developed is dependent upon many factors, such as mobility of species, reproductive capacities and habits, life-span etc. The removal of the Nemahbin Roller Mill dam should allow these fragmented populations to freely migrate and reproduce. The segmentation of the populations will be effectively ended, allowing them a greater range in which to feed, nest, breed, and seek shelter. Removal of the dam will open additional riverine habitat to fish and other aquatic life species that have been isolated downstream of the dam.

Reductions in sedimentation will cause improvements in the quality of physical habitat and convert the substrate back to its natural condition of a sand and cobble stream bottom. Most benthic invertebrates require this rocky substrate. These invertebrates are an important food source for fish. Many fish species also prefer these rocky bottom conditions for spawning and feeding. Native species and most sport fish exhibit lowered vitality and productivity under the stresses of increased turbidity, lowered water quality, and scarcity of suitable habitat. Other, generalist types of species, such as carp, are unaffected or actually flourish despite these adverse effects and often dominate the fish community in impoundments.

The removal of the Nemahbin Roller Mill dam will improve dissolved oxygen levels and decrease the water temperature in this reach of the Bark River. The removal will also eliminate the artificial warming caused by the impoundment. These effects should have positive impacts on fish and aquatic life.

Following the permanent drawdown and removal of the dam, the former aesthetics of the Millpond would

be lost and replaced with a meandering, free-flowing creek. This would be similar to what existed under pre-development conditions and what currently exists upstream and downstream of the Nemahbin Roller Mill Dam and Millpond.

Any adverse impacts associated with this project are expected to be short-term only. These adverse impacts include turbidity in the waterway, soil disturbance and human activity near the dam site. These adverse impacts will be only those which are unavoidable and occur despite control measures. Unavoidable turbidity effects will precede the spawning period when fish are most vulnerable. There should be no significant impacts in terms of temperature.

Short-term adverse impacts associated with the conversion of the Millpond into a free-flowing stream may affect wildlife which currently use the pond, including ducks, herons, turtles and frogs, muskrats, and raccoon. There are substantial areas of wetland adjacent to the project area along the Bark River that will provide adequate habitat for wildlife displaced from the Millpond during dam removal. The adverse impacts may affect some individuals, but will have no significant long-term impact on the overall numbers, the reproductive capability, or the success and stability of the species or regional populations as a whole.

Long-term effects on the riparian and aquatic system should be highly beneficial. Improvements will occur in physical characteristics, which in turn will create ecological and biological benefits. The Millpond will revert back to a natural sandy-cobble substrate characteristic of the Bark River, providing additional habitat for riverine forms of aquatic life.

20. Significance of Cumulative Effects

The cumulative impacts of similar projects have shown to have increasingly beneficial effects on aquatic habitat. The adverse environmental impacts associated with dams and impoundments are well documented in literature regarding riparian systems. Selective dam removal has been proposed as a cost-effective and technically feasible means of restoring river ecosystems in southeastern Wisconsin. Dams have been constructed across Wisconsin waterways to serve a variety of purposes, including generation of hydraulic power, flood control, and the creation of an impoundment for recreational use.

According to the WDNR Dam Safety Section there are approximately 3,800 dams in the state. The Dam Safety Section reviews the condition of dams throughout the State in the interests of public safety, navigability and flood control issues. Many of these dams were put in place over a century ago as a source of energy for a variety of uses and have become obsolete with the development of wide-scale provisions of electric power. Many obsolete dams are no longer providing any benefit and basically serve no useful purpose. In most cases, these neglected and deteriorated dams are hazards to safety, are obstructions to navigation and fish migration and create adverse environmental impacts.

Dam removal projects are underway at many locations across the country. Repeated actions of this type have been found to restore river systems to healthy ecosystems.

21. Significance of Risk

There are some unknowns that create uncertainty in predicting the effects on the surrounding environment with a dam removal. It is possible that a substantial amount of sediment will scour upon removal of the dam, and be carried downstream, settling along bends, within pools, and in the floodplain in times of higher flows. The draw down process will aid in stabilizing the sediment in the Millpond by allowing vegetation to take root. During a typical removal, Best Management Practices for erosion control and turbidity are used

to minimize impacts of sediment transport downstream.

Typical construction projects require work site inspections at the close of each working day in which the functionality and integrity of all erosion and flow control devices are verified and repaired as necessary. These inspections are also conducted when rainfall exceeds ½-inch. The draw down of the Millpond will mitigate the effects of exposed soils and runoff by allowing vegetation from existing seed bank to establish itself. Areas exposed by dam removal activities will be seeded to further minimize runoff, erosion, and transport of these materials downstream.

Typically pre-construction meetings for dam removal projects are held with potential property owners, local residents, county and city officials, and local emergency officials, as appropriate.

22. Significance of Precedent

This project does not set any precedent or hold the potential to influence any future WDNR actions or decisions. Water regulation decisions are made on a case-by-case basis, and this decision will not impact future projects.

23. Significance of Controversy over Environmental Effects

Discuss the effects on the quality of the environment, including socio-economic effects, that are (or are likely to be) highly controversial, and summarize the controversy.

Property owners with frontage on the Millpond and along the millrace will be directly impacted as a result of the conversion from a quiescent pool of water to a free flowing river. Wetland environments are likely to replace former impounded areas.

ALTERNATIVES

24. Briefly describe the impacts of no action and of alternatives that would decrease or eliminate adverse environmental effects. (Refer to any appropriate alternatives from the applicant or anyone else.)

No Action – Leaving the dam in place and allowing it to deteriorate due to the effects of river action, weathering and erosion, and freeze and thaw cycle. The dam would not be upgraded to meet DNR Code requirements. This is neither a technically or environmentally sound, nor a legally acceptable alternative. The dam and supporting infrastructure is structurally unsound and presents a safety hazard to human health and property and the environment should it fail. Sediments from the Millpond would continue to breach the dam during times of high flow, adding to the downstream accumulations at the mouth of the Bark River from previous dam failures. The dam would be out of compliance with NR 333.07, Wisconsin Administrative Code.

Ultimately, dam failure would occur as an uncontrolled and catastrophic event, releasing downstream a wall of flood water, structural debris and sediment. Ultimately, this alternative would result in the greatest negative environmental and socio-economic impacts when compared to other alternatives.

Reconstruct the dam – Four alternative spillway systems were considered in the "Rehabilitation Feasibility

Report" prepared by Mead & Hunt for the Roller Mill Dam. The estimated costs for reconstruction ranged from $672,000 to $854,466. The owner of the Roller Mill Dam has determined that reconstructing the dam is not economically feasible at this point in time and reconstructing the dam would not provide the environmental benefits associated with dam abandonment as previously discussed. The owner would also have to take on the long-term cost of maintaining the dam.

Declare the dam abandoned and remove – Proposed action.

Modify the dam – There is no cost-effective modification to the dam that would meet the State requirements for maintenance of this dam other than total reconstruction.

SUMMARY OF ISSUE IDENTIFICATION ACTIVITIES

25. List agencies, citizen groups and individuals contacted regarding the project (include DNR personnel and title) and summarize public contacts, completed or proposed).

Date	Contact	Comment Summary
08/02/2007	Sue Beyler – Inland Fisheries Team Supervisor, Southeast Region, WDNR	Provided fish survey data for the Bark River
04/25/2007	Craig Helker - Water Resources Management Specialist, WDNR	Conducted sediment survey on the Nemahbin Roller Mill Dam Millpond
09/17/2007	Mark Dudzik – Archaeologist, WDNR	Assessed historical and archaeological impacts of dam removal at Nemahbin Roller Mill Dam
10/29/2007	Thomas Slawski – Principal Planner, SEWRPC	Provided mapping and sediment, fish and mussel data from the Nemahbin Roller Mill Dam Millpond
11/01/2007	William Wawrzyn – Fisheries Biologist, WDNR	Provided input on sediment management, fish and mussel communities for the Bark River and the Nemahbin Roller Mill Dam Millpond
11/27/2007	Brian Glenzinski – Wildlife Biologist, WDNR	Provided an assessment of wildlife habitat adjacent to the Roller Mill Dam Millpond
09/13/2007	Heidi Bunk – Lakes Biologist, WDNR	Provided field assessment of Nemahbin Roller Mill Dam Millpond and Bark River, and sediment depth analysis

04/25/2007	Steve Galarneau – Lake Michigan Program Coordinator, WDNR	Conducted sediment survey on the Nemahbin Roller Mill Dam Millpond
ongoing	Michelle Schneider – Water Management Engineer, WDNR	Inspected Nemahbin Roller Mill Dam. Provided technical dam engineering content
ongoing	Brent Binder – Water Management Engineer, WDNR	Inspected Nemahbin Roller Mill Dam. Provided technical dam engineering content
ongoing	Bill Sturtevant – Dam Safety Engineer, WDNR	Inspected Nemahbin Roller Mill Dam
ongoing	Zoe McManama – Water Resources Specialist, WDNR	Field work participant, data analyst, and document collator.

Project Name: Nemahbin Roller Mill Dam Abandonment County: Waukesha

DECISION (This decision is not final until certified by the appropriate authority)

In accordance with s. 1.11, Stats., and Ch. NR 150, Adm. Code, the Department is authorized and required to determine whether it has complied with s.1.11, Stats., and Ch. NR 150, Wis. Adm. Code.

Complete either A or B below:

A. EIS Process Not Required ☐

The attached analysis of the expected impacts of this proposal is of sufficient scope and detail to conclude that this is not a major action which would significantly affect the quality of the human environment. In my opinion, therefore, an environmental impact statement is not required prior to final action by the Department.

B. Major Action Requiring the Full EIS Process ☐

The proposal is of such magnitude and complexity with such considerable and important impacts on the quality of the human environment that it constitutes a major action significantly affecting the quality of the human environment.

Signature of Evaluator	Date Signed

Number of responses to news release or other notice:

Certified to be in compliance with WEPA	
Environmental Analysis and Liaison Program Staff	Date Signed

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed.

For judicial review of a decision pursuant to sections 227.52 and 227.53, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

To request a contested case hearing pursuant to section 227.42, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to serve a petition for hearing on the Secretary of the Department of Natural Resources. The filing of a request for a contested case hearing is not a prerequisite for judicial review and does not extend the 30-day period for filing a petition for judicial review.

Note: Not all Department decisions respecting environmental impact, such as those involving solid waste or hazardous waste facilities under sections 144.43 to 144.47 and 144.60 to 144.74, Stats., are

subject to the contested case hearing provisions of section 227.42, Stats.

This notice is provided pursuant to section 227.48(2), Stats.

Appendix E

WISCONSIN DEPARTMENT OF ADMINISTRATION ORDER TO ABANDON ROLLER MILL DAM: APRIL 2009

Before The
State Of Wisconsin
DIVISION OF HEARINGS AND APPEALS

In the Matter of an Application by Margaret Zerwekh to Abandon and Remove the Nemahbin Roller Mill Dam	Case No.: IP-SE-2008-68-67868
and	
An Order for Drawdown of the Impoundment Located on the Bark River in the City of Delafield, Waukesha County, Wisconsin	Case No.: IP-SE-2008-68-67870

FINDINGS OF FACT, CONCLUSIONS OF LAW, ORDERS AND PERMIT

Pursuant to due notice including publication, hearing was held on December 10-11, 2008, at Waukesha, Wisconsin, Jeffrey D. Boldt, Administrative Law Judge, presiding. Pursuant to Wis. Stat. § 31.185(4), the Division deferred action on the request for abandonment for 120 days to allow for any "municipalities or other persons or associations" to acquire ownership of the dam. The 120 day waiting period expired on April 10, 2009, and the Division was not made aware of any such acquisition by any group or entity. The Division formally notified all parties and interested persons that the 120 day period had expired on April 13, 2009. The record closed on April 17, 2009, which was the last date to respond to an ex-parte letter submitted on April 7, 2009.

In accordance with Wis. Stat. §§ 227.47 and 227.53(1)(c), the PARTIES to this proceeding are certified as follows:

Wisconsin Department of Natural Resources, by

Attorney Michael Scott
Department of Natural Resources
P. O. Box 7921
Madison, WI 53707-7921

Margaret E. Zerwekh
500 Mill Road
Delafield, WI 53018, by

Attorney Steven D. Schmuki
Sayas, Schmuki & Plum, S.C.
11430 West Bluemound Road, #200
Wauwatosa, WI 53226-4050

Upper Nemahbin Lake Management District, by

Tim Mentkowski
34234 Venice Park Road
Delafield, WI 53018

Named petitioners formerly represented by Attorney Paul Kent by,

Raffi Shirikian
740 Mill Road
Delafield, WI 53018

Neil Mooers
257 West Main Street
Delafield, WI 53018

RULING ON MOTION TO DELAY DECISION

At the close of the hearing record, as well as in subsequent correspondence after the hearing from the City of Delafield, there were requests to delay issuance of the decision past the 120 day statutory waiting period. These requests are denied. The four month statutory period provides ample time for a decisive action to be commenced, if not always finalized, with respect to a change of dam ownership or effort to repair and or reconstruct the dam. As of the close of the record in this matter on April 17, 2009, no formal action to change the ownership of the dame has been started, nor is there any indication that such an action is imminent. Further, as set forth below in the Findings of Fact, DNR Dam Safety Engineer Bill Sturtevant was persuasive that concerns about dam owner liability in the event of a further failure argued against any further delay beyond the 120 day statutory waiting period. In addition to reasonable concerns about downstream liability, Sturtevant noted, the dam is very close to Ms. Zerwekh's home. Finally, environmental and water quality concerns argue for getting the project started during the growing season to facilitate re-vegetation. The motion to delay is, accordingly, denied.

FINDINGS OF FACT

1. On October 3, 2004, Margaret E. Zerwekh filed an Application for a Permit to Abandon and Remove the Nemahbin Roller Mill Dam with the Wisconsin Department of Natural Resources (DNR).

2. On June 18, 2008, the DNR issued Findings of Fact, Conclusions of Law and Order for Drawdown of the Impoundment Located on the Bark River in the City of Delafield, Waukesha County, Wisconsin.

3. On June 30, 2008, Raffi Shirikin, Lynne Olson, Gayle Gaborsky, Douglas and Joanne Prittie, Larry and Elizabeth Michels, Michael and Ann Gagliano, Alfred and Susan

Wagner, and Neil and Eileen Mooers filed a Petition for a Contested Case Hearing relating to the drawdown order. On July 16, 2008, the DNR granted the request for hearing.

4. On July 18, 2008, the Upper Nemahbin Lake Management District filed a Request for a Contested Case Hearing relating to the abandonment and removal of the Nemahbin Roller Mill Dam. On August 4, 2008, the DNR granted the request for hearing.

5. On August 7, 2008, the DNR forwarded both matters to the Division of Hearings and Appeals for hearing.

ABANDONMENT ADOPTED FINDINGS

6. The Nemahbin Roller Mill Dam is located on the Bark River in the NW ¼ of the NE ¼ of Section 19, Town 7 North, Range 18 East, in Waukesha County. The dam is approximately 400 feet long and has a structural height of 14 feet.

7. The Bark River is a navigable waterway. It is identified as a "Fish and Aquatic Life Water" of the state in NR 102 Wisconsin Administrative Code and supports a warm water sport fishery.

8. The Nemahbin Roller Mill Dam was originally constructed around 1839. The dam was used to power a sawmill and later a feed and flourmill. The current owner obtained the dam in 1949, began restoring the powerhouse, and by 1980 was using it to produce electricity.

9. On October 3, 2004, the owner of the Nemahbin Roller Mill Dam, Margaret Zerwekh, applied to abandon the dam.

10. The Department conducted sediment sampling within the Nemahbin Roller Mill Dam impoundment on June 14, 2006. The results of the sampling showed that arsenic was present at levels higher than typically found in Southeast Region waterways, but below the Probable Effect Concentration. No other appreciable contaminant levels were identified.

11. On June 3, 2008, the Department of Natural Resources issued a press release announcing the availability of a draft Environmental Assessment on the abandonment and removal of the Nemahbin Roller Mill Dam. The notice stated that written comments should be provided to the Department of Natural Resources by July 3, 2008.

12. During a period of high water, the headrace gate failed on June 11, 2008, rendering the dam's only low level drain inoperable. The Department issued a safety drawdown on June 18, 2008.

13. The Nemahbin Roller Mill Dam does not meet the design standards in Administrative Code NR 333, Dam Design and Construction Standards, nor does it meet the definition of a compliant dam in NR 116, Wisconsin's Floodplain Management administrative code.

14. The dam, in its present condition, does not have sufficient spillway capacity, is unsafe, and is a danger to life, health and property.

ADDITIONAL FINDINGS OF FACT

15. The applicant has carried her burden of proof sufficiently to receive the dam abandonment permit, subject to the conditions specified by the DNR and additional conditions that the petitioners have demonstrated are reasonable and necessary to safely abandon the dam.

16. The DNR has carried its burden of proof with respect to the drawdown order.

17. DNR Water Management Specialist Andy Hudak coordinated preparation of an extensive Environmental Analysis (EA) of the proposed abandonment of the Roller Mill Dam. (Ex. 8a) The environmental review concluded that the overall impact of the dam removal would have a positive impact upon the Bark River.

Hudak provided testimony that supported the conclusions of the EA, and specifically opined that dam removal would not have a detrimental impact upon "public rights in navigable waters" within the meaning of § 31.185(5).

Specifically, removal of the dam will reintegrate upstream and downstream fish populations on the Bark River, opening up additional habitat for fish and other aquatic life species that have been blocked by the dam.

Hudak concluded as follows:

> "Reductions in sedimentation will cause improvements in the quality of physical habitat and convert the substrate back to its natural condition of a sand and cobble stream bottom. Most benthic invertebrates require this rocky substrate. These invertebrates are an important food source for fish. Many fish species also prefer these rocky bottom conditions for spawning and feeding. Native species and most sport fish exhibit lowered vitality and productivity under the stresses of increased turbidity, lowered water quality, and scarcity of suitable habitat. Other, generalist types of species, such as carp, are unaffected or actually flourish despite these adverse effects and often dominate the fish community in impoundments.
>
> The removal of the Nemahbin Roller Mill dam will improve dissolved oxygen levels and decrease the water temperature in this reach of the Bark River. The removal will also eliminate the artificial warming caused by the impoundment. These effects should have positive impacts on fish and aquatic fish."

18. Any adverse impacts associated with this project are expected to be short-term in nature. These adverse impacts include turbidity in the waterway, soil disturbance and human activity near the dam site. These adverse impacts will be only those which are unavoidable and occur despite control measures. Unavoidable turbidity effects should not occur during the

spawning period when fish are most vulnerable. There should be no significant impacts in terms of temperature.

Short-term adverse impacts associated with the conversion of the Millpond into a free-flowing stream may affect wildlife which currently use the pond, including ducks, herons, turtles and frogs, muskrats, and raccoon. There are substantial areas of wetland adjacent to the project area along the Bark River that will provide adequate habitat for wildlife displaced from the Millpond during dam removal. The adverse impacts may affect some individuals, but will have no significant long-term impact on the overall numbers, the reproductive capability, or the success and stability of the species or regional populations as a whole.

Long-term effects on the riparian and aquatic system should be highly beneficial. Improvements will occur in physical characteristics, which in turn will create ecological and biological benefits. The Millpond will revert back to a natural sandy-cobble substrate characteristic of the Bark River, providing additional habitat for riverine forms of aquatic life. (Ex. 8a)

To ensure that the transition from short-term adverse impacts to the long term benefits is as smooth as possible, the final plans should include objective standards for re-vegetation over the intermediate period, which will likely be several growing seasons. Some seeding of areas has occurred, but the existing ground cover needs to be enhanced with a final planting plan that emphasizes native plant species that provide habitat value. (Thompson; Montgomery)

19. DNR dam safety engineer Bill Sturtevant testified that he has been involved in more than 50 dam abandonment permits and that the Department has gained insights into sequencing and final construction issues. A slow drawdown allows for consolidation of sediments, gradual re-vegetation, settling of sediments particularly in wetland areas, and floodplain controls. (Sturtevant) Sturtevant testified that the DNR will provide considerable support in downstream monitoring efforts.

20. Sturtevant was persuasive that concerns about dam owner liability in the event of a further failure argued against any further delay beyond the 120 day statutory waiting period. In addition to reasonable concerns about downstream liability, Sturtevant noted, the dam is very close to Ms. Zerwekh's home. Finally, environmental concerns argue for getting the project started during the growing season to facilitate re-vegetation.

21. Removal of the dam will not have a detrimental impact upon wetlands. The wetland area near the site is likely to increase after the Roller Mill dam is fully removed. (Reed) The wetland functional values, particularly for water quality protection and surface water runoff storage and filtering, will also be enhanced. (Reed) Wetland scientist Alice Thompson testified on behalf of dam removal opponents. She expressed concern that there would be a net loss of wetland acreage because the former pond itself was largely a wetland and that it had high functional value for recreational and aesthetic uses. (Ex.224) Further, species dependent upon open water pond habitat would suffer a loss of habitat area. This loss must be balanced with the improved fishery values and improved habitat for fish and mollusks and other invertebrates

discussed below. Finally, Sturtevant opined that wetland areas in other dam removal projects ultimately provided new and enhanced recreational opportunities along the river.

22. The complete removal of the dam will have a positive impact upon fishery values. (Beyler) The drawdown has resulted in some significant short term sediment release. However, the overall impact of the drawdown is likely to be positive over the long-term as the free flowing river allows numerous fish species to pass. Ms. Beyler provided undisputed expert testimony that fish habitat values are likely to improve after dam removal, particularly in the half-mile section near the impoundment. (Id.) Further, dam removal will also improve habitat and opportunities for mussels and other freshwater mollusks, as will the expected improvement in water quality. (Id.) Under controlled conditions, sediment is especially likely to be deposited in quieter and shallower areas and may actually improve habitat values for some species. (Id.)

23. It would be fundamentally unfair to require the applicant to clean up and monitor the entire Bark River below the dam. (Sturtevant) However, the petitioners have demonstrated that there is a significant risk of the proliferation of harmful invasive plant species after dam removal. The Division concludes that the permit should contain a new condition which requires monitoring for invasive species and for sedimentation, limited to on-site areas directly subject to the control of the applicant. (Condition 8)

The DNR testified at hearing that it would reasonably expect to undertake monitoring on off-property areas after full dam removal has been accomplished. It is expected that the City of Delafield will also be kept informed of (and included, with City approval) in some of these efforts in the areas owned by the City, including the riparian area near Cushing Memorial Park that lies at the eastern edge of the former mill pond area.

24. Given the proximity of Upper Nemahbin Lake a short distance downstream, it is important to minimize sediment transport to the extent that is possible. Some sediment release is to be expected and is part of the natural process of a riverine system. However, all care should be taken to avoid a massive release of sediment that would have a detrimental impact upon Upper Nemahbin Lake water quality.

25. This order is to allow abandonment of the dam. Given the expense of drafting detailed plans, the DNR does not require final dam removal plans until a decision has been made on whether or not the dam can be abandoned. (Sturtevant) Preliminary engineering design plans for the removal of the dam have been prepared by Interflure, Inc., a well known river restoration design firm. (Ex. 111)

26. The final dam removal plans shall address in detail all of the following and shall be subject to approval by Department staff:

- Drawdown Plan
- Material Removal Plan
- Erosion Control Plan
- Sediment Stabilization Plan

- Planting Plan
- Floodplain Analysis
- Stream bank Stabilization Plan
- Existing and Proposed Grades
- Construction and Post-Construction Sequencing
- Site specific analysis
- On-site post-construction monitoring, including but not limited to : invasive species control, objective re-vegetation standards, sedimentation stabilization and other physical or biological conditions requested by Department staff
(Id; Exs. 8a and Ex. 222; Hudak; Sturtevant; Montgomery)

DISCUSSION

There is no question that the loss of the Nemahbin Pond will be difficult for the petitioners who have organized to oppose the dam abandonment. They spoke eloquently and with conviction about how their families and friends have enjoyed the pond for many years, as well as of their sincere desire to contribute financially to reconstruction of the dam if the applicant chose to pursue it. However, Ms. Zerwekh, for very sound reasons of her own, has not chosen to do so. Instead, she has maintained her right to pursue abandonment of the dam which she and her late husband have heroically maintained for nearly sixty years. After all of those years, Ms. Zerwekh is understandably tired of the responsibility of maintaining the dam and of protecting her assets against its potential liabilities.

Ms. Zerwekh is also looking forward to restoring the river to its natural state. But her reasons for pursuing abandonment are not really at issue in this case. The only issue is whether or not the abandonment meets state standards for doing so. Ms. Zerwekh has established that it does, so long as it is undertaken in accordance with the conditions described below.

The experts for the opponents raised reasonable concerns about the release of accumulated sediment, the impact on wetlands and the ability of the applicant to bear the high cost of doing the dam removal in an environmentally responsible manner. There is no question that some sediment will be released during final dam removal. It is expected that the final plans will minimize any short-term detrimental impact upon water quality in downstream areas.

However, the great weight of the evidence was that the long-term effects of dam removal on public rights in the riparian and aquatic system should be highly beneficial. Given the likely long term benefits of dam removal, the balancing of public rights in public waters clearly supports issuance of the permit to abandon the dam. Further, Ms. Zerwekh has operated the dam in a highly responsible way that benefited the public interest for many years. There is every reason to expect that she will undertake the dam removal in the same manner.

Based upon the record made at the hearing, the Division has added three new conditions to the original DNR permit. First, a requirement for the dam owner to monitor her 15-acre parcel to protect against introduction of invasive species, to control sediment release, and to monitor any other physical or biological condition deemed a concern by DNR staff. (Sturtevant) Second,

a specific requirement for a new planting plan which includes objective performance standards (i.e. targeted percentage of cover) and which emphasizes native species with habitat value. (Thompson & Montgomery) Finally the final permit contains a requirement for construction (Hudak) and post-construction (Montgomery) sequencing and final plans.

While it is outside the scope of this review of the draw down order and dam abandonment permit, it is hoped that the parties and interested entities, including if necessary the City of Delafield, will work cooperatively to resolve any issues related to preserving or establishing riparian rights for the properties along the former Mill Pond. To the extent practicable, the final plans should make every effort to maintain existing riparian Bark River access for the affected properties.

The conditions set forth below are reasonable and necessary to preserve public rights in navigable waters, to promote safety, and to protect life, health and property.

CONCLUSIONS OF LAW

1. The Division of Hearings and Appeals has authority under Wis. Stat. §§ 227.43 and 31.185 to hear contested case relating to permits to abandon dams and cases relating to drawdown orders pursuant to Wis. Stat. § 31.19(5).

2. Wisconsin Stat. § 31.185(4):

> Prior to the hearing the department shall have its staff make its own investigation of the dam and, on the basis of such investigation, shall make recommendations as to the type of requirements, if any, which it would impose on the applicant under sub. (5) as a condition to granting the permit. Such recommendations shall be presented at the hearing. If no one registers opposition to the application at the hearing, the department shall grant the permit, subject to such conditions as it deems necessary under sub. (5). If someone registers opposition to the abandonment at the hearing and such opposition is not withdrawn, the department shall defer action on the application for a period of 120 days after the hearing. Within a reasonable time after the expiration of such period, the department shall deny the permit, or grant the permit, subject to such conditions as it imposes under sub. (5), unless, within such 120-day period, one or more municipalities or other persons or associations have agreed to acquire ownership of the dam and have furnished satisfactory proof of intent to comply with s. 31.14 (2) or (3).
>
> The 120 day waiting period has run as of April 10, 2009. No municipalities or other persons or associations have agreed to acquire ownership of the dam.

3. As a prerequisite to the granting of a permit under this section, the department may require the applicant to comply with such conditions as it deems reasonably necessary in the particular case to preserve public rights in navigable waters, to promote safety, and to protect life, health and property. Wisconsin Stat. § 31.185(5)

The conditions set forth below are necessary to accomplish the objectives described above.

4. A dam abandonment is a Type 2 action pursuant to NR 150.03(f)(7)(a). The DNR prepared an Environmental Assessment (Ex. 8) and has complied with the procedural requirements of WEPA in this matter.

ORDERS

WHEREFORE, IT IS HEREBY ORDERED, that the dam be declared abandoned, and that the removal of the dam be permitted to the owner specified above;

IT IS FURTHER ORDERED, that the owner of the Nemahbin Roller Mill Dam must develop final plans and specifications for the removal of the dam subject to the permit conditions specified below and approval by DNR staff:

CONDITIONS

1. The dam must remain in a drawn down condition until plans for the removal have been approved.

2. The owner will obtain the services of a Professional Engineer (PE) registered in the State of Wisconsin to develop the required plans and specifications for the removal of the dam and restoration of the Bark River.

3. The plan must be submitted within six months of the date of this order.

4. The plan must include best management practices and techniques to remove or stabilize existing sediment deposits and control transportation of material to the maximum extent practicable.

5. Construction site erosion control technical standards and best management practices must be followed.

6. The plans must include the complete removal of all concrete, metal and wood portions of the dam and the removal of portions of the earthen embankment to the extent necessary to pass the regulatory flood.

7. Demolished dam materials must be disposed of properly.

8. On-site monitoring plans for invasive species, control of sediments and any other physical or biological conditions requested by DNR staff.

9. A planting plan that emphasizes native species with habitat value and that includes objective standards of re-vegetation performance.

10. Construction and post-construction sequencing and final plans.

Dated at Madison, Wisconsin on April 21, 2009.

STATE OF WISCONSIN
DIVISION OF HEARINGS AND APPEALS
5005 University Avenue, Suite 201
Madison, Wisconsin 53705
Telephone: (608) 266-7709
FAX: (608) 264-9885

By:_____
Jeffrey D. Boldt
Administrative Law Judge

NOTICE

Set out below is a list of alternative methods available to persons who may desire to obtain review of the attached decision of the Administrative Law Judge. This notice is provided to insure compliance with Wis. Stat. § 227.48 and sets out the rights of any party to this proceeding to petition for rehearing and administrative or judicial review of an adverse decision.

1. Any party to this proceeding adversely affected by the decision attached hereto has the right within twenty (20) days after entry of the decision, to petition the secretary of the Department of Natural Resources for review of the decision as provided by Wisconsin Administrative Code NR 2.20. A petition for review under this section is not a prerequisite for judicial review under Wis. Stat. §§ 227.52 and 227.53.

2. Any person aggrieved by the attached order may within twenty (20) days after service of such order or decision file with the Division of Hearings and Appeals a written petition for rehearing pursuant to Wis. Stat. § 227.49. Rehearing may only be granted for those reasons set out in Wis. Stat. § 227.49(3). A petition under this section is not a prerequisite for judicial review under Wis. Stat. §§ 227.52 and 227.53.

3. Any person aggrieved by the attached decision which adversely affects the substantial interests of such person by action or inaction, affirmative or negative in form is entitled to judicial review by filing a petition therefore in accordance with the provisions of Wis. Stat. §§ 227.52 and 227.53. Said petition must be filed within thirty (30) days after service of the agency decision sought to be reviewed. If a rehearing is requested as noted in paragraph (2) above, any party seeking judicial review shall serve and file a petition for review within thirty (30) days after service of the order disposing of the rehearing application or within thirty (30) days after final disposition by operation of law. Since the decision of the Administrative Law Judge in the attached order is by law a decision of the Department of Natural Resources, any petition for judicial review shall name the Department of Natural Resources as the respondent and shall be served upon the Secretary of the Department either personally or by certified mail at: 101 South Webster Street, P. O. Box 7921, Madison, WI 53707-7921. Persons desiring to file for judicial review are advised to closely examine all provisions of Wis. Stat. §§ 227.52 and 227.53, to insure strict compliance with all its requirements.

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Appendix F

UPPER NEMAHBIN LAKE MANAGEMENT DISTRICT ANNUAL MEETING MINUTES: 2007 AND 2008

UNLMD Annual Meeting Minutes
Thursday, November 8, 2007

1 Call to Order
Tim Mentkowski called the meeting to order at 7:10pm. In attendance were 29 UNLMD *members and 5 UNLMD commissioners.*

2. General Discussion of Members interest

   a. *Web page for lake district; Steven Libbey volunteered to create a web page*
   b. Noise level from I-94, wall barrier to help block out noise; Jon LoDuca is contacting agencies regarding a barrier

3. Water Quality Committee
See next page for summary from Bill Barthel on water quality.

4. Budget Hearing and Request for Vote of Approval of 2008 Proposed Activities
   a. Basic Expenses passed by majority
   Pat Corocoran made a motion to approve, Judy Bay seconded the motion
   b. Water Quality passed by majority
   Pat Corcoran made a motion to approve, Judy Bay seconded the motion
   c. Annual Picnic passed by majority
   Mike Donabauer made a motion to approve, Linda Daniels seconded the motion
   d. Fireworks passed by majority (23 approved; 11 do not approve)
   Pat Corcoran made a motion to approve, Mike Donabauer seconded the motion

5. Annual Meeting November 13, 2008
The next meeting has been approved for November 8, 2007

6. Election of commissioners
Bill Barthel, Tim Mentkowski, and Kent Brooks were unanimously elected as UNLMD Commissioners.

7. Adjournment
Meeting was adjourned at 8:20pm.

Respectfully Submitted
Jackie Smith
UNLMD *commissioner/secretary*

UNLMD
Water Quality Report
November 8, 2007

Summary

1. Proposed FEMA floodplain elevation increases to 874.1 ft from the current (1983) 872.4 to be increased to 875.1 ft with the completion of the repairs to the two floodgates at the Nagawicka Dam in Delafield. This increase is attributed to the potential increase in flow over the Nagawicka Dam and the restriction of the Bark River channel at the Highway DR Bridge.

2. Highway P bridge replacement over the Bark River design has been awarded to Romenesko Engineering. The current intent of Waukesha County is to keep the roadway on its current alignment. As a result the adjacent dam will conflict with shoulder widening which will require a need to remove and relocate the dam.

3. Mrs. Zerwekh's application for the abandonment of the Roller Mills Dam has been accepted by the WDNR. The WDNR has reported that rumors of hazardous materials included in the impoundment have been proven untrue as a result of chemical analysis of sediment samples by the WDNR. The Waukesha office of the WDNR is drafting an Environmental Assessment of the dam abandonment and removal. It has been reported that the EA could be completed and published for the 30-day public review in January 2008. The UNLMD study that includes an engineered solution to the re-establishment of the Bark River in the event that the dam is removed is underway. The study will recommend the steps to be followed before the removal of the dam.

UPPER NEMAHBIN LAKE MANAGEMENT DISTRICT

Minutes 2008 Annual Meeting
November 13, 2008

1. Call to Order – 7:05 p.m.
   Bill Barthel called the meeting to order. Four board members present were Bill Barthel, Marilynn Charlson, Larry Schmidt, Jackie Smith
2. Minutes - 2007 Annual meeting minutes
   Motion to Accept – Mike Donabauer
   2nd Motion – Jennifer Reek
   Vote – majority voted yes to approve minutes as read
3. Water Quanity
   2008 FEMA study – Larry Schmidt
   In affect November 19, 2008. An appeal of this mapping was in on time noting errors. Letter of Final determination stated municipalities needed to adopt new elevations to receive FEMA insurance. An engineering firm will be needed to have all areas re-studied.
4. Water Quality – Bill Barthel
   a. Highway P Dam reconstruction update. Description of design – twin block culvert, bike trail crossing bridge, and existing dam will be replaced with a canoe portage. Projects will be done separately.
   b. Roller Mill Dam abandonment and efforts to minimize its negative environmental impact. Environmental Assessment meeting June 5, 2008 led everyone to believe there was a plan on abandonment. Court action taken with DNR to stop destruction.
5. Budget Hearing and Request for Approval – Bill Barthel
   a. Basic Expenses (budget items 1 – 5)
      Motion to Approve, Mike Donabauer, 2nd Motion, Kent Brooks
      Passed (Yes-28, No-0)
   b. Water Quality (budget item 6)
      Motion to Approve, Mike Donabauer, 2nd Motion, Kent Brooks
      Passed Yes-28, No-0
   c. Annual Picnic (budget item 7)
      Motion to Approve, Linda Daniels, 2nd Motion, Mike Donabauer
      Passed (Yes- 22, No- 6)
   d. Fireworks (budget item 8)
      Motion to Approve, Linda Daniels, 2nd Motion, Mike Donabauer
      Passed (Yes- 14, No- 11)
6. Annual Meeting November 12, 2008
   Accept motion to hold 2009 Annual Meeting on November 12, 2009 Passed 100%
7. Election of Commissioners
   Jennifer Reek was elected to the board Passed (Yes- 24, No- 0)
   Pat Clifford – Town Board member

8. Adjournment of Meeting
   Motion to adjourn meeting – 8:45 p.m.

Submitted By Jennifer Reek _____ Secretary