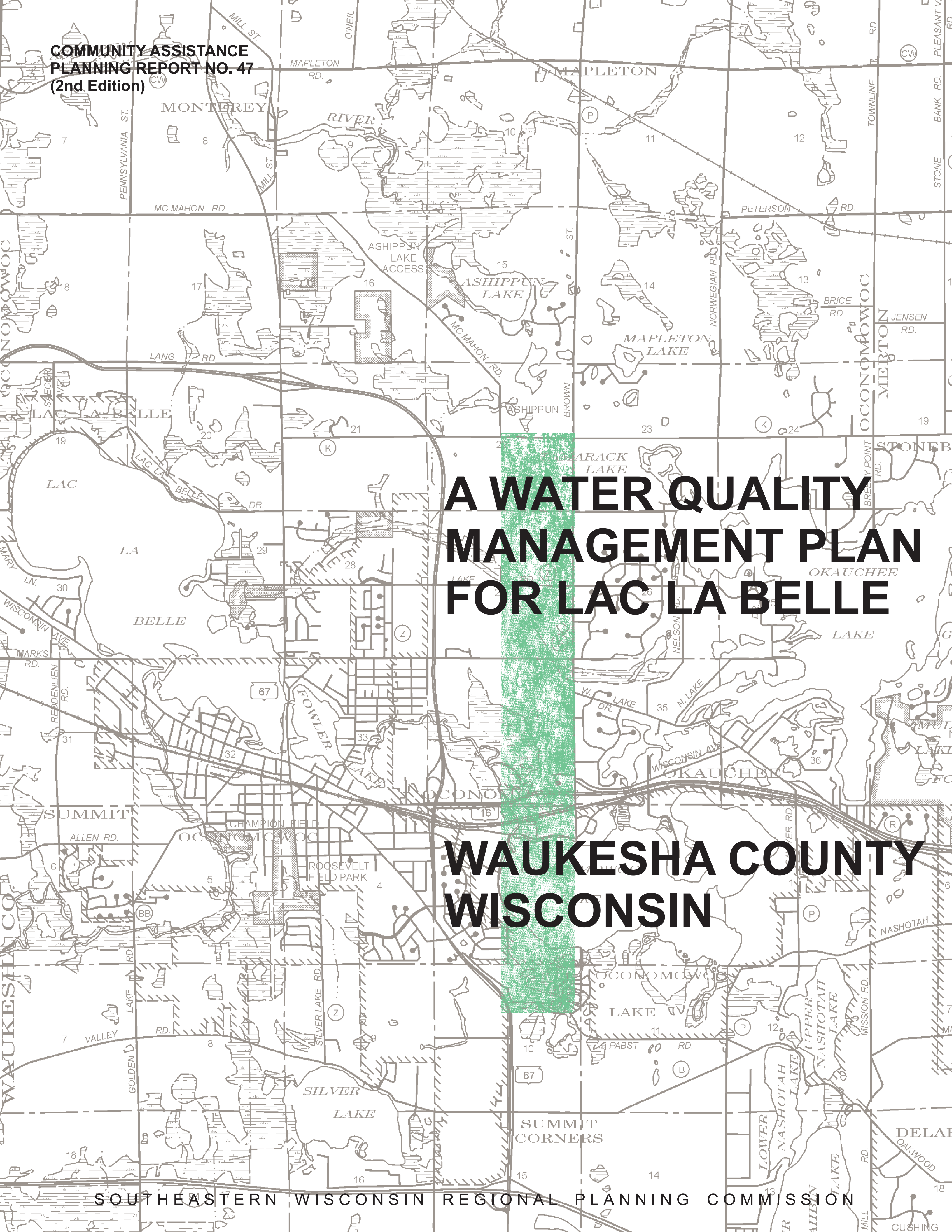
COMMUNITY ASSISTANCE
PLANNING REPORT NO. 47
(2nd Edition)

A WATER QUALITY MANAGEMENT PLAN FOR LAC LA BELLE

WAUKESHA COUNTY WISCONSIN



SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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NUMBER 47, 2nd Edition

A WATER QUALITY MANAGEMENT PLAN FOR LAC LA BELLE
WAUKESHA COUNTY, WISCONSIN

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Chapter I

INTRODUCTION

Lac La Belle is a 1,164-acre through-flow lake located entirely within U.S. Public Land Survey Township 8 North, Range 17 East, in the City and Town of Oconomowoc and the Village of Lac La Belle, all in Waukesha County. Lac La Belle is the last lake in a chain of six major Lakes along the Oconomowoc River system within the Southeastern Wisconsin Region.[1] The Oconomowoc River forms the principal inflow and outflow to Lac La Belle. For many years, the Lake has experienced various management problems, including recreational user conflicts, water quality-related use limitations, and public concerns over the aesthetic degradation. In response to these concerns, Lac La Belle has been the subject of numerous planning efforts, including the preparation of lake-specific plan elements within the regional water quality management plan,[2] and a water quality management plan for Lac La Belle that was completed by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in 1980.[3] The regional water quality management plan identified surface water quality problems within the Oconomowoc River watershed; identified major sources of pollution; and provided recommendations for abating those sources over time to achieve specific water use objectives and attendant water quality standards that were refined in the lake-specific plan. In addition, the Wisconsin Department of Natural Resources (WDNR) prepared a nonpoint source pollution control plan for the Oconomowoc River basin, which was adopted in 1986.[4]

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[1]*Lake management plans have been prepared by the Southeastern Wisconsin Regional Planning Commission for each of these six waterbodies: see SEWRPC Community Assistance Planning Report No. 98, 2nd Edition,* A Lake Management Plan for Friess Lake, Washington County, Wisconsin*, November 1997; SEWRPC Community Assistance Planning Report No. 54,* A Water Quality Management Plan for North Lake, Waukesha County, Wisconsin*, July 1982; SEWRPC Community Assistance Planning Report No. 53, Second Edition,* A Water Quality Management Plan for Okauchee Lake, Waukesha County, Wisconsin*, October 2003; SEWRPC Community Assistance Planning Report No. 181,* A Water Quality Management Plan for Oconomowoc Lake, Waukesha County Wisconsin*, March 1990; SEWRPC Community Assistance Planning Report No. 187,* A Management Plan for Fowler Lake, Waukesha County, Wisconsin*, March 1994; SEWRPC Community Assistance Planning Report No. 47,* A Water Quality Management Plan for Lac La Belle, Waukesha County, Wisconsin*, December 1980.*

[2]*SEWRPC Planning Report No. 30*, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, *Volume Two*, Alternative Plans, *February 1979; see also, SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report*, March 1995.*

[3]*SEWRPC Community Assistance Planning Report No. 47,* op. cit.

[4]*Wisconsin Department of Natural Resources Publication No. WR-194-86,* A Nonpoint Source Control Plan for the Oconomowoc River Priority Watershed Project*, March 1986.*

The Lac La Belle community has a long history of efforts by the residents to protect and improve the Lake's water quality. The creation of the Lac La Belle Management District, during 1978, pursuant to Chapter 33 of the *Wisconsin Statutes*, provided a vehicle for focusing community attention on lake-related issues. Since that time, the Lake Management District has participated in a number of previous planning and monitoring efforts, including investigations carried out by the U.S. Environmental Protection Agency;[5] the U.S. Geological Survey;[6] the WDNR;[7] and SEWRPC. [8] Additional studies of the Lake have been carried out as part of the Oconomowoc River Priority Watershed Project,[9] the sanitary sewer service area facilities study,[10] and aquatic plant management planning studies.[11] Lac La Belle has adequate public recreational boating access pursuant to Chapter NR 1 of the *Wisconsin Administrative Code*.[12]

The location of Lac La Belle within rapidly growing Waukesha County and its proximity to the greater Milwaukee metropolitan area may be expected to contribute to a continued demand for more urban development in the vicinity of the Lake with concomitant demands for water-based recreational opportunities. As urban growth is occurring in and around the City of Oconomowoc and its environs, the Lac La Belle community remains concerned about present and future impacts on the Lake and its ecosystem of continued urbanization within the lake drainage basin. Because of the widespread and ongoing nature of these concerns, and given that the current lake management plan for Lac La Belle has reached its design lifespan, the Lac La Belle Management District has resolved that a refined lake management plan be prepared for Lac La Belle.

Previous studies related to lake water quality included participation in the WDNR Self-Help Monitoring Program and U.S. Geological Survey Trophic State Index (TSI) monitoring program. Data gathered through these studies of lake water quality and lake use have been included in the aforereferenced comprehensive water quality management plan prepared by the SEWRPC in 1980, and in a recreational use plan prepared by Aron & Associates in 1993. The Lac La Belle Management District also historically participated in the WDNR Long-Term Trend monitoring program. However, the discontinuation of this program in recent years has resulted in a dearth of comprehensive data on the lake environment. The data collected for use in these plans and studies, as

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[5]*U.S. Environmental Protection Agency Working Paper No. 62,* Report on Lac La Belle, Waukesha County, Wisconsin, EPA Region V*, June 1975.*

[6]*These data are compiled and reported annually by the U.S. Geological Survey: during the period through 1993, the data were published in the U.S. Geological Survey Water-Data Report series,* Water Resources Data, Wisconsin*, and, subsequent to 1993, in the U.S. Geological Survey Open-File Report series,* Water-Quality and Lake-Stage Data for Wisconsin Lakes*.*

[7]*Wisconsin Department of Natural Resources,* Lac La Belle Lake, Waukesha County, Long Term Trend Lake*, 1986 and 1987; Donald H. Les and Glenn Gunterspergen,* 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.*

[8]*SEWRPC Community Assistance Planning Report No. 47,* op. cit*.*

[9]*Wisconsin Department of Natural Resources Publication No. WR-194-86,* op. cit*.*

[10]*SEWRPC Community Assistance Planning Report No. 172, 2nd Edition,* Sanitary Sewer Service Area for the City of Oconomowoc and Environs, Waukesha County, Wisconsin*, September 1999.*

[11]*Timothy Lowry and Patrick Sorge, A Survey of the Aquatic Plants in Lac La Belle, Waukesha County, Wisconsin, October 1983.*

[12]*Aron & Associates,* Lac La Belle Planning Grant*, 1993.*

well as additional data gathered as part of this planning program, were used in the formulation of an updated comprehensive lake management plan for Lac La Belle.

This report discusses the physical, chemical, and biological characteristics of the Lake and the pertinent characteristics of its tributary watershed, as well as the feasibility of various water quality management alternatives which may enhance water quality conditions in the Lake. Specific management goals for Lac La Belle include achieving the recommended water quality standards in support of the objective of providing water quality suitable for maintaining a healthy fishery and maintaining opportunities for water-based recreational activities. The recommended management plan for the Lake, presented herein, conforms to the requirements and standards set forth in the relevant *Wisconsin Administrative Codes*,[13] and, accordingly, should constitute a practical, as well as technically sound, guide for the management of Lac La Belle and its tributary drainage basin.

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

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Chapter II

PHYSICAL DESCRIPTION

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 Lac La Belle, its watershed, and on the climate and hydrology of the Lac La Belle watershed. Subsequent chapters deal with the land use conditions, and the chemical and biological environments of the Lake.

WATERBODY CHARACTERISTICS

The drainage area directly tributary to Lac La Belle lies within the civil divisions of the City and Town of Oconomowoc and the Village of Lac La Belle in Waukesha County, with the total drainage area extending to the northeast through Waukesha County into Washington County, as shown on Map 1. Lac La Belle is a flow-through lake, having both a defined inflow and outflow. The Lake lies in a glacial valley fed and drained by the Oconomowoc River. The lake levels are presently controlled by a fixed crest outlet structure built in 1936.

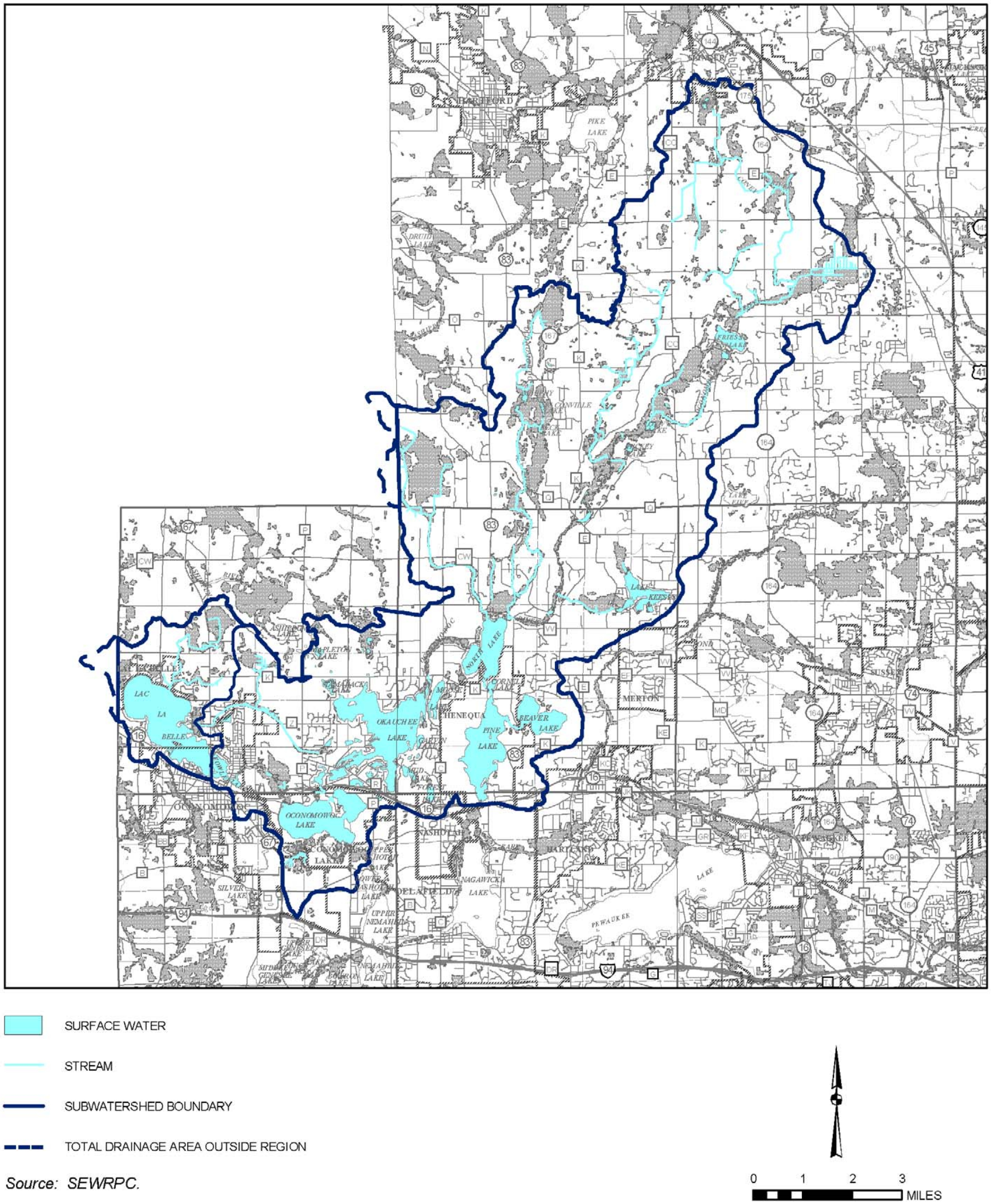
Lac La Belle has a surface area of about 1,164 acres, with a maximum depth of 45 feet and a mean depth of about 11 feet. About 38 percent of the lake area has a water depth of less than five feet, 28 percent of the lake area has a water depth between five and 10 feet, 12 percent has a water depth between 10 and 20 feet, and 22 percent has a depth of more than 20 feet. Lac La Belle is 2.6 miles long and 1.2 miles wide at its widest point. The major axis of the Lake lies in a northwesterly-southeasterly direction. The Lake contains two islands connected to the shore by roadways. The shore length is 11.2 miles, and the shoreline development factor is 2.01, indicating that the lake shoreline is irregular and about twice as long as that of a circular lake of the same area. The Lake has a total volume of approximately 12,924 acre-feet. The hydrographical and morphometric data are presented in Table 1 and the bathymetry of the Lake is shown on Map 2.

The shoreline of Lac La Belle is mostly developed for residential uses. Three significant wetland areas occur along the Lake's shoreline: one near the northwestern shore, another near the western shoreline, and the last near the eastern shoreline of the Lake. A public beach, boat ramp, and picnic area is located at the southeastern end of the Lake, within, and operated by, the City of Oconomowoc.

Erosion of shorelines results in the loss of land, damage to shoreline infrastructure, and interference with recreational access and lake use and sediment deposition in the Lake. Such erosion is usually caused by wind-

Map 1

LOCATION OF LAC LA BELLE



Source: SEWRPC.

Table 1

HYDROLOGY AND MORPHOMETRY CHARACTERISTICS OF LAC LA BELLE: 2000

Parameter	Measurement
Size (total)	
Surface Area	1,164 acres
Total Drainage Area	64,076 acres
Direct Tributary Drainage Area	4,329 acres
Volume	12,924 acre-feet
Residence Time[a]	0.32 year
Shape	
Maximum Length of Lake	2.6 miles
Length of Shoreline	11.2 miles
Maximum Width	1.2 miles
Shoreline Development Factor[b]	2.01
Depth	
Area of Lake Less than Five Feet	38 percent
Area of Lake Five to 10 Feet	28 percent
Area of Lake 10 to 20 Feet	12 percent
Area of Lake Greater than 20 Feet	22 percent
Mean Depth	11 feet
Maximum Depth	45 feet

[a]*Residence Time: Time required for a volume of equivalent of full volume replacement by inflowing waters to enter the lake.*

[b]*Shoreline Development Factor: Ratio of shoreline length to that of a circular lake of the same area.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

wave action, ice movement, and motorized boat traffic. A survey of the Lac La Belle shoreline, conducted during the summer of 2001 by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) staff, identified existing shoreline protection structures around the Lake, as shown on Map 3. Most were observed to be in a good state of repair, with no obvious failures. Most of the developed shoreland of Lac La Belle had some form of shoreline protection during 2001. Improperly installed and failing shoreline protection structures can contribute to shoreline erosion on Lac La Belle. However, such structures presently are a limited cause for concern.

Lake bottom sediment types are shown on Map 4. Sand and muck are the predominant lake bottom material. Other bottom sediment types, primarily along the shoreline, consist of silt, sand, gravel, and rock.

WATERSHED CHARACTERISTICS

The total drainage area tributary to Lac La Belle is approximately 64,000 acres, or about 100 square miles in areal extent, of which the direct drainage area, that is the area which drains directly into the Lake, totals about 4,330 acres, or approximately 6.8 square miles. Lac La Belle has a moderately low watershed-to-lake surface area ratio of 55:1. The Oconomowoc River forms the major inflow to the Lake, entering Lac La Belle on the southeastern shore directly downstream from the spillway and mill race of the impoundment augmenting water levels in Fowler Lake. Other inlets include two intermittent creeks entering Lac La Belle along the northern shore, Saeger Creek and La Belle Creek, and one perennial stream entering Lac La Belle on the eastern shore, Rosenow Creek. Rosenow Creek has a resident fish population, including trout. The Oconomowoc River forms the outflow of Lac La Belle, joining the mainstem of the Rock River about 13 miles downstream of the lake outlet within Jefferson County.

SOIL TYPES AND CONDITIONS

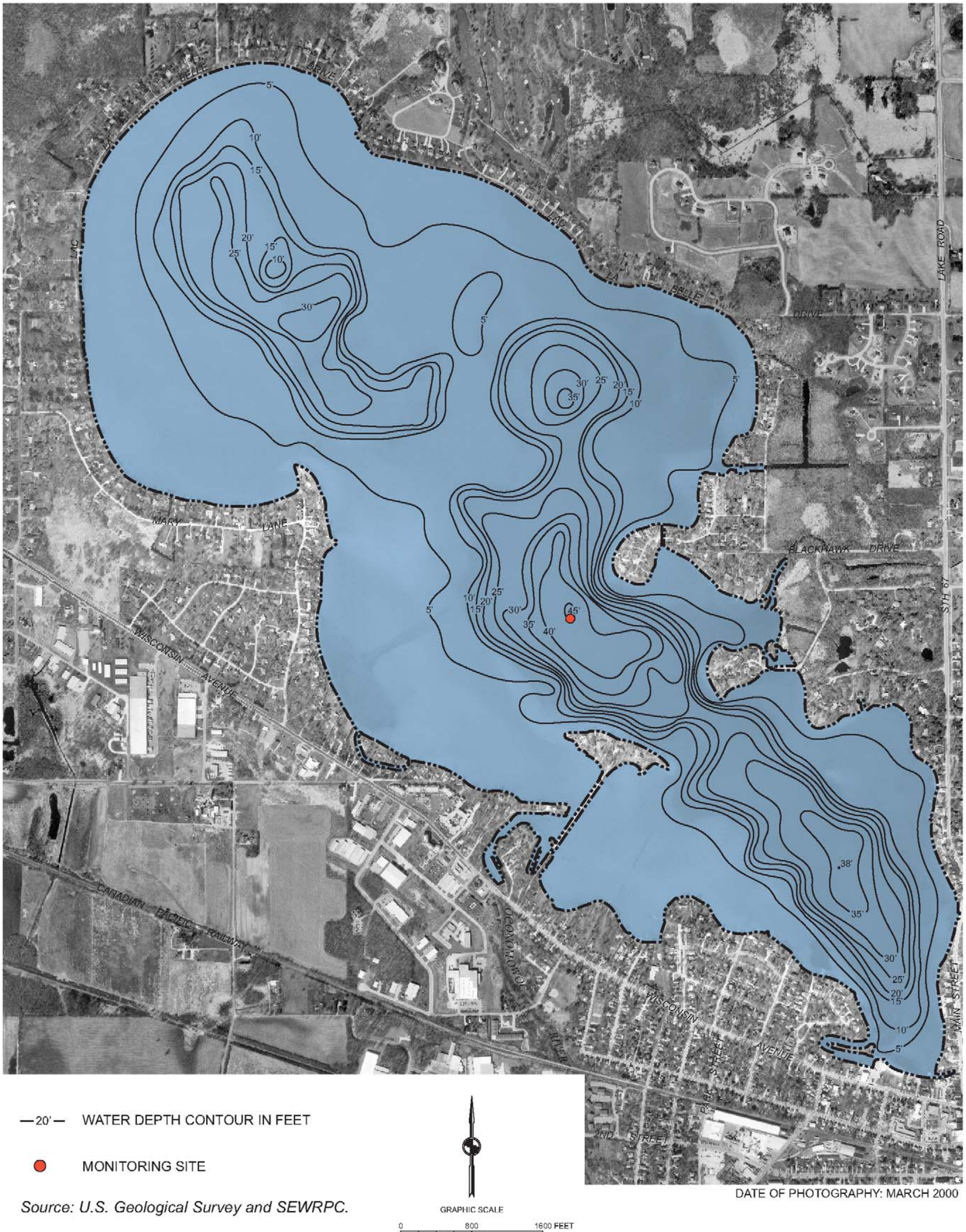
Soil type, land slope, and land use are among the more important factors determining lake water quality conditions. Soil type, land slope, and vegetative cover are also important factors affecting the rate, amount, and quality of stormwater runoff. Soil texture and soil particle structure influence the permeability, infiltration rate, and erodibility of soils. Land slopes are important determinants of stormwater runoff rates and of the susceptibility of soils to erosion. The erosivity of the runoff can be moderated or modified by vegetation.

The U.S. Natural Resources Conservation Service, formerly the U.S. Soil Conservation Service, under contract to SEWRPC, completed a detailed soil survey of the Lac La Belle area in 1966.[1] The soil survey contained interpretations for planning and engineering applications, as well as for agricultural applications. Using the regional soil survey, an assessment was made of hydrologic characteristics of the soils in the drainage area of Lac La Belle. The suitability of the soils for urban residential development was assessed using three common development scenarios. These ratings reflected the requirements of Chapter Comm 83 of the *Wisconsin*

[1]*SEWRPC Planning Report No. 8,* Soils of Southeastern Wisconsin, *June 1966.*

Map 2

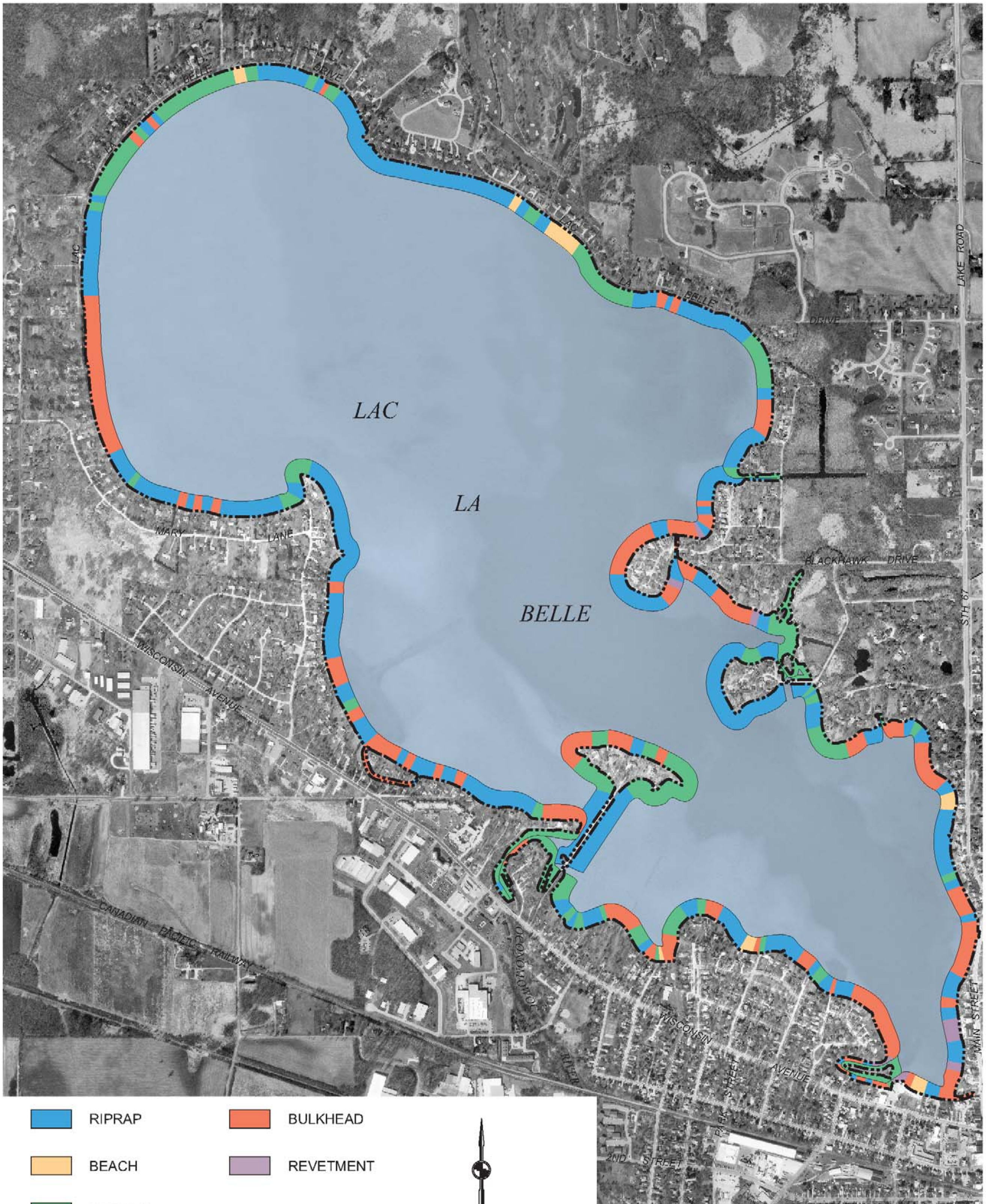
BATHYMETRIC MAP OF LAC LA BELLE



Source: U.S. Geological Survey and SEWRPC.

Map 3

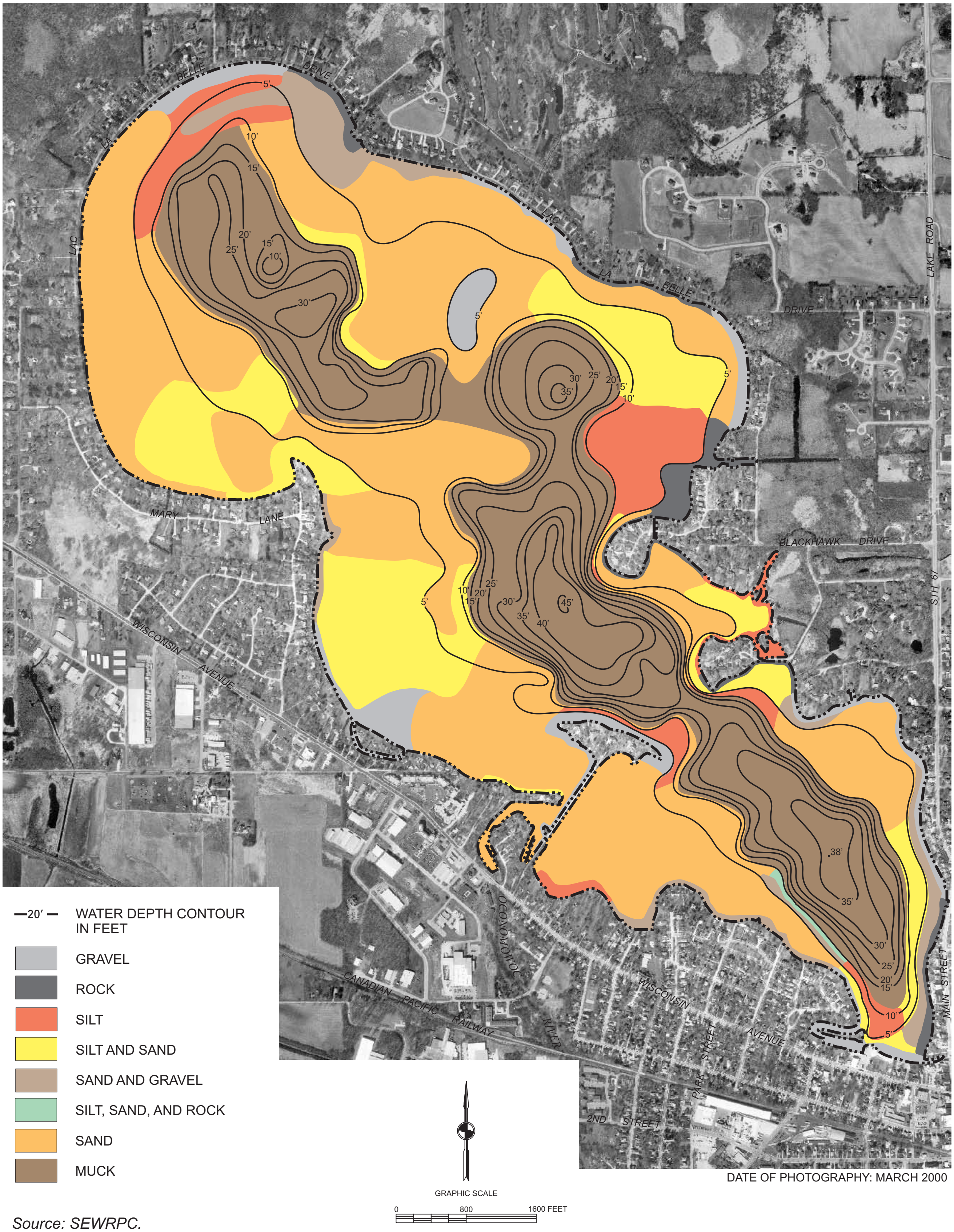
SHORELINE PROTECTION STRUCTURES ON LAC LA BELLE: 2001



Source: SEWRPC.

Map 4

SEDIMENT SUBSTRATE DISTRIBUTION IN LAC LA BELLE: 2001



Source: SEWRPC.

Administrative Code governing onsite sewage disposal systems as it existed through the year 2000. During 2000, the Wisconsin Legislature amended Chapter Comm 83 and adopted new rules governing onsite sewage disposal systems. These rules, which had an effective date of July 1, 2000, significantly altered the existing regulatory framework and have effectively increased the area in which onsite sewage disposal systems may be utilized.

While the majority of homes within the drainage area directly tributary to Lac La Belle are served by public sanitary sewerage systems, the interpretations associated with the soil survey are such that they continue to provide insights into the potential for land-based sources of pollution to affect the Lake water quality either as a consequence of overland flows during storm events or through groundwater interflows in the Lake. Consequently, based upon the soil ratings for onsite sewage disposal systems as determined pursuant to the then-existing requirements of Chapter Comm 83 of the *Wisconsin Administrative Code*, Map 5 suggests that portions of the drainage area tributary to Lac La Belle may potentially contribute to the contaminant loadings quantified in Chapter IV due to movement of contaminated groundwater into the surface water system. It is useful to note that about one-third of the lands within the drainage area tributary to Lac La Belle are covered by soils that are categorized as having few limitations for onsite sewage disposal systems. However, about one-half of the lands had severe limitations, suggesting a potential sensitivity to disturbance and likelihood of being permeable to pollutants.

Soils within the Lac La Belle watershed can be categorized into the three main hydrologic groups, as well as an "other" category, as indicated in Table 2. About two-thirds of the soils found in the Lac La Belle watershed can be categorized as moderately drained, Group B soils, with the balance of the soils within the tributary area being distributed among well drained, Group A soils; poorly drained, Group C soils; very poorly drained, Group D soils; and "other" soils for which a classification could not be determined due to disturbances to the soil profile by placement of fill or construction activities. The areal extent of these soils and their locations within the watershed are shown on Map 6.

The major specific soil types present within the Lac La Belle watershed include: Casco series, Hockheim series, Boyer sandy loam, Fox silt loam, Matherton silt loam, St. Charles silt loam, Sebewa silt loam, Virgil silt loam, Theresa silt loam, Houghton muck, and Palms muck.

Land slopes within the drainage area tributary to Lac La Belle are generally low, with more than 60 percent of the watershed having slopes of less than 6 percent. About 12 percent of the total drainage area tributary to Lac La Belle has slopes of between 6 and 12 percent, as shown on Map 7.

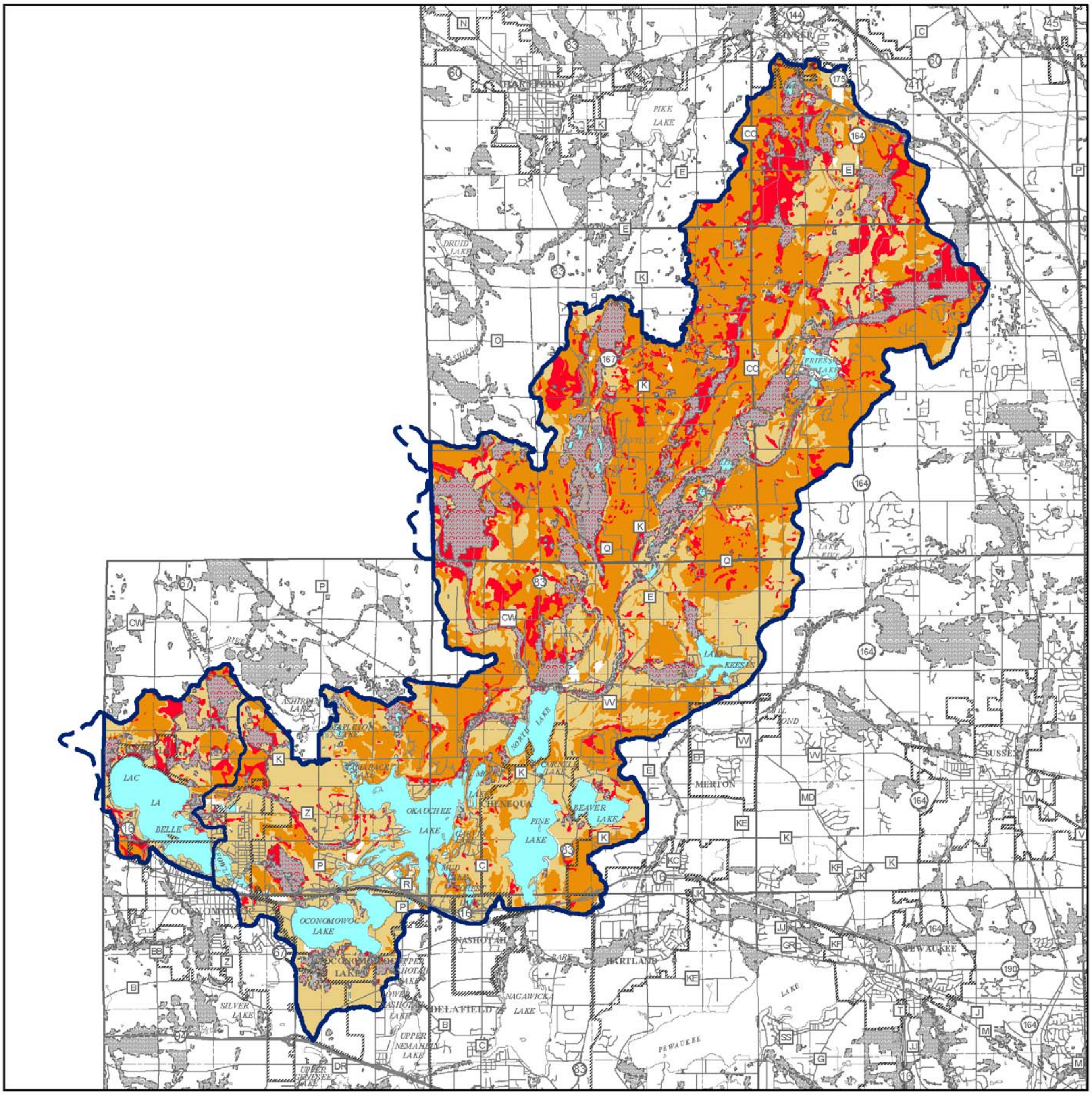
CLIMATE AND HYDROLOGY

Long-term average monthly air temperature and precipitation values for the Lac La Belle area are set forth in Table 3. These averages were taken from official National Oceanic and Atmospheric Administration (NOAA) records of temperature and precipitation for the weather recording station at Oconomowoc, Wisconsin. The records of this station may be considered as typical of the lake area. Table 3 also sets forth surface water runoff values derived from U.S. Geological Survey (USGS) flow records obtained at the downstream USGS Rock River gauging station located at Afton, Wisconsin.

The mean annual temperature of 45.2ºF at Oconomowoc is quite similar to that of other recording locations in southeastern Wisconsin. The mean annual precipitation at Oconomowoc is about 30.9 inches. More than half of the normal yearly precipitation falls during the growing season, from May to September. Runoff rates are generally low during this period, since evapotranspiration rates are high, vegetation cover is good, and soils are not frozen. Normally, less than 15 percent of the summer precipitation is expressed as surface runoff, but intense summer storms occasionally produce high runoff. Approximately 20 percent of the annual precipitation occurs during the winter or early spring when the ground is frozen, resulting in peak runoff during that period from snowmelt and/or rain. Impervious areas, such as street surfaces, parking lots, and rooftops, increase the amount of surface runoff and decrease soil infiltration.

Map 5

GROUNDWATER CONTAMINATION POTENTIAL WITHIN THE TOTAL DRAINAGE AREA TO LAC LA BELLE



UNSUITABLE: Areas covered by soils which have a high probability of not meeting the June 2000 criteria of Chapter Comm 83 of the *Wisconsin Administrative Code* governing conventional onsite sewage disposal systems

UNDETERMINED: Areas covered by soils having a range of characteristics and or slopes which span the June 2000 criteria of Chapter Comm 83 of the *Wisconsin Administrative Code* governing conventional onsite sewage disposal systems so that no classification can be assigned

SUITABLE: Areas covered by soils having a high probability of meeting the June 2000 criteria of Chapter Comm 83 of the *Wisconsin Aministrative Code* governing conventional onsite sewage disposal systems

OTHER: Areas consisting for the most part of disturbed land for which no interpretive data are available

SURFACE WATER

Total drainage area outside region with no soil group data available

0 1 2 3 MILES

Source: U.S. Department of Agriculture Natural Resources Conservation Service and SEWRPC.

Table 2

GENERAL HYDROLOGIC SOIL TYPES WITHIN THE TOTAL AND DIRECT DRAINAGE AREAS TRIBUTARY TO LAC LA BELLE

Group	Soil Characteristics	Direct Tributary Drainage Area (acres)	Percent of Total	Total Tributary Drainage Area (acres)	Percent of Total
A	Well drained; very rapidly to rapid permeability; low shrink-swell potential	- -	- -	151	0.2
A/B	Well drained soils; moderately drained soil [a]	- -	- -	2,295	3.6
A/D	Well drained soil/; very poorly drained soil [b]	- -	- -	4,238	6.7
B	Moderately well drained; texture intermediate between coarse and fine; moderately rapid to moderate permeability; low to moderate shrink-swell potential	1,975	45.6	40,622	64.7
B/D	Moderately drained soil; very poorly drained soil [c]	- -	- -	2,027	3.2
C	Poorly drained; high water table for part or most of the year; mottling, suggesting poor aeration and lack of drainage, generally present in A to C horizons	349	8.1	3,583	5.7
C/D	Poorly drained soil; very poorly drained soil [d]	- -	- -	128	0.2
D	Very poorly drained; high water table for most of the year; organic or clay soils; clay soils having high shrink-swell potential	786	18.2	3,026	4.9
Other	Group not determined	19	0.4	1,505	2.4
- -	Water	1,200	27.7	5,297[e]	8.4
- -	Total	4,329	100.0	62,912[e]	100.0

[a]*Well-drained if water table is lowered through provision of a drainage system. Moderately drained soil if water table is not lowered.*

[b]*Well-drained if water table is lowered through provision of a drainage system. Very poorly drained if water table is not lowered.*

[c]*Moderately drained soil if water table is lowered through provision of a drainage system. Very poorly drained soil if water table is not lowered.*

[d]*Poorly drained soil if water table is lowered through provision of a drainage system. Very poorly drained soil if water table is not lowered.*

[e]*Excludes the surface area of Lac La Belle.*

Source: SEWRPC.

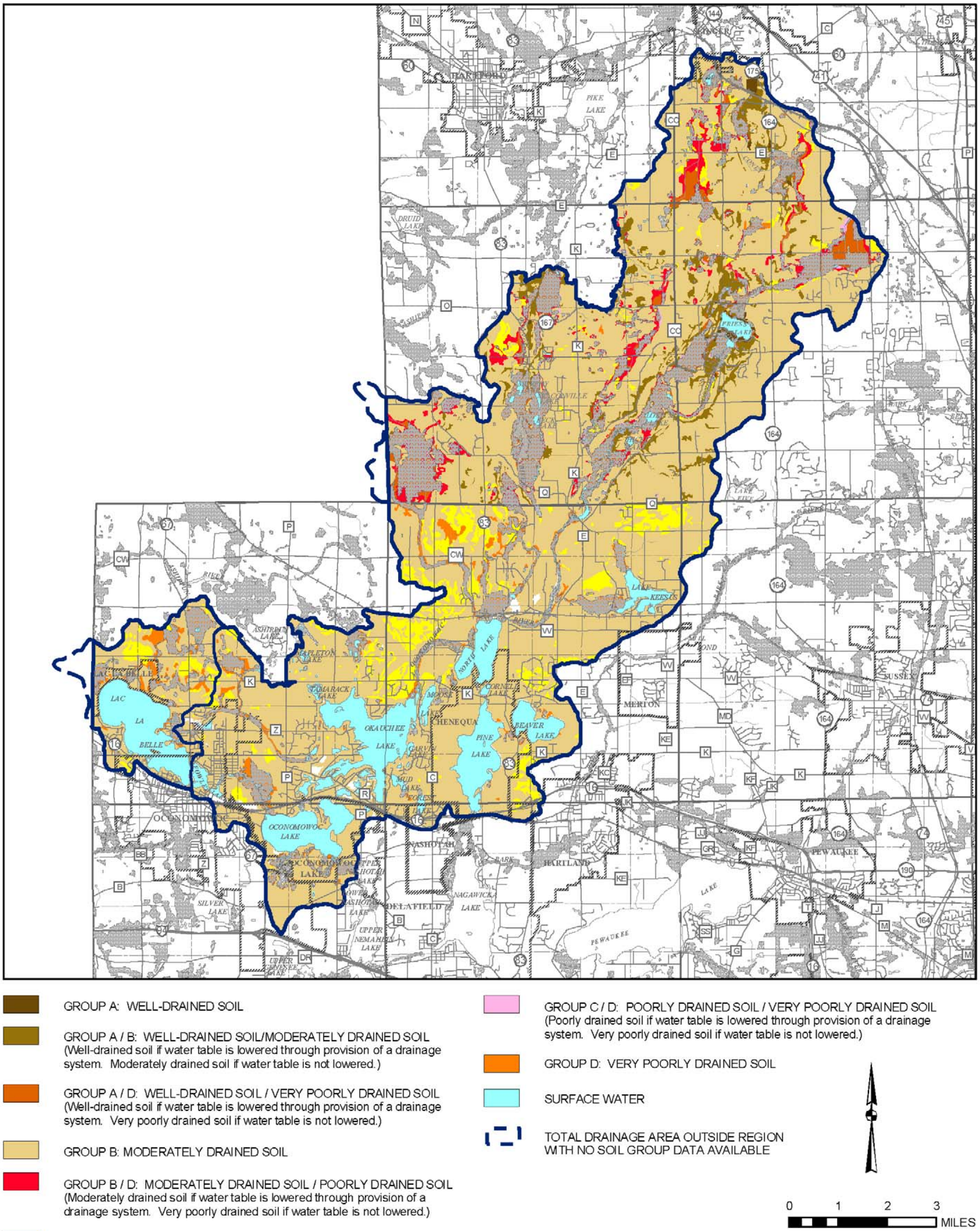
The 12-month period over which the Lac La Belle water quality sampling study was carried out, January 1999 through December 1999, was a period of variable temperatures and rainfall in southeastern Wisconsin, as indicated in Table 3. Temperatures were generally normal to above normal during the year. Precipitation at Oconomowoc during the sampling period was about 37.9 inches, or 23 percent above normal, with the greatest increase from the average, 3.62 inches, occurring during April 1999. Six of the 12 months of the study period, January, April, May, June, July, and December 1999, experienced above normal amounts of precipitation.

Lake Stage

The water level for Lac La Belle is primarily determined by a low-head, fixed-crest weir located at the outlet of the Lake to the Oconomowoc River. As established by the operating permit for this structure issued by the

Map 6

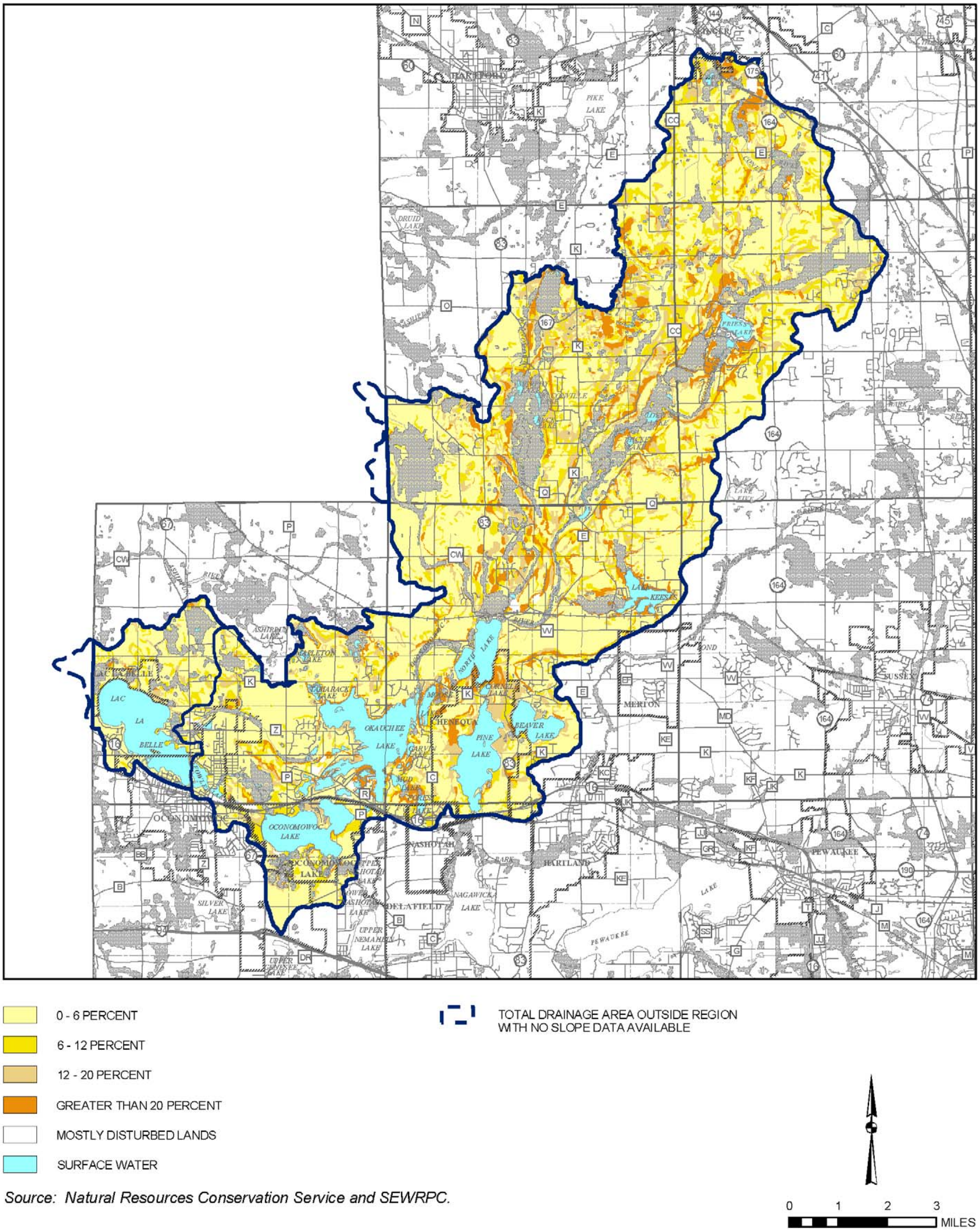
HYDROLOGIC SOIL GROUPS WITHIN THE TOTAL DRAINAGE AREA TO LAC LA BELLE



Source: U.S. Department of Agriculture Natural Resources Conservation Service and SEWRPC.

Map 7

LAND SLOPES WITHIN THE DRAINAGE AREA TO LAC LA BELLE



Source: Natural Resources Conservation Service and SEWRPC.

Table 3

LONG-TERM AND 1999 STUDY YEAR TEMPERATURE, PRECIPITATION, AND RUNOFF DATA FOR THE LAC LA BELLE AREA

Temperature													
Air Temperature Data (°F)	January	February	March	April	May	June	July	August	September	October	November	December	Mean
Long-Term Mean Monthly	15.2	19.4	31.9	45.4	57.5	66.7	71.7	68.8	60.1	49.0	35.5	21.4	45.2
1999 Mean Monthly	15.9	31.4	33.9	48.8	59.9	67.8	75.0	67.8	60.7	49.2	43.0	26.5	48.3
Departure from Long-Term Mean	0.70	12.0	2.0	3.4	2.4	1.1	3.3	-1.0	0.6	0.2	7.5	5.1	3.1

Precipitation														
Precipitation Data (inches)	January	February	March	April	May	June	July	August	September	October	November	December	Mean	Total
Long-Term Mean Monthly	1.99	0.94	1.87	2.76	2.86	3.6	3.76	3.93	3.88	2.52	2.12	1.67	2.66	30.9
1999 Mean Monthly	3.46	0.73	0.73	6.38	5.23	6.10	5.72	1.82	3.48	0.92	1.39	1.96	3.16	37.9
Departure from Long-Term Mean	2.47	-0.21	-1.14	3.62	2.37	2.50	1.96	-2.11	-0.40	-1.60	-0.73	0.29	0.59	7.0

Runoff													
Runoff Data (inches)	January	February	March	April	May	June	July	August	September	October	November	December	Mean
Long-Term Mean Monthly	0.48	0.48	1.08	1.44	0.84	0.60	0.48	0.36	0.36	0.46	0.53	0.49	0.63
1999 Mean Monthly	0.31	1.04	0.60	1.35	1.75	1.07	0.97	1.30	0.28	0.29	0.28	0.44	0.81
Departure from Mean Monthly	-0.17	0.56	-0.48	-0.09	0.91	0.47	0.49	0.94	-0.08	-0.17	-0.21	-0.05	0.18

Source: National Oceanic and Atmospheric Administration and U.S. Geological Survey.

Wisconsin Department of Natural Resources (WDNR), the surface level of the Lake is to be maintained at an elevation ranging from 851.5 feet to 852.2 feet above the National Geodetic Vertical Datum of 1929 (NGVD-29).

Water Budget

A water budget for Lac La Belle was computed from inflow and outflow data collected during the initial planning period, 1976-1977, and estimated for the current planning period using regional norms. During the initial planning project, about 31,960 acre-feet of water entered the Lake through the Oconomowoc River inflow, direct surface runoff, and direct precipitation onto the Lake's surface. About 29,930 acre-feet was lost from the Lake through the outlet structure and from evaporation. Groundwater outflows were considered to account for the net water loss of about 2,520 acre-feet, or in a decrease in lake level of about 0.4 foot during the initial study period. During 1976 and 1977, these groundwater flows were estimated using nine pairs of groundwater sampling wells. Groundwater was reported to generally flow into the Lake from the west and southwest. It is important to note that, although a net loss occurred over the entire 1976-1977 study period, there was a net gain to the Lake from groundwater inflows during May and June 1976, and during the winter months. The greatest losses occurred from July through October 1976, during the peak of a drought period.

During the current study period, 1999-2000, a water budget for Lac La Belle was estimated based upon measured flows in the Rock River at Watertown, Wisconsin.[2] These estimates suggested that, for the study period,

[2]*U.S. Geological Survey Water-Data Report No. WI-00-1,* Water Resources Data, Wisconsin: Water Year 2000*, 2001; data for hydrological gauging station number 05425500.*

approximately 41,100 acre-feet of water entered the Lake as surface runoff, with a further approximately 3,700 acre-feet entering the Lake as a result of direct precipitation onto the lake surface. Of this volume, about 2,800 acre-feet were lost to evaporation from the lake surface, approximately 2,500 acre-feet through groundwater outflows, assuming that these outflows remained relatively constant at the level measured during the 1976-1977 study period, and about 39,500 acre-feet through surface water outflows through the Oconomowoc River, assuming no net change in lake level during this period.

Over the longer term, based upon the period of record from 1931 through 2001, approximately 37,100 acre-feet of water entered the Lake as surface runoff, with a further approximately 3,000 acre-feet entering the Lake as a result of direct precipitation onto the lake surface as shown in Figure 1.[3] Of this volume, about 2,800 acre-feet were lost to evaporation from the lake surface, approximately 2,500 acre-feet through groundwater outflows, and about 34,800 acre-feet through surface water outflows through the Oconomowoc River, assuming no net change in lake level during this period.

Based upon these long-term estimates, the Oconomowoc River contributes about 92 percent of the known inflow to the Lake with direct precipitation onto the Lake's surface accounting for the balance of about 8 percent of the total inflow. Evaporation from the Lake's surface accounts for about 7 percent of the outflow, groundwater outflows for about 6 percent, and surface outflows via the Oconomowoc River for the balance of about 87 percent, assuming no net change in Lake level.

The hydraulic residence time is important in determining the expected response time of the Lake to increased or reduced nutrient loadings. The hydraulic residence time for Lac La Belle during the initial 1976-1977 study period was estimated to be 0.39 year, but this was an exceptionally dry period. The hydraulic residence time during a year of more normal precipitation would be shorter, estimated at that time to be about 0.32 year based upon the long term-period of record.

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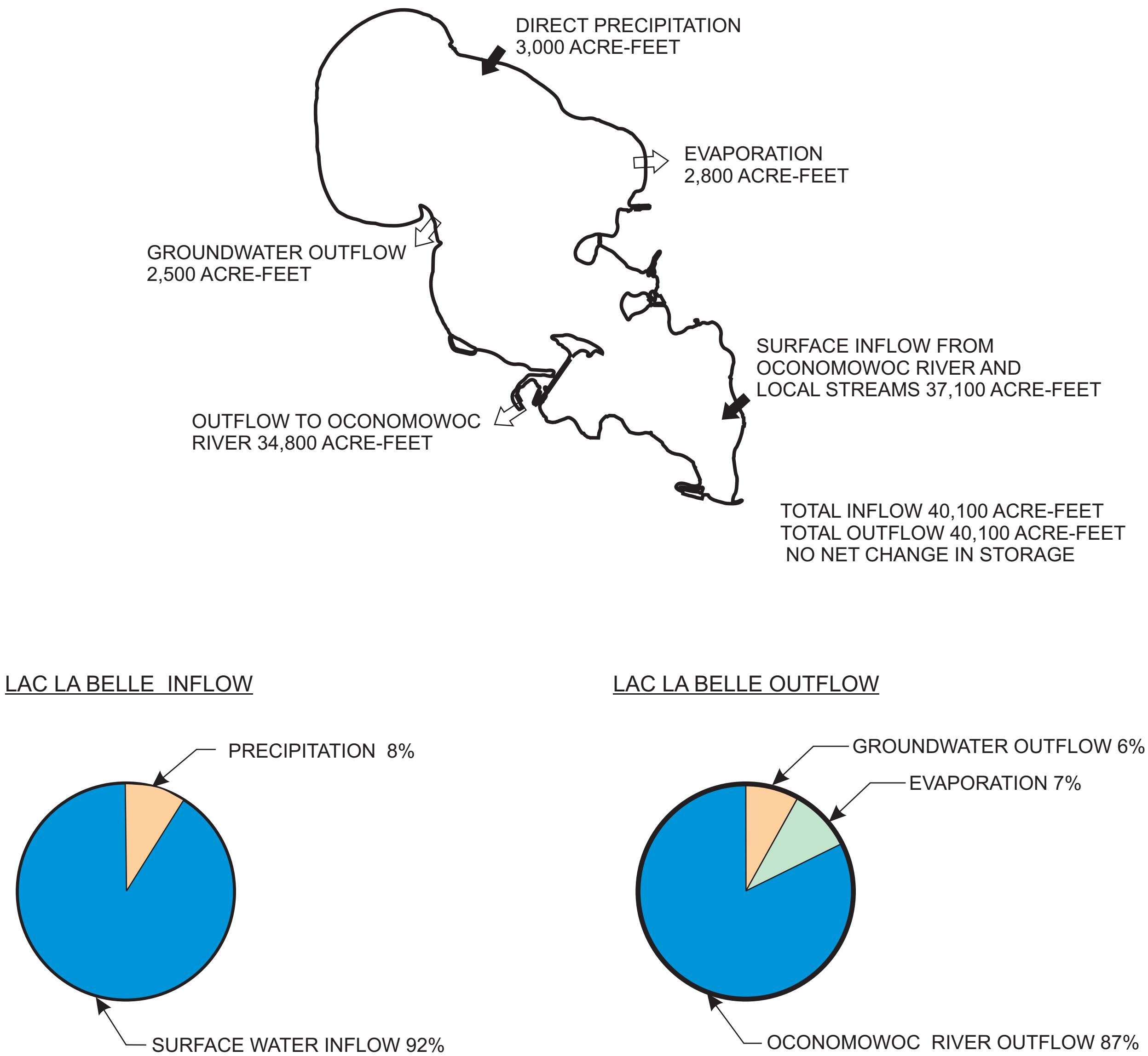
[3] *U.S. Geological Survey Water-Data Report No. WI-01-1,* Water Resources Data, Wisconsin: Water Year 2001*, 2002; data for hydrological gauging station number 05425500.*

Figure 1

LONG-TERM HYDROLOGIC BUDGET FOR LAC LA BELLE: 1931-2001



Source: U.S. Geological Survey and SEWRPC.

Chapter III

HISTORICAL, EXISTING, AND FORECAST LAND USE AND POPULATION LEVELS

INTRODUCTION

Water pollution problems, recreational use conflicts, and deterioration of the natural environment are all primarily a function of the human activities within the area tributary to a waterbody, as are the ultimate solutions to these problems. This is especially true with respect to lakes, which are highly susceptible to deterioration from human activities because of relatively long pollutant retention times, and because of the variety of often conflicting uses to which lakes are subjected. Furthermore, urban development is often concentrated in the direct drainage areas, around the shoreline of lakes, where there are no intermediate stream segments to attenuate pollutant runoff and loadings. This type of degradation is more likely to interfere with desired water uses and is often more difficult and costly to correct than degradation arising from clear identifiable point sources of pollution in the watershed. Accordingly, the land uses and attendant population levels in the drainage area directly tributary to a lake are important considerations in any lake management planning effort. For this reason, land use and population distributions are summarized in this Chapter, together with a review of jurisdictional issues relevant to water quality and lake management.

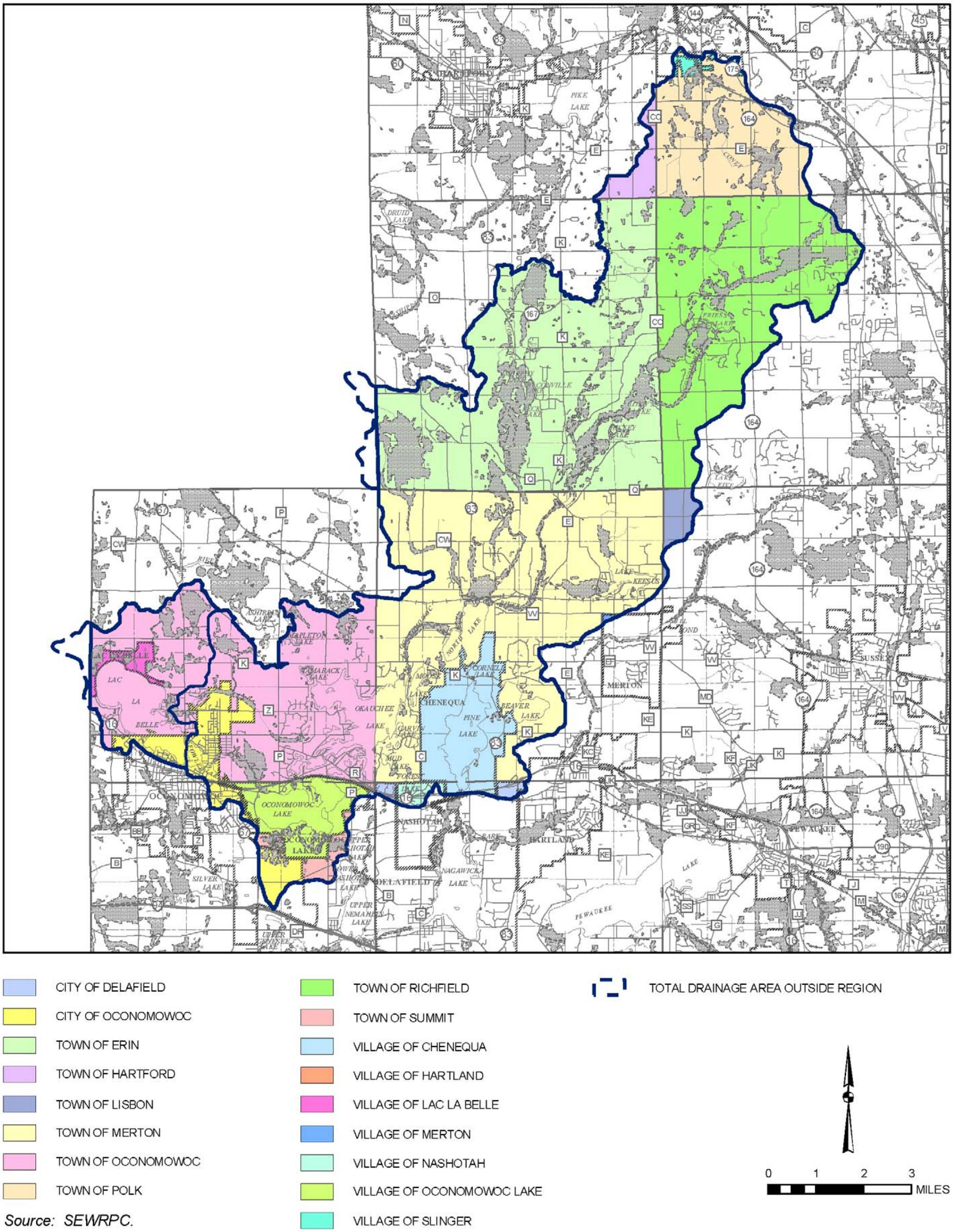
CIVIL DIVISIONS

The geographic extent and functional responsibilities of civil divisions and special-purpose units of government are important factors related to land use and management, since these local units of government provide the basic structure of the decision-making framework within which land use development and redevelopment must be addressed. Superimposed on the irregular drainage area boundary tributary to Lac La Belle is a generally rectilinear pattern of local municipal boundaries, as shown on Map 8.

The area directly tributary to Lac La Belle includes portions of the City of Oconomowoc and the Town of Oconomowoc, both in Waukesha County, and the Town of Ixonia in Jefferson County. The only civil division entirely within the area directly tributary to the lake is the Village of Lac La Belle in Waukesha County. The area and proportion of the direct drainage area lying within the jurisdiction of each civil division, as of 1995, are set forth in Table 4. The total area tributary to Lac La Belle extends northeastward into Washington and Dodge Counties, and includes portions of the Cities of Delafield and Oconomowoc; the Villages of Chenequa, Hartland, Lac La Belle, Merton, Nashotah, and Oconomowoc Lake; and Towns of Lisbon, Merton, Oconomowoc, and Summit in Waukesha County; and portions of the Village of Slinger, and the Towns of Erin, Hartford, Polk and Richfield in Washington County; and portions of the Town of Ashippun in Dodge County.

Map 8

CIVIL DIVISIONS WITHIN THE TOTAL DRAINAGE AREA TO LAC LA BELLE



Source: SEWRPC.

Table 4

AREAL EXTENT OF CIVIL DIVISION BOUNDARIES WITHIN THE TOTAL DRAINAGE AREA TRIBUTARY TO LAC LA BELLE

Community	Civil Division Area within Area (acres)	Percent of Area within Civil Division
City of Delafield	182	0.3
City of Oconomowoc	1,537	2.5
Village of Chenequa	2,466	3.9
Village of Hartland	8	<0.1
Village of Lac La Belle	283	0.5
Village of Merton	31	<0.1
Village of Nashotah	23	<0.1
Village of Oconomowoc Lake	1,946	3.1
Village of Slinger	166	0.3
Town of Erin	14,810	23.7
Town of Hartford	641	1.0
Town of Lisbon	487	0.8
Town of Merton	14,031	22.4
Town of Oconomowoc	10,826	17.3
Town of Polk	4,640	7.4
Town of Richfield	9,553	15.3
Town of Summit	940	1.5
Total	62,570[a]	100.0

[a]*Excludes the portions of the drainage area tributary to Lac La Belle within the Town of Ashippun in Dodge County and Town of Ixonia in Jefferson County, totaling about 1,506 acres.*

Source: SEWRPC.

Table 5

HISTORIC AND FORECAST RESIDENT POPULATION AND HOUSEHOLD LEVELS WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO LAC LA BELLE: 1950-2020

Year	Number of Residents	Number of Households
1950	1,380	- -
1960	2,000	- -
1970	2,950	- -
1975	3,300	- -
1985[a]	2,588	784
1990[a]	2,638	921
1995[a]	2,693	974
2000[b]	3,475	1,316
2020 Recommended[a]	4,504	1,747
2020 High Growth Plan[a]	5,286	1,897

[a]*Study area approximated using whole U.S. Public Land Survey one-quarter sections and U.S. Census Bureau data.*

[b]*Study area approximated using U.S. Census Bureau Census Tract Block Group Data.*

Source: U.S. Census Bureau and SEWRPC.

POPULATION

As indicated in Table 5, the resident population of the drainage area directly tributary to Lac La Belle has increased steadily since 1985. Forecast population growth to the year 2020 in the direct drainage area of the Lake is expected to continue this pattern. This population growth may be expected to place a steadily increasing stress on the natural resource base of the Lake's drainage area, and both water resource demands and use conflicts may be expected to increase. The number of resident households also has followed a similar trend.

LAND USE

The type, intensity, and spatial distribution of land uses within the drainage area tributary to Lac La Belle are important determinants of lake water quality and recreational use demands. The current and planned land use patterns placed in the context of the historical development of the area are, therefore, important considerations in any lake management planning effort for Lac La Belle.

The movement of European settlers into the Southeastern Wisconsin Region began about 1830. The completion of the U.S. Public Land Survey in southeastern Wisconsin by 1836 and the subsequent sale of public lands brought many settlers into the area. Map 9 shows the 1914 U.S. Public Land Survey map for the Lac La Belle area.

Significant urban development in the drainage area tributary to Lac La Belle began prior to 1850. Map 10 and Table 6 set forth the historical urban growth in the drainage area tributary to Lac La Belle. The largest increases in urban development have occurred since 1920, with the greatest increases occurring between 1963 and 1985. Prior to 1940, most urban development in the drainage area occurred in what is now the City of Oconomowoc and in the Village of Lac La Belle. During the 1940s, 1950s, and early 1960s, urban development was extended around

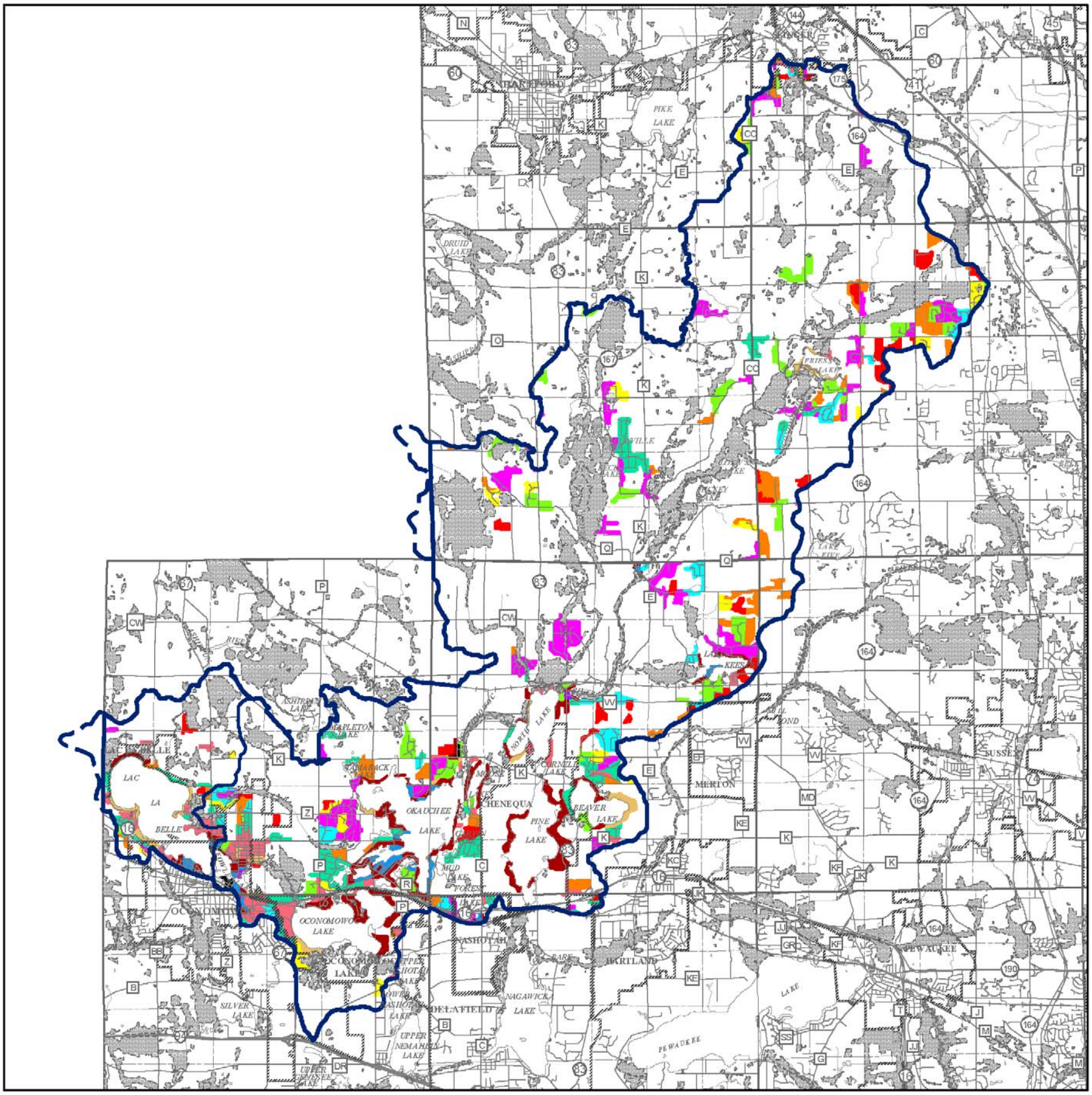
Map 9

HISTORIC PLAT MAP OF THE LAC LA BELLE AREA: 1914

Source: Geo. A. Ogle & Company, Chicago, Illinois.

Map 10

HISTORIC URBAN GROWTH WITHIN THE TOTAL DRAINAGE AREA TO LAC LA BELLE



1850
1880
1900
1920
1940
1950
1963
1970
1975
1980
1985
1990
1995
2000

TOTAL DRAINAGE AREA OUTSIDE REGION WITH NO HISTORIC URBAN GROWTH DATA AVAILABLE

0 1 2 3 MILES

Source: SEWRPC.

Table 6

EXTENT OF URBAN GROWTH WITHIN THE TOTAL DRAINAGE AREA TRIBUTARY TO LAC LA BELLE: 1850-1995

Year	Direct Drainage Area		Total Tributary Drainage Area	
	Extent of New Urban Development Occurring Since Previous Year (acres)[a]	Cumulative Extent of Urban Development (acres)[a]	Extent of New Urban Development Occurring Since Previous Year (acres)[a]	Cumulative Extent of Urban Development (acres)[a]
1850	8	8	30	30
1880	15	23	73	103
1900	5	28	36	139
1920	35	63	244	383
1940	92	155	1,308	1,691
1950	95	250	375	2,066
1963	175	425	900	2,966
1970	141	566	1,187	4,153
1975	1	567	721	4,874
1980	22	589	1,875	6,749
1985	8	597	1,247	7,996
1990	20	617	585	8,581
1995	42	659	1,134	9,715

[a]*Urban development, as defined for the purposes of this discussion, includes those areas within which houses or other buildings have been constructed in relatively compact groups, thereby indicating a concentration of urban land uses. Scattered residential developments were not considered in this analysis.*

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

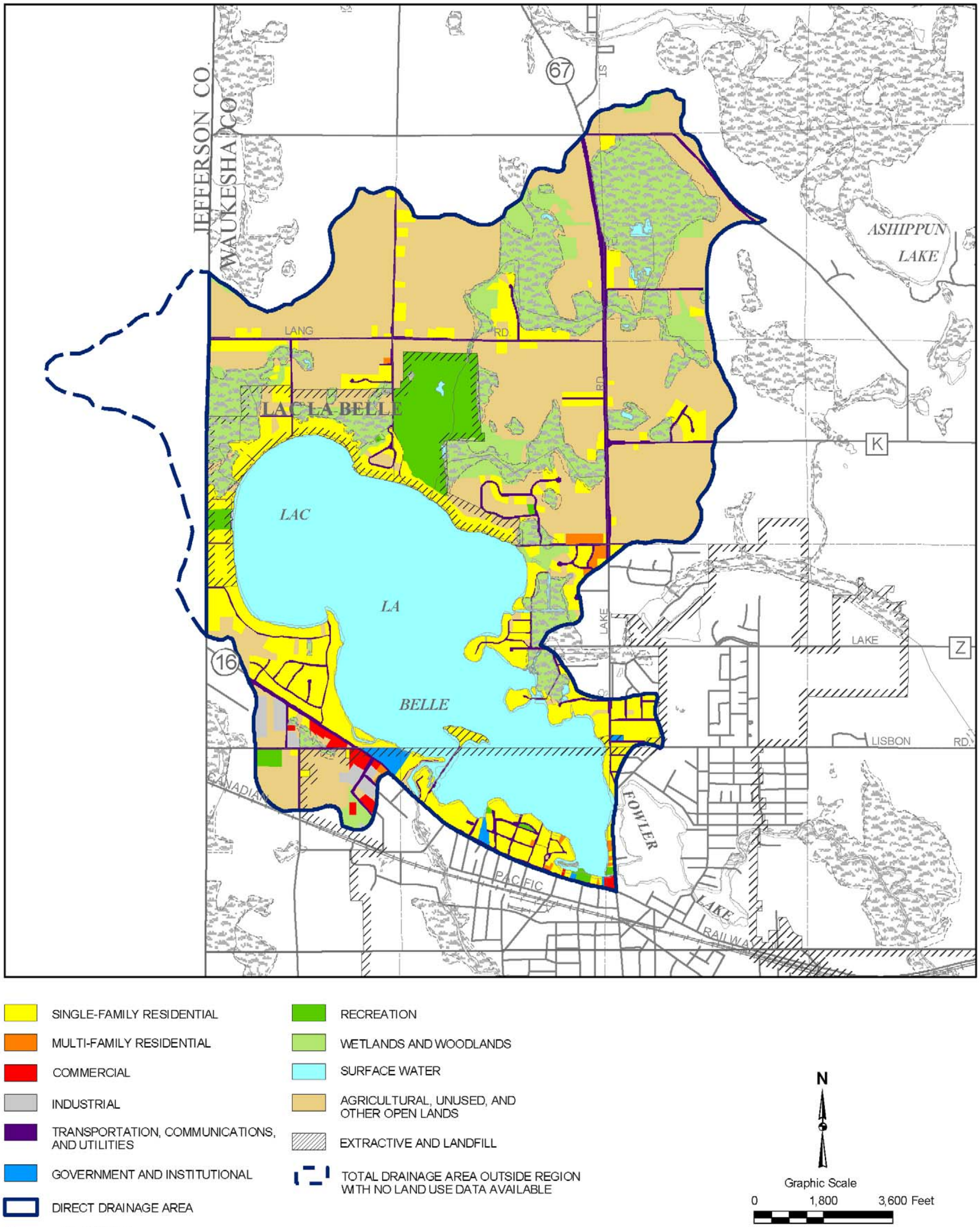
almost the entire lake shoreline, and scattered urban-density development occurred throughout the watershed, but primarily within Waukesha County. Since 1963, urban development has occurred in a generally outward pattern from the Lake and at scattered locations within the tributary area.

The existing 2000 land use pattern in the area directly tributary to Lac La Belle, and in the total area tributary to the Lake, is shown on Maps 11 and 12. Existing land uses are quantified in Table 7. As indicated in Table 7, about 20 percent of the total drainage area tributary to the Lake is in urban land use, with the dominant urban land use being residential development encompassing about 65 percent of the urban land area. As of 2000, about 50,000 acres, or about 80 percent of the total drainage area tributary to Lac La Belle, were still devoted to rural land uses. About 28,000 acres, or about 60 percent of the land area devoted to rural land uses, were agricultural land uses. Woodlands, wetlands, and surface waters, including the surface area of Lac La Belle, accounted for approximately 21,000 acres, or about 45 percent of the land area in rural usage.

As of 2000, within the drainage area directly tributary to Lac La Belle, about 1,000 acres, or about 25 percent of the drainage area, were devoted to urban land uses, as shown in Table 7. The dominant urban land use was residential, encompassing about 600 acres, or about 60 percent of the area in urban usage. As of 2000, about 3,300 acres, or about 80 percent of the drainage area directly tributary to Lac La Belle, were devoted to rural land uses. About 1,400 acres, or about 40 percent of the rural area, were in agricultural land uses. Woodlands, wetlands, and surface waters, including the surface area of Lac La Belle, accounted for approximately 1,900 acres, or about 60 percent of the area in rural usage.

Map 11

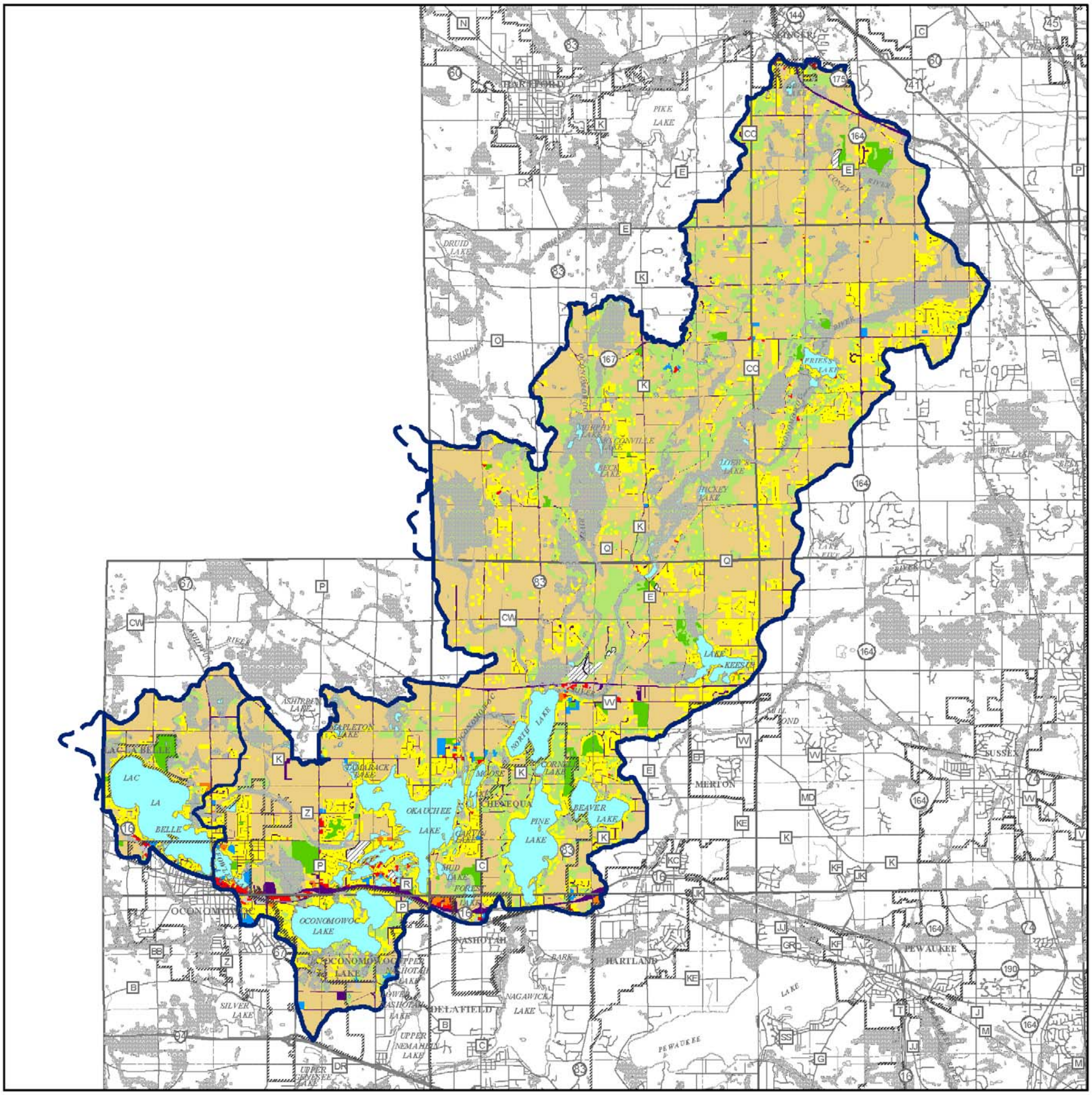
EXISTING LAND USE WITHIN THE DIRECT DRAINAGE AREA TRIBUTARY TO LAC LA BELLE: 2000



Source: SEWRPC.

Map 12

EXISTING LAND USE WITHIN THE TOTAL DRAINAGE AREA TRIBUTARY TO LAC LA BELLE: 2000



SINGLE-FAMILY RESIDENTIAL

MULTI-FAMILY RESIDENTIAL

COMMERCIAL

INDUSTRIAL

TRANSPORTATION, COMMUNICATIONS, AND UTILITIES

GOVERNMENT AND INSTITUTIONAL

RECREATION

WETLANDS AND WOODLANDS

SURFACE WATER

AGRICULTURAL, UNUSED, AND OTHER OPEN LANDS

EXTRACTIVE AND LANDFILL

TOTAL DRAINAGE AREA OUTSIDE REGION WITH NO LAND USE DATA AVAILABLE

0 1 2 3 MILES

Source: SEWRPC.

Table 7

EXISTING LAND USE WITHIN THE DIRECT AND TOTAL DRAINAGE AREAS TRIBUTARY TO LAC LA BELLE: 2000

Land Use Categories[a]	Direct Tributary Area (acres)	Percent of Direct Tributary Drainage Area	Total Tributary Area (acres)	Percent of Total Tributary Drainage Area
Urban				
Residential	592	13.7	9,293	14.6
Commercial	17	0.4	2180	0.3
Industrial	25	0.6	112	0.2
Governmental and Institutional	14	0.3	281	0.4
Transportation, Communication, and Utilities	199	4.6	3,325	5.2
Recreational	154	3.6	992	1.5
Subtotal	1,001	23.2	14,221	22.2
Rural				
Agricultural and Other Open Lands	1,401	32.3	28,280	44.2
Wetlands	592	13.7	7,428	11.6
Woodlands	135	3.1	8,010	12.5
Water	1,200	27.7	5,922	9.2
Extractive	- -	- -	215	0.3
Landfill	- -	- -	- -	- -
Subtotal	3,328	76.8	49,855	77.8
Total	4,329	100.0	64,076	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

Under planned year 2020 conditions, the trend toward more intensive urban land usage is expected to continue and be reflected in the land usage in the drainage area tributary to the Lake.[1] Much of this development is expected to occur as agricultural lands are converted to urban lands, primarily for residential use, as shown on Maps 13 and 14. Nevertheless, some redevelopment of existing properties, the reconstruction of existing single-family residences, and the infilling of platted lots may be expected, especially on lakeshore properties. By 2020, urban land uses within the drainage area directly tributary to Lac La Belle are expected to increase in areal extent to about 1,600 acres, or about 40 percent of the drainage area directly tributary to the Lake, as shown in Table 8. Urban residential uses are expected to increase from about 600 acres in 2000, to about 980 acres by the year 2020. Agricultural lands in the drainage area, consequently, are expected to decrease in areal extent from about 1,400 acres in 2000, to less than 780 acres by the year 2020.

In the total area tributary to Lac La Belle, urban land uses are expected to increase in areal extent to about 20,200 acres, and comprise about 30 percent of the drainage area by the year 2020, as shown in Table 8. Urban residential uses are expected to increase from about 9,300 acres, as of 2000, to about 13,300 acres by the year 2020, comprising about 20 percent of the drainage area. Agricultural lands in the total drainage area, in contrast, are expected to decrease in areal extent from about 28,300 acres as of 2000, to about 22,200 acres by the year 2020.

Recent surveillance indicates that changes in land use due to urban development appear to be due to large-lot residential development. If this trend continues, some of the open space areas remaining in the tributary area are likely to be replaced with large-lot urban residential development, resulting in the potential for increased pollutant

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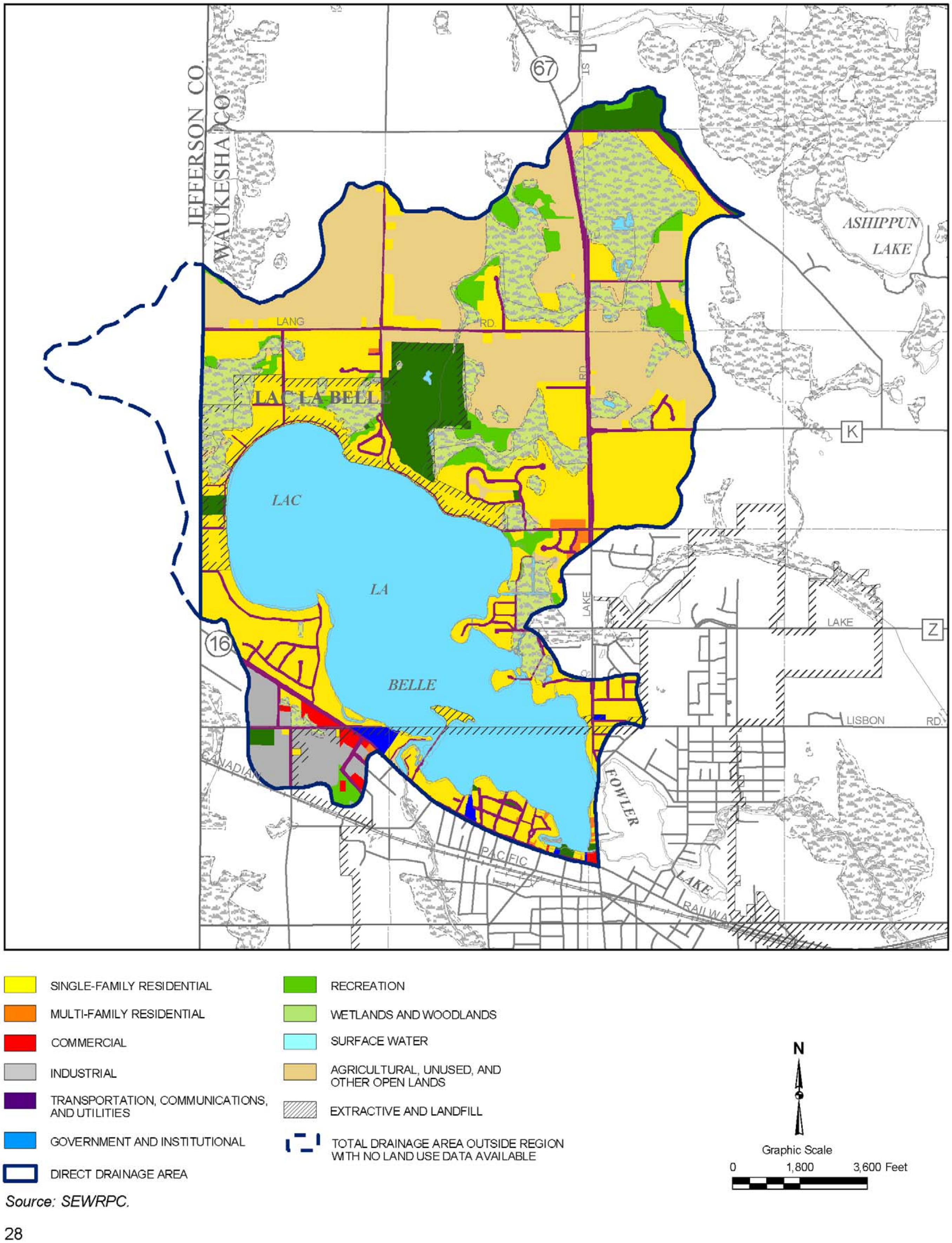
[1]*SEWRPC Planning Report No. 45,* A Regional Land Use Plan for Southeastern Wisconsin: 2020*, December 1997; SEWRPC Community Assistance Planning Report No. 209,* A Development Plan for Waukesha County, Wisconsin*, August 1996.*

Map 13

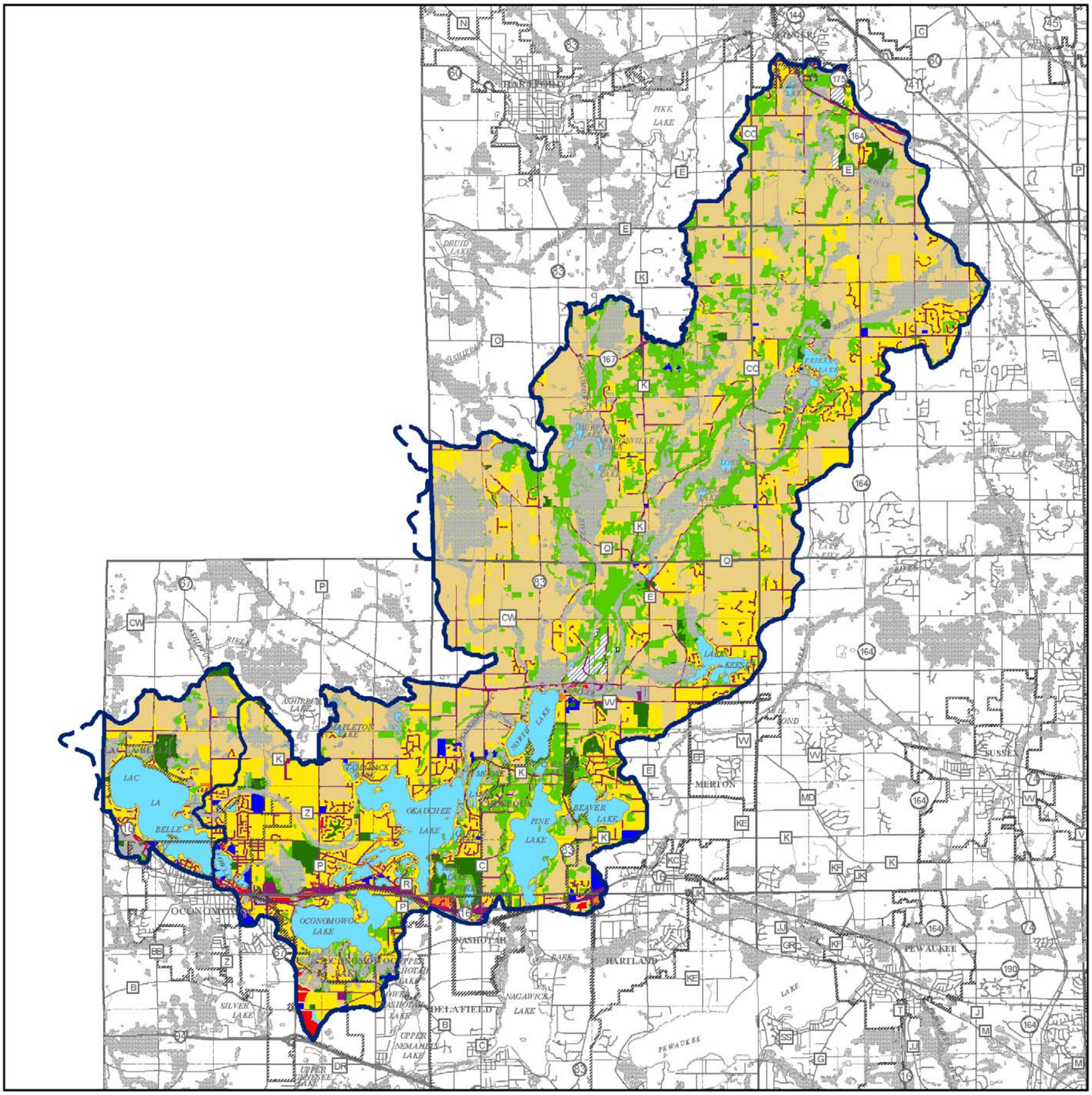
PLANNED LAND USE WITHIN THE DIRECT DRAINAGE AREA TRIBUTARY TO LAC LA BELLE: 2020



Source: SEWRPC.

Map 14

PLANNED LAND USE WITHIN THE TOTAL DRAINAGE AREA TRIBUTARY TO LAC LA BELLE: 2020



SINGLE-FAMILY RESIDENTIAL

MULTI-FAMILY RESIDENTIAL

COMMERCIAL

INDUSTRIAL

TRANSPORTATION, COMMUNICATIONS, AND UTILITIES

GOVERNMENT AND INSTITUTIONAL

RECREATION

WETLANDS AND WOODLANDS

SURFACE WATER

AGRICULTURAL, UNUSED, AND OTHER OPEN LANDS

EXTRACTIVE AND LANDFILL

TOTAL DRAINAGE AREA OUTSIDE REGION WITH NO LAND USE DATA AVAILABLE

0 1 2 3 MILES

Source: SEWRPC.

Table 8

PLANNED LAND USE WITHIN THE DIRECT AND TOTAL DRAINAGE AREAS TRIBUTARY TO LAC LA BELLE: 2020

Land Use Categories[a]	Direct Tributary Area (acres)	Percent of Direct Tributary Drainage Area	Total Tributary Area (acres)	Percent of Total Tributary Drainage Area
Urban				
Residential	983	22.7	13,334	20.8
Commercial	19	0.4	390	0.6
Industrial	99	2.3	320	0.5
Governmental and Institutional	14	0.3	435	0.7
Transportation, Communication, and Utilities	306	7.1	4,406	6.9
Recreational	202	4.7	1,323	2.1
Subtotal	1,623	37.5	20,208	31.6
Rural				
Agricultural and Other Open Lands	779	18.0	22,215	34.7
Wetlands	592	13.7	7,428	11.6
Woodlands	135	3.1	8,006	12.5
Water	1,200	27.7	5,934	9.2
Extractive	- -	- -	225	0.3
Landfill	- -	- -	60	0.1
Subtotal	2,706	62.5	43,868	68.4
Total	4,329	100.0	64,076	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

loadings to the Lake. This development could occur in the form of residential clusters on smaller lots within conservation subdivisions, thereby preserving portions of the remaining open space and, thus, reducing the impacts on the Lake.[2]

LAND USE REGULATIONS

The comprehensive zoning ordinance represents one of the most important and significant tools available to local units of government in directing the proper use of lands within their area of jurisdiction. Local zoning regulations include general, or comprehensive, zoning regulations, and special-purpose regulations governing floodland and shoreland areas. General zoning and special-purpose zoning regulations may be adopted as a single ordinance or as separate ordinances; they may or may not be contained in the same document. Any analysis of locally proposed land uses must take into consideration the provisions of both general and special-purpose zoning. As already noted, the drainage area directly tributary to Lac La Belle includes portions of the City of Oconomowoc, Town of Oconomowoc, and the Village of Lac La Belle, all in Waukesha County, and of the Town of Ixonia in Jefferson County. The ordinances administered by these units of government are summarized in Table 9.

General Zoning

Cities in Wisconsin are granted comprehensive, or general, zoning powers under Section 62.23 of the *Wisconsin Statutes.* The same powers are granted to villages under Section 61.35 of the *Wisconsin Statutes*. Counties are granted general zoning powers within their unincorporated areas under Section 59.69 of the *Wisconsin Statues*. However, a county zoning ordinance becomes effective only in those towns that ratify the county ordinance. Towns that have not adopted a county zoning ordinance may adopt village powers, and subsequently utilize the

[2]*See SEWRPC Planning Guide No. 7,* Rural Cluster Development Guide*, December 1996.*

Table 9

LAND USE REGULATIONS WITHIN THE DRAINAGE AREA TRIBUTARY TO LAC LA BELLE IN DODGE, JEFFERSON, WASHINGTON AND WAUKESHA COUNTIES BY CIVIL DIVISION: 2003

Community	Type of Ordinance				
	General Zoning	Floodland Zoning	Shoreland or Shoreland-Wetland Zoning	Subdivision Control	Erosion Control and Stormwater Management
Waukesha County	Adopted	Adopted	Adopted and Wisconsin Department of Natural Resources approved	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 Lac La Belle	Adopted	Adopted	Adopted	Adopted	Adopted[c]
Village of Merton	Adopted	Adopted	Adopted	Adopted	None
Village of Nashotah	Adopted	None[a]	Adopted and Wisconsin Department of Natural Resources approved	Adopted	None
Village of Oconomowoc Lake	Adopted	Adopted	Adopted	Adopted	None
Town of Lisbon	Adopted	County ordinance	County ordinance	Adopted	Adopted
Town of Merton	Adopted	County ordinance	County ordinance	Adopted	None
Town of Oconomowoc	County ordinance	County ordinance	Adopted and Wisconsin Department of Natural Resources approved	Adopted	Adopted
Town of Summit	Adopted	County ordinance	Adopted and Wisconsin Department of Natural Resources approved	Adopted	None
Washington County	- -[d]	Adopted	Adopted and Wisconsin Department of Natural Resources approved	Floodland and shoreland only	Adopted
Village of Slinger	Adopted	Adopted	Adopted	Adopted	None
Town of Erin	Adopted	County ordinance	County ordinance	Adopted	County ordinance
Town of Hartford	Adopted	County ordinance	County ordinance	County ordinance	County ordinance
Town of Polk	Adopted	County ordinance	County ordinance	Adopted	County ordinance
Town of Richfield	Adopted	County ordinance	County ordinance	Adopted	County ordinance
Dodge County	Adopted	Adopted	Adopted and Wisconsin Department of Natural Resources approved	Adopted	Adopted
Town of Ashippun	County ordinance	County ordinance	County ordinance	Adopted	County ordinance
Jefferson County	Adopted	Adopted	Adopted and Wisconsin Department of Natural Resources approved	Adopted	None
Town of Ixonia	County ordinance	County ordinance	County ordinance	Adopted	None [e]

[a]*No flood hazard areas have been identified or mapped.*

[b]*No erosion control ordinance.*

[c]*No stormwater management ordinance.*

[d]*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.*

[e]*Erosion control standards are built into the subdivision control ordinance.*

Source: SEWRPC.

city and village zoning authority conferred in Section 62.23, subject, however, to county board approval where a general-purpose county zoning ordinance exists. Alternatively, a town may adopt a zoning ordinance under Section 60.61 of the *Wisconsin Statutes* where a general board fails to adopt a county ordinance at the petition of the governing body of the town concerned. General zoning is in effect in all communities in Waukesha County.

Floodland Zoning

Section 87.30 of the *Wisconsin Statutes* requires that cities, villages, and counties, with respect to their unincorporated areas, adopt floodland zoning to preserve 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 100-year recurrence interval flood event, the event which has a 1 percent probability of occurring in any given year. 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 may also restrict 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 100-year recurrence flood. 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 Protection Zoning Ordinance. However, the Town of Ixonia in Jefferson County and the Town of Oconomowoc in Waukesha County, both of which are partially within the drainage area directly tributary to Lac La Belle currently are regulated only by their respective county ordinances for floodplain zoning. Floodland zoning ordinances are in effect within all parts of the total drainage area tributary to Lac La Belle.

Shoreland Zoning

Under Section 59.692 of the *Wisconsin Statutes*, counties in Wisconsin are required to adopt zoning regulations within statutorily defined shoreland areas, those lands within 1,000 feet of a navigable lake, pond, or flowage, or 300 feet of a navigable stream, or to the landward side of the floodplain, whichever distance is greater, within their unincorporated areas. Minimum standards for county shoreland zoning ordinances are set forth in Chapter NR 115 of the *Wisconsin Administrative Code*. Chapter NR 115 sets forth minimum requirements regarding lot sizes and building setbacks; restrictions on cutting of trees and shrubbery; and restrictions on filling, grading, lagooning, dredging, ditching, and excavating that must be incorporated into county shoreland zoning regulations. In addition, Chapter NR 115 requires that counties place all wetlands within the statutory shoreland zoning jurisdiction area into a shoreland wetland conservancy zoning district to ensure their preservation after completion of appropriate wetland inventories by the Wisconsin Department of Natural Resources (WDNR).

In 1982, the State Legislature extended shoreland-wetland zoning requirements to cities and villages in Wisconsin. Under Sections 62.231 and 61.351, respectively, of the *Wisconsin Statutes*, cities and villages in Wisconsin are required to place wetlands five acres or larger and located in statutory shorelands into a shoreland-wetland conservancy zoning district to ensure their preservation. Minimum standards for city and village shoreland-wetland zoning ordinances are set forth in Chapter NR 117 of the *Wisconsin Administrative Code*.

It should be noted that the basis for identification of wetlands to be protected under Chapters NR 115 and NR 117 is the Wisconsin Wetlands Inventory. Mandated by the State Legislature in 1978, the Wisconsin Wetlands Inventory resulted in the preparation of wetland maps covering each U.S. Public Land Survey township in the State. The inventory was completed for counties in southeastern Wisconsin in 1982, the wetlands being delineated by the Regional Planning Commission on its 1980, one inch equals 2,000 feet scale, ratioed and rectified aerial photographs as discussed in Chapter V.[3]

County shoreland zoning ordinances are in effect in all unincorporated areas of Dodge, Jefferson, Washington and Waukesha Counties. Also, all of the incorporated municipalities within the total drainage area tributary to Lac La Belle have adopted shoreland-wetland zoning ordinances.

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[3]*SEWRPC, in cooperation with the WDNR, is updating wetland delineations for the entire seven-county Region. That inventory is expected to be completed in early 2008, and it will be available for use in updating local shoreland-wetland zoning maps.*

Subdivision Regulations
Chapter 236 of the *Wisconsin Statutes* requires the preparation of a subdivision plat whenever five or more lots of 1.5 acres or less in area are created either at one time or by successive divisions within a period of five years. The *Statutes* set forth requirements for surveying lots and streets, for plat review and approval by State and local agencies, and for recording approved plats. Section 236.45 of the *Wisconsin Statutes* allows any city, village, town, or county that has established a planning agency to adopt a land division ordinance, provided the local ordinance is at least as restrictive as the State platting requirements. Local land division ordinances may include the review of other land divisions not defined as "subdivisions" under Chapter 236, such as when fewer than five lots are created or when lots larger than 1.5 acres are created.

The subdivision regulatory powers of towns and counties are confined to unincorporated areas. City and village subdivision control ordinances may be applied to extraterritorial areas, as well as to the incorporated areas.[4] It is possible for both a county and a town to have concurrent jurisdiction over land divisions in unincorporated areas, or for a city or village to have concurrent jurisdiction with a town or county in the city or village extraterritorial plat approval area. In the case of overlapping jurisdiction, the most restrictive requirements apply. Each of the incorporated communities within the total drainage area tributary to Lac La Belle, with the exception of the Village of Chenequa, has adopted its own subdivision ordinance. All four counties within the drainage area tributary to Lac La Belle have adopted subdivision control ordinances; however, the subdivision control ordinances adopted and administered by Washington and Waukesha Counties apply only to the unincorporated statutory shoreland areas within the respective County.

Construction Site Erosion Control and Stormwater Management Regulations
Section 62.23 of the *Wisconsin Statutes* grants authority to cities and villages in Wisconsin to adopt ordinances for the prevention of erosion from construction sites and the management of stormwater runoff from lands within their jurisdiction. Towns may adopt village powers and subsequently utilize the authority conferred on cities and villages under Section 62.23 to adopt their own erosion control and stormwater management ordinances, subject to county board approval where a county ordinance exists. The administrative rules for the State stormwater discharge permit program are set forth in Chapter NR 216 of the *Wisconsin Administrative Code*, which initially took effect on November 1, 1994, and was most recently recreated with an effective date of August 1, 2004. Within the total drainage area tributary to Lac La Belle, the counties, cities, villages, and towns listed in Table 10 have been identified by the WDNR as being in urbanized areas that have been, or will be, required to obtain stormwater discharge permits unless they receive exemptions.

Through 1997 Wisconsin Act 27, the State Legislature required the WDNR and the Wisconsin Department of Agriculture, Trade and Consumer Protection (WDATCP) to develop performance standards for controlling nonpoint source pollution from agricultural and nonagricultural land and from transportation facilities.[5] Chapter

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[4]*Under Section 236.02 of the* Wisconsin Statutes*, the extraterritorial plat approval jurisdiction is the area within three miles of the corporate limits of a first-, second-, or third-class city and within 1.5 miles of a fourth-class city or a village. The City of Oconomowoc is a third-class city and the City of Delafield is a fourth-class city.*

[5]*The State performance standards are set forth in the Chapter NR 151, "Runoff Management," of the* Wisconsin Administrative Code. *Additional Code chapters that are related to the State nonpoint source pollution control program include: Chapter NR 152, "Model Ordinances for Construction Site Erosion Control and Storm Water Management," Chapter NR 153, "Runoff Management Grant Program," Chapter NR 154, "Best Management Practices, Technical Standards and Cost-Share Conditions," and Chapter NR 155 "Urban Nonpoint Source Water Pollution Abatement and Stormwater Management Grant Program." Those chapters of the* Wisconsin Administrative Code *became effective in October 2002. Chapter NR 120, "Priority Watershed and Priority Lake Program," and Chapter NR 243, "Animal Feeding Operations," were repealed and recreated in October 2002. The Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) revised Chapter ATCP 50, "Soil and Water Resource Management," to incorporate changes in DATCP programs as required under 1997 Wisconsin Act 27.*

Table 10

COUNTIES AND COMMUNITIES IN THE TOTAL DRAINAGE AREA TRIBUTARY TO LAC LA BELLE WITH MUNICIPAL SEPARATE STORM SEWER SYSTEMS IN URBANIZED AREAS: 2004[a]

County
Washington
Waukesha
Community
City of Delafield
City of Oconomowoc
Village of Chenequa
Village of Hartland
Village of Lac La Belle
Village of Merton
Village of Nashotah
Village of Oconomowoc Lake
Town of Lisbon[b]
Town of Merton
Town of Oconomowoc
Town of Richfield
Town of Summit

[a]*These counties and communities are listed in Section NR 216.02(3) of the* Wisconsin Administrative Code *and they have obtained, or will be required to obtain, WPDES permits, unless they receive exemptions.*

[b]*The Town of Lisbon has already received its permit.*

Source: SEWRPC.

NR 216 of the *Wisconsin Administrative Code* identifies several categories of municipalities, industries, and construction sites that must obtain permits. The permit requirements are based on the performance standards set forth in Chapter NR 151 of the *Wisconsin Administrative Code*, which became effective on October 1, 2002 and were revised in July 2004.

Agricultural Performance Standards

Agricultural performance standards cover the following areas:

- Cropland sheet, rill, and wind erosion control,
- Manure storage,
- Clean water diversions, and
- Nutrient management.

For existing land that does not meet the Chapter NR 151 standards and that was cropped or enrolled in the U.S. Department of Agriculture (USDA) Conservation Reserve Program (CRP) or Conservation Reserve Enhancement Program (CREP) as of October 1, 2002, agricultural performance standards are required to be met only if cost share funding is available. Existing cropland that met the standards as of October 1, 2002, must continue to meet the standards. New cropland must meet the standards, regardless of whether cost share funds are available.

Nonagricultural (urban) Performance Standards

The nonagricultural performance standards set forth in Chapter NR 151 of the *Wisconsin Administrative Code* encompass two major types of land management. The first includes standards for areas of new development and redevelopment and the second includes standards for developed urban areas. The performance standards address the following areas:

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

Chapter NR 151 requires municipalities with Wisconsin Pollutant Discharge Elimination System (WPDES) stormwater discharge permits to reduce the amount of total suspended solids in stormwater runoff from areas of existing development that were in place as of October 2004 to the maximum extent practicable, according to the following standards:

- By March 10, 2008, the NR 151 standards call for a 20 percent reduction, and
- By October 1, 2013, the standards call for a 40 percent reduction.

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

Regardless of whether a municipality is required to have a stormwater discharge permit under Chapter NR 216 of the *Wisconsin Administrative Code*, Chapter NR 151 requires that all construction sites that disturb one acre or more of land must achieve an 80 percent reduction in the sediment load generated by the site. With certain limited exceptions, those sites required to have construction erosion control permits must also have post-development stormwater management practices to reduce the total suspended solids load from the site by 80 percent for new development, 40 percent for redevelopment, and 40 percent for infill development occurring prior to October 1, 2012. After October 1, 2012, infill development will be required to achieve an 80 percent reduction. If it can be demonstrated that the solids reduction standard cannot be met for a specific site, total suspended solids must be controlled to the maximum extent practicable.

Section NR 151.12 of the *Wisconsin Administrative Code* requires infiltration of runoff from areas of new development, subject to specific exclusions and exemptions as set forth in Sections 151.12(5)(c)5 and 151.12(5)(c)6, respectively. In residential areas, either 90 percent of the annual predevelopment infiltration volume or 25 percent of the post-development runoff volume from a two-year recurrence interval, 24-hour storm, is required to be infiltrated. However, no more than 1 percent of the area of the project site is required to be used as effective infiltration area. In commercial, industrial, and institutional areas, 60 percent of the annual predevelopment infiltration volume, or 10 percent of the post-development runoff volume from a two-year recurrence interval, 24-hour storm, is required to be infiltrated. In this case, no more than 2 percent of the rooftop and parking lot areas are required to be used as effective infiltration area.

Section NR 151.12 also generally requires impervious area setbacks of 50 feet from streams, lakes, and wetlands. This setback distance is increased to 75 feet around Chapter NR 102-designated Outstanding or Exceptional Resource Waters or Chapter NR 103-designated wetlands of special natural resource interest. Reduced setbacks from less susceptible wetlands and drainage channels of not less than 10 feet may be allowed.

In addition to these provisions, Section NR 151.13 of the *Wisconsin Administrative Code* requires municipalities to implement informational and educational programming to promote good housekeeping practices in developed urban areas, as well as related operational programs in those municipalities subject to stormwater permitting requirements pursuant to Chapter NR 216 of the *Wisconsin Administrative Code*.

In 2005, Waukesha County adopted a stormwater management and erosion control ordinance that applies to all unincorporated areas of the County, including the Towns of Lisbon, Merton, Oconomowoc, and Summit.[6] That ordinance was developed to be consistent with the provisions of Chapter NR 151, "Runoff Management," of the *Wisconsin Administrative Code*, and in some instances it imposes more stringent requirements for control of runoff than does Chapter NR 151.

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[6]*Waukesha County Code, Chapter 14, Article VIII, "Storm Water Management and Erosion Control Ordinance," adopted by the Waukesha County Board on March 22, 2005.*

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Chapter IV

WATER QUALITY

INTRODUCTION

The earliest data on water quality conditions in Lac La Belle date back to the early 1900s, when E.A. Birge and C. Juday, widely recognized pioneering lake researchers from the University of Wisconsin-Madison, collected basic information on the Lake.[1] However, most water quality information is relatively recent. Water chemistry data for Lac La Belle were collected by the Wisconsin Conservation Department, now the Wisconsin Department of Natural Resources (WDNR), between 1925 and 1966, and additional data were included in the 1972 WDNR report, *Report on Water Quality of Lac La Belle, Waukesha County*.[2] From 1984 through 2003, the WDNR monitored the water quality of Lac La Belle under the auspices of their Long-Term Trend Monitoring Program. These latter studies involved the determination of the physical and chemical characteristics of the Lake's water, including dissolved oxygen concentrations and water temperature profiles, pH, specific conductance, water clarity, and nutrient and chlorophyll-*a* concentrations.[3] Since 2001, the Lake has been included at intervals in the U.S. Geological Survey Trophic State Index (TSI) water quality monitoring program.[4] The U.S. Geological Survey sampling program, which includes measurements of dissolved oxygen concentrations and water temperature profiles, pH, specific conductance, water clarity, and nutrient and chlorophyll-*a* concentrations, has

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[1]*E.A. Birge and C. Juday, "The Inland Lakes of Wisconsin, I. The Dissolved Gases and Their Biological Significance,"* Bulletin of the Wisconsin Geological and Natural History Survey*, Volume 22, 1911.*

[2]*T.A. Moe, "Report on Water Quality of Lac La Belle, Waukesha County," Wisconsin Department of Natural Resources, 1972.*

[3]*See, for example, Wisconsin Department of Natural Resources,* Lac La Belle, Waukesha County: Long-Term Trend Lake, 1986, *1986; Wisconsin Department of Natural Resources,* Lac La Belle, Waukesha County: Long-Term Trend Lake, 1987, *1987. Other data collected during this period were included in miscellaneous WDNR files and data reports.*

[4]*These data are compiled and reported annually by the U.S. Geological Survey. During the period through 1993, the data were published in the U.S. Geological Survey Water-Data Report series,* Water Resources Data, Wisconsin*, and, subsequent to 1993, in the U.S. Geological Survey Open-File Report series,* Water-Quality and Lake-Stage Data for Wisconsin Lakes.

been conducted on Lac La Belle periodically since 1984, with samples being analyzed from 1984 through 1985, in 1991, and from 2001 through 2003.[5]

EXISTING WATER QUALITY CONDITIONS

Water quality data gathered under the auspices of the U.S. Geological Survey TSI water quality monitoring program were used to assess lake water quality in Lac La Belle. Available data from the period between 1984 and 2003 are used to determine water quality conditions in the Lake, and to characterize the suitability of the Lake for recreational use and for the support of fish and aquatic life.[6] The primary sampling station used for the various sampling studies was located at the deepest portions of the Lake, at the so-called "deep hole" station, as shown on Map 1 in Chapter II of this report. Additional data, for the period 1976 and 1977, summarized in the current lake management plan for Lac La Belle, are referenced as appropriate for purposes of highlighting historic and existing conditions in the Lake.[7]

Thermal Stratification

Thermal and dissolved oxygen profiles for Lac La Belle are shown in Figure 2. Between 1984 and 2003, water temperatures in Lac La Belle ranged from a minimum of 32ºF during the winter, to a maximum of 83.5ºF during the summer, as shown in Table 11. The maximum summer water temperature was approximately 5ºF warmer in recent years than those recorded during the initial planning study, conducted during 1976 and 1977. Maximum summer temperatures recorded during the initial study were reported to be 79ºF. Elsewhere in the Southeastern Wisconsin Region, similar conditions prevailed in Pewaukee Lake, for example, where surface water temperatures approached 10ºF warmer in recent years, compared with the 1976 and 1977 data.[8]

Lac La Belle is dimictic, which means that it mixes completely two times per year and is subject to thermal stratification during the summer and winter. This process is illustrated diagrammatically in Figure 3, and can be most clearly seen in the 2002 dissolved oxygen concentration profiles, shown in Figure 2, which generally show deoxygenation of the deeper waters of the Lake during February, June, July, and August.

Thermal stratification is a result of the differential heating of the lake water, and the resulting water temperature-density relationships at various depths within the lake water column. Water is unique among liquids because it reaches its maximum density, or mass per unit volume, at about 39ºF. The development of summer thermal stratification begins in early summer, reaches its maximum in late summer, and disappears in the fall. Stratification may also occur during winter under ice cover. The annual thermal cycle within Lac La Belle is described below.

As summer begins, the Lake absorbs solar energy at the surface. Wind action and, to some extent, internal heat transfers mechanism transmit this energy to the underlying portions of the waterbody. As the upper layer of water

[5]*U.S. Geological Survey Open-File Report No. 02-135,* Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2001*, 2002; U.S. Geological Survey Open-File Report No. 03-99,* Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2002*, 2003; U.S. Geological Survey Water-Data Report No. WI-03-1,* Water Resources Data: Wisconsin, Water Year 2003*, 2004.*

[6]*See for example, Wisconsin Department of Natural Resources*, 1986, op. cit.; *and Wisconsin Department of Natural Resources*, *1987*, op. cit.

[7]*SEWRPC Community Assistance Planning Report No. 47,* A Water Quality Management Plan for Lac La Belle, Waukesha County, Wisconsin*, December 1980.*

[8]*See SEWRPC Community Assistance Planning Report No. 58, 2nd Edition,* A Lake Management Plan for Pewaukee Lake, Waukesha County, Wisconsin*, May 2003.*

Figure 2

DISSOLVED OXYGEN AND TEMPERATURE PROFILES FOR LAC LA BELLE: 1984-2003

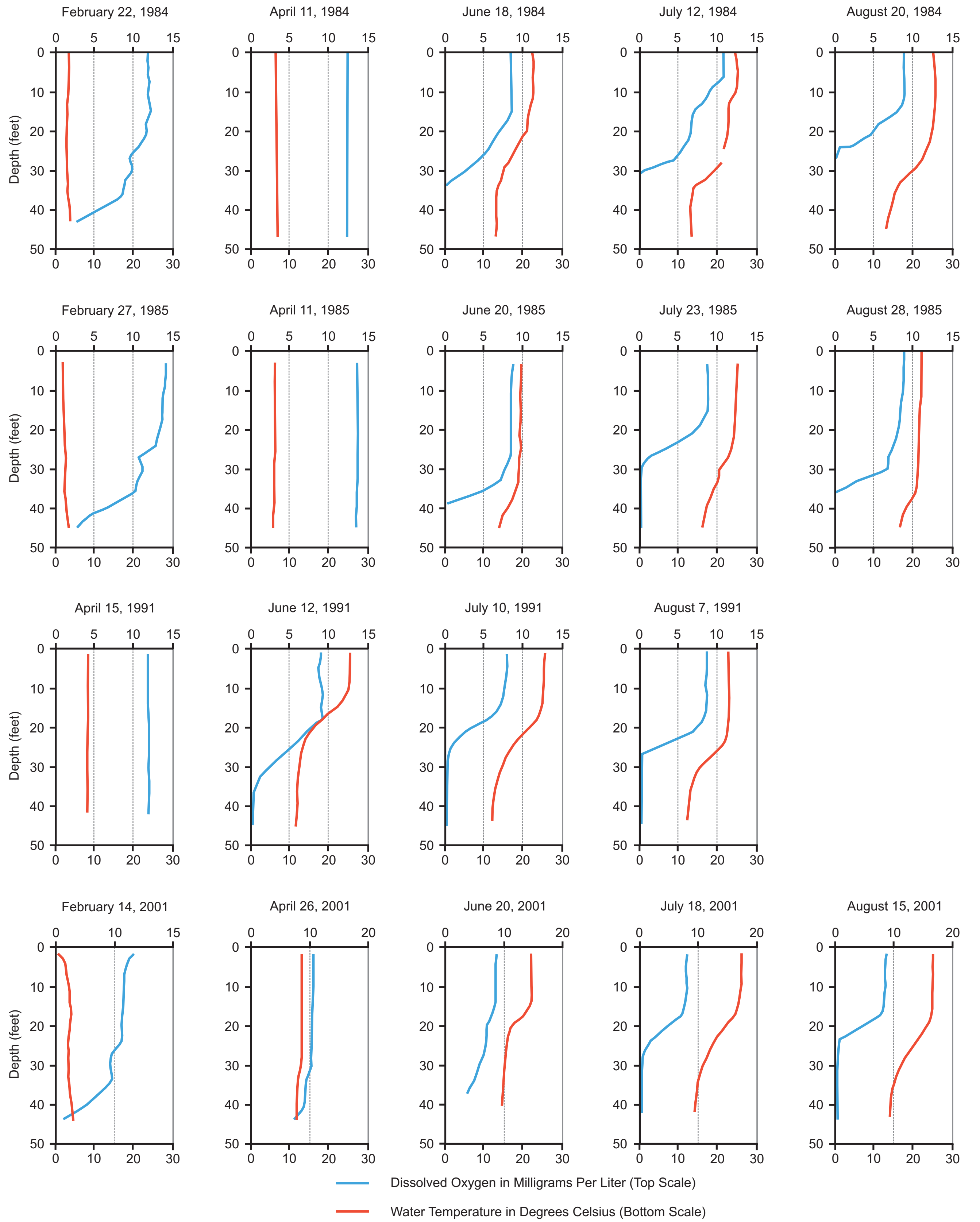
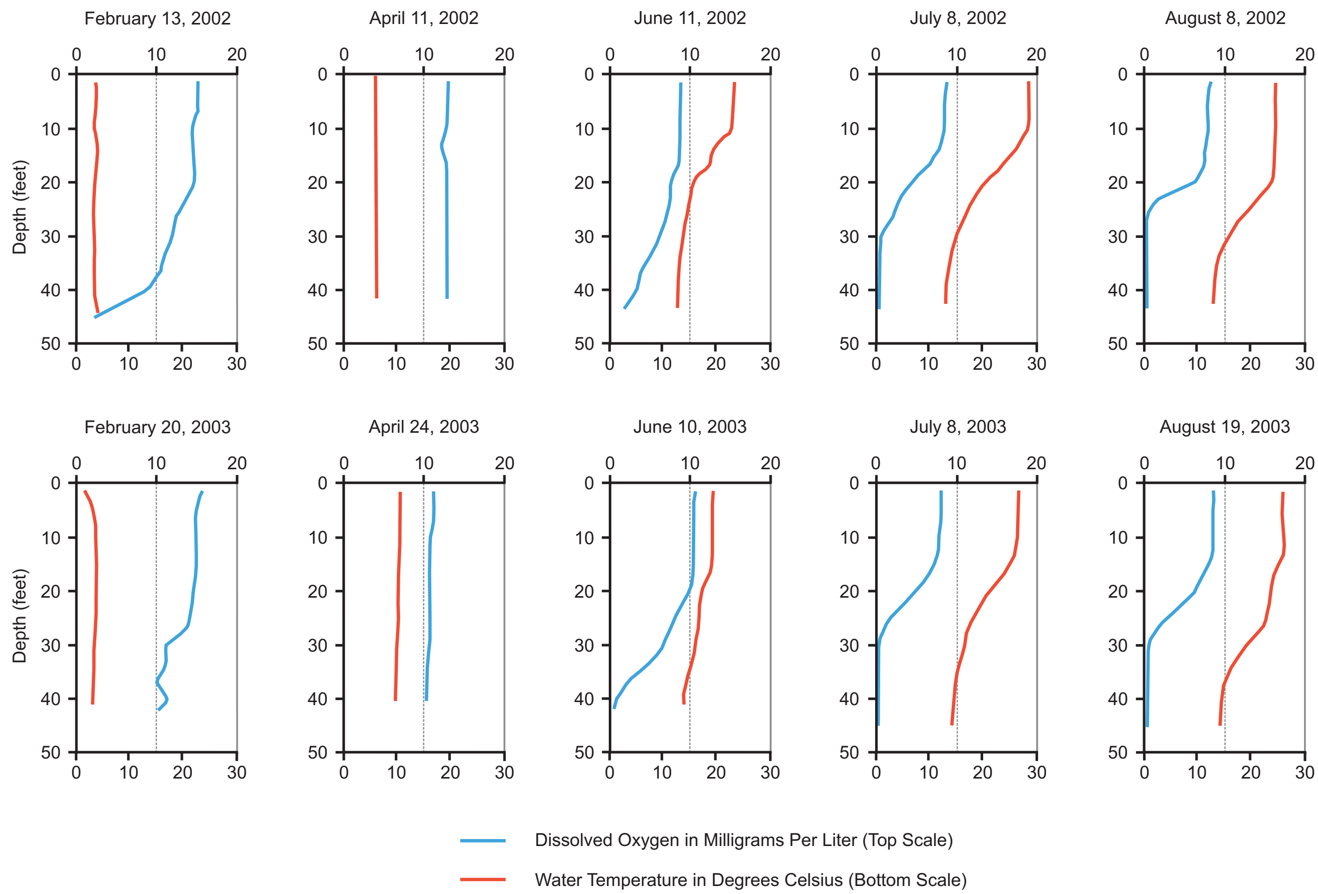


Figure 2 (continued)



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

is heated by solar energy, a physical barrier, created by differing water densities between warmer and cooler water, begins to form between the warmer surface water and the colder, heavier bottom water, as shown in Figure 3. This "barrier" is marked by a sharp temperature gradient known as the thermocline and is characterized by a 1ºC drop in temperature per one meter (or about a 2ºF drop in temperature per three feet) of depth that separates the warmer, lighter, upper layer of water (called the epilimnion) from the cooler, heavier, lower layer (called the hypolimnion), as shown in Figure 4. Although this barrier is readily crossed by fish, provided sufficient oxygen exists, it essentially prohibits the exchange of water between the two layers. This condition has a major impact on both the chemical and biological activity in a lake.

The autumnal mixing period occurs when air temperatures cool the surface water and wind action results in the erosion of the thermocline: as the surface water cools, it becomes heavier, sinking and displacing the now relatively warmer water below. The colder water sinks and mixes under wind action until the entire column of water is of uniform temperature, as shown in Figure 3. This action, which follows summer stratification, is known as "fall turnover."

When the water temperature drops to the point of maximum water density, 39.2ºF, the waters at the lake surface become more dense than the now warmer, less-dense bottom waters, and "sink" to the bottom. Eventually, the water column is cooled to the point where the surface waters, cooled to about 32ºF, are now lighter than the bottom waters which remain at about 39ºF. The lake surface may then become ice covered, isolating the lake water from the atmosphere for a period of up to four months. On Lac La Belle, ice cover typically exists from

Table 11

SEASONAL WATER QUALITY CONDITIONS IN LAC LA BELLE: 1976-2003

Parameter[a]	Fall (mid-September to mid-December) Shallow[b]	Fall (mid-September to mid-December) Deep[c]	Winter (mid-December to mid-March) Shallow[b]	Winter (mid-December to mid-March) Deep[c]	Spring (mid-March to mid-June) Shallow[b]	Spring (mid-March to mid-June) Deep[c]	Summer (mid-June to mid-September) Shallow[b]	Summer (mid-June to mid-September) Deep[c]
Physical Properties								
Alkalinity, as $CaCO_3$								
Range	168.00-200.00	184.00-246.00	206.00-218.00	252.00-292.00	192.00-232.00	190.00-240.00	180.00-199.00	198.00-202.00
Mean	185.80	207.33	212.50	272.00	209.75	213.93	193.50	200.33
Standard Deviation	12.22	24.22	5.00	17.59	9.18	12.94	9.04	2.08
Number of Samples	5	6	4	4	16	15	4	3
Color								
Range	- -	- -	- -	- -	5.00-20.00	5.00-20.00	8.70-15.00	0.00-0.10
Mean	- -	- -	- -	- -	11.36	11.25	10.26	0.03
Standard Deviation	- -	- -	- -	- -	4.52	5.16	2.70	0.06
Number of Samples	- -	- -	- -	- -	11	8	5	3
Dissolved Oxygen								
Range	7.70-11.60	0.00-11.30	5.20-14.50	0.02-11.00	10.50-20.00	7.10-15.00	7.00-11.10	0-4.10
Mean	10.22	7.72	11.93	5.76	12.17	11.16	8.50	0.45
Standard Deviation	1.58	4.78	2.25	3.23	2.26	2.17	0.81	0.79
Number of Samples	5	5	14	12	17	17	44	43
pH (units)								
Range	8.10-8.40	7.60-8.30	7.50-8.80	7.20-8.30	7.90-8.90	7.80-8.70	7.10-8.70	7.00-8.70
Mean	8.26	8.05	8.10	7.82	8.27	8.23	8.33	7.64
Standard Deviation	0.11	0.32	0.35	0.33	0.26	0.24	0.31	0.33
Number of Samples	5	6	15	13	17	16	48	46
Secchi Depth (feet)								
Range	5.50-9.30	- -	1.64-21.98	- -	5.25-11.48	- -	3.77-13.12	- -
Mean	7.68	- -	13.36	- -	7.82	- -	6.80	- -
Standard Deviation	1.60	- -	6.47	- -	2.11	- -	1.64	- -
Number of Samples	4	- -	11	- -	17	- -	49	- -
Specific Conductance (μS/cm)								
Range	323.00-466.00	333.00-521.00	296.00-576.00	325.00-685.00	285.00-560.00	377.00-625.00	382.00-543.00	418.00-658.00
Mean	412.20	446.67	455.10	541.40	474.19	490.00	485.09	539.73
Standard Deviation	53.31	68.92	100.73	121.60	77.36	72.71	34.93	51.36
Number of Samples	5	6	10	2	16	16	45	45
Temperature (°F)								
Range	39.20-61.50	39.20-60.00	32.00-39.20	32.00-39.20	38.00-60.98	38.00-49.08	59.90-83.48	44.60-79.34
Mean	47.48	46.62	34.70	37.02	47.67	43.70	74.57	55.83
Standard Deviation	9.54	8.74	2.07	2.40	6.83	3.32	5.13	4.91
Number of Samples	5	5	15	13	17	17	48	47
Turbidity (NTU)								
Range	1.60-2.60	1.70-3.50	0.80-2.10	1.10-2.30	0.70-3.10	0.60-11.50	0.60-2.50	0.80-3.20
Mean	2.10	2.38	1.55	1.60	1.76	2.31	1.67	2.33
Standard Deviation	0.37	0.67	0.56	0.50	0.70	2.64	0.97	1.33
Number of Samples	5	6	4	4	16	15	3	3
Metals/Salts								
Dissolved Calcium								
Range	37.00-64.00	36.00-80.70	36.00-53.00	59.00-117.00	41.00-82.00	41.00-59.00	27.00-44.00	45.00-65.00
Mean	45.6	55.07	46.25	77.00	49.13	48.88	38.00	52.67
Standard Deviation	10.95	18.84	7.93	26.88	9.17	4.53	6.75	10.79
Number of Samples	5	6	4	4	16	16	5	3

Table 11 (continued)

Parameter[a]	Fall (mid-September to mid-December)		Winter (mid-December to mid-March)		Spring (mid-March to mid-June)		Summer (mid-June to mid-September)	
	Shallow[b]	Deep[c]	Shallow[b]	Deep[c]	Shallow[b]	Deep[c]	Shallow[b]	Deep[c]
Metals/Salts (continued)								
Dissolved Chloride								
Range	15.00-19.00	13.00-19.00	16.00-24.00	18.00-25.00	16.00-43.30	15.00-43.20	15.00-19.00	15.00-20.00
Mean	16.40	15.50	19.00	21.00	29.58	26.52	17.67	18.00
Standard Deviation	1.67	2.26	3.56	3.56	10.78	10.41	2.31	2.65
Number of Samples	5	6	4	4	12	11	3	3
Dissolved Iron (µg/l)								
Range	0.03-0.13	0.05-0.06	0.03-0.04	0.03-0.04	0.01-20.00	0.02-20.00	0.03-0.39	0.03-0.35
Mean	0.08	0.05	0.03	0.03	2.49	2.48	0.21	0.20
Standard Deviation	0.07	0.01	0.01	0.01	5.58	5.97	0.26	0.23
Number of Samples	2	2	2	2	13	12	2	2
Dissolved Magnesium								
Range	36.00-48.90	32.50-44.00	32.00-46.00	32.00-56.00	30.00-35.00	31.00-41.00	31.00-118.00	21.00-44.00
Mean	43.10	37.43	40	43.75	33.25	34.56	57.50	34.00
Standard Deviation	5.94	4.50	5.83	10.21	1.57	2.61	40.68	11.79
Number of Samples	5	6	4	4	16	16	4	3
Dissolved Manganese (µg/l)								
Range	0.02-0.04	0.02-0.05	0.00-0.31	0.02-0.04	0.02-20.00	0.02-20.00	0.02-0.04	0.02-0.12
Mean	0.03	0.03	0.11	0.03	5.93	6.30	0.03	0.07
Standard Deviation	0.02	0.03	0.18	0.02	8.18	8.07	0.02	0.07
Number of Samples	2	2	3	2	13	13	2	2
Dissolved Potassium								
Range	1.60-8.30	1.06-6.90	0.70-2.40	1.10-5.70	1.40-3.70	1.00-2.70	1.00-5.70	1.80-6.30
Mean	4.08	3.57	1.68	2.95	2.14	2.05	2.97	3.47
Standard Deviation	2.60	1.85	0.75	1.96	0.53	0.46	2.44	2.47
Number of Samples	5	6	4	4	16	16	3	3
Dissolved Silica								
Range	- -	- -	- -	- -	1.20-5.20	1.60-5.08	- -	- -
Mean	- -	- -	- -	- -	2.96	3.34	- -	- -
Standard Deviation	- -	- -	- -	- -	1.31	1.12	- -	- -
Number of Samples	- -	- -	- -	- -	12	11	- -	- -
Dissolved Sodium								
Range	8.00-13.00	5.30-13.00	7.00-11.00	8.00-14.00	6.00-20.00	6.00-20.00	7.00-13.00	6.00-14.00
Mean	9.50	8.50	9.30	9.75	13.11	12.50	10.67	9.33
Standard Deviation	2.06	2.87	1.71	2.87	4.23	4.43	3.22	4.16
Number of Samples	5	6	4	4	14	14	3	3
Dissolved Sulfate SO_4								
Range	28.00-38.00	21.00-32.00	36.00-40.00	35.00-38.00	23.00-35.00	24.00-36.00	34.00-36.00	32.00-35.00
Mean	32.00	27.00	38.00	36.50	29.15	29.88	35	33.50
Standard Deviation	4.90	4.42	2.83	2.12	4.15	3.93	1.41	2.12
Number of Samples	4	5	2	2	14	12	2	2
Nutrients								
Dissolved Nitrogen, Ammonia								
Range	0.11-0.18	0.06-3.61	0.06-0.24	0.12-1.22	0.01-0.12	0.02-0.19	0.02-0.16	- -
Mean	0.15	1.19	0.15	0.55	0.05	0.08	0.07	- -
Standard Deviation	0.03	1.60	0.08	0.49	0.03	0.05	0.06	- -
Number of Samples	5	6	4	4	16	16	6	- -

Table 11 (continued)

Parameter[a]	Fall (mid-September to mid-December)		Winter (mid-December to mid-March)		Spring (mid-March to mid-June)		Summer (mid-June to mid-September)	
	Shallow[b]	Deep[c]	Shallow[b]	Deep[c]	Shallow[b]	Deep[c]	Shallow[b]	Deep[c]
Nutrients (continued)								
Dissolved Nitrogen, NO_2+NO_3								
Range	0.07-0.46	0.14-0.27	0.17-0.36	1.30-1.82	0.31-1.11	0.01-1.12	0.05-0.32	- -
Mean	0.27	0.21	0.25	1.65	0.68	0.67	0.18	- -
Standard Deviation	0.14	0.04	0.08	0.24	0.19	0.24	0.11	- -
Number of Samples	5	6	4	4	16	17	6	- -
Total Nitrogen, Organic								
Range	0.48-0.77	0.50-0.79	0.40-0.60	0.25-0.78	0.07-0.90	0.36-0.84	0.48-1.13	0.46-1.05
Mean	0.63	0.62	0.50	0.44	0.54	0.61	0.87	0.79
Standard Deviation	0.10	0.10	0.09	0.24	0.17	0.15	0.28	0.30
Number of Samples	5	6	4	4	17	17	4	3
Dissolved Orthophosphorus								
Range	0.01-0.03	0.01-0.03	0.01-0.02	0.02-0.15	0.00-0.03	0.00-0.03	0.00-0.03	0.00-0.02
Mean	0.02	0.02	0.01	0.05	0.01	0.01	0.01	0.01
Standard Deviation	0.01	0.01	0.01	0.06	0.01	0.01	0.01	0.01
Number of Samples	5	6	4	5	15	13	5	3
Total Phosphorus								
Range	0.02-0.05	0.02-0.11	0.01-0.35	0.01-0.15	0.01-0.04	0.01-0.04	0.00-0.05	0.00-0.06
Mean	0.03	0.05	0.04	0.03	0.02	0.02	0.01	0.02
Standard Deviation	0.01	0.03	0.10	0.04	0.01	0.01	0.01	0.01
Number of Samples	5	6	13	12	17	17	48	49
Biological								
Chlorophyll-*a* (µg/l)								
Range	- -	- -	0.40-9.00	- -	1.00-12.10	- -	0.05-7.00	- -
Mean	- -	- -	2.52	- -	5.34	- -	3.86	- -
Standard Deviation	- -	- -	2.86	- -	3.64	- -	1.69	- -
Number of Samples	- -	- -	8	- -	13	- -	45	- -

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

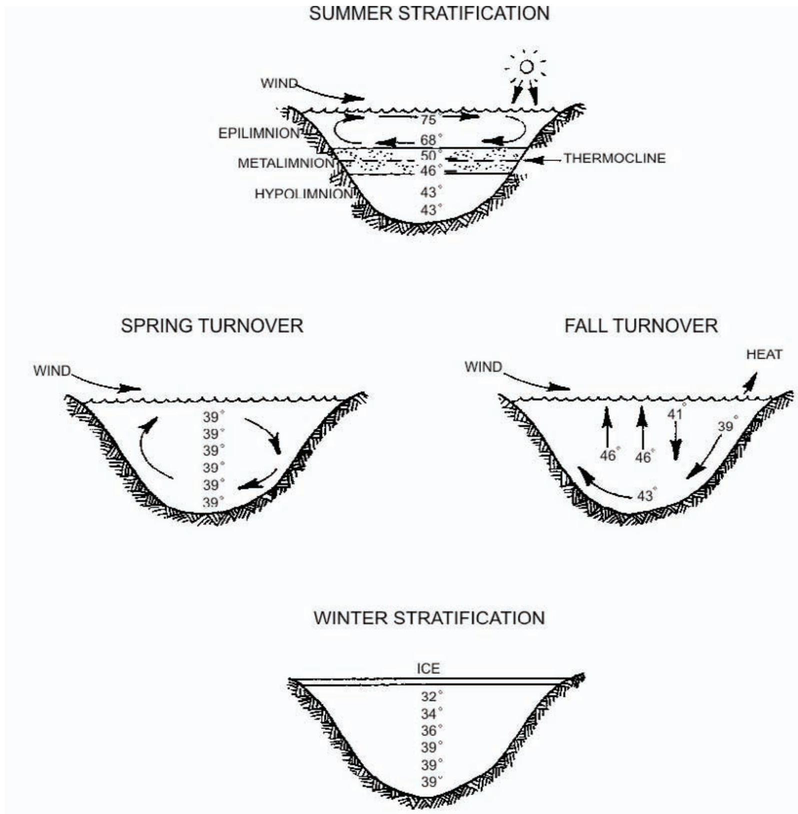
[b]*Depth of sample approximately 1.5 feet.*

[c]*Depth of sample greater than 30 feet.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 3

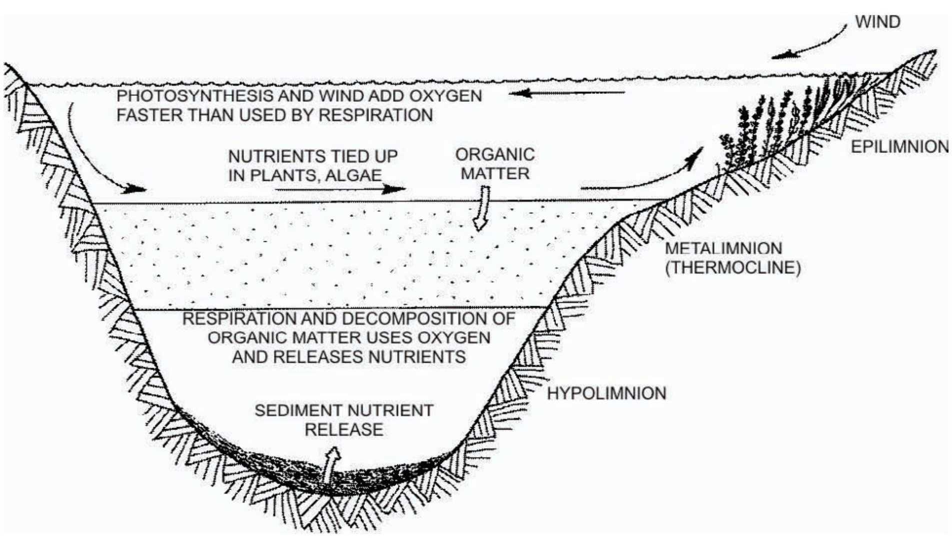
THERMAL STRATIFICATION OF LAKES



Source: University of Wisconsin-Extension and SEWRPC.

Figure 4

LAKE PROCESSES DURING SUMMER STRATIFICATION



Source: University of Wisconsin-Extension and SEWRPC.

December until early April. As shown in Figure 3, winter stratification occurs as the colder, lighter water and ice remain at the surface, separated from the relatively warmer, heavier water near the bottom of the lake.

Spring brings a reversal of the process. As the ice thaws and the upper layer of water warms, it becomes denser and begins to approach the temperature of the warmer, deeper water until the entire water column reaches the same temperature from surface to bottom. This is referred to as “spring turnover” and usually occurs within weeks after the ice goes out, as shown in Figure 3 and during the April 2002 sampling set forth in Figure 2. Table 12 summarizes the water quality of the Lake at the time of spring turnover. After spring turnover, the water at the surface again warms and becomes lighter, causing it to float above the colder, deeper water. Wind and resulting waves carry some of the energy of the warmer, lighter water to lower depths, but only to a limited extent. Thus, begins the formation of the thermocline and another period of summer thermal stratification.

Dissolved Oxygen

Dissolved oxygen levels are one of the most critical factors affecting the living organisms of a lake ecosystem. As shown in Figure 2, dissolved oxygen levels are generally higher at the surface of Lac La Belle, 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 on the bottom of the Lake, where decomposer organisms and chemical oxidation processes utilize oxygen in the decay process. When any lake becomes thermally stratified, as described above, the surface supply of dissolved oxygen to the hypolimnion is cut off. Gradually, if there is not enough dissolved oxygen to meet the total demands from the bottom dwelling aquatic life and decaying of organic material, the dissolved oxygen levels in the bottom waters may be reduced, even to zero, a condition known as anoxia, or anaerobiasis, as shown diagrammatically in Figure 4, and as documented during February, June, July, and August, as set forth in Figure 2.

Dissolved oxygen concentrations in the surface waters of Lac La Belle range from about 20 milligrams per liter (mg/l) during the spring to about 5.2 mg/l during the winter, as shown in Table 11. Hypolimnetic dissolved oxygen concentrations, as shown in Figure 2 and Table 11, have dropped to zero during late summer. This pattern continues to be observed with the hypolimnion of Lac La Belle becoming anoxic during summer stratification. Dissolved oxygen concentrations in the bottom waters of Lac La Belle typically fall to zero by mid- to late-June, as shown in Figure 2. Oxygen concentrations at or above 5.0 mg/l are considered to be the minimum level necessary to support many species of fish. Oxygen concentrations fell below that threshold during the summer months at between about 15 feet and 20 feet of depth.

Fall turnover between September and October in most years, naturally restores the supply of oxygen to the bottom water, although hypolimnetic anoxia can be reestablished during the period of winter thermal stratification. Winter anoxia is more common during the years of heavy snowfall, when snow covers the ice, reducing the degree of light penetration and reducing algal photosynthesis that takes place under the ice. In some lakes in the Region, hypolimnetic anoxia can occur at times during winter stratification. Under these conditions anoxia can contribute to the winter-kill of fish. Although dissolved oxygen levels in the hypolimnion of Lac La Belle were found to be below the 5.0 mg/l level during winter, a relatively large volume of the Lake retained adequate dissolved oxygen concentrations to sustain fish populations throughout the winter. At the end of winter, dissolved oxygen concentrations in the bottom waters of the Lake were restored during the period of spring turnover, which generally occurs between March and May, as shown in Figure 2 and, diagrammatically, in Figure 3.

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 to warmer water portions of the lake where their condition and competitive success may be severely impaired.

Table 12

LAC LA BELLE SPRING OVERTURN WATER QUALITY: 1984-2001

Water Quality Parameter	April 11, 1984		April 11, 1985		April 27, 1989		March 3, 1990		April 15, 1991		April 13, 1992		February 17, 1993		February 22, 1994	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Middle	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample (feet)	3	44	3	43	- -	- -	- -	- -	1.5	42	- -	- -	- -	- -	- -	- -
Specific Conductance (μS/cm)	505	517	489	487	285	405	360	400	509	527	410	410	314	325	296	- -
pH	8.9	8.7	8.7	8.7	8.05	- -	8.1	8	8.3	8.3	8.4	8.4	8.3	8.3	8.1	- -
Water Temperature (°F)	44.4	43.9	43.7	41.9	55.4	47.3	39.2	37.4	47.12	46.4	38.3	38.3	36.5	32	35.24	38.3
Color (platinum-cobalt scale)	20.0	20.0	10.0	15.0	10	10	- -	- -	15.0	5.0	10	10	- -	- -	- -	- -
Turbidity (Nephelometric turbidity units)	1.5	1.4	1.0	0.6	1.8	3.3	- -	- -	2.2	1.2	1.2	1.3	- -	- -	- -	- -
Secchi Disk (feet)	3.5	- -	2.5	- -	5.2	- -	- -	- -	1.6	- -	10.8	- -	19.7	- -	13.1	- -
Dissolved Oxygen	12.4	12.2	13.8	13.5	11.4	8.6	12	10.4	11.7	11.7	14	13.3	5.2	11	11.1	0.019
Hardness, as $CaCO_3$	240	240	260	250	250	- -	- -	- -	240	240	260	270	- -	- -	- -	- -
Calcium	45	45	51	49	- -	- -	- -	- -	44	43	48	49	- -	- -	- -	- -
Magnesium	32	32	31	31	34	34	- -	- -	33	33	35	35	- -	- -	- -	- -
Sodium	11	11	9.6	10	13	13	- -	- -	13	13	- -	- -	- -	- -	- -	- -
Potassium	2.1	2.0	1.7	1.6	2.0	2.2	- -	- -	2.23	2.35	2.03	2.09	- -	- -	- -	- -
Alkalinity, as $CaCO_3$	206	206	215	214	210	214	- -	- -	207	209	210	210	- -	- -	- -	- -
Chloride	27	25	23	23	- -	- -	- -	- -	30	30	- -	- -	- -	- -	- -	- -
Sulfate	35	33	29	29	26.6	26.6	- -	- -	33	33	34	34	- -	- -	- -	- -
Dissolved Solids	296	274	330	289	- -	- -	- -	- -	302	298	- -	- -	- -	- -	- -	- -
Nitrate/Nitrite Nitrogen	0.7	0.7	0.9	<0.01	0.49	0.49	- -	- -	0.662	0.663	1.11	1.12	- -	- -	- -	- -
Ammonia Nitrogen	0.1	0.12	0.05	0.02	<0.02	0.09	- -	- -	0.066	0.059	0.062	0.061	- -	- -	- -	- -
Kjeldahl Nitrogen	0.6	0.78	0.65	0.48	0.6	0.7	- -	- -	0.534	0.841	0.5	0.6	- -	- -	- -	- -
Total Phosphorus	<0.1	<0.1	0.041	0.009	0.018	0.031	0.013	0.016	0.011	0.015	0.007	0.009	0.005	0.006	0.037	0.019
Orthophosphorus	<0.1	<0.1	0.005	<0.001	0.005	0.005	- -	- -	0.003	0.003	- -	- -	- -	- -	- -	- -
Iron (μg/l)	<4	<3	5	8	<0.05	<0.05	- -	- -	- -	- -	<0.05	<0.05	- -	- -	- -	- -
Manganese (μg/l)	<1	<1	<1	1	<40	<40	- -	- -	<40	<40	<40	<40	- -	- -	- -	- -
Chlorophyll-*a* (μg/l)	1.8	- -	1	- -	12	- -	4	- -	5	- -	5	- -	1.5	- -	0.663	- -

Water Quality Parameter	March 29, 1995		April 17, 1996		April 29, 1997		March 30, 1997		April 7, 1999		May 1, 2000		April 26, 2001	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
Depth of Sample (feet)	- -	- -	- -	- -	1	40	1	40	3	42	1	42	0.5	13
Specific Conductance (μS/cm)	540	541	546	546	560	561	499	496	469	470	- -	- -	556	570
pH	8.2	8.2	8.2	8.2	8.5	8.2	7.9	7.9	8.26	8.27	8.3	8	8.2	7.9
Water Temperature (°F)	41.54	41.36	44.42	44.06	53.42	44.96	51.44	46.04	49.3	49.1	60.98	46.94	55.22	52.52
Color (platinum-cobalt scale)	15	15	- -	- -	- -	- -	10	- -	5	5	5	- -	15.0	- -
Turbidity (Nephelometric turbidity units)	1.6	1.7	1.1	1.1	1.3	1.3	2.2	- -	0.7	0.6	- -	- -	3.1	- -
Secchi Disk (feet)	9.2	- -	7.9	- -	7.9	- -	6.2	- -	5.6	- -	11.5	- -	2.4	- -
Dissolved Oxygen	11.8	11.5	11.8	11.9	20	15	11.5	12	11.01	10.75	10.9	7.9	10.5	7.3
Hardness, as $CaCO_3$	260	260	- -	- -	260	260	- -	- -	- -	- -	- -	- -	243	- -
Calcium	47	48	48	48	50	51	48	48	50	50	48	49	48	- -
Magnesium	35	35	34	33	33	33	33	33	35	35	- -	- -	30	- -
Sodium	16	16	17	17	- -	- -	17	17	20	20	- -	- -	18	- -
Potassium	2.4	2.4	2.6	2.4	2	2	2.1	2.1	2.3	2.3	- -	- -	1.4	- -
Alkalinity, as $CaCO_3$	207	209	212	212	222	225	217	- -	232	216	- -	- -	206	- -
Chloride	- -	- -	- -	- -	37.7	37.5	38.9	- -	43.2	43	43.3	43.2	40.8	- -
Sulfate	27	27	27	26	25	24	23	- -	25.6	25.9	- -	- -	24.9	- -
Dissolved Solids	- -	- -	- -	- -	- -	- -	- -	- -	326	318	- -	- -	332	- -
Nitrate/Nitrite Nitrogen	0.641	0.673	0.972	0.968	0.694	0.7	0.657	0.659	- -	0.7	0.628	0.585	0.755	- -
Ammonia Nitrogen	0.115	0.111	0.027	- -	0.027	0.127	0.038	0.056	- -	0.032	0.043	0.19	0.024	- -
Kjeldahl Nitrogen	0.9	0.7	0.5	0.5	0.6	0.7	0.44	0.37	< 0.14	0.7	0.6	0.74	0.61	- -
Total Phosphorus	0.012	0.013	0.008	0.009	0.015	0.016	0.016	0.017	0.013	0.016	0.019	0.013	0.015	0.017
Orthophosphorus	0.003	0.003	0.002	- -	- -	- -	0.002	0.002	0.004	0.003	0.002	- -	< 0.002	- -
Iron (μg/l)	0001	0.02	- -	- -	0.03	- -	0.04	0.03	0.03	0.04	- -	- -	<10	- -
Manganese (μg/l)	2.8	3.7	3	3	3	4	3	3	5	7	- -	- -	< 0.4	- -
Chlorophyll-*a* (μg/l)	7.93	- -	7.78	- -	3.06	- -	4.11	- -	12.1	- -	1.9	- -	4.7	- -

Source: Wisconsin Department of Natural Resources and SEWRPC.

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. The likely import of internal loading to the nutrient budget of Lac La Belle is discussed further below.

Specific Conductance

Specific conductance is an indicator of the concentration of dissolved solids in the water; as the amount of dissolved solids increases, the specific conductance increases. During periods of thermal stratification, specific conductance can increase at the lake bottom due to an accumulation of dissolved materials in the hypolimnion, as shown on Figure 5 during the February and August sampling periods. This is a consequence of the "internal loading" phenomenon noted above. As shown in Table 11, the specific conductance of Lac La Belle during the period 1976 through 2003 ranged from 285 to 685 microSiemens per centimeter (μS/cm). During the initial planning study, conductivity ranged from 427 to 639 μS/cm. Significant surface to bottom conductivity gradients were observed during the study period, especially during the summer period when specific conductance increased with depth from between 382 and 543 μS/cm at the surface to between 418 and 658 μS/cm at depth. These ranges are not dissimilar to the ranges reported from other lakes in southeastern Wisconsin.[9]

Chloride

During the initial planning study, chloride concentrations were reported to range from 12 to 25 mg/l, with an average of 18 mg/l. These concentrations were already reported to be somewhat higher than those reported by the WDNR during the 1960s,[10] and have continued to increase, with chloride concentrations in Lac La Belle during the recent planning study ranging from 13 to 43 mg/l, as shown in Table 11. The most important anthropogenic source of chlorides to Lac La Belle is believed to be the salts used on streets and highways for winter snow and ice control.[11] The other major anthropogenic source of chloride, water softener salt, is of lesser importance to Lac La Belle, as such salts are conveyed away from the Lake by the sanitary sewerage system. Treated effluents from the City of Oconomowoc sewage treatment facility are discharged downstream of the Lake. An increasing trend in chloride concentrations has been observed within the Southeastern Wisconsin Region, as shown in Figure 6.

Alkalinity and Hardness

Alkalinity is an index of the buffering capacity of a lake, or the capacity of a lake to absorb and neutralize acids. The alkalinity of a lake depends on the levels of bicarbonate, carbonate, and hydroxide ions present in the water.

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[9]*See, for example, water quality data compiled within SEWRPC Community Assistance Planning Report No. 98, 2nd Edition,* A Lake Management Plan for Friess Lake, Washington County, Wisconsin*, November 1997; SEWRPC Community Assistance Planning Report No. 54,* A Water Quality Management Plan for North Lake, Waukesha County, Wisconsin*, July 1982; SEWRPC Community Assistance Planning Report No. 53, 2nd Edition,* A Water Quality Management Plan for Okauchee Lake, Waukesha County, Wisconsin*, October 2003; SEWRPC Community Assistance Planning Report No. 181,* A Water Quality Management Plan for Oconomowoc Lake, Waukesha County Wisconsin*, March 1990; SEWRPC Community Assistance Planning Report No. 187,* A Management Plan for Fowler Lake, Waukesha County, Wisconsin*, March 1994.*

[10]*R.J. Poff and C.W. Threinen,* Surface Water Resources of Waukesha County*, Wisconsin Conservation Department, 1963.*

[11]*The major sources of chlorides to lakes in the Southeastern Wisconsin Region include both road salt applications during winter months and salts discharged from water softeners.*

Figure 5

SPECIFIC CONDUCTANCE AND pH PROFILES FOR LAC LA BELLE: 1985-2003

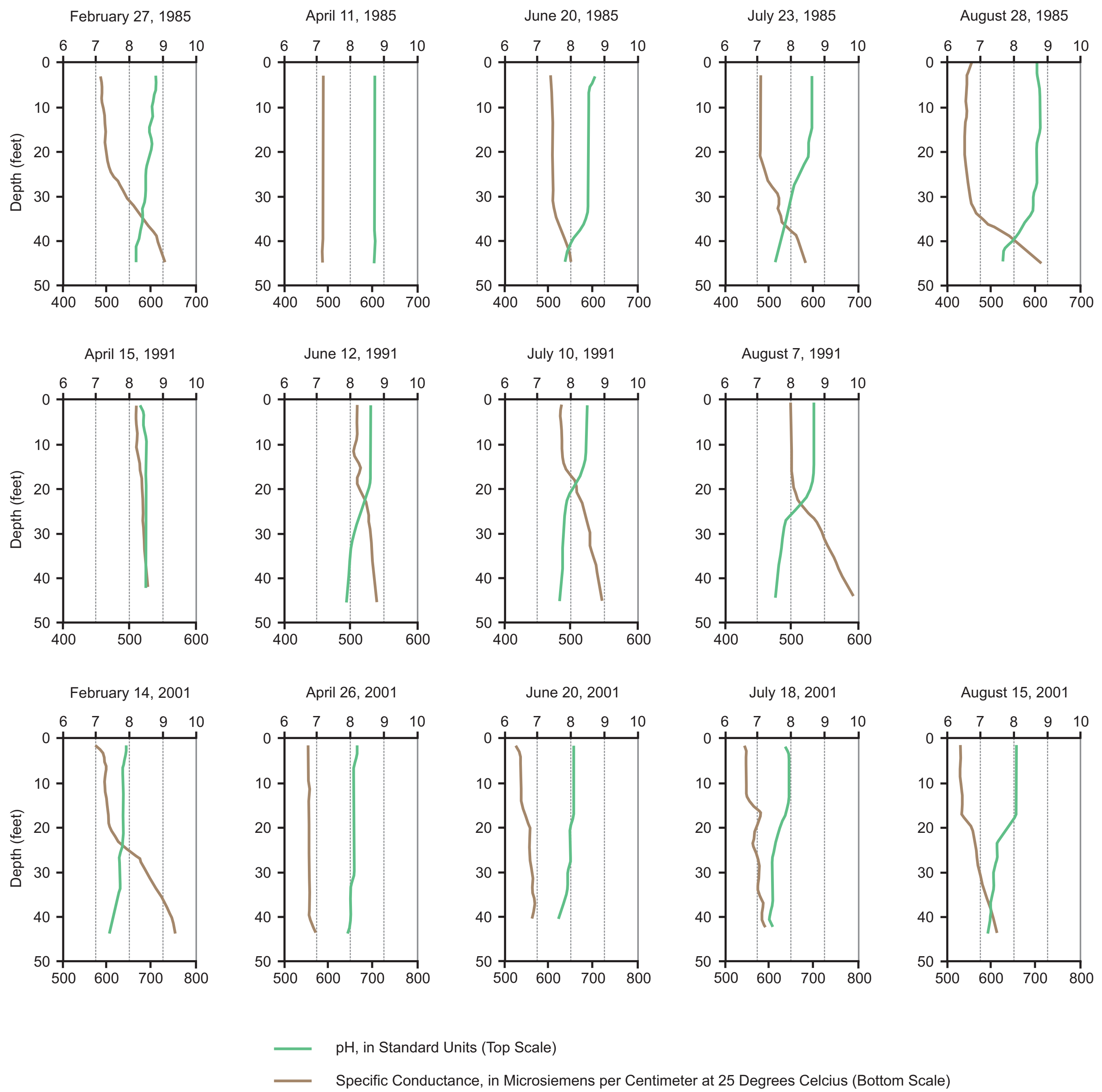
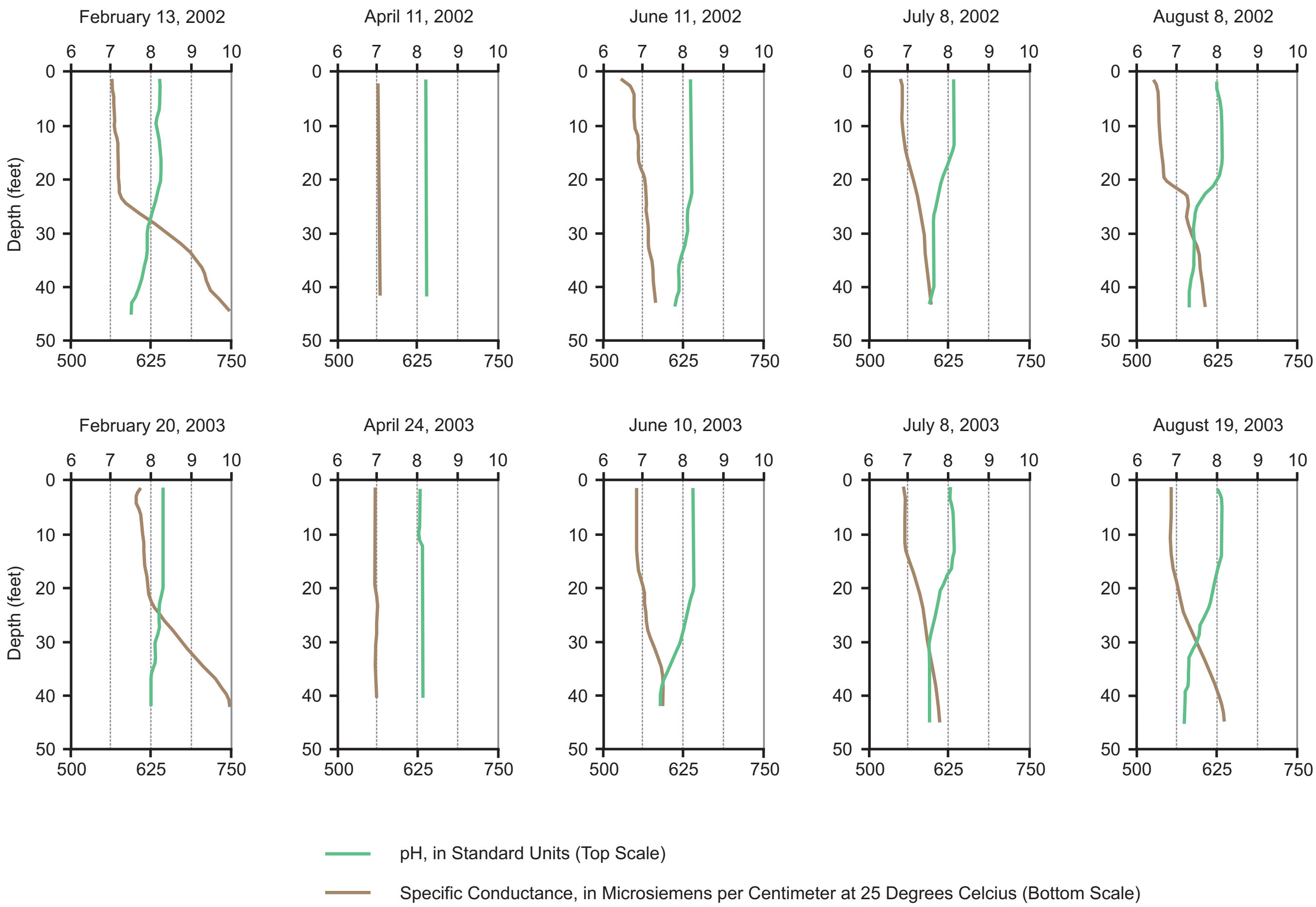


Figure 5 (continued)



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

Lakes in southeastern Wisconsin typically have a high alkalinity because of the types of soils and underlying bedrock in the Region's watersheds. In contrast, water hardness is a measure of the multivalent metallic ion concentrations, such as those of calcium and magnesium, present in a lake. Hardness is usually reported as an equivalent concentration of calcium carbonate (CaCO3). Applying these measures, Lac La Belle may be classified as a hard-water alkaline lake. During the initial study period, the spring alkalinity averaged about 210 mg/l. During the current study period, alkalinity ranged from 168 to 292 mg/l, as shown in Table 11. These values are within the normal range of concentrations found in lakes in southeastern Wisconsin.[12]

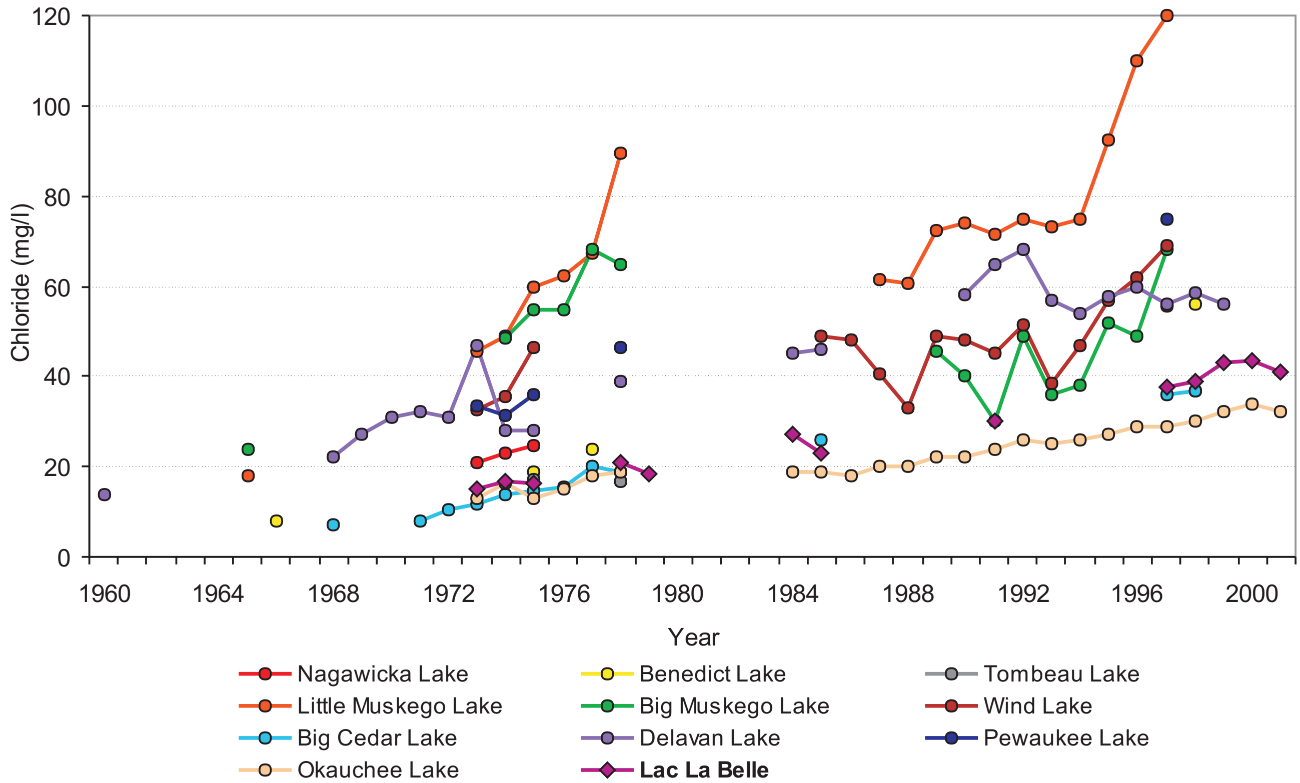
Hydrogen Ion Concentration (pH)

The pH is a logarithmic measure of hydrogen ion concentration on a scale of 0 to 14 standard units, with 7 indicating neutrality. A pH above 7 indicates basic (or alkaline) water, and a pH below 7 indicates acidic water. In Lac La Belle, the pH was found to range between 7.6 and 8.4 standard units during the initial study period, and between 7.0 and 8.9 during the current planning period, as shown in Table 11. Since Lac La Belle has a high

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

Figure 6

CHLORIDE CONCENTRATION TRENDS FOR SELECTED LAKES IN SOUTHEASTERN WISCONSIN: 1960-2001



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

alkalinity or buffering capacity, and because the pH does not fluctuate below 7, the Lake is not considered to be susceptible to the harmful effects of acidic deposition. These values are within the normal range of pH values found in lakes in southeastern Wisconsin.[13]

Water Clarity

Water clarity, or transparency, provides an indication of overall water quality; clarity may decrease because of turbidity caused by high concentrations of organic and inorganic suspended materials such as algae and zooplankton, and suspended sediment, and/or because of color caused by high concentrations of dissolved organic substances. Water clarity is measured with a Secchi disc, 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-disc reading." Such measurements comprise an important part if the Wisconsin Department of Natural Resources Self-Help Monitoring Program in which citizen volunteers assist in lake water quality monitoring efforts.

Water clarity varies throughout the year as algal populations increase and decrease in response to changes in weather conditions and nutrient loadings. Secchi-disc depth measurements for the period from 1973 through 1975 for Lac La Belle ranged from 5.5 feet in September 1973 to 9.0 feet in July 1975, with an average of about 7.5 feet. The lower readings were usually recorded during July and August, primarily because of excessive growth of free floating algae. During the current study period, Secchi-disc readings for Lac La Belle were between about 1.6

[13]Ibid.

feet and 22.0 feet, with an average of about 9.0 feet. As shown in Figure 7, during recent years, these values indicate fair to good or very good water quality compared to other lakes in the southeastern Wisconsin.[14] In part, however, this improved water clarity may be related to the presence of zebra mussel, Dreissena polymorpha, in the Lake, which mollusk is an invasive, nonnative filter feeding shellfish known to impact water clarity in inland lakes. This shellfish, although present in the Lake, was not observed to be abundant.

Chlorophyll-*a*

Chlorophyll-*a* is the major photosynthetic ("green") pigment in algae. The amount of chlorophyll-*a* present in the water is an indication of the biomass or amount of algae in the water. Chlorophyll-*a* concentrations determined from Lac La Belle during the initial study ranged from a low of 1.0 microgram per liter (µg/l) in February 1977, to a high of 18 µg/l in March 1976. In July and August 1976, chlorophyll-*a* concentrations were above 10 µg/l. As shown in Figure 7, during the current study period, chlorophyll-*a* concentrations in Lac La Belle ranged from 0.4 µg/l to 12 µg/l. Mean chlorophyll-*a* concentrations in recent years were consistently below 10 µg/l. All of these values are generally within the range of chlorophyll-*a* concentrations recorded in other lakes in the Region[15] and indicate fair to very good water quality, as illustrated in Figure 7. Chlorophyll-*a* levels above about 10 µg/l range result in a green coloration of the water that may be severe enough to impair recreational activities such as swimming and skiing.[16]

Nutrient Characteristics

Aquatic plants and algae require such nutrients as phosphorus and nitrogen for growth. In hard-water alkaline lakes, most of these nutrients are generally found in concentrations that exceed the needs of growing plants. However, in lakes where the supply of one or more of these nutrients is limited, plant growth is limited by the amount of that nutrient available. The ratio of total nitrogen (N) to total phosphorus (P) in lake water indicates which nutrient is the factor most likely limiting aquatic plant growth in a lake.[17] Where the N:P ratio is greater than 14:1, phosphorus is most likely to be the limiting nutrient. If the ratio is less than 10:1, nitrogen is most likely to be the limiting nutrient. As shown in Table 13, the nitrogen-to-phosphorus ratios in samples collected from Lac La Belle were always greater than 10, and were well over 10 during the recent past. This indicates that plant production was most likely consistently limited by phosphorus. In fact, Table 13 indicates the summer N:P ratio was always equal to or greater than 14:1.

Both total phosphorus and soluble phosphorus were measured for Lac La Belle. Soluble phosphorus, being dissolved in the water column, is readily available for plant growth. However, its concentration can vary widely over short periods of time as plants take up and release this nutrient. Therefore, total phosphorus is usually considered a better indicator of nutrient status. Total phosphorus includes the phosphorus contained in plant and animal fragments suspended in the lake water, phosphorus bound to sediment particles, and phosphorus dissolved in the water column.

Total phosphorus concentrations in Lac La Belle were found to be generally at or below the levels necessary to support periodic nuisance algae blooms. The recommended guideline for phosphorus, set forth in the adopted regional water quality management plan, is 0.02 mg/l of total phosphorus or less during spring turnover. This is

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[14]Ibid.

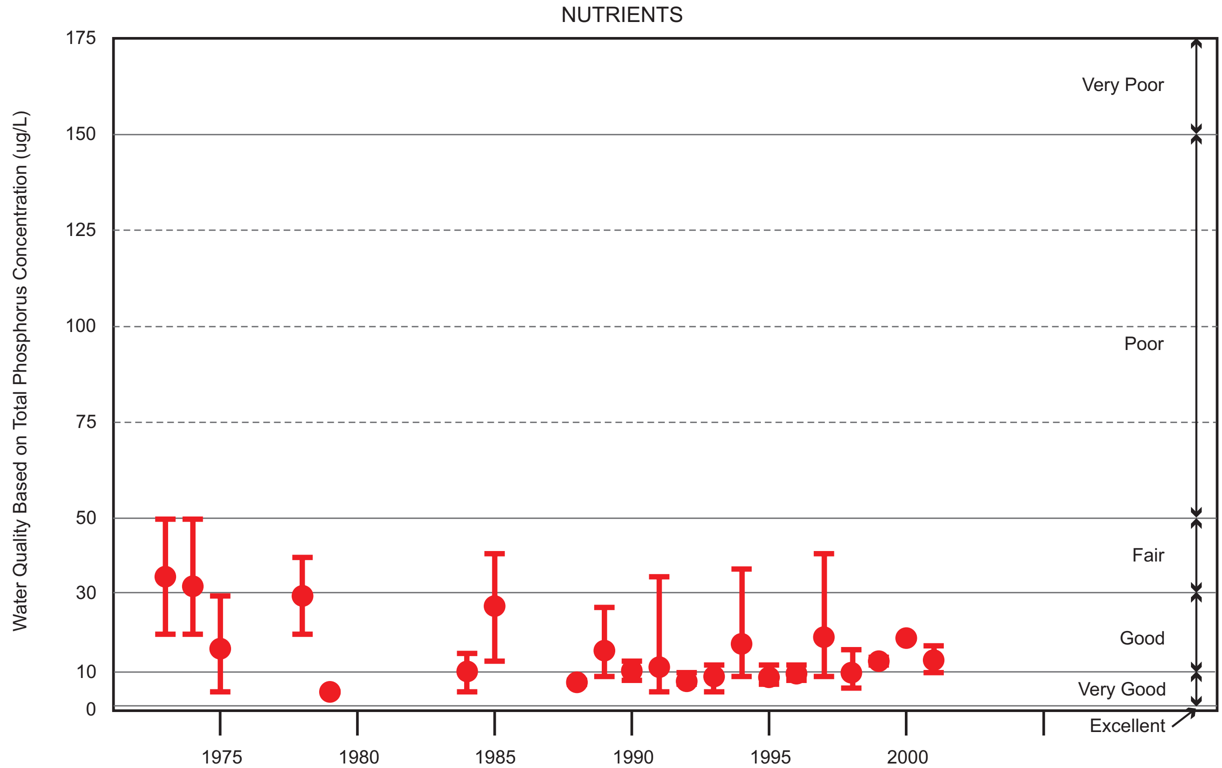
[15]Ibid.

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

[17]*M.0. Allum, R.E. Gessner, and T.H. Gakstatter, U.S. Environmental Protection Agency Working Paper No. 900,* An Evaluation of the National Eutrophication Data*, 1976.*

Figure 7

PRIMARY WATER QUALITY INDICATORS FOR LAC LA BELLE: 1973-2001



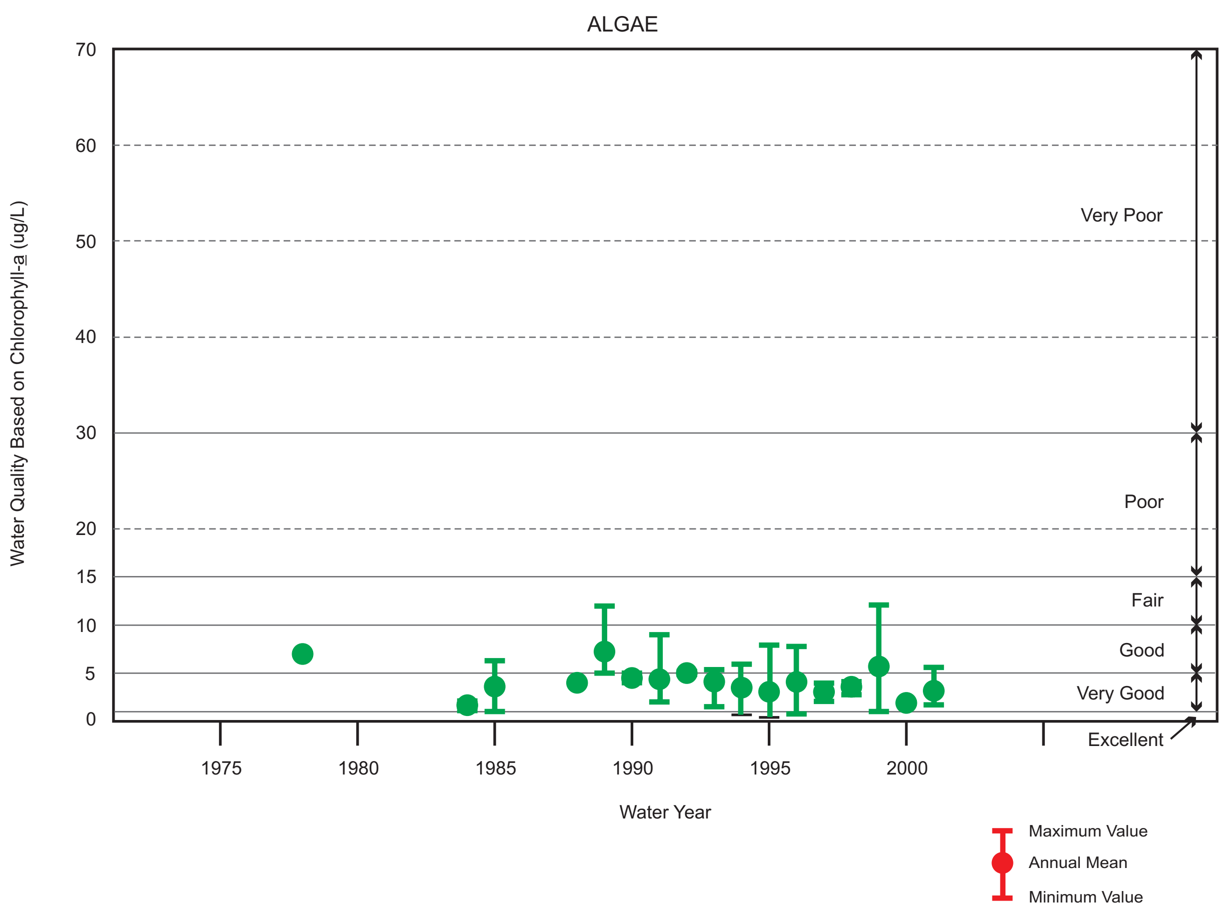
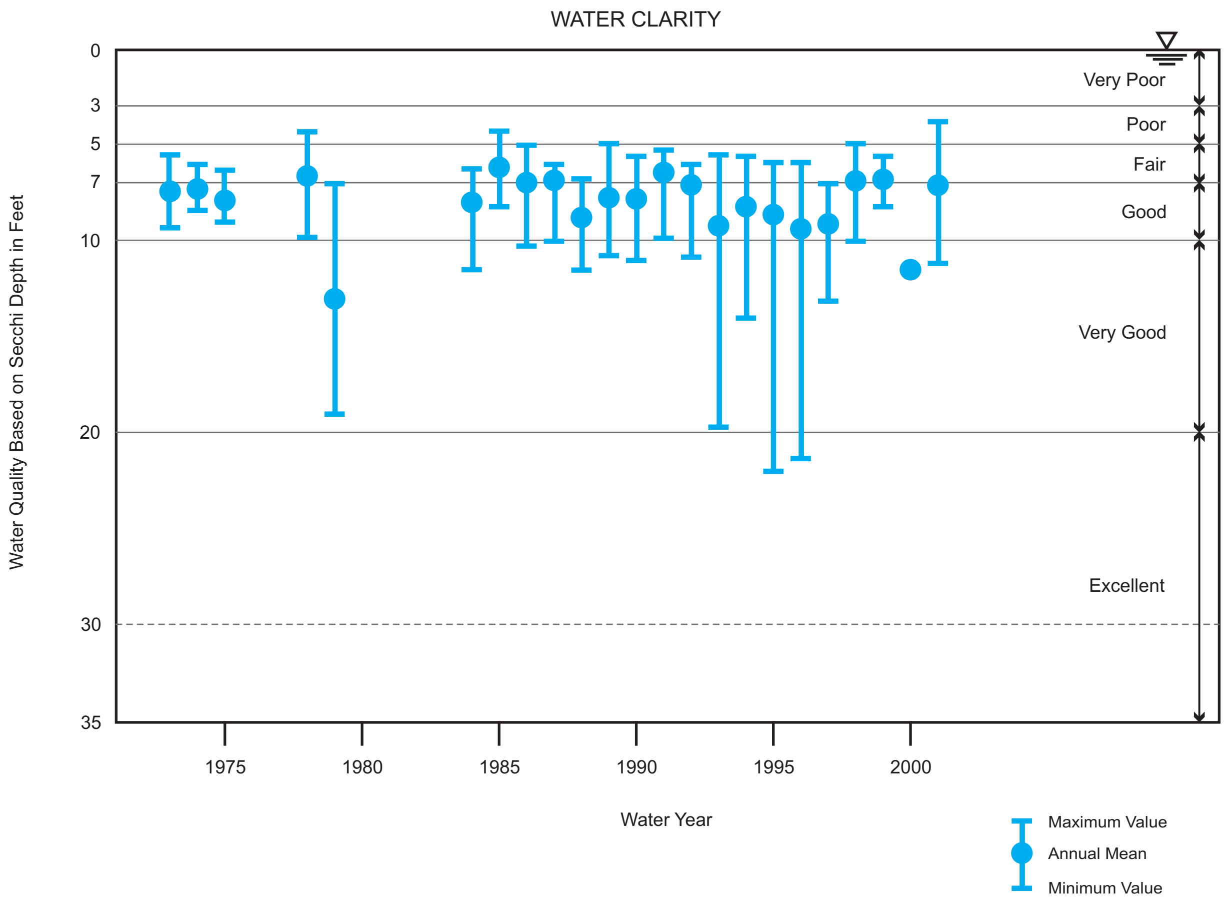


Figure 7 (continued)



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

the level considered in the regional plan as necessary to limit algae and aquatic plant growth to levels consistent with the recreational and warmwater fishery and other aquatic life water use objectives.

In Lac La Belle, during the period of 1976 through 1977, the mean concentration of total phosphorus was about 0.04 mg/l during both spring turnover and on an average annual basis. Most recently, during 2001 through 2003, the mean total phosphorus concentration was about 0.018 mg/l on an annual average basis. Total phosphorus concentrations were found to be higher in the bottom waters, ranging from about 0.02 to 0.15 mg/l, during the initial planning period, and from about 0.01 mg/l to 0.06 mg/l, during the current study period. The average bottom water total concentration in Lac La Belle during the 1976-1977 study period was about 0.023 mg/l, and about 0.024 mg/l during the 2001 through 2003 study period. Throughout both study periods, total spring phosphorus in the surface waters of Lac La Belle generally averaged 0.016 mg/l, indicating good water quality.

During 1976-1977, dissolved phosphorus concentrations ranged from 0.009 mg/l to 0.027 mg/l in the surface waters, and from 0.005 mg/l to 0.021 mg/l in the hypolimnion during periods of summer stratification. During 2001 to 2003, these same concentrations ranged from less than 0.002 mg/l to 0.004 mg/l in the surface waters of the Lake.

The seasonal gradients in phosphorus concentrations between the epilimnion and the hypolimnion reflect the biogeochemistry of this growth element. When aquatic organisms die, they usually sink to the bottom of the lake, where they are decomposed. Phosphorus from these organisms is then either stored in the bottom sediments or re-released into the water column. Because phosphorus is not highly soluble in water, it readily forms insoluble

Table 13

TOTAL NITROGEN: TOTAL PHOSPHORUS RATIO FOR LAC LA BELLE: 1976-2002

Sampling Date	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen: Total Phosphorus Ratio
05/17/76	1.15	0.050	23.0
06/02/76	1.12	0.050	22.4
06/17/76	0.96	0.040	24.0
07/01/76	1.04	0.030	34.7
07/14/76	1.12	0.020	56.0
07/28/76	0.83	0.030	27.7
08/11/76	0.97	0.030	32.3
08/26/76	1.02	0.040	25.5
09/13/76	0.93	0.030	31.0
09/23/76	0.90	0.040	22.5
10/22/76	1.09	0.040	27.3
12/07/76	1.11	0.030	37.0
12/22/76	0.89	0.030	29.7
01/18/77	0.65	0.030	21.7
02/17/77	0.59	0.030	19.7
03/31/77	0.40	0.020	20.0
04/14/77	0.39	0.020	19.5
04/26/01	1.39	0.015	92.7
04/11/02	1.30	0.016	81.2

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

precipitates with calcium, iron, and aluminum under aerobic conditions and accumulates, predominantly, in the lake sediments. If the bottom waters become depleted of oxygen during stratification, certain chemical changes occur, especially the change in the oxidation state of iron from soluble $Fe3+$ state to the more soluble $Fe2+$ state. The effect of these chemical changes is that phosphorus becomes soluble and is more readily released from the sediments. This process also occurs under aerobic conditions, but generally at slower rates than under anaerobic conditions. As the waters mix, this phosphorus may be dispersed widely throughout the waterbody and become available for algal growth.

The data indicate that there is some potential for internal loading of phosphorus from the bottom sediments of Lac La Belle, although in recent years the low gradient between surface water and bottom water total phosphorus concentrations observed in the Lake would suggest that this potential is minimal. The dissolved phosphorus concentrations in the bottom waters during 1976-1977 ranged from about 0.012 mg/l to 0.060 mg/l for samples collected during the summer when such releases of phosphorus are most likely to occur. In recent years, the surface to bottom gradient in total phosphorus concentrations ranged from about 0.013 mg/l to 0.028 mg/l. The magnitude of this release and its concomitant effects in contributing to algal growth in the surface waters of the Lake may be moderated by a number of circumstances, including the rate of mixing during the spring and fall overturn events. Given the relatively small surface-to-bottom gradients in total phosphorus concentration, the contribution of phosphorus from the bottom waters of Lac La Belle could be considered minimal in terms of the total phosphorus load, and is not considered further.

POLLUTION LOADINGS AND SOURCES

Pollutant loadings 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 drainage lakes, like Lac La Belle, pollutant loadings transported across the land surface directly tributary to a lake, in the absences of identifiable or point source discharges from industries or wastewater treatment facilities, comprise the principal route by which contaminants enter a waterbody.[18] Currently there are no significant point source discharges of pollutants to Lac La Belle or to the surface waters tributary to Lac La Belle. For this reason, the discussion that follows is based upon nonpoint source pollutant loadings to Lac La Belle.

[18]*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.*

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, nonpoint source phosphorus, suspended solids, and urban-derived metals. The inputs to, and outputs from, Lac La Belle of representative nonpoint source contaminant loads were estimated using the Wisconsin Lake Model Spreadsheet (WILMS version 3.0) for phosphorus and unit area loading (UAL)-based models for suspended solids and urban-derived metals developed for use within the Southeastern Wisconsin Region. These estimates are contrasted with the nutrient and sediment load estimates set forth in the adopted lake management plan, which were based upon measured values of runoff, atmospheric fallout and washout from the drainage basin, groundwater inflow and outflow, and flow through the lake outlet. Inputs to the Lake were calculated from flow and water quality data collected at the Oconomowoc River and Rosenow Creek. Outputs were based on flow and water quality data collected at the Lake outlet. Ranges and mean values for water quality parameters measured at these sites are set forth in Table 14. Atmospheric contributions of nitrogen, phosphorus, and suspended solids were calculated based on precipitation records and literature values which are considered representative of these different constituents for the Lac La Belle region.[19]

Phosphorus Loadings

Phosphorus has been identified as the factor generally limiting aquatic plant growth in Lac La Belle. Thus, excessive levels of phosphorus in the Lake are likely to result in conditions that interfere with the desired use of the Lake. During the initial study, existing 1975 and forecast year 2000 phosphorus sources to the Lake were identified and quantified using Southeastern Wisconsin Regional Planning Commission (Commission) 1975 land use inventory data; Commission planned year 2000 land use data, derived from the adopted regional land use plan; and the Commission water quality simulation model.

Table 15 sets forth the estimated phosphorus loads to Lac La Belle under existing 1975 conditions. It was estimated, that, under the then-existing 1975 conditions, the total phosphorus load to Lac La Belle was about 6,475 pounds. Of this total, about 1,540 pounds, or 24 percent, were estimated to be contributed by runoff from livestock operations. In addition, the Oconomowoc River was estimated to have contributed 3,000 pounds, or 46 percent of the total phosphorus load. Malfunctioning septic tank systems were estimated to have contributed a further 175 pounds, or about 3 percent of the total phosphorus load to the Lake. The remaining land uses in the area directly tributary to Lac La Belle—urban land cover, construction activities, rural land cover, and atmospheric contributions—were estimated to have contributed another 1,760 pounds, or 27 percent of the phosphorus load to the Lake.

During the 1976-1977 study period, the total phosphorus load to the Lake, set forth in Table 16, was estimated to be 4,200 pounds. Of this load, it was estimated that 17 percent of the phosphorus entered the Lake from the direct drainage area; 61 percent from the Oconomowoc River; and 22 percent from the atmosphere through direct deposition onto the Lake surface. Of the total mass of phosphorus entering Lac La Belle, about 42 percent of the phosphorus was estimated to have remained in the Lake.

Without the implementation of remedial measures, the Commission estimated that, under year 2000 conditions, the total phosphorus load to the Lake would increase to approximately 7,110 pounds per year, or by about 10 percent over the estimated 1975 loadings. However, changes in land usage have occurred, and some remedial measures have been implemented, throughout the area tributary to Lac la Belle, as noted in Chapter III of this report. Consequently, changes in the nutrient, sediment and metal loadings to Lac La Belle may be anticipated. The WILMS and unit area loading models were used to evaluate the potential impacts of these changes on

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[19]*J.W. Kluesner,* Nutrient Transport and Transformation in Lake Wingra, Wisconsin*, Ph.D. Thesis, University of Wisconsin at Madison, 1972; T.J. Hurphy and P.V. Doskey, "Inputs of Phosphorus From Precipitation to Lake Michigan,"* Journal of Great Lakes Research*, Volume 2, No. 1, 1976, pp. 66-70.*

Table 14

WATER QUALITY VALUES FOR LAC LA BELLE INLET STREAMS, OUTLET, AND GROUNDWATER: 1976-1977

Chemical Parameters[a]	L-4 Oconomowoc River Inlet		L-5 Rosenow Creek Inlet		L-6 Golf Course Creek Inlet	
	Range	Mean[b]	Range	Mean[b]	Range	Mean[b]
Nitrite+Nitrate Nitrogen	0.002-0.209	0.075 (22)	0.461-7.728	3.089 (23)	1.376-11.792	6.910 (5)
Ammonia Nitrogen	0.03-0.15	0.06 (22)	0.03-0.29	0.05 (23)	0.04-0.10	0.05 (5)
Organic Nitrogen	0.22-1.09	0.57 (22)	0.06-1.74	0.56 (23)	1.78-2.47	2.14 (5)
Total Nitrogen	0.32-1.23	0.703 (22)	1.58-8.07	3.68 (23)	3.19-14.29	9.10 (5)
Reactive Phosphorus	0.007-0.071	0.20 (22)	0.004-0.246	0.054 (22)	0.032-0.370	0.088 (5)
Total Phosphorus	0.01-0.42	0.06 (22)	0.01-0.41	0.09 (22)	0.07-0.53	0.16 (5)
Chloride	14-22	17 (16)	14-35	21 (17)	16-31	28 (4)
Total Suspended Solids	0-26.33	5.0 (14)	0.01-20.67	6.6 (16)	3.2-7.2	4.5 (4)
Conductivity (micromhos/cml)	386-533	425 (16)	437-708	632 (17)	403-837	715 (4)
pH (standard units)	7.7-8.5	- -	7.6-8.1	- -	7.5-7.6	- -
Calcium	- -	- -	- -	- -	- -	- -
Magnesium	- -	- -	- -	- -	- -	- -
Sodium	- -	- -	- -	- -	- -	- -
Potassium	- -	- -	- -	- -	- -	- -
Iron	- -	- -	- -	- -	- -	- -
Manganese	- -	- -	- -	- -	- -	- -
Sulfate	- -	- -	- -	- -	- -	- -
Total Alkalinity	- -	- -	- -	- -	- -	- -

Chemical Parameters[a]	L-7 Unnamed Stream Inlet		L-8 Oconomowoc River Outlet		Groundwater	
	Range	Mean[b]	Range	Mean[b]	Range	Mean[b]
Nitrite+Nitrate Nitrogen	0.182-8.151	3.152 (6)	0.017-0.273	0.132 (22)	- -	- -
Ammonia Nitrogen	0.04-0.12	0.05 (6)	0.04-0.14	0.06 (22)	- -	- -
Organic Nitrogen	1.23-2.23	1.66 (6)	0.38-0.90	0.63 (22)	- -	- -
Total Nitrogen	1.47-10.42	4.85 (6)	0.51-1.13	0.18 (22)	0.053-9.250	2.246 (16)
Reactive Phosphorus	0.026-0.246	0.059 (6)	0.013-0.065	0.021 (22)	- -	- -
Total Phosphorus	0.02-0.44	0.10 (6)	0.02-0.13	0.04 (22)	0.01-0.61	0.117 (16)
Chloride	10-22	13 (5)	15-22	18 (16)	22-560	161 (18)
Total Suspended Solids	0.8-3.6	2.6 (4)	0.33-10.0	4.1 915)	- -	- -
Conductivity (micromhos/cml)	418-669	559 (5)	429-555	471 (16)	459-2,552	1,166 (18)
pH (standard units)	7.5-7.7	- -	7.7-8.3	- -	7.4-8.1	- -
Calcium	- -	- -	- -	- -	55-114	91 (13)
Magnesium	- -	- -	- -	- -	25-63	45 (13)
Sodium	- -	- -	- -	- -	7-153	55 (13)
Potassium	- -	- -	- -	- -	0.7-6.5	3.4 (13)
Iron	- -	- -	- -	- -	0.06-5.03	1.36 (13)
Manganese	- -	- -	- -	- -	0.03-0.72	0.34 (13)
Sulfate	- -	- -	- -	- -	10-26	19 (3)
Total Alkalinity	- -	- -	- -	- -	166-460	346 (18)

[a]*All values in mg/l, unless otherwise specified.*

[b]*Number of samples in parentheses.*

Source: Wisconsin Department of Natural Resources.

forecast nutrient, sediment, and metal loads to Lac La Belle.[20] The refined nutrient, sediment, and metal loads, based upon current 2000 land use and planned 2020 land use, are set forth in Tables 17 and 18, respectively.

[20]*The WILMS model is described in: 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*, October 2003.*

Table 15

ESTIMATED TOTAL PHOSPHORUS LOADS TO LAC LA BELLE: 1975 AND 2000

Source	Existing 1975		Forecast 2000	
	Pounds	Percentage	Pounds[a]	Percentage[a]
Urban				
Urban Lands	296	4.6	365	8.4
Land Under Development and Construction Activities	570	8.8	570	13.1
Onsite Sewage Disposal Systems[b]	174	2.7	32	0.7
Subtotal	1,040	16.1	967	22.2
Rural				
Rural Lands	337	5.2	295	6.8
Livestock (animal units)[c]	1,540	23.8	1,540	35.3
Atmospheric contribution to receiving surface water[d]	558	8.6	558	12.8
Subtotal	2,435	37.6	2,393	54.9
Oconomowoc River	3,000	46.3	1,000	22.9
Total	6,475	100.0	4,360	100.0

[a]*Assumes provision of sanitary server service as recommended in the regional water quality management plan, assumes no nonpoint source control.*

[b]*Includes only those systems on soils having severe or very severe limitations for disposal of septic tank effluent.*

[c]*An animal unit is the equivalent in waste production of a 1,000 pound dairy cow.*

[d]*Includes the surface area of Lac La Belle.*

Source: SEWRPC.

The estimated phosphorus budget for Lac La Belle under existing 2000 land use conditions is shown in Table 17. An annual total phosphorus load of between about 3,000 pounds and 11,800 pounds per year was estimated to be contributed to Lac La Belle. Within this range of loadings, the lower value was considered to be the most likely annual total phosphorus load, based upon concurrence with observed, in-lake total phosphorus concentrations. About 2,000 pounds per year, or about two-thirds of the total loading, was estimated to be contributed by runoff from rural lands, while about 1,000 pounds per year, or about one-third of the total phosphorus load, was estimated to have been contributed from urban lands.

Phosphorus release from the lake bottom sediments, internal loading, may also contribute phosphorus to the Lake. However, this loading was assumed to be negligible given good agreement between predicted and observed phosphorus concentrations. It is likely that overturn events generally occur at rates such that little of the hypolimnetic phosphorus is mixed into the epilimnion of the Lake, i.e., at rates on the order of days versus hours.[21]

Under buildout conditions, as set forth in the Waukesha County development plan and adopted regional land use plan, the annual total phosphorus load to the Lake is anticipated to continue to remain relatively unchanged as agricultural activities within the total area tributary to Lac La Belle 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 3,280 pounds of phosphorus, relatively equally distributed between rural and urban lands. While a reduction in nutrient

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[21]*See, for example, R.D. Robarts, P.J. Ashton, J.A. Thornton, H.J. Taussig, and L.M. Sephton, "Overturn in a hypertrophic, warm, monomictic impoundment (Hartbeespoort Dam, South Africa)," Hydrobiologia, Volume 97, 1982, pp. 209-224.*

Table 16

ANNUAL LOADING BUDGETS TO LAC LA BELLE FOR NITROGEN, PHOSPHORUS, AND SEDIMENT BASED ON MEASURED DATA: 1976-1977

Source[a]	Nitrogen		Phosphorus		Sediment	
	Amount (pounds)	Total Input (percent)	Amount (pounds)	Total Input (percent)	Amount (pounds)	Total Input (percent)
Inputs						
Oconomowoc River	52,411	44.0	2,542	61.0	349,589	74.0
Direct Tributary Drainage Area						
Rosenow Creek	32,798	28.0	552	13.0	61,100	13.0
Other Direct Drainage	12,045	10.0	170	4.0	11,645	3.0
Atmospheric Contributions	21,420	18.0	933	22.0	49,703	11.0
Total	118,674	100.0	4,197	100.0	472,037	100.0
Outputs						
Outlet	65,805	56.0	2,454	58.0	307,636	65.0
Net Deposition into Bottom Sediments	52,869	45.0	1,743	42.0	164,401	35.0
Total	118,674	100.0	4,197	100.0	472,037	100.0

[a]*Groundwater loads were not estimated.*

Source: Wisconsin Department of Natural Resources

Table 17

ESTIMATED EXTERNAL SOURCES OF PHOSPHORUS IN THE TOTAL DRAINAGE AREA TRIBUTARY TO LAC LA BELLE: 2000 AND 2020

Source	2000		2020	
	Pounds[a]	Percentage[a]	Pounds[a]	Percentage[a]
Urban				
High-Density (commercial and industrial uses and multi-family residential uses)	618	14.0	945	22.0
Low-Density (single-family and suburban-density residential uses)	436	10.0	671	17.0
Recreational Lands	16	1.0	21	1.0
Subtotal	1,070	25.0	1,637	40.0
Rural				
Mixed Agriculture	1,660	66.0	1,307	54.0
Row Crop Agriculture	18	1.0	26	1.0
Wetlands	133	2.0	133	2.0
Woodlands	68	2.0	68	2.0
Water	106	5.0	106	1.0
Subtotal	1,985	75.0	1,640	60.0
Total	3,055	100.0	3,277	100.0

[a]*Percentages estimated from WILMS model results.*

Source: SEWRPC.

loads from agricultural lands may be anticipated as agricultural lands are converted to urban land uses, studies within the Southeastern Wisconsin Region indicate that urban residential lands, fertilized with a phosphorus-based fertilizers, can contribute up to two times more dissolved phosphorus to a lake than lawns fertilized with a phosphorus-free fertilizer or not fertilized at all.[22]

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

Table 18

ESTIMATED CONTAMINANT LOADS FROM THE TOTAL DRAINAGE AREA TRIBUTARY TO LAC LA BELLE: 2000 AND 2020

Land Use	2000 Area (acres)	Sediment[a] (pounds)	Copper[a] (pounds)	Zinc[a] (pounds)	Cadmium[a] (pounds)
Residential	7,926	9,600	0.0	19.8	0.0
Commercial	310	15,000	17.0	115.5	0.8
Industrial	92	4,400	5.1	34.3	0.2
Transportation, Communications, and Utilities	2,732	18,800	0.2	587.4	6.8
Governmental	232	7,400	4.1	46.4	0.0
Recreational	883	1,400	0.0	0.0	0.0
Water	5,297[b]	68,000	0.0	0.0	0.0
Extractive	196	5,600	0.0	0.0	0.0
Wetlands	7,721	1,600	0.0	0.0	0.0
Woodlands	7,380	1,600	0.0	0.0	0.0
Agricultural	30,143	847,800	0.0	0.0	0.0
Total	62,912[b]	981,200	26.4	803.4	7.8

Land Use	2020 Area (acres)	Sediment[a] (pounds)	Copper[a] (pounds)	Zinc[a] (pounds)	Cadmium[a] (pounds)
Residential	12,178	14,800	0.0	30.5	0.0
Commercial	423	21,000	23.3	170.2	1.1
Industrial	331	15,600	18.2	123.3	0.8
Transportation, Communications, and Utilities	3,949	27,000	0.2	849.0	9.9
Governmental	447	14,200	7.8	89.4	0.0
Recreational	1,162	1,800	0.0	0.0	0.0
Water	5,297[b]	68,000	0.0	0.0	0.0
Extractive	285	8,000	0.0	0.0	0.0
Wetlands	7,271	1,600	0.0	0.0	0.0
Woodlands	7,380	1,600	0.0	0.0	0.0
Agricultural	23,739	667,600	0.0	0.0	0.0
Total	62,912[b]	841,200	49.5	1,262.4	11.8

[a]*Values corrected for retention in upstream lakes.*

[b]*Excludes the surface area of Lac La Belle.*

Source: SEWRPC.

Nitrogen Loadings

During the 1976-1977 study period, measured concentrations were used to develop an annual budget for nitrogen, as show in Table 16. As noted above, inputs and outputs to the Lake were calculated from flow and water quality data collected at Oconomowoc River, Rosenow Creek, and the Lake outlet, as set forth in Table 14, and atmospheric contributions of nitrogen were calculated based on precipitation records and literature values for nitrogen deposition for the Lac La Belle region.[23] During that study period, it was estimated that 118,700 pounds of nitrogen entered Lac La Belle. About 38 percent of the nitrogen load entered the Lake from the direct drainage area; about 44 percent from the Oconomowoc River; and about 18 percent from atmospheric contributions. Of the total mass of the nutrient entering Lac La Belle, about 45 percent, or about 52,900 pounds of nitrogen, was estimated to have remained in the Lake.

[23]*J.W. Kluesner,* op. cit.*; T.J. Hurphy and P.V. Doskey,* op. cit.

Sediment Loadings
During the 1976-1977 study period, measured concentrations were used to develop an annual budget for sediment, as shown in Table 16. As noted above, inputs and outputs to the Lake were calculated from flow and water quality data summarized in Table 14, and atmospheric contributions of nitrogen were calculated based on precipitation and literature values for sediment deposition. During that study period, it was estimated that 236 tons of sediment entered Lac La Belle. About 16 percent of the annual sediment load entered the Lake from direct drainage area; 74 percent from the Oconomowoc River; and about 11 percent from atmospheric contributions. Of the total mass of sediment entering Lac La Belle, about 35 percent was estimated to have remained in the Lake.

The estimated sediment budget for Lac La Belle under existing 2000 land use conditions is shown in Table 18. A total annual sediment loading of about 981,200 pounds of sediment was estimated to be contributed to Lac La Belle. Of the likely annual sediment load, it was estimated that 860,000 pounds per year, or about 87 percent of the total load, were contributed by runoff from rural lands, 62,000 pounds from urban lands, and 68,000 pounds by direct precipitation onto the lake surface. Of the sediment load generated from rural land uses, almost all the load, or about 99 percent, was indicated as being of agricultural origin.

Under buildout conditions, as set forth in the Waukesha County development plan and adopted regional land use plan, the annual sediment load to the Lake is anticipated to decrease slightly. The forecast annual sediment load from the total area tributary to the Lake under buildout conditions is estimated to be 841,200 pounds. About 670,000 pounds of this sediment are estimated to be contributed from rural, primarily, agricultural sources. A further load of about 102,000 pounds of sediment per year is estimated to be contributed from urban sources, with the balance, about 68,000 pounds of sediment per year, being contributed by direct precipitation onto the lake surface.

Urban Heavy Metals Loadings
Urbanization brings with it increased use of metals and other materials that contribute pollutants to aquatic systems.[24] Table 18 sets forth the estimated loadings of copper, zinc, and cadmium likely to be contributed to Lac La Belle from urban development surrounding the Lake. The majority of these particles become associated with sediment particles[25] and are likely to be encapsulated into the bottom sediments of the Lake.

The estimated heavy metal budget for Lac La Belle under existing 2000 land use conditions is shown in Table 18. About 26 pounds of copper, 800 pounds of zinc, and eight pounds of cadmium were estimated to be contributed annually to Lac La Belle from urban lands.

Under buildout conditions, as set forth in the Waukesha County development plan and adopted regional land use plan, the annual heavy metal loads from the total area tributary to the Lake are anticipated to increase by between 50 and 90 percent, depending upon the constituent. The most likely annual loads to the Lake under buildout conditions are estimated to be 50 pounds of copper, 1,300 pounds of zinc, and 12 pounds of cadmium.

Groundwater Quality
During the 1976-1977 planning program, groundwater was monitored in nine pairs of observation wells around Lac La Belle. Groundwater concentrations of total nitrogen ranged from 0.05 mg/l to 9.25 mg/l, with a mean value of 2.25 mg/l. Total phosphorus concentrations ranged from less than 0.01 mg/l to 0.61 mg/l, with a mean value of 0.12 mg/l. One well had extremely high phosphorus readings, which influenced the high mean value for phosphorus. The groundwater quality data are summarized in Table 14.

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

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

RATING OF TROPHIC CONDITION

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. Theses 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 plants 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 algal 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 abundant fisheries.

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 is applied. In this case, two indices, appropriate for Wisconsin lakes, have been used; namely, the Vollenweider-OECD open-boundary trophic classification system,[26] and the Carlson Trophic State Index (TSI).[27] In addition, the Wisconsin Trophic State Index (WTSI) is presented.[28] The WTSI is refinement of the Carlson TSI designated to account for the greater humic acid content, brown water color, present in Wisconsin lakes, and has been adopted by the Wisconsin Department of Natural Resources for use in lake management investigations.

Vollenweider Trophic State Classification

Using the Vollenweider trophic system and applying the data in Table 11, Lac La Belle would be classified as having about a 50 percent probability of being oligotrophic or mesotrophic based upon phosphorus levels, as shown in Figure 8. The Lake would have less than a 5 percent probability of being either ultra-oligotrophic or eutrophic, based upon mean annual phosphorus concentrations. Based upon chlorophyll-*a* levels, the Lake would be classified as having about a 50 percent probability of being mesotrophic, with about a 40 percent probability of being oligotrophic, and about a 10 percent probability of being either ultra-oligotrophic or eutrophic, as shown in Figure 8. Based upon Secchi-disc readings, the Lake would be classified as having about a 55 percent probability of being eutrophic, with about a 20 percent probability of being either mesotrophic or hypertrophic, and a

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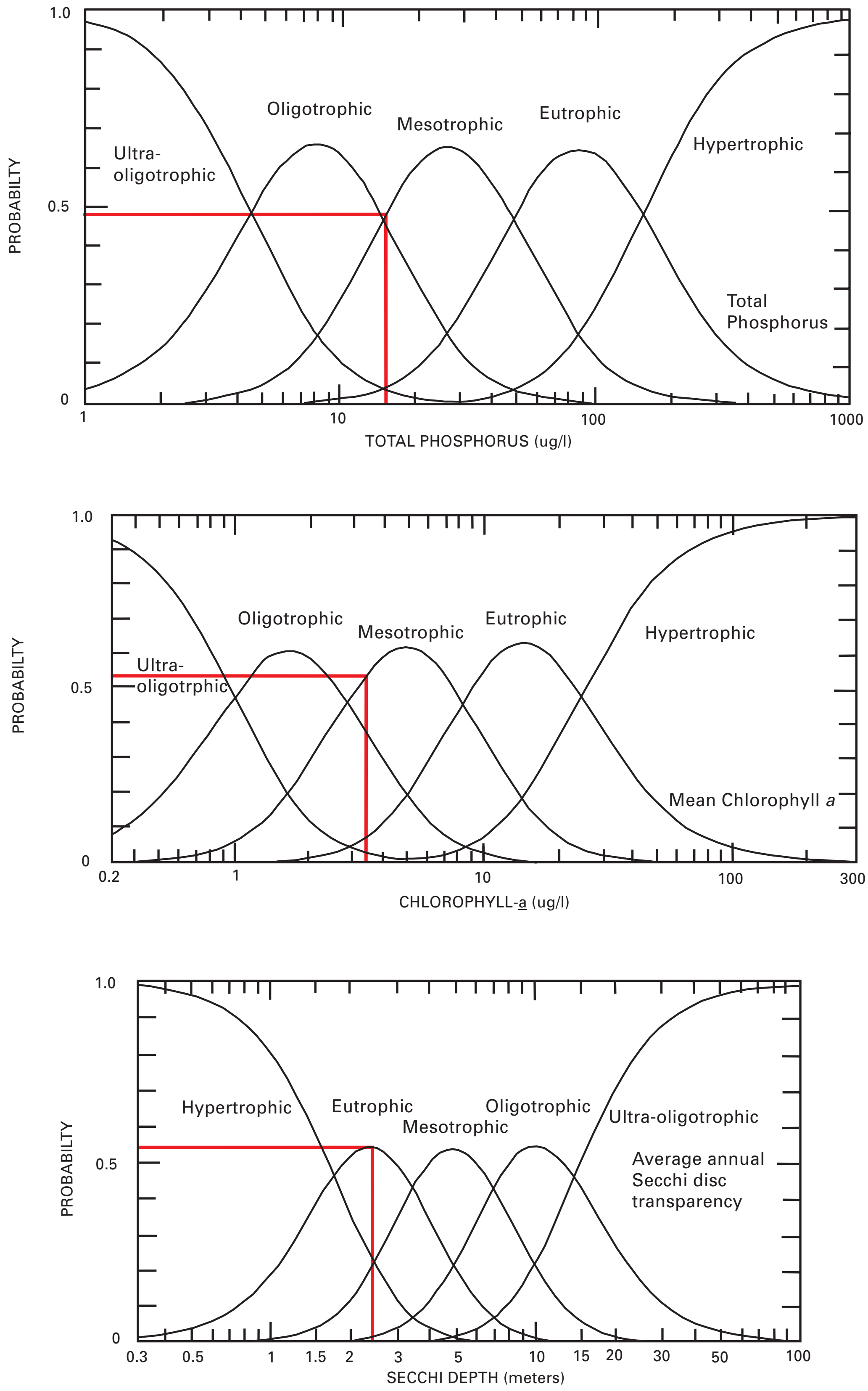
[26] *Organization for Economic Cooperation and Development (OECD),* Eutrophication of Waters: Monitoring, Assessment and Control*, Paris, 1982; see also H. Olem and G. Flock, U.S. Environmental Protection Agency Report EPA-440/4-90-006,* The Lake and Reservoir Restoration Guidance Manual, Second Edition*, Washington, D.C., August 1990.*

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

[28] *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.*

Figure 8

TROPHIC STATE CLASSIFICATION OF LAC LA BELLE BASED UPON THE VOLLENWEIDER MODEL: 2001



Source: U.S. Geological Survey and SEWRPC.

5 percent probability of being either oligotrophic, as shown in Figure 8. While these indicators result in slightly differing lake trophic state classifications, it may be concluded that Lac La Belle should be classified as an oligo-mesotrophic lake, or a lake with very good water quality for most uses.

Trophic State Index

The Trophic State Index (TSI) assigns a numerical trophic condition rating based on Secchi-disc transparency, and total phosphorus and chlorophyll-*a* concentrations. The original Trophic State Index developed by Carlson, has been modified for Wisconsin lakes by the Wisconsin Department of Natural Resources using data on 184 lakes throughout the State.[29] The Wisconsin Trophic State Index (WTSI) adjusts the Carlson TSI value to account for the humic coloration present in Wisconsin waters. The presence of these colored organic substances was noted to artificially increase the Carlson TSI value, and hence suggest that a Wisconsin lake was more severely enriched than was actually the case, based upon other indicators. The WTSI ratings for Lac La Belle are shown in Figure 9 a as function of sampling date. Based upon the Wisconsin Trophic State Index rating of between 35 and 55, Lac La Belle may be classified as oglio-mesotrophic. Figure 9 also suggests that lake trophic status has remained relatively stable between 1984 and 2003.

SUMMARY

Lac La Belle is a hard-water, alkaline lake that is considered to have relatively good water quality. Physical and chemical parameters measured during the study period indicate that the water quality was within the “fair” to “good” range, depending upon the parameters considered. Total phosphorus levels are generally at the level considered to cause few nuisance algal and macrophytic growths. Summer stratification is commonly observed in Lac La Belle. The surface waters of the Lake remain well oxygenated and support a healthy fish population. Winterkill is not considered to be a problem in Lac La Belle. Internal releases of phosphorus from the bottom sediments also are not considered to be a problem in Lac La Belle.

There were no significant point sources of pollutants in the Lac La Belle tributary area. Nonpoint sources of pollution included stormwater runoff from urban and agricultural areas. In 2000, the annual total phosphorus load to Lac La Belle was estimated to be 3,000 pounds, and that loading rate was expected to remain relatively static during the planning period through the year 2020. However, the sources of the nonpoint source phosphorus load will shift from largely agricultural lands to a condition in which urban and rural lands are anticipated to contribute approximately equal masses of phosphorus to Lac La Belle.

About one-half of the total phosphorus load to Lac La Belle is expected to be retained within the lake basin, either as biomass or through sedimentation.

Based upon the Vollenweider-OECD phosphorus loading model, and the Wisconsin Trophic State Index ratings for Lac La Belle, the Lake is likely to be classified as oligo-mesotrophic

[29]Ibid.

Figure 9

WISCONSIN TROPHIC STATE INDEX FOR LAC LA BELLE: 1973-2001

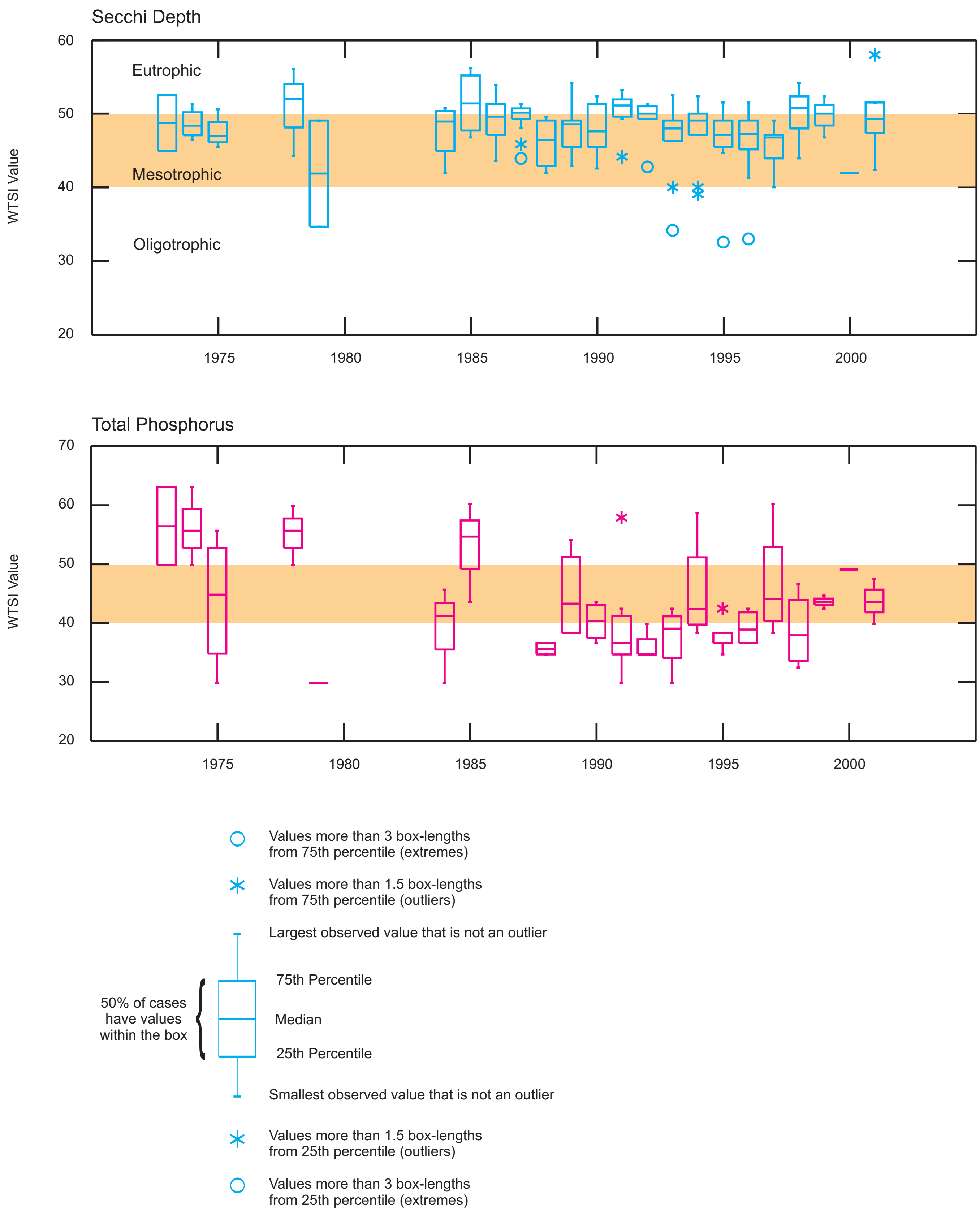
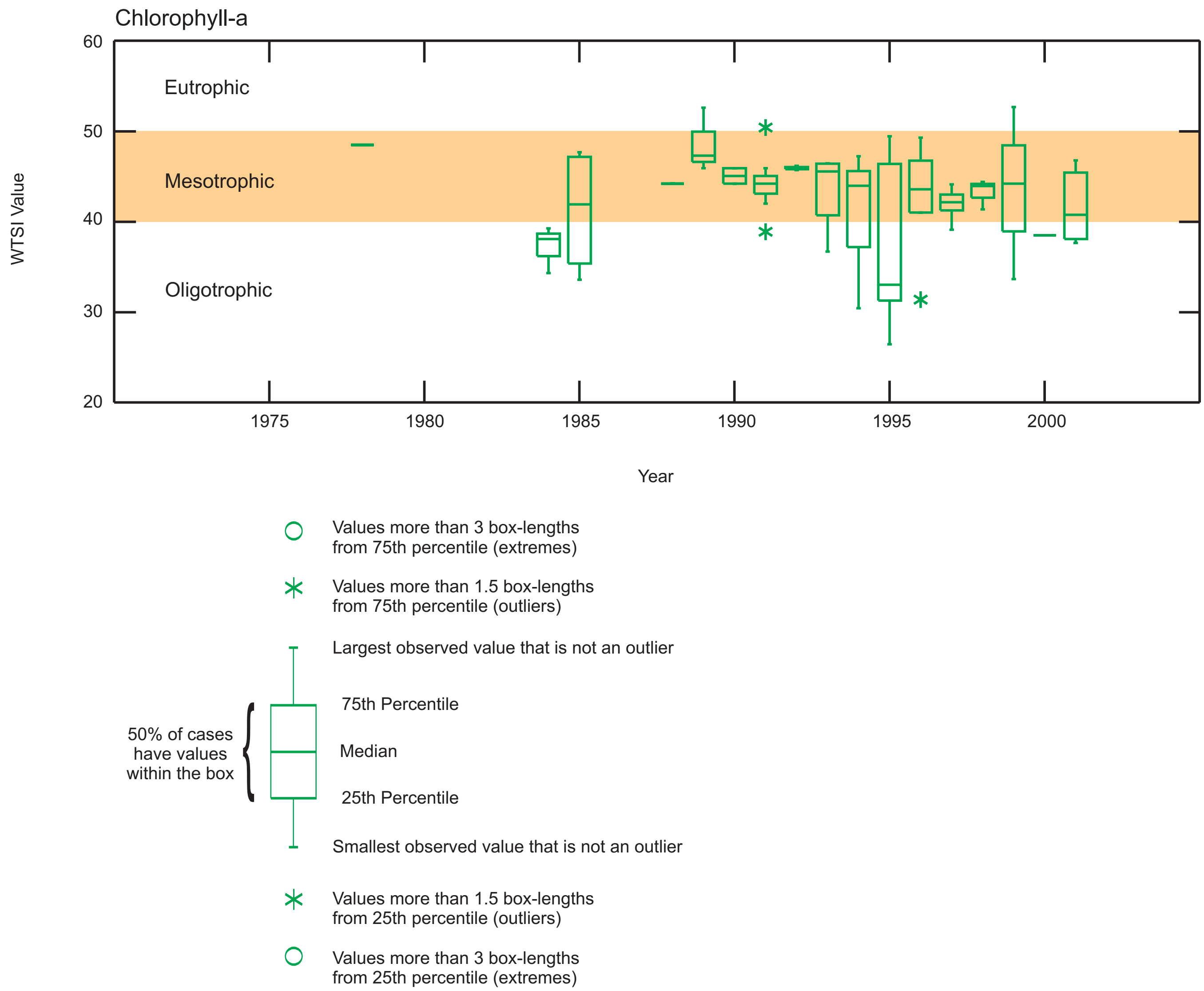


Figure 9 (continued)



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

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Chapter V

AQUATIC BIOTA AND ECOLOGICALLY VALUABLE AREAS

INTRODUCTION

Lac La Belle is an important element of the natural resource base of the City and Town of Oconomowoc and the Village of Lac La Belle. The Lake, its biota, and the adjacent park and residential lands combine to contribute to the quality of life in the area. When located in urban settings, resource features, such as lakes and wetlands, are typically subject to extensive recreational use and high levels of pollutant discharges, common forms of stress to aquatic systems, and these stresses may result in the deterioration of these natural resource features. For this reason, the formulation of sound management strategies must be based on a thorough knowledge of the pertinent characteristics of the individual resource features, as well as of the urban development in the area concerned. Accordingly, this chapter provides information concerning the natural resource features of the Lac La Belle watershed, including data on aquatic plants, fish, wildlife, wetlands and woodlands, and environmental corridors. Recreational activities are described and quantified in Chapter VI of this report.

AQUATIC PLANTS

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

To document the types, distribution, and relative abundance of aquatic macrophytes and phytoplankton in Lac La Belle, a number of surveys were conducted as part of the initial planning program and the current planning effort.

Aquatic plant surveys were conducted by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) staff during the summer of 1976 and the summer of 2001. Additional data on aquatic plant communities were collected during the summer of 1983.[1] Phytoplankton populations were sampled only during the 1976 survey. ese data are summarized below.

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[1]*Timothy Lowry and Patrick Sorge,* A Survey of the Aquatic Plants in Lac La Belle Waukesha County, Wisconsin, *October 17, 1983.*

Phytoplankton
Phytoplankton, or algae, are small, generally microscopic plants that are found in all lakes and streams. They occur in a wide variety of forms, as single-cells or in colonies, and can be either attached or free-floating. Phytoplankton abundance varies seasonally with fluctuations in solar irradiance, turbulence due to prevailing winds, and nutrient availability.

The major groups of algae include both green and blue-green algae, and diatoms. Green algae (Chlorophyta) are the most important source of food for zooplankton, or microscopic animals, in the lakes of Southeastern Wisconsin. Blue-green algae (Cyanophyta) are not ordinarily utilized by zooplankton or fish populations, and may become over-abundant and out of balance with the organisms that feed on them. Dramatic population increases or blooms of blue-green algae may occur when excessive nutrient supplies are available, optimal sunlight and temperature conditions exist, and minimal competition from other aquatic plant species and grazing zooplankton occurs. Diatoms include both single-celled organisms and filamentous, or multi-celled, plants. Many species of diatoms form important food resources for planktivorous fishes, although certain species can form blooms under appropriate conditions. However, diatoms, because of their silica-rich cell walls, tend to be well mixed into the water column and rarely form surface scums.

The concentrations and types of algae present in Lac La Belle during the initial planning project period are shown in Figures 10 and 11, respectively. Algal populations were highest during mid-August 1976. Seasonally, algal populations were greatest during the summer months, June through September 1976. Concentrations greater than 10 million cells per liter are generally considered to result in "bloom" conditions in a lake, which threshold was always exceeded during the 1976-1977 study period. The lowest populations, approximately 15 million cells per liter, occurred during February 1977. The mean chlorophyll-*a* concentration of about 4.0 µg/l and a maximum chlorophyll-*a* concentration of about 7.0 µg/l would suggest that casual observers would be unlikely to see a green tinge to the water, which coloration is considered typical of bloom situations. Chlorophyll-*a* concentrations in excess of about 10 µg/l are considered to result in such a coloration.[2]

Blue-green algae (Cyanophyta) were the dominant group of algae in Lac La Belle throughout much of the 1976-1977 study period, generally comprising over 90 percent of the total numbers of algae in the Lake from June through October 1976 and during February 1977. *Microcystis* sp. (= *Anacystis* sp.), a small spherical, bloom-forming alga that occurs as a floating film on the water, was the most numerous species present. Other dominant blue-green algae included: *Merismopedia tenuissima*, a flat, plate-like colony of round cells that occur in multiples of four; *Coelospharium naeglianum,* hollow spheres of numerous coccoid algae; *Aphanocapsa delicattisrima*, a solid sphere of hundreds of shiny, blue-green algae evenly spaced throughout the sphere; and, *Aphanazomenon* sp., a long, thread-like group of rod-shaped cells which often clump together to form flakes which resemble grass clippings floating on the water. During blooms, and the ensuing decomposition period, wind-concentrated accumulations of these algae were reported to have resulted in odors and other undesirable conditions that occasionally curtailed swimming activities in the Lake during this period.

Species other than blue-green algae which were dominant at certain times included *Fragilaria crotomensis*, dominant in May 1976 and April 1977; *Synedra radians*, dominant during April 1977; and *Stephanodiscus hantzii*, dominant during late March 1977. These three species are diatoms and are characteristically found during periods of cool water temperature and low light intensities. An increase or bloom of diatoms occurs in the spring in many lakes in the Region. During late December 1976 and January 1977, *Erkinia* sp., a yellow-green alga, was among the three most abundant species, as shown in Figure 11.

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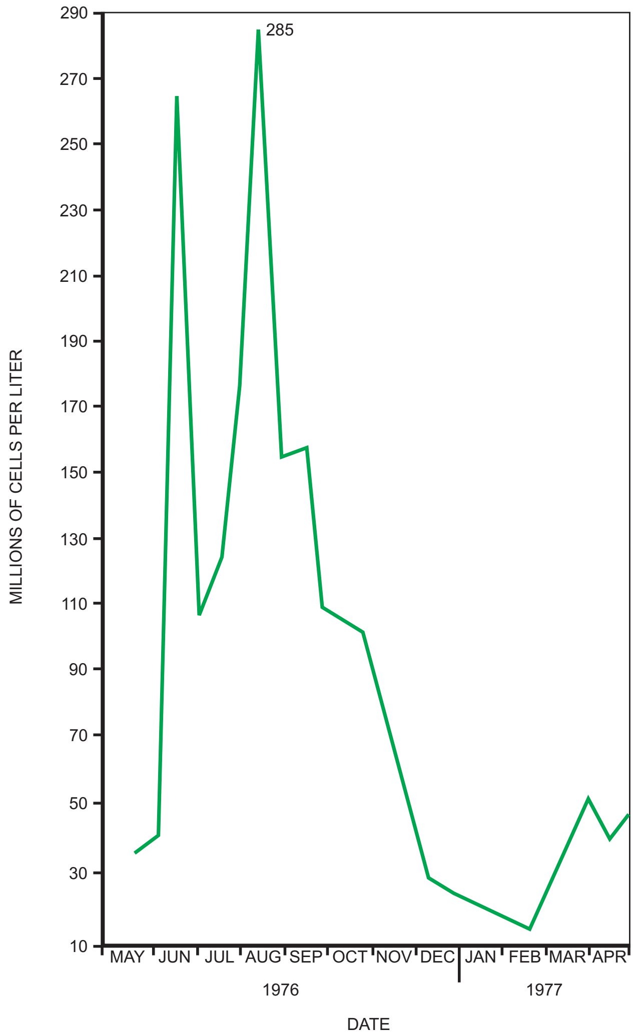
[2]*Organization for Economic Cooperation and Development (OECD),* Eutrophication of Waters: Monitoring, Assessment and Control*, Paris, 1982; J.A. Thornton, P.H. Mcmillan and P. Romanovsky, "Perceptions of Water Pollution in South Africa: Case Studies from Two Waterbodies (Hartbeespoort Dam and Zandvlei)."* South African Journal of Psychology*, Vol. 19, 1989, pp. 197-204; and J.A. Thornton and P.H. Mcmillan, "Reconciling Public Opinion and Water Quality Criteria in South Africa."* Water SA*, Vol. 1, 19895, pp. 221-226.*

Figure 10

MONTHLY ALGAL POPULATIONS IN LAC LA BELLE: 1976-1977



Source: Wisconsin Department of Natural Resources.

In recent years, as reported in Chapter IV, chlorophyll-*a* concentrations in Lac La Belle have remained relatively stable, suggesting little change in the nature and character of the algal community in the Lake. The relatively low concentrations of chlorophyll-*a*, less than 10 μg/l, suggest that few concerns are likely to exist relative to the abundance of phytoplankton and algae in the Lake.

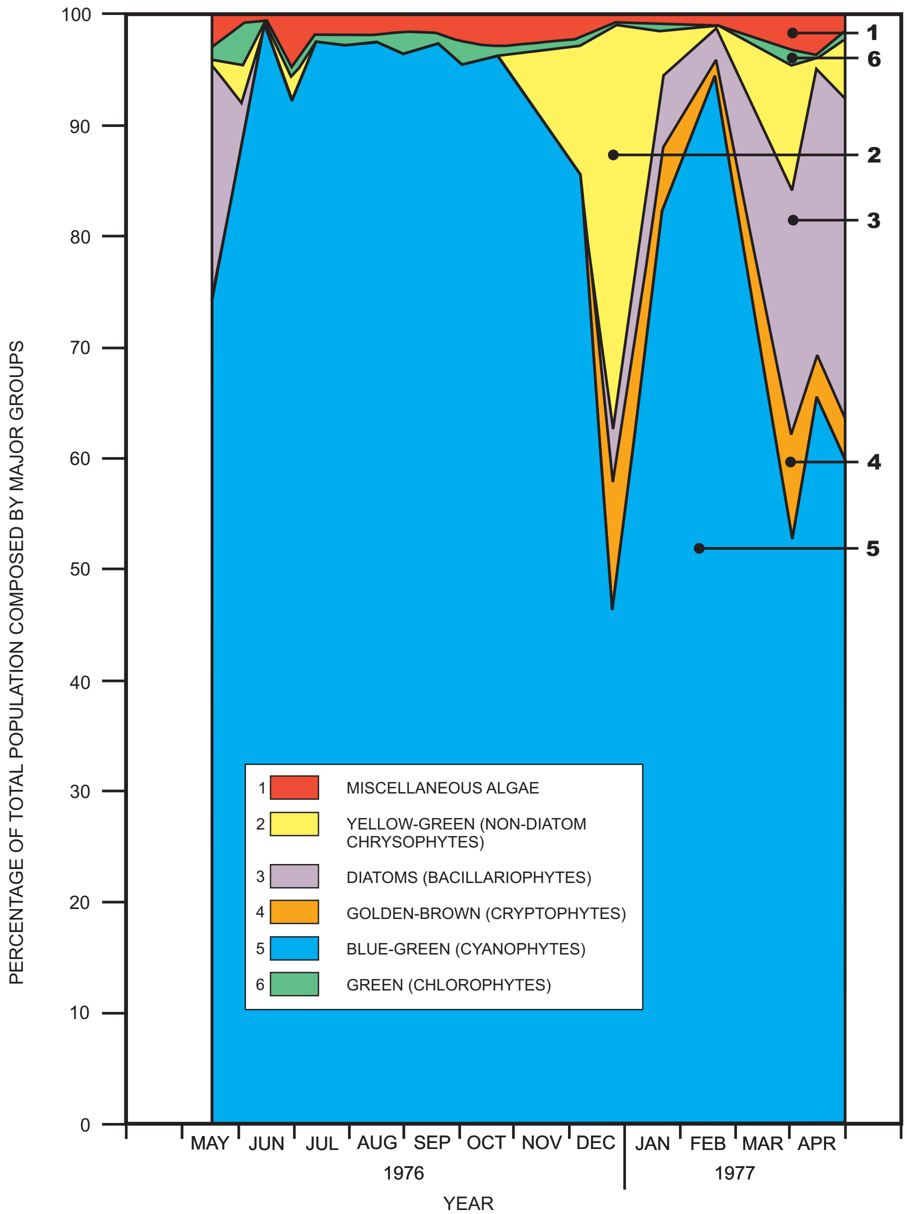
Aquatic Macrophytes

Large, or macroscopic, aquatic plants or macrophytes, including emergent species, such as rushes and cattails; floating-leaves species, such as lily pads; and submergent species, such as pondweeds, coontail, and water milfoil, play an important role in the ecology of southeastern Wisconsin lakes. Depending on their types, distribution, and abundance, they can be beneficial or a nuisance. Macrophytes growing in locations and in densities considered to be reasonable in a lake are beneficial in maintaining lake fisheries and wildlife populations and provide habitat for a variety of aquatic organisms. They also remove nutrients from the water that otherwise would contribute to excessive algal growth. Aquatic plants can become a nuisance when their densities become so great as to interfere with swimming and boating activities; when their growth forms limit habitat diversity; and when the plants reduce the aesthetic appeal of the resource. Many factors, including lake configuration, depth, water clarity, nutrient availability, bottom substrate, wave action, and type and size of fish populations present, determine the distribution and abundance of aquatic macrophytes in lakes, with most waterbodies within the Southeastern Wisconsin Region naturally supporting abundant and diverse aquatic plant communities. Illustrations of representative macrophyte species observed in Lac La Belle are set forth in Appendix A.

Early aquatic plant surveys on Lac La Belle, conducted during 1946 along the northwestern and northeastern shores of the Lake, reported 11 species of macrophytes growing in relatively shallow water. Subsequently, 13 species of emergent, floating-leaved, and submergent aquatic plants were reported during the 1976-1977 study period. The species recorded during the 1976-1977 survey are shown in Table 19. Macrophyte growth in Lac La Belle was reported to be moderate to very sparse at the time of that survey. The dominant submerged macrophyte identified during the survey was native or northern water milfoil (*Myriophyllum sibiricum* = *Myriophyllum exalbescens*). It was found in all areas of the Lake in moderate abundance. The second most frequently observed species was curly-leaf pondweed (*Potamogeton crispus*), a nonnative, invasive species from Europe. Species found in lesser densities included: Eurasian water milfoil (*Myriophyllum spicatum*), another European invader, as well as eel grass (*Vallisneria* spp.), large-leaf pondweed (*Potamogeton amplifolius*), and Sago pondweed (*Potamogeton pectinatus*). The dominant emergent species observed during the 1976-1977 survey included broadleaf cattail (*Typha latifolia*) and rushes (*Juncus* spp.). The emergent species, the rushes and cattails, were found in Areas 4, 6, and 8, in channels around Beggs Island in the northeast corner of the Lake, and along the lake outlet, as shown on Map 15. The floating-leaved species, the lotus and lily pads, were found in the more silty

Figure 11

TYPES OF ALGAE PRESENT IN LAC LA BELLE: 1976-1977



Source: Wisconsin Department of Natural Resources.

substrates near Beggs Island. *Zizania aquatica* (wild rice), a valuable emergent aquatic grass which was historically present in Lac La Belle, was observed, but not sampled.

The August 1983 survey reported only six macrophyte species in the Lake. These included Eurasian water milfoil (*Myriophyllum spicatum*), curly-leaf pondweed (*Potamogeton crispus*), yellow water lily (*Nuphar* sp.), American lotus (*Nelumbo lutea*), other pondweed species (*Potamogeton* spp.), and rushes (*Juncus* spp.).

Most recently, an aquatic plant survey was conducted by SEWRPC staff during July 2001. During this survey, 13 species of submergent aquatic plants were identified in Lac La Belle, as shown in Table 20. Eurasian water milfoil (*Myriophyllum spicatum*) was the dominant species recorded during this survey, with Sago pondweed

Table 19

AQUATIC PLANT SPECIES PRESENT IN LAC LA BELLE: 1976-1977

Area	Common Name	Scientific Name	Relative Abundance
1	Northern water milfoil Curly-leaf pondweed	*Myriophyllum exalbescens* *Potamogeton crispus*	Moderate Sparse
2	Northern water milfoil Eel grass Eurasian water milfoil[a]	*Myriophyllum exalbescens* *Vallisneria* sp. *Myriophyllum spicatum*	Moderate Very sparse Very sparse
3	Curly-leaf pondweed Northern water milfoil Large-leaf pondweed Eurasian water milfoil[a]	*Potamogeton crispus* *Myriophyllum exalbescens* *Potamogeton amplifolius* *Myriophyllum spicatum*	Sparse Moderate Very sparse Sparse
4	White water lily Yellow water lily American lotus Northern water milfoil Broad-leaved cattail Curly-leaf pondweed Large-leaf pondweed	*Nymphaea* sp. *Nuphar* sp. *Nelumbo lutea* *Myriophyllum exalbescens* *Typha latifolia* *Potamogeton crispus* *Potamogeton amplifolius*	Very sparse Sparse Sparse Moderate Sparse Very sparse Very sparse
5	Sago pondweed Water milfoil sp. Large-leaf pondweed Floating-leaf pondweed	*Potamogeton pectinatus* *Myriophyllum sp.* *Potamogeton amplifolius* *Potamogeton natans*	Very sparse Moderate Sparse Sparse
6	Curly-leaf pondweed Northern water milfoil Rush sp.	*Potamogeton crispus* *Potamogeton exalbescens* *Juncus* sp.	Sparse Moderate Very sparse
7	Northern water milfoil Curly-leaf pondweed Yellow water lily	*Myriophyllum exalbescens* *Potomogeton crispus* *Nuphar* sp.	Sparse Very sparse Very sparse
8	Northern water milfoil Curly-leaf pondweed Rush sp. Yellow water lily	*Myriophyllum exalbescens* *Potomogeton crispus* *Juncus* sp. *Nuphar* sp.	Moderate Moderate Very sparse Sparse
9	Yellow water lily Curly-leaf pondweed Northern water milfoil	*Nuphar* sp. *Potomogeton crispus* *Myriophyllum exalbescens*	Sparse Very sparse Sparse
10	Northern water milfoil Curly-leaf pondweed	*Myriophyllum exalbescens* *Potomogeton crispus*	Very sparse Very sparse

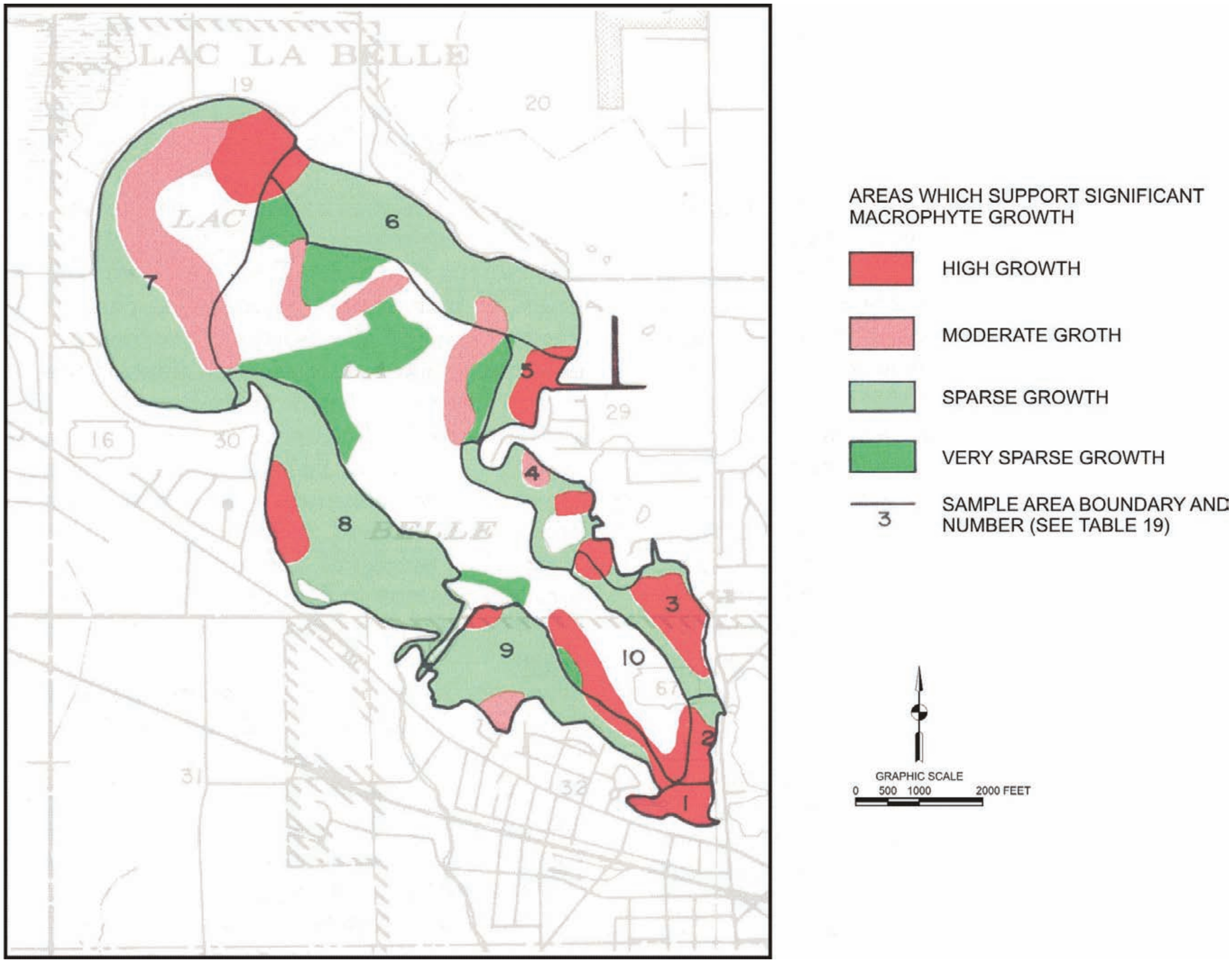
[a]*Nonnative or alien species.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

(*Potamogeton pectinatus*) and curly-leaf pondweed (*Potamogeton crispus*) also being present. Species that interfere with the recreational and aesthetic use of lakes, such as *Myriophyllum spicatum*, *Ceratophyllum demersum*, and *Potamogeton crispus*, were all found to be present in Lac La Belle. Pondweeds were most commonly found at depths of between five and 10 feet, as shown on Map 16. Eurasian water milfoil was dominant throughout the Lake, but largely confined to areas of the Lake with depths of between five and 15 feet. While certain areas of the Lake, generally embayments in the vicinities of inlets and the outlet, had more abundant aquatic plant growth than most areas of the main lake basin, aquatic plant growth throughout Lac La Belle was observed to be at very low levels compared with most lakes in southeastern Wisconsin.

Map 15

AQUATIC PLANT COMMUNITY DISTRIBUTION IN LAC LA BELLE: 1976



Source: SEWRPC.

In general, therefore, Lac La Belle can be described as supporting a sparse, if diverse, aquatic macrophyte community. Changes in the aquatic macrophyte species distribution and abundance in Lac La Belle between 1976-1977 and 2001 are summarized in Table 21, and the positive ecological values of these plants are shown in Table 22.

Aquatic Plant Management

Records of aquatic plant management efforts on Wisconsin lakes were not maintained by the Wisconsin Department of Natural Resources (WDNR) prior to 1950. Thus, the first recorded efforts to manage the aquatic plants in Lac La Belle have taken place since 1950. Aquatic plant management activities on Lac La Belle can be categorized as chemical macrophyte and algal control, and macrophyte harvesting. In addition, the Lake has been subjected to efforts to enhance the aquatic plant community of the Lake by planting aquatic plants in various portions of the Lake. Currently, all forms of aquatic plant management are subject to permitting by the WDNR pursuant to authorities granted to the WDNR under Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code*. These various aquatic plant management measures are discussed further below.

Table 20

FREQUENCY OF OCCURRENCE AND DENSITY RATINGS OF SUBMERGENT PLANT SPECIES IN LAC LA BELLE: JULY 2001

Aquatic Plant Species Present	Sites Found	Frequency of Occurrence (percent)	Relative Density	Importance Value
Chara vulgaris (muskgrass)	1	0.85	1.0	0.85
Elodea canadensis (waterweed)	2	1.70	1.0	1.70
Myriophyllum sp. (native water milfoil)	1	0.85	3.0	2.56
Myriophyllum spicatum (Eurasian water milfoil)	41	35.00	2.5	88.00
Najas flexilis (bushy pondweed)	1	0.85	1.0	0.85
Najas marina (spiny naiad)	1	0.85	1.0	0.85
Potamogeton crispus (curly-leaf pondweed)	6	5.10	1.0	5.10
Potamogeton gramineus (variable pondweed)	2	1.70	1.0	1.70
Potamogeton illinoensis (Illinois pondweed)	2	1.70	1.5	2.60
Potamogeton pectinatus (Sago pondweed)	11	9.40	1.3	12.00
Ranunculus longirostris (stiff water crowfoot)	1	0.85	1.0	0.85
Vallisneria americana (eel grass)	2	1.70	1.0	1.70
Zosterella dubia (water stargrass)	1	0.85	1.0	0.85

NOTE: There were 117 total sample sites during the July 2001 survey.

Source: SEWRPC.

Chemical Controls

Perceived excessive macrophyte growths on Lac La Belle have historically resulted in the application of chemical controls. Although the use of chemicals to control aquatic plants has been regulated in Wisconsin since 1941, records of aquatic herbicide applications have only been maintained by the WDNR since 1950. Recorded chemical herbicide treatments that have been applied to Lac La Belle from 1950 through 1978 are set forth in Table 23.

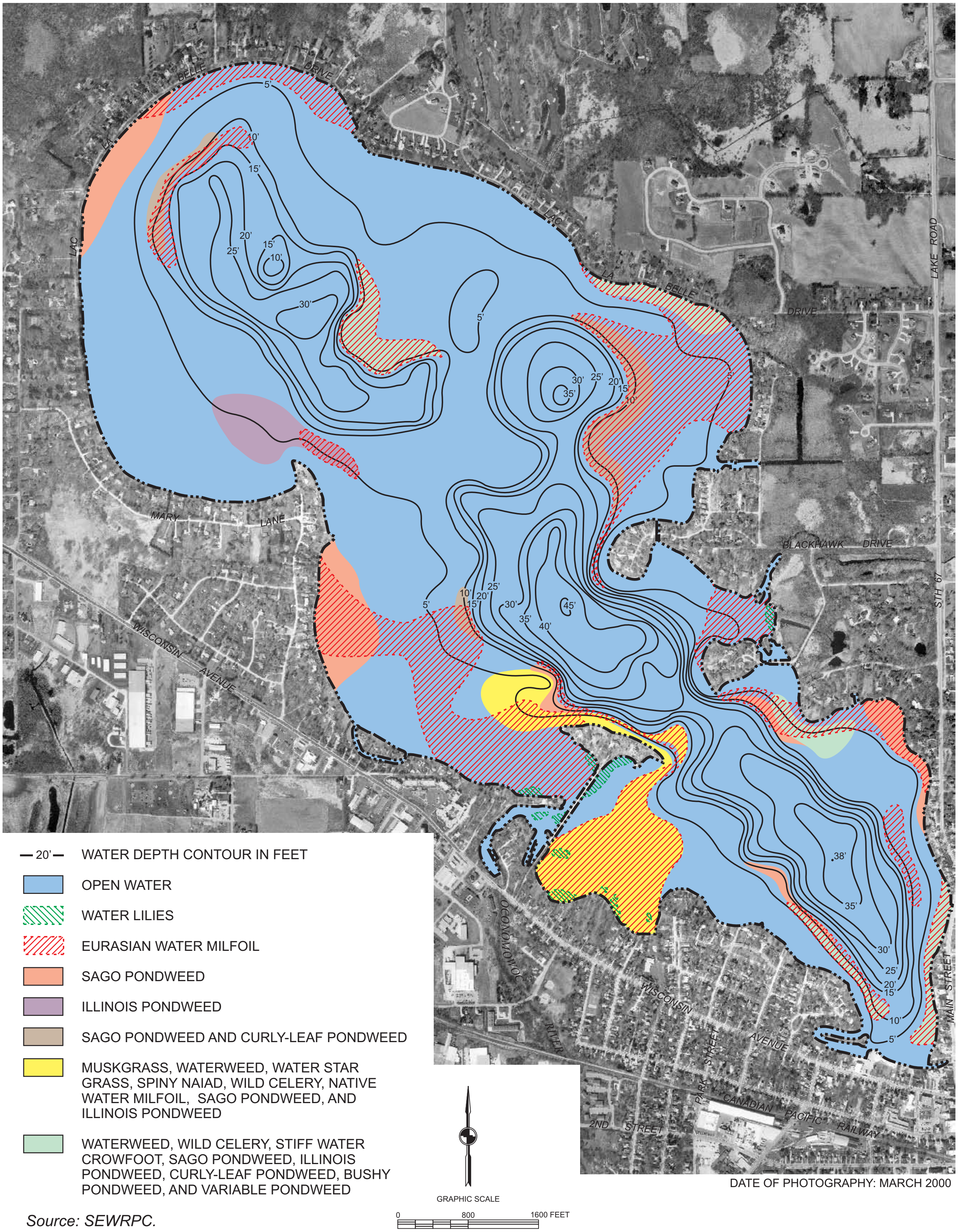
In 1926, sodium arsenite, an agricultural herbicide, was first applied to lakes in the Madison area, and, by the 1930s, sodium arsenite was widely used throughout the State for aquatic plant control. No other chemicals were applied in significant amounts to control macrophytes until recent years, when a number of organic chemical herbicides came into general use. The amounts of sodium arsenite applied to Lac La Belle, and the years of application during the period 1950 through 1967, are listed in Table 23. The total amount of sodium arsenite applied over this 28-year period was about 77,900 pounds, which is the seventh largest amount of this chemical herbicide applied to any lake in Wisconsin.[3]

Sodium arsenite was typically sprayed onto the surface of Lac La Belle within an area of up to 200 feet from the shoreline. Treatment typically occurred between mid-June and mid-July. The amount of sodium arsenite used was calculated to result in a concentration of about 10 milligrams per liter (mg/l) sodium arsenite (about 5.0 mg/l arsenic) in the treated lake water. The sodium arsenite typically remained in the water column for less than 120 days. Although the arsenic residue was naturally converted from a highly toxic form to a less toxic biologically active form, much of the arsenic residue was deposited in the lake sediments where it remained potentially available to aquatic organisms resident in the sediments, organisms preying upon them, and release back into the water column as a result of biogeochemical processes under anaerobic conditions. When it became apparent in 1969 that arsenic was accumulating in the sediments of treated lakes, and that the accumulations of arsenic were

[3]*Wisconsin Department of Natural Resources Technical Bulletin No. 57,* Biology and Control of Aquatic Nuisances in Recreational Waters*, 1972.*

Map 16

AQUATIC PLANT COMMUNITY DISTRIBUTION IN LAC LA BELLE: 2001



Source: SEWRPC.

Table 21

AQUATIC PLANT SPECIES PRESENT IN LAC LA BELLE: 1976-2001

Aquatic Plant Species	1976-1977 Survey	2001 Survey
Chara vulgaris (muskgrass)	- -	X
Elodea canadensis (waterweed)	- -	X
Lemna minor (lesser duckweed)	- -	X
Myriophyllum sp. (native water milfoil)	X	X
Myriophyllum spicatum (Eurasian water milfoil)[a]	X	X
Najas flexilis (bushy pondweed)	- -	X
Najas marina (spiny naiad)	- -	X
Nelumbo lutea (American lotus)	X	X[c]
Nuphar variegatum (yellow water lily)	X	X
Nymphaea tuberosa (white water lily)	X	X
Potamogeton amplifolius (large-leaf pondweed)[b]	X	- -
Potamogeton crispus (curly-leaf pondweed)[a]	X	X
Potamogeton gramineus (variable pondweed)	- -	X
Potamogeton illinoensis (Illinois pondweed)	- -	X
Potamogeton natans (floating-leaf pondweed)	X	- -
Potamogeton pectinatus (Sago pondweed)[b]	X	- -
Ranunculus longirostris (stiff water crowfoot)	- -	X
Vallisneria americana (water celery)[b]	X	X
Zosterella dubia (water stargrass)	- -	X

[a]*Designated as invasive and nonnative aquatic plant species pursuant to section NR 109.07 of the* Wisconsin Administrative Code*.*

[b]*Considered a high-value aquatic plant species known to offer important values in specific aquatic ecosystems under Section NR 107.08 (4) of the* Wisconsin Administrative Code*.*

[c]*American lotus were observed, but not sampled during the 2001 survey.*

Source: SEWRPC.

found to present potential health hazards to both humans and aquatic life, the use of sodium arsenite was discontinued in the State.

As shown in Table 23, a variety of other aquatic herbicides, including diquat, endothall, and 2,4-D, have been applied to Lac La Belle to control aquatic macrophyte growth. Diquat and endothall (Aquathol®) are contact herbicides and kill plant parts exposed to the active ingredient. 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.) and naiads (*Najas* spp.). Endothall primarily kills pondweeds, but does not control such nuisance species as Eurasian water milfoil (*Myriophyllum spicatum*). The herbicide 2,4-D is a systemic herbicide that is absorbed by the leaves and translocated to other parts of the plant; it is more selective than the other herbicides listed above and is generally used to control Eurasian water milfoil. However, it will also kill species such as water lilies (*Nymphaea* sp. and *Nuphar* sp.). The present restrictions on water use after application of these herbicides are given in Table 24.

In addition to the chemical herbicides used to control large aquatic plants, algicides have also been applied to Lac La Belle. As shown in Table 23, copper sulfate (Cutrine Plus) has been applied to Lac La Belle on occasion. Like arsenic, copper, the active ingredient in many algicides, including Cutrine Plus, may accumulate in the bottom sediments. Excessive levels of copper may be toxic to fish and benthic organisms, but, generally, have not been

Table 22

LAC LA BELLE AQUATIC PLANT SPECIES ECOLOGICAL SIGNIFICANCE

Aquatic Plant Species Present	Ecological Significance
Chara vulgaris (muskgrass)	Excellent producer of fish food, especially for young trout, bluegills, and small and large mouth 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
Lemna minor (lesser duckweed)	A nutritious food source for ducks and geese, also provides food for muskrat, beaver, and fish; while rafts of duckweed provide shade and cover for insects; in addition extensive mats of duckweed can inhibit mosquito breeding
Myriophyllum sp. (native water milfoil)	Provides valuable food and shelter for fish; fruits are eaten by many wildfowl
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)	Provides good food and shelter for fish and food for ducks
Nuphar variegatum (yellow water lily)	Leaves, stems, and flowers are eaten by deer; roots eaten by beaver; seeds eaten by wildfowl; leaves provide harbor to insects, in addition to shade and shelter for fish
Nymphaea tuberosa (white water lily)	Provides shade and shelter for fish; seeds eaten by waterfowl; rootstocks and stalks eaten by muskrat; roots eaten by beaver, deer, moose, and porcupine
Potamogeton crispus (curly-leaf pondweed)	Provides food, shelter, and shade for some fish and food for wildfowl
Potamogeton gramineus (variable pondweed)	Provides habitat for fish and food for waterfowl, in addition to muskrat, beaver, deer, and moose
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
Ranunculus longirostris (stiff water crowfoot)	Provides food for trout, upland game birds, and wildfowl
Vallisneria americana (eel grass)	Provides good shade and shelter; supports insects and is valuable fish food
Zosterella dubia (water stargrass)	Provides food and shelter for fish; locally important food for waterfowl

Source: SEWRPC.

found to be harmful to humans.[4] Restrictions on water uses after the use of Cutrine Plus are also given in Table 24.

Macrophyte Harvesting

The Town and City of Oconomowoc have historically conducted an aquatic macrophyte harvesting program on Lac La Belle, Okauchee Lake, Fowler Lake, and Upper Oconomowoc Lake, beginning in the 1960s. Harvesting on Lac La Belle typically occurred along the fishing pier and the public beach. Since the year 2000, no harvesting operations have been performed on Lac La Belle.

[4]*Jeffrey A. Thornton and Walter Rast, "The Use of Copper and Copper Compounds as Algicides," in H. Wayne Richardson,* Handbook of Copper Compounds and Applications*, Marcel Dekker, New York, 1997, pp. 123-142.*

Table 23

CHEMICAL CONTROL OF AQUATIC PLANTS IN LAC LA BELLE: 1950-2000

		Algae Control		Macrophyte Control							
Year	Total Acres Treated	Copper Sulfate (pounds)	Cutrine or Cutrine Plus (gallons)	Sodium Arsenite (pounds)	2, 4-D (gallons)	2, 4-D (pounds)	Aquathol (gallons)	Aquathol (pounds)	Diquat (gallons)	Endothall (gallons)	Glyphosate (ounces)
1950	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1951	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1952	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1953	- -	- -	- -	400	- -	- -	- -	- -	- -	- -	- -
1954	- -	- -	- -	1,508	- -	- -	- -	- -	- -	- -	- -
1955	- -	- -	- -	2,520	- -	- -	- -	- -	- -	- -	- -
1956	- -	- -	- -	8,640	- -	- -	- -	- -	- -	- -	- -
1957	- -	- -	- -	16,536	- -	- -	- -	- -	- -	- -	- -
1958	77.8	200.0	- -	10,220	- -	- -	- -	- -	- -	- -	- -
1959	46.0	- -	- -	7,740	- -	- -	- -	- -	- -	- -	- -
1960	40.5	475.0	- -	4,860	- -	- -	- -	- -	- -	- -	- -
1961	42.5	700.0	- -	12,240	- -	- -	- -	- -	- -	- -	- -
1962	22.0	120.0	- -	3,366	- -	- -	- -	- -	- -	- -	- -
1963	33.0	175.0	- -	4,800	- -	- -	- -	- -	- -	- -	- -
1964	10.5	- -	- -	1,260	- -	- -	- -	- -	- -	- -	- -
1965	5.0	- -	- -	1,260	- -	- -	- -	- -	- -	- -	- -
1966	8.0	- -	- -	1,248	- -	- -	- -	- -	- -	- -	- -
1967	8.0	- -	- -	1,260	- -	- -	- -	- -	- -	- -	- -
1968	8.0	- -	- -	- -	45.0	- -	- -	- -	- -	- -	- -
1969	45.0	- -	- -	- -	123.0	150	- -	- -	20.5	- -	- -
1970[a]	18.7	- -	- -	- -	15.0	240	- -	25	- -	20.0	- -
1971	28.0	- -	- -	- -	4.0	30	50.00	- -	14.0	- -	- -
1972	47.4	- -	- -	- -	3.0	- -	110.00	350	14.0	- -	- -
1973	48.8	- -	- -	- -	- -	- -	- -	- -	15.0	- -	- -
1974	68.5	- -	- -	- -	18.0	- -	- -	- -	76.0	16.0	- -
1975	34.6	45.3	15.0	- -	21.0	- -	- -	- -	25.0	10.0	- -
1976	11.6	- -	- -	- -	20.0	- -	- -	- -	3.5	3.0	- -
1977	17.0	- -	- -	- -	24.0	- -	- -	- -	- -	- -	- -
1978	24.6	- -	15.5	- -	51.0	- -	- -	- -	8.0	15.5	- -
1979	94.4	- -	9.5	- -	10.0	- -	13.50	- -	9.5	- -	- -
1980	45.0	- -	8.5	- -	24.0	- -	5.00	- -	7.0	1.0	- -
1981	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1982	15.7	- -	0.3	- -	24.0	- -	0.70	- -	- -	- -	- -
1983	15.1	- -	38.0	- -	19.5	25	15.00	- -	- -	- -	- -
1984	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1985	18.0	- -	12.0	- -	45.0	15	14.50	- -	- -	- -	- -
1986	19.0	- -	6.0	- -	4.0	12	12.00	- -	15.0	- -	- -
1987	7.5	- -	10.3	- -	20.2	7	18.00	- -	- -	- -	- -
1988	19.9	- -	5.0	- -	52.0	- -	15.00	100	- -	- -	- -
1989	5.6	- -	- -	- -	24.0	- -	0.75	- -	- -	- -	- -
1990	4.6	- -	0.4	- -	30.0	- -	0.75	- -	- -	- -	- -
1991	0.3	- -	- -	- -	2.0	- -	- -	- -	- -	- -	- -
1992	0.7	- -	- -	- -	4.0	- -	- -	- -	- -	- -	- -
1993	1.4	- -	- -	- -	2.8	- -	- -	- -	- -	- -	128
1994	1.8	- -	- -	- -	- -	- -	- -	- -	- -	- -	20
1995	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1996	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1997	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1998	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1999	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
2000	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Total	- -	1,715.3	120.5	77,858	585.5	479	255.20	475	207.5	65.5	148

[a]*120 pounds of lime were applied in 1970.*

[b]*Private chemical treatments of aquatic plants.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 24

PRESENT RESTRICTIONS ON WATER USES AFTER APPLICATION OF AQUATIC HERBICIDES[a]

Use	Days after Application					
	Copper Sulfate	Diquat	Glyphosate	Endothall	2,4-D	Fluridone
Drinking	- -[b]	14	- -[c]	7-14	- -[d]	- -[e]
Fishing	0	14	0	3	0	0
Swimming	0	1	0	- -	0	0
Irrigation	0	14	0	7-14	- -[d]	7-30

[a]*The U.S. Environmental Protection Agency has indicated that, if these restrictions are observed, pesticide residues in water, irrigated crops, or fish will not pose an unacceptable risk to humans and other organisms using or living in the treatment zone.*

[b]*According to the Wisconsin Department of Natural Resources, if water is to be used as potable water, the residual copper content cannot exceed one part per million (ppm).*

[c]*According to the Wisconsin Department of Natural Resources, if water is to be used as potable water, the drinking water tolerance of glyphosate (Rodeo®) is one part per million (ppm).*

[d]*2,4-D products are not to be applied to waters used for irrigation, animal consumption, drinking, or domestic uses, such as cooking and watering vegetation.*

[e]*According to the Wisconsin Department of Natural Resources, if water is to be used as potable water, the drinking water tolerance of fluridone (Sonar®) is 0.15 parts per million (ppm).*

Source: Wisconsin Department of Natural Resources.

Biological Controls

The paucity of the aquatic plant community in Lac La Belle prompted the Lac La Belle Management District, in partnership with the WDNR and University of Wisconsin-Milwaukee, to attempt to supplement the aquatic plant community of the Lake by selective plantings of pondweeds.[5] Several hundred pondweeds were planted from pontoon boats, 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.[6]

AQUATIC ANIMALS

Aquatic animals include microscopic zooplankton; benthic, or bottom-dwelling, invertebrates; fish and reptiles; amphibians; mammals; and waterfowl and other birds that inhabit the Lake and its shorelands. These make up the primary and secondary consumers of the food web.

Zooplankton

Zooplankton are microscopic animals which inhabit the same environment as the phytoplankton, the microscopic plants. An important link to the food chain, zooplankton feed mostly on algae, and, in turn, are a good food source for fish. During a 1974 study, zooplankton were found in Lac La Belle in varying abundance, as shown in Table 25, populations of most zooplankton peaked during spring and fall as shown in Figure 12. *Daphnia galaeta*

[5]*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.*

[6]*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.*

Table 25

CRUSTACEAN ZOOPLANKTON FOUND IN LAC LA BELLE: 1974-1988

Type	1974-1975	1976-1977	1986	1988
Acanthocyclops vernalis	X	- -	X	- -
Allona costa	- -	X	- -	X
Alona quadrangularis	- -	- -	- -	X
Bosmina longirostris	X	X	X	X
Calanoid copepodids	- -	- -	- -	X
Calanoid nauplii	- -	- -	- -	X
Ceriodaphnia quadrangula	- -	- -	- -	X
Ceriodaphnia sp.	- -	- -	- -	X
Chydorus sphaericus	X	X	X	X
Cyclopoid copepodids	- -	- -	- -	X
Cyclopoid nauplii	- -	- -	- -	X
Cyclops bicuspidatus thomasi	X	X	X	- -
Daphnia ambigua	X	- -	X	- -
Daphnia dubia	- -	- -	- -	X
Daphnia galeata mendotae	X	X	- -	X
Daphnia pulex	- -	- -	X	- -
Daphnia pulicaria	X	X	- -	X
Daphnia retrocurva	X	X	X	X
Daphnia rosea	- -	X	- -	- -
Diacyclops thomasi	- -	- -	X	X
Diaphanosoma birgei	- -	- -	- -	X
Diaphanosoma leuchtenbergianum	X	X	X	- -
Epishura lacustris	X	X	- -	- -
Ergasilis chautauquiensis	- -	X	- -	- -
Eubosmina coregoni	X	X	X	X
Eucyclops speratus	X	- -	X	X
Eucyclops prionophorus	- -	- -	- -	X
Eurycercus lamellatus	- -	X	- -	- -
Leptodiaptomus siciloides	X	X	X	X
Leptodora kindtii	X	X	X	- -
Mesocyclops edax	X	X	X	X
Orthocyclops modestus	- -	- -	- -	X
Ostracoda	- -	- -	- -	X
Skistodiaptomus oregonensis	X	X	X	X
Skistodiaptomus pallidus	X	X	X	X
Tropocyclops prasinus	X	X	X	X

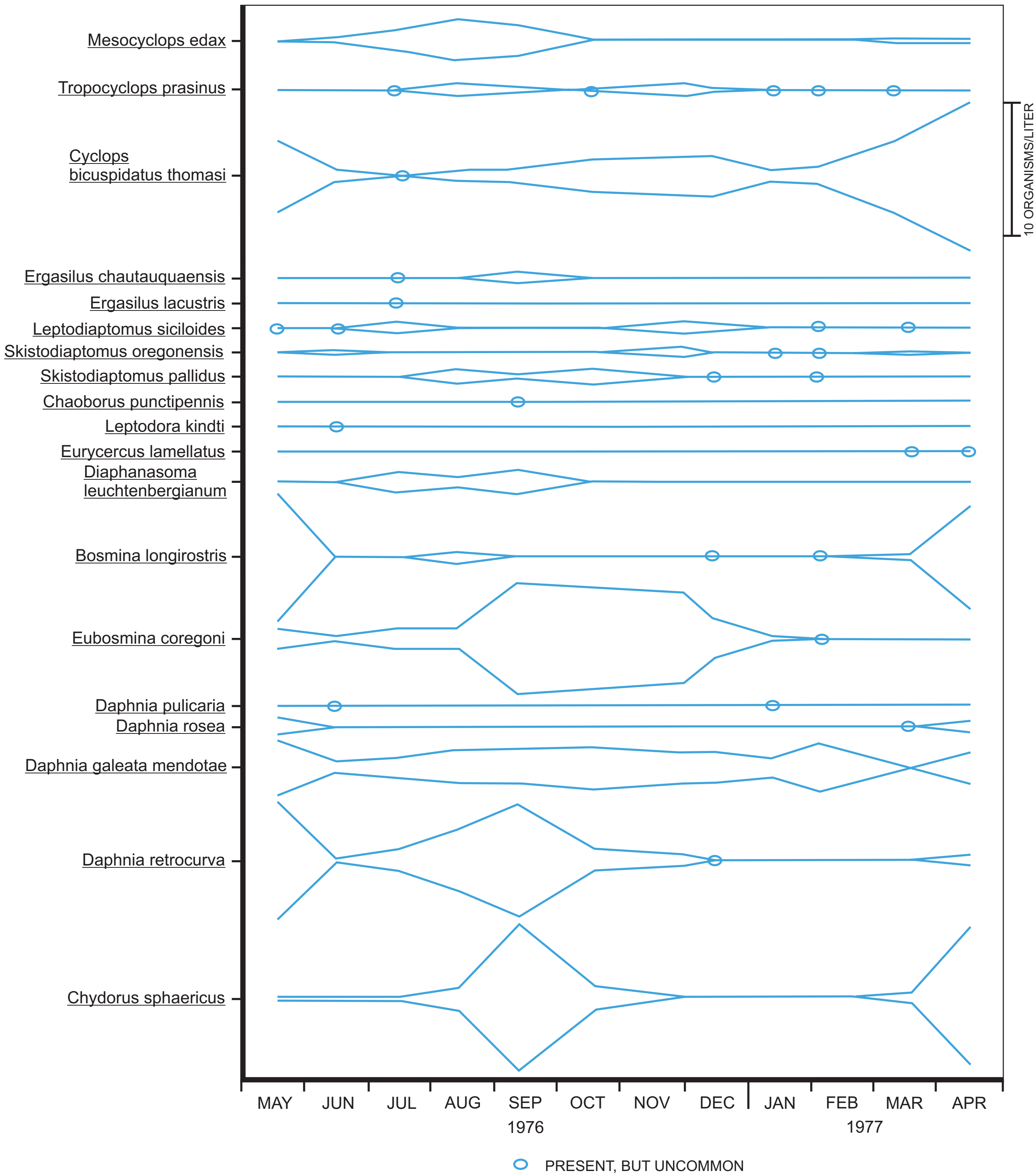
Source: Wisconsin Department of Natural Resources and SEWRPC.

medotae, *Daphnia retrocurva*, *Eubosmina coregoni*, *Chydorus spaericus*, and *Cyclops bicuspidatus thomasi* were the dominant species. Larger zooplankton, such as *Daphnia pulicaria* and *Leptodora kindtii*, were present, but in small numbers. This may indicate selective cropping of the zooplankton by fish.

Additional zooplankton sampling was performed during 1976, 1986, and 1988. During the 1976 survey, in addition to the species identified in 1974, *Acanthocyclops vernalis* and *Eucyclops speratus* were also identified. Eighteen species of zooplankton were identified during the 1986 survey. The dominant species reported from that sampling included: *Bosmina longirostris*, *Chydorus sphaericus*, *Daphnia galeata medotae*, *Mesocyclops edax*, and *Tropocyclops prasinus.* During the 1988 survey, 27 species of zooplankton were identified. The dominant species included: *Diacyclops bicuspidatus thomasi*, *Cyclopoid copepodids*, *Cyclopoid nauplii*, *Chydorus spaericus*, *Daphnia galeata medotae*, *Daphnia pulicaria*, and *Eubosmina corgoni*.

Figure 12

ABUNDANCE OF ZOOPLANKTON SPECIES FOUND IN LAC LA BELLE: 1976-1977



Source: Wisconsin Department of Natural Resources and SEWRPC.

Benthic Invertebrates

The benthic, or bottom dwelling, faunal communities of lakes include such organisms as sludge worms, midges, and caddisfly larvae. These organisms are an important part of the food chain, acting as processors of organic material that accumulates on the lake bottom. Some benthic fauna are opportunistic in their feeding habits, while others are predaceous. The diversity of benthic faunal communities can be used as an indicator of lake trophic status. In general, a reduced or limited diversity of organisms present is indicative of a eutrophic lake; however, there is no single "indicator organism." Rather, the entire community must be assessed in order to determine trophic status, as populations can fluctuate widely through the year and between years as a consequence of season, climatic variability, and localized water quality changes.

The benthic faunal population of Lac La Belle was sampled during the early spring of 1976 and 1977 prior to metamorphosis and emergence of adult benthic organisms.[7] The results of these surveys are set forth in Table 26. At that time, the community was dominated by the phantom midge (*Chaoborus punctipennis*). In addition, four other species were present in smaller numbers: *Procladius* sp., *Chironomus attenuatus*, *Chironomus plumosus,* and *Parachironomus* sp.

Most recently, the WDNR has reported the presence of the nonnative, invasive mollusk, zebra mussel (*Dreissena polymorpha*), in Lac La Belle during 2001.

Fish

The WDNR periodically monitors the fish population of Lac La Belle to evaluate changes in the population with time. In recent years, the WDNR conducted an annual survey during spring to assess the carp population and the growth and diversity of the gamefish population. An annual survey is also conducted in autumn to determine the level of natural reproduction that is occurring within the fish community. Creel surveys were conducted by the WDNR from May to September during both 1982 and 1992 to evaluate angling pressure and catch and harvest rates in Lac La Belle, and to determine the most sought after fish and their specific catch and harvest rates. These surveys were conducted on weekends, weekdays, and holidays in order to determine when the greatest angling pressures occur in the Lake.

In addition, since 1950, the WDNR has regularly stocked a variety of gamefish and panfish into the Lake, as documented in Table 27. Between 1985 and 1991, the WDNR conducted a fisheries rehabilitation project to improve water quality and the fishery in Lac La Belle. Their efforts included the chemical eradication of about 58,000 carp (*Cyprinus carpio*); the installation of approximately 1,200 feet of artificial spawning reef for enhancing walleye (*Stizostedion vitreum vitreum*) habitat, and about 600 half-logs for enhancing smallmouth bass (*Micropterus dolomieui*) habitat; and, the stocking of walleye fingerlings, adult panfish (mainly bluegill), and adult flathead catfish (*Pylodictis olivaris*). The catfish were stocked as carp predators. A 20-inch size limit and a one-fish bag limit on walleye, a 15-fish bag limit on panfish, and a restriction on the harvest of flathead catfish remained in place following this project.

Since 1992, the WDNR began evaluating the success of the rehabilitation project by conducting fyke net surveys during March and April of each year to assess the gamefish and panfish populations. Assessing walleye population trends was a major goal of these surveys. An element of the 1992 comprehensive survey included the conduct of an electrofishing survey over two nights to supplement the data collection effort and permit an assessment of the panfish and gamefish populations. The fyke net survey stations and electrofishing stations are shown on Map 17. In addition, a randomized creel survey was conducted from May to September. In 1993, as a consequence of this evaluation, the WDNR began an alternate year stocking of walleye fingerlings, in order to

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[7] *Samples were collected in the deep basin in the western portion of the Lake, and processed by sieving through a 60-mesh sieve; samples were preserved in 95 percent ethyl alcohol. The larvae were picked from the debris, counted, and classified. Chironomid larvae, however, were not reared to adult stages and, therefore, species identification must be considered tentative.*

Table 26

BENTHIC FAUNA FOUND IN LAC LA BELLE: 1976-1977

Type		1976	1977
Insecta	*Chaoborus punctipennis*	X	X
Chironomidae	*Procladius* species	X	X
	Chironomus attenuatus	X	X
	Chironomus plumosus	X	X
	Parachironomus species	X	- -

Source: Wisconsin Department of Natural Resources and SEWRPC.

evaluate the amount of natural reproduction of walleye that was occurring in the Lake, and utilized the fall electrofishing survey data to assess the growth rate of the young-of-the-year walleye.

An electric carp barrier subsequently was placed in the Oconomowoc River during 2002, near the confluence of the Oconomowoc River and Rock River prior to the conduct of a program to eradicate the common carp from Lac La Belle. In late May to early June of 2004, the WDNR introduced rotenone, a fish toxicant, into the Oconomowoc River between the outlet of Lac La Belle and the electric carp barrier. Several additional locations within Lac La Belle, upstream of the Lac La Belle outlet, locally known as Kohl's Bay, Spaulding's Channel, Islandale Bay, Recreation Center Lagoon, the outlet bay, and the two bays southeast of Begg's Isle, have been identified for future treatment to further reduce the carp population in the Lake.

Fish Population Dynamics

Lac La Belle supports a relatively large and diverse fish community, as shown in Table 28. WDNR fisheries survey reports indicate that, between 1946 and 1974, 29 different fish species were captured in the Lake. Surveys conducted between 1946 and 1974 indicated that Lac La Belle had a diverse population of gamefish, panfish, roughfish, and minnow species. Gamefish are defined as all varieties of fish, except roughfish and minnows. Roughfish include dace, suckers, carp, goldfish, redhorse, freshwater drum, burbot, bowfin, gar, and buffalo, among others. Minnows include the mud minnow, madtom, stonecat, killifish, stickleback, trout perch, darter, sculpin, and other species in the minnow family, except goldfish and carp.[8]

Gamefish captured during the historic surveys included, but were not limited to, northern pike (*Esox lucius*), walleye, largemouth bass (*Micropterus salmoides)*, and smallmouth bass. These species are carnivorous, and feed primarily on other fish, crayfish, and frogs. A wide range of panfish also were present in Lac La Belle during these surveys, as shown in Table 28. "Panfish" is a common term applied to a broad range of smaller fish, with a relatively short and usually broad shape, makes them perfect size for the frying pan and include the following fish species: yellow perch (*Perca flavescens*), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), white crappie (*Pomoxis annularis*), pumpkinseed (*Lepomis gibbosus*), green sunfish (*Lepomis cyanellus*), warmouth (*Lepomis gulosus*), and orange-spotted sunfish (*Lepomis humilis*). Large numbers of some of these panfish were caught during the 1974 survey, including some 9,700 bluegill, 420 yellow perch, and 1,100 pumpkinseed. The habitats of these panfish vary widely among the different species, depending upon the availability of food supplies, such as insects and plants, and breeding rates and breeding success; this can lead to large populations of panfish compared to gamefish species.

Some lakes within southeastern Wisconsin have "stunted" panfish populations, characterized by a large number of very small individuals. This condition can be caused by a number of factors that directly or indirectly affect the growth rates of fishes, including temperature, dissolved oxygen levels, food availability, competition with other fishes, predation, and fishing pressure.[9] This condition is not limited to panfish species and may also occur for gamefish species, such as largemouth bass. Whatever the causes of stunting, stunted fish reach sexual maturity at an unusually small size. This early maturity can result in dense populations of small fish, unsuitable for

[8] *Wisconsin Department of Natural Resources Publication No. PUB-FH-301 2005,* Guide to Wisconsin Hook and Line Fishing Regulations 2004-2005*, Effective April 1, 2005 through March 31, 2006.*

[9] *Robert J. Wootton,* Ecology of Teleost Fishes, Fish and Fisheries Series: 1*, Chapman and Hall, 1990.*

Table 27

SUMMARY OF HISTORICAL REPORTS OF FISHES COLLECTED IN LAC LA BELLE: 1946-1999

Fish Species Categories	Date of Survey: 1946-1974 Species Present[a]	1982[b] Catch	1982[b] Harvest	1992[b] Catch	1992[b] Harvest	Supplemental Stocking Since 1982[c]	1998-1999: Species Present (number of fish caught per mile)
Gamefish							
Brown Trout	- -	0	0	15	0	- -	- -
Largemouth Bass	X	340	98	1,777	65	X	2
Muskellunge	- -	0	0	0	0	- -	1
Northern Pike	X	115	71	296	84	X	<1
Smallmouth Bass	X	646	285	2,354	155	X	7
Walleye	X	219	38	3,302	27	X	11
White Bass	X	2,420	1,220	1,339	319	- -	- -
Yellow Bass	- -	0	0	811	689	- -	43
Panfish							
Black Crappie	X	1,374	651	599	145	- -	1
Bluegill	X	1,686	323	2,570	650	X[d]	8
Golden Shiner	X	0	0	0	0	- -	- -
Green Sunfish	X	0	0	30	15	- -	- -
Logperch	X	0	0	0	0	- -	- -
Pirate Perch	X	0	0	0	0	- -	- -
Pumpkinseed	X	22	0	8	0	- -	- -
Rock Bass	X	169	33	492	110	- -	3
Warmouth	- -	38	28	0	0	- -	- -
Yellow Perch	X	651	115	92	9	- -	19
Roughfish							
Black Bullhead	X	0	0	0	0	- -	- -
Bowfin	X	0	0	18	0	- -	- -
Brown Bullhead	X	- -	- -	- -	- -	X	- -
Channel Catfish	- -	0	0	25	18	- -	- -
Common Carp	X	318	247	328	141	- -	7
Flathead Catfish	- -	0	0	155	0	X	1
Longnose Gar	X	0	0	152	14	- -	- -
Smallmouth Buffalo	X	- -	- -	- -	- -	- -	- -
White Sucker	X	0	0	4	0	- -	- -
Yellow Bullhead	X	816	88	0	0	- -	- -
Minnows							
Banded Killifish	X	- -	- -	- -	- -	- -	- -
Blackstripe Topminnow	X	- -	- -	- -	- -	- -	- -
Bluntnose Minnow	X	- -	- -	- -	- -	- -	- -
Brooksilverside	X	- -	- -	- -	- -	- -	2
Central Mudminnow	X	- -	- -	- -	- -	- -	- -
Johnny Darter	X	- -	- -	- -	- -	- -	- -
Mimic Shiner	X	- -	- -	- -	- -	- -	- -
Total	29	13	12	19	14	7	13

[a]*Total population abundance not known, but an X indicates a species was recorded to be present in the Lake in at least one survey from the time period of 1946-1974.*

[b]*Creel surveys were focused on primarily recording selected gamefish, panfish, and roughfish species.*

[c]*Fish stocked into Lac La Belle from 1950 to 2003.*

[d]*An undefined number of other panfish species were included as part of stocking of Bluegill.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

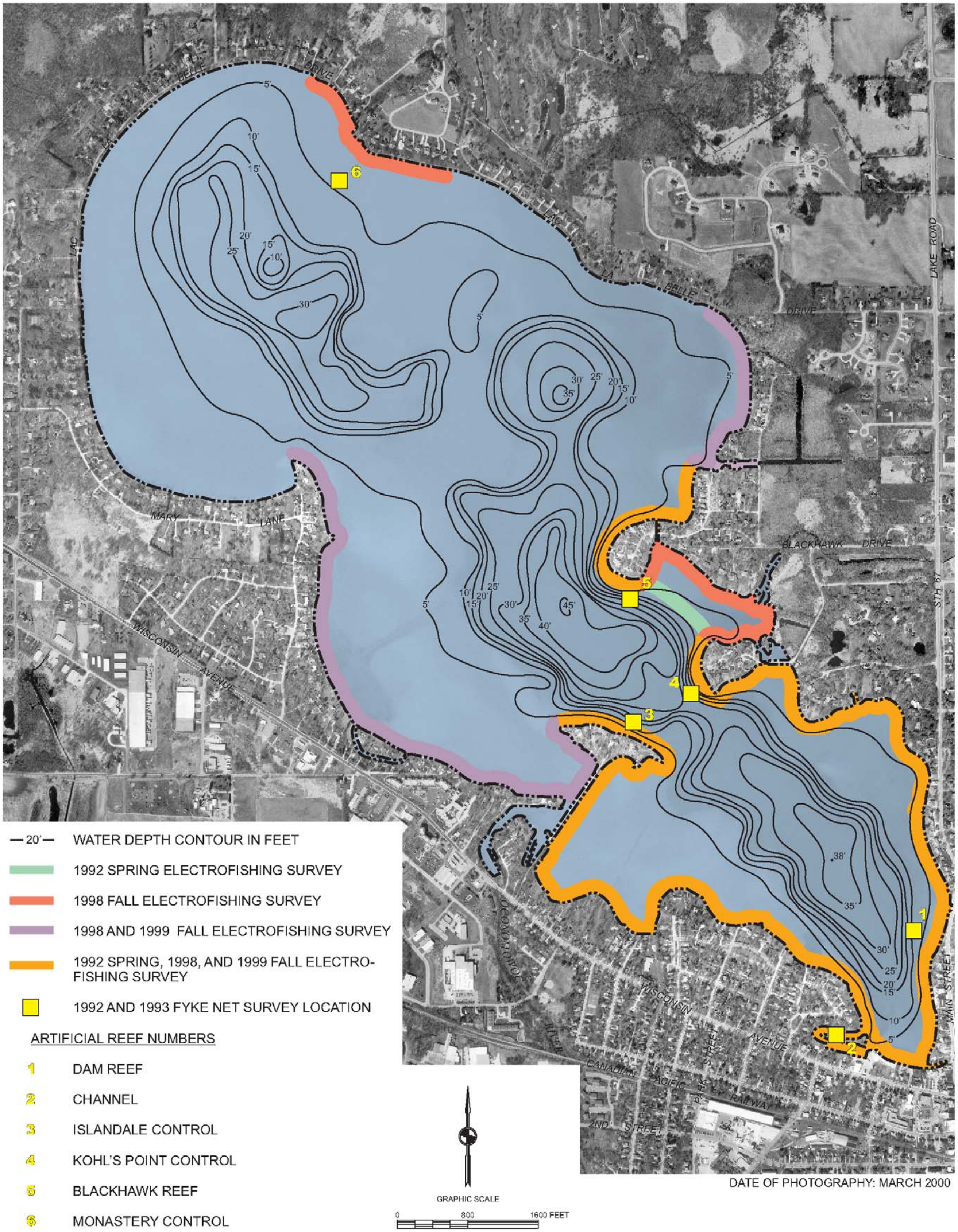
harvesting. This condition is also a potential problem in the fish aquaculture industry and much effort has been devoted to developing techniques to avoid stunting.[10]

Figure 13 illustrates the importance of a balanced predator-prey relationship, using walleye and perch as an example. It is important to note, however, that Figure 13 is a simplistic model that does not incorporate the effects

[10]*R.S.V. Pullin and R.H. Lowe-McConnell,* The Biology and Culture of Tilapias*. ICLARM, Manila, 1981.*

Map 17

ELECTROFISHING, FYKE NET SURVEYS, AND ARTIFICIAL REEFS IN LAC LA BELLE: 1992-1999



Source: SEWRPC.

Table 28

FISH SPECIES OCCURRING IN LAC LA BELLE: 1946-1974

Species	Family	Scientific Name
Bowfin	Amiidae	*Amia calva*
Pirate Perch	Aphredoderidae	*Aphredoderus sayanus*
Brook Silversides	Atherinidae	*Labidesthes sicculus*
White Sucker	Catostomidae	*Catostomus commersoni*
Smallmouth Buffalo	Catostomidae	*Ictiobus bubalus*
Largemouth Bass	Centrarchidae	*Micropterus salmoides*
Smallmouth Bass	Centrarchidae	*Micropterus dolomieui*
Bluegill	Centrarchidae	*Lepomis macrochirus*
Pumpkinseed	Centrarchidae	*Lepomis gibbosus*
Green Sunfish	Centrarchidae	*Lepomis cyanellus*
Rock Bass	Centrarchidae	*Ambloplites ruperstris*
Black Crappie	Centrarchidae	*Pomoxis nigromaculatus*
Bluntnose Minnow	Cyprinidae	*Pimephales notatus*
Mimic Shiner	Cyprinidae	*Notropis volucellus*
White Bass	Percichthyidae	*Morone chrysops*
Carp	Cyprinidae	*Cyprinus carpio*
Golden Shiner	Cyprinidae	*Notemigonus rysoleucas*
Banded Killifish	Cyprinodontidae	*Fundulus diaphanous*
Blackstripe Topminnow	Cyprinodontidae	*Fundulus notatus*
Northern Pike	Escocidae	*Esox lucius*
Black Bullhead	Ictaluridae	*Ictalurus melas*
Brown Bullhead	Ictaluridae	*Ictalurus nebulosus*
Yellow Bullhead	Ictaluridae	*Ictalurus natalis*
Longnose Gar	Lepisosteidae	*Lepisosteus osseus*
Johnny Darter	Percidae	*Etheostoma nigrum*
Walleye	Percidae	*Stizostedion vitreum vitreum*
Logperch	Percidae	*Percina caprodes*
Yellow Perch	Percidae	*Perca flavescens*
Central Mudminnow	Umbridae	*Umbra limi*

Source: Wisconsin Department of Natural Resources and SEWRPC.

of several important factors such as: 1) supplemental stocking of one or more gamefish or panfish species, affecting the population dynamics of the predator-prey relationship in a lake; 2) changes in available spawning habitat and cover refugia affecting the risk to juvenile fishes from predation; and, 3) competition for food, cover or spawning substrate within a particular species, termed “intraspecific competition” (e.g., walleye versus walleye), or between species, termed “interspecific competition” (e.g., bluegill versus largemouth bass).[11]

Based on data from the 1982 creel survey, the WDNR concluded that white bass were the principal gamefish, and black crappie and yellow perch were the predominant panfish in Lac La Belle.[12] While walleye, northern pike, pumpkinseed, and rock bass (*Ambloplites ruperstris*) were reported, their population densities appeared to be low. The survey also showed that smallmouth bass, largemouth bass, warmouth, carp, and yellow bullhead (*Ictalurus natalis*) were present.

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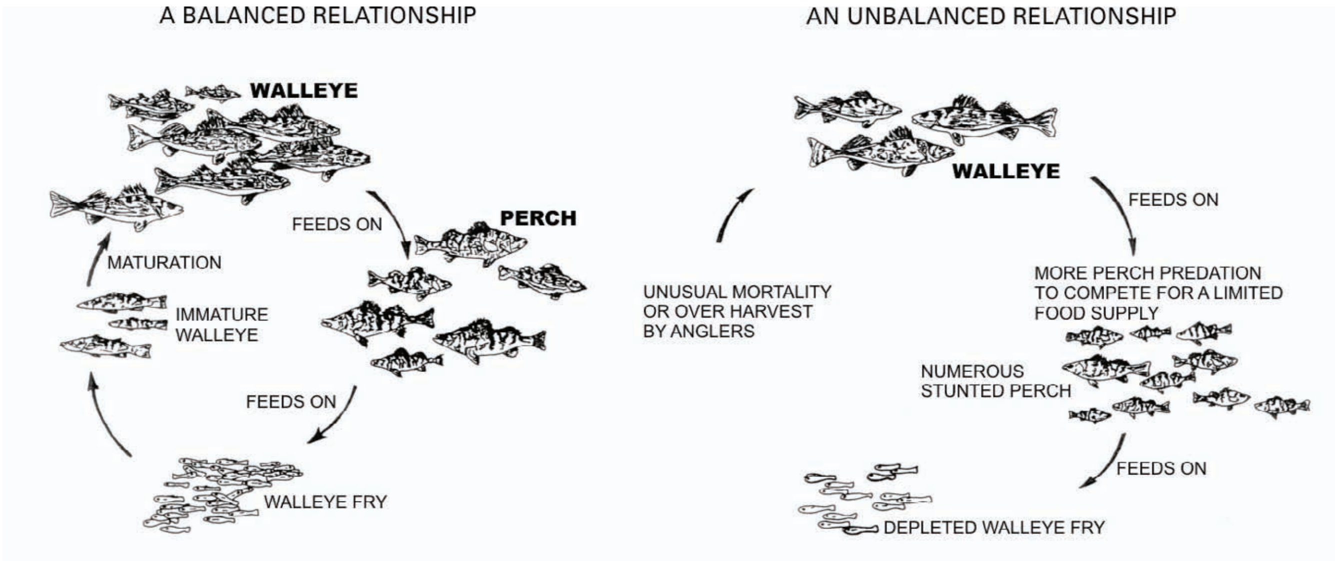
[11]*Robert J. Wootton,* op. cit.

[12]*R. Schumacher and S. Beyler,* 1992 Comprehensive Fishery Survey on Lac La Belle and Walleye Reef Evaluation. *Wisconsin Department of Natural Resources Memorandum, November 1993.*

Figure 13

THE PREDATOR-PREY RELATIONSHIP



Source: Wisconsin Department of Natural Resources.

In the 10 years following the 1982 creel survey, Lac La Belle's fishery went through several changes. In 1992, the WDNR reported that walleye were both the most commonly caught fish and the predominant gamefish in the Lake. The numbers of white bass, formerly the dominant gamefish, had declined since 1982. Bluegill had replaced black crappie and yellow perch as the predominant panfish encountered on the Lake. Yellow bass (*Morone mississippiensis*), smallmouth bass, and largemouth bass were abundant. Their populations had grown since 1982. Yellow bullhead and warmouth, reported to be present during the 1982 survey, were not found in 1992.[13]

Some of these trends continued into 1993. The WDNR spring survey reported that the number of adult walleye had increased since 1991, especially for adult females, while immature walleye were also reported to be abundant. This led the WDNR to conclude that the 1991 stocking had been successful.[14] Bluegill continued to be the dominant panfish in the Lake, and was the most commonly encountered fish in the Lake during 1992. The WDNR also reported that large numbers of black crappie were present. During 1993, a large number of yellow bass were encountered even though only one yellow bass previously had been reported in the Lake. While largemouth bass and flathead catfish were not as abundant as black crappie, they were common. Northern pike were reported, but the numbers caught were lower than in previous years.

Electrofishing data from the 1998 WDNR fall survey showed that the Lac La Belle fishery continued to change. These data indicated that smallmouth bass and walleye were the most commonly observed gamefish in the

[13]Ibid.

[14]*R. Schumacher and S. Beyler, 1993,* op. cit.

Lake.[15] Northern pike, largemouth bass, and flathead catfish were also present, but their population sizes were lower than those reported in previously surveyed years. Yellow perch and bluegill were the most abundant panfish species reported; however, the numbers of bluegill in the Lake appeared to be decreasing. Though this species was once abundant, the black crappie population also had plummeted, while the carp population increased to five times its 1993 population level. Yellow bass, which were nearly absent in 1992, remained abundant.

During the 1999 survey, the WDNR captured about 70 walleye and about 110 smallmouth bass, compared to 10 or fewer largemouth bass, northern pike, muskellunge (*Esox masquinongy*), and flathead catfish. Yellow bass continued to be abundant during the 1999 survey, with about 110 specimens being captured. Bluegill, yellow perch, black crappie, rock bass, and carp were also sampled, although less than 20 individuals were reported during the 1999 survey. Common carp numbers, however, were lower than those reported in previous years, despite information obtained from anglers that suggested the population was continuing to increase. The carp have been a point of public concern over the years in Lac La Belle.

Analyzing these data, the WDNR noted that yellow bass appeared to be cyclical in their abundance in the Lake. Note was made of the relatively low numbers of bluegill, despite a large stocking program amounting to nearly one-half million fishes conducted during the late 1980s to redress the stunted bluegill population.[16] Scarce vegetation within the Lake, and increasing numbers of carp, were considered to be factors in this condition. The carp population in Lac La Belle was considered to be a problem. Carp are large fish that are highly visible and make a tremendous commotion during their spawning activities. Even a relatively few carp can appear to be a large number because of their concentrated spawning activities in shallow water. The species is destructive to habitat and water quality. Most other roughfish species in Lac La Belle were found in low densities, and it was noted that white sucker (*Catostomus commersoni*) young-of-the-year, yearlings, and small adults provided a tremendous forage base for many of the gamefish species. Recent data from the WDNR suggest that Lac La Belle has a sustainable smallmouth bass fishery, with both smallmouth bass and walleye being present in significantly greater numbers than other gamefish species in the Lake.[17]

Age and Growth

Scale samples were collected by the WDNR staff from selected gamefish, panfish, and roughfish species and processed to assess the age structure of the various fish populations, as summarized below. Mean lengths and weights for selected species at known ages were then calculated and compared to statewide averages to determine the relative health and quality of the fishes in Lac La Belle.

Gamefish

Smallmouth bass are currently considered to be a self sustaining population, and have been one of the most common gamefish species collected from Lac La Belle during the period from 1992 through 1999, as shown in Figure 14. However, the length distribution of specimens collected from electrofishing in the Lake during the years surveyed, shown in Figure 15, suggests that not all size classes are well represented over the length range from five to 17 inches. The length distribution show that the size class from seven to 10 inches is well represented, but there is a low proportion of larger adults of greater than 14 inches in length. No fishes of less than five to six inches in length were recorded during the 1998 and 1999 fall surveys, suggesting that all fishes captured were older than six-months old, since six-month old smallmouth bass typically range in size from about

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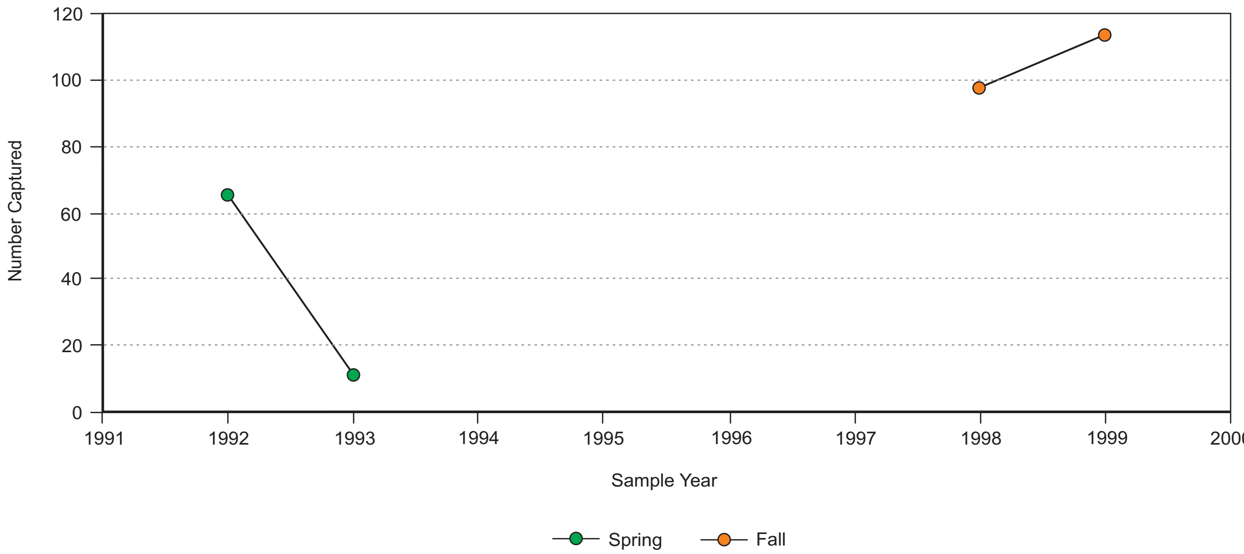
[15]*R. Schumacher and S. Beyler,* 1998 Fall Walleye Fingerling Assessment on Lac La Belle. *Wisconsin Department of Natural Resources Memorandum*, *November 1999.*

[16]*Sue Beyler and Steve Gospodarek,* Fall 1999 Electrofishing Survey to Assess Walleye Fingerling Production on Lac La Belle, WBIC 084880*, Wisconsin Department of Natural Resources Memorandum, October 2000.*

[17]Ibid.

Figure 14

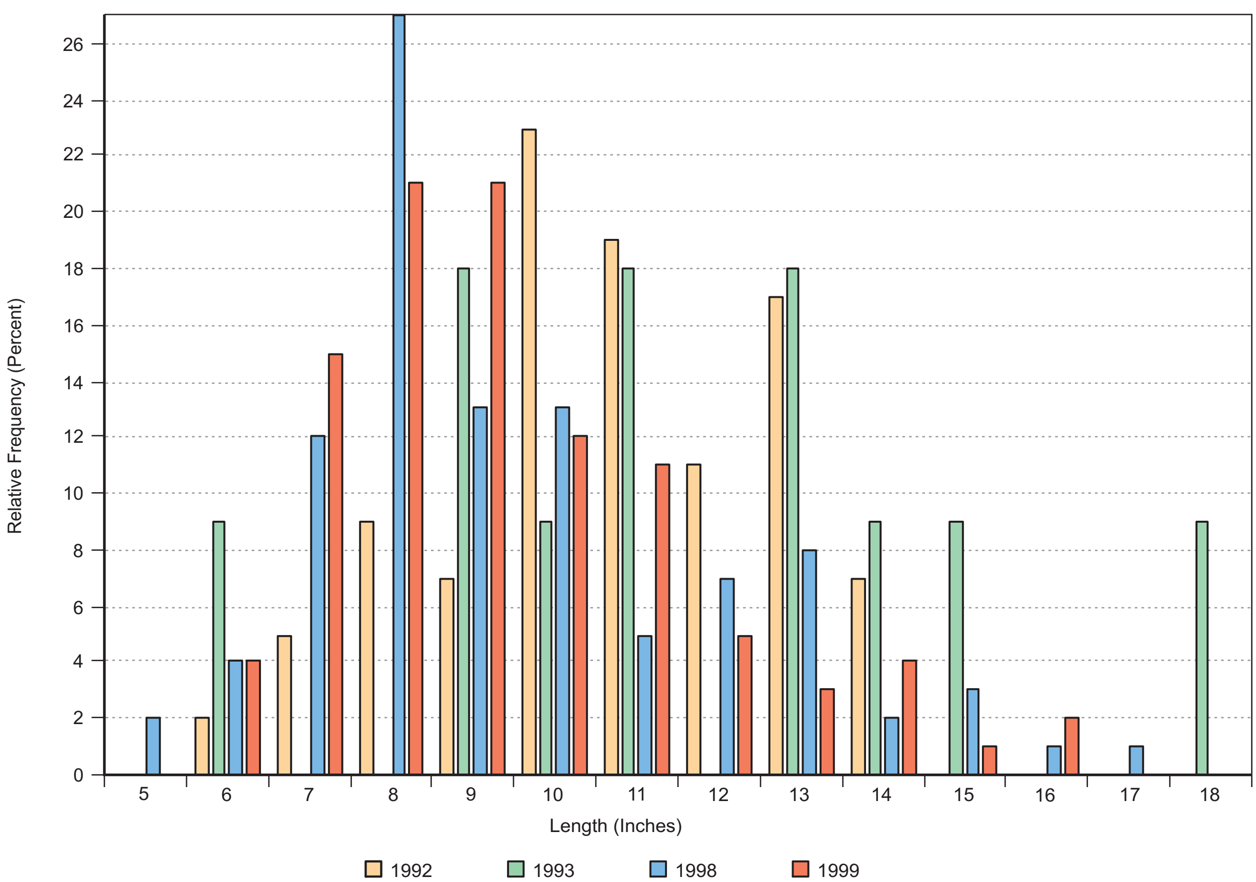
SMALLMOUTH BASS POPULATION ABUNDANCE IN LAC LA BELLE: 1992-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 15

SMALLMOUTH BASS LENGTH DISTRIBUTION IN LAC LA BELLE: 1992-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

2.5 to 4.0 inches in length.[18] The absence of this year class indicates poor recruitment during these recent surveys, which is not a characteristic of a healthy, self sustaining smallmouth bass population. This is further supported by the catch-per-unit-effort (CPE) data during the electrofishing surveys, of 9.3 fishes per hour in 1999, which are greatly reduced from the CPE values of 13.0 and 17.3 fishes per hour reported in 1992 and 1998, respectively, suggesting that the smallmouth bass fishery may be in decline in Lac La Belle. Population estimates for smallmouth bass in Lakes throughout Wisconsin are scarce,[19] and no estimates of numbers per acre were determined for smallmouth bass in Lac La Belle. Nevertheless, in comparison to other lakes, Lac La Belle has a very low percentage, 7 percent, of catchable smallmouth bass; i.e., those greater than or equal to 14 inches in length. This could be an indication that the fishes are food limited, causing the fish to grow more slowly and the overall population size to decrease—the phenomenon referred to as "stunting"—or that there is significant fishing pressure on the Lake, where the fish are being harvested as soon as they achieve the legal limit of 14 inches.

Northern pike populations are relatively small in Lac La Belle, as shown in Figure 16. Spring fyke net lifts during 1992 and 1993 averaged about 0.5 pike per net-night, while electrofishing CPE averaged about 0.6 pike per hour. These data are similar to those reported during the 1998 and 1999 surveys, in which the electrofishing CPE averaged about 0.8 pike per hour, suggesting that their abundances have remained relatively constant over this period. Northern pike ranged in size from nine to 33 inches in length, as shown in Figure 17. There were limited numbers of fish under 12 inches in length caught in any year sampled indicating that there is severely limited natural reproduction in the Lake—northern pike in the age-I year class vary in size from 7.4 inches to 11.0 inches.[20] Although northern pike are considered to be present in Lac La Belle, trophy pike greater than 32 inches in length are extremely rare, and the WDNR placed a 26-inch-minimum size limit on northern pike during 1994 in an attempt to both increase the size of the population and the mean length of the fish. A number of factors could be contributing to the failure of northern pike to become established in the Lake. First, and probably the most critical, is the lack of sufficient spawning habitat. Grasses, sedges, and rushes with fine leaves make the best substrate for egg deposition.[21] Because Lac La Belle has a relatively sparse aquatic plant community and heavily developed shoreline,[22] the offers little spawning habitat for the northern pike.[23] Second is the competition for food with other gamefish species, which may be exacerbated by the stocking of northern pike. The food and space available to support northern pike is limited in most waters, and overstocking or high densities of pike may increase the susceptibility of these fish to parasitic infection or exceptionally high mortality from other causes.[24] The WDNR has stocked northern pike into Lac La Belle since 1990, as noted in Table 27, and these fishes have exhibited a growth regime that shows that the northern pike were generally growing at the same rate as the statewide average rates of growth for pike, which indicates that the growth rates for pike are good, but that reproduction is unlikely to be self-sustaining.

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[18]*Wisconsin Chapter of the American Fisheries Society,* Biological Statistics for Fisheries Management Workshop*, January 13-14, 2003.*

[19]*William J. Michalek, Jr. and Martin P. Engel,* Lake Mallalieu, WDNR Comprehensive Lake Survey Report, St Croix County, Wisconsin 2001*, May 2002.*

[20]*G.C. Becker,* Fishes of Wisconsin*, University of Wisconsin Press, 1983.*

[21]Ibid.

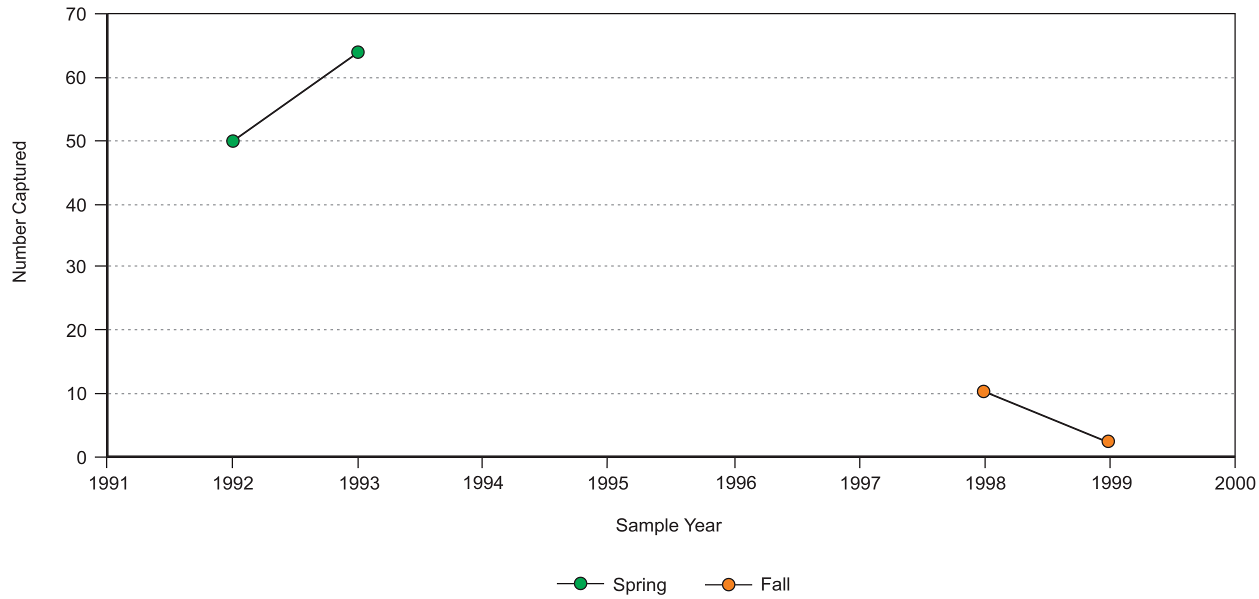
[22]*Wisconsin Department Natural Resources,* Aquatic Plant Management Sensitive Area Assessment Summary*, June 1990.*

[23]*R. Schumacher and S. Beyler, 1999,* op. cit.

[24]*G.C. Becker,* op. cit.

Figure 16

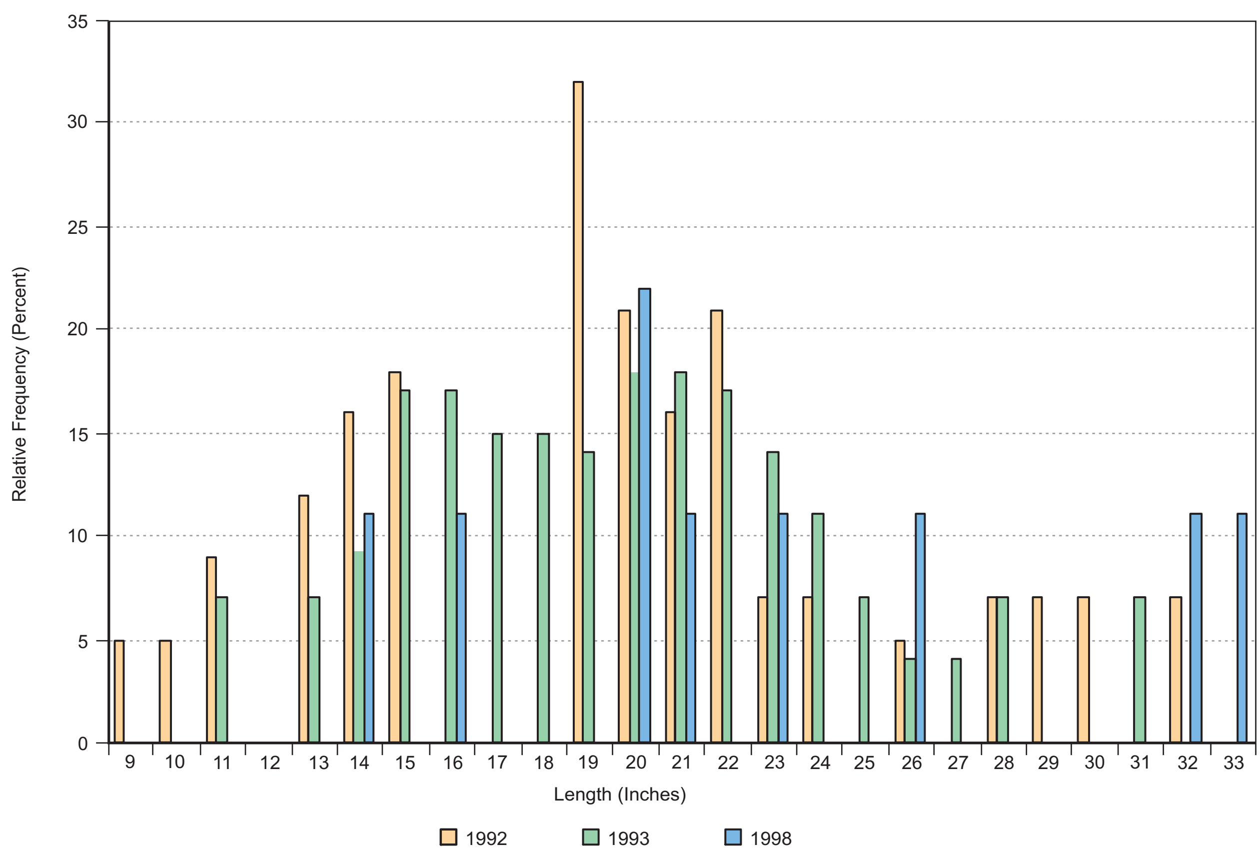
NORTHERN PIKE POPULATION ABUNDANCE IN LAC LA BELLE: 1992-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 17

NORTHERN PIKE LENGTH DISTRIBUTION IN LAC LA BELLE: 1992-1998



Source: Wisconsin Department of Natural Resources and SEWRPC.

Largemouth bass populations are relatively small in Lac La Belle, as shown in Figure 18. Spring fyke net lifts in 1992 and 1993 averaged about 0.4 largemouth bass per net night and electrofishing CPE averaged about three per hour, which rates are not dissimilar to those recorded during the 1998 and 1999 surveys, which reported an average electrofishing CPE of about five per hour. This suggests that largemouth bass abundances have remained relatively constant over this period. Largemouth bass ranged in length from three to 20.8 inches in 1993 and all size ranges were represented, although fishes greater than 14 inches were rare, as shown in Figure 19. In the 1998 survey, there were no individuals greater than 14 inches in length, most likely due to the high amount of angling pressure seen at Lac La Belle.[25] During this period, the average size of largemouth bass decreased from about 12 inches to about eight inches in length. Largemouth bass growth rate data for the spring of 1993 compared to the mean length at age for other WDNR Southeast Region lakes, indicating that these fishes were growing at near or slightly below average. Despite supplemental stocking as recently as 1997, this species continues to produce very few fishes of lengths greater than the 14-inch legal size limit, as shown in Table 27. Several factors may be responsible for this size distribution pattern, including limitation of food and/or intense angling pressure.

Walleyed pike are a highly sought after gamefish and much of the fishery management effort has been targeted toward the development and maintenance of a healthy and productive walleye fishery. The WDNR has regularly stocked walleye into the Lake since 1981, as noted in Table 29. About 2.5 million fry and fingerlings, equivalent to more than 1,100 pounds of fish, were stocked into the Lake during the 1980s. In addition, the WDNR has regulated the harvest of walleye through special size and bag limits, as well as installed artificial onshore reefs to provide spawning habitat for adult walleye. Adult walleye population abundance has increased since 1981, seeming to peak in the late 1980s and early 1990s and again in the late 1990s, as shown in Figure 20. The maximum population of about 20 walleye per mile is equivalent to a population estimate of less than one walleye per acre. Since the early 1990s, walleye fingerling and adult abundances seem to fluctuate from about five to ten walleye per mile, despite continued stocking an average of approximately 60 fingerling per acre every other year.[26] The objective of these interventions has been to obtain a population density of two adult walleye per acre.[27]

Such fluctuations in walleye abundance as summarized above are not uncommon and reflect mortality, especially during incubation and the transition from pelagic (open water) to demersal (shoreland) that occurs between the time of hatching in the spring and the first fall season.[28] Walleye move offshore after hatching and become widespread, especially within about six feet of the water surface. After mid-June, walleye tend to become progressively demersal and move inshore at night. Fall abundances of walleye in the age-0 year class have been shown to be directly related to spring abundances of walleye and *Daphnia*, a zooplankter, in Escanaba Lake, Wisconsin, as shown in Figure 21.[29] Stocked walleye are often cannibalized during this period, especially in years when yellow perch were scarce.[30] Figure 20 suggests that this type of predation may be occurring in Lac La Belle,

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[25]*R. Schumacher and S. Beyler, 1999,* op. cit.

[26]*R. Schumacher and S. Beyler, 1993,* op. cit.

[27]*R. Schumacher and S. Beyler, 1999,* op. cit.

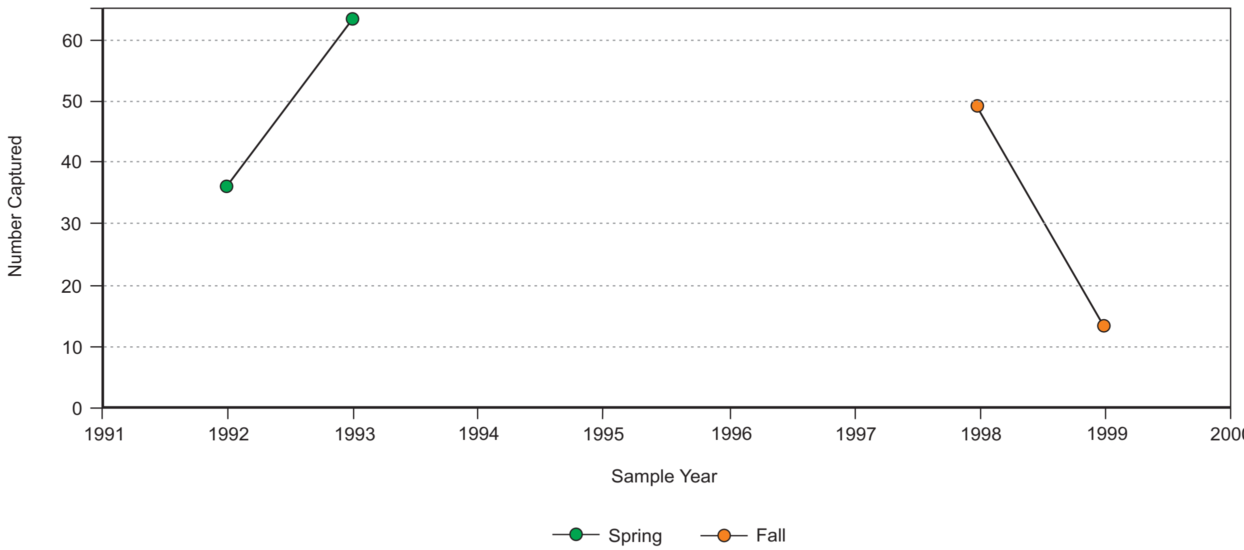
[28]*Wisconsin Department of Natural Resources Publication No. PUB-SS-584,* Walleye Fry Hatching, Diet, Growth, and Abundance in Escanaba Lake, Wisconsin, 1985-1992, *Research Report 184, December 2000.*

[29]Ibid.

[30]*J. Kampa and M. Jenning.* A Review of Walleye Stocking Evaluations and Factors Influencing Stocking Success, *Wisconsin Department of Natural Resources, Research Report 178, December, 1998; and J.L. Forney,* Year-class formation in the walleye *(Stizostedion vitreum vitreum)* population of Oneida Lake, New York, 1966-73. *Journal of the Fisheries Research Board of Canada, Volume 33, pages 783-792, 1976.*

Figure 18

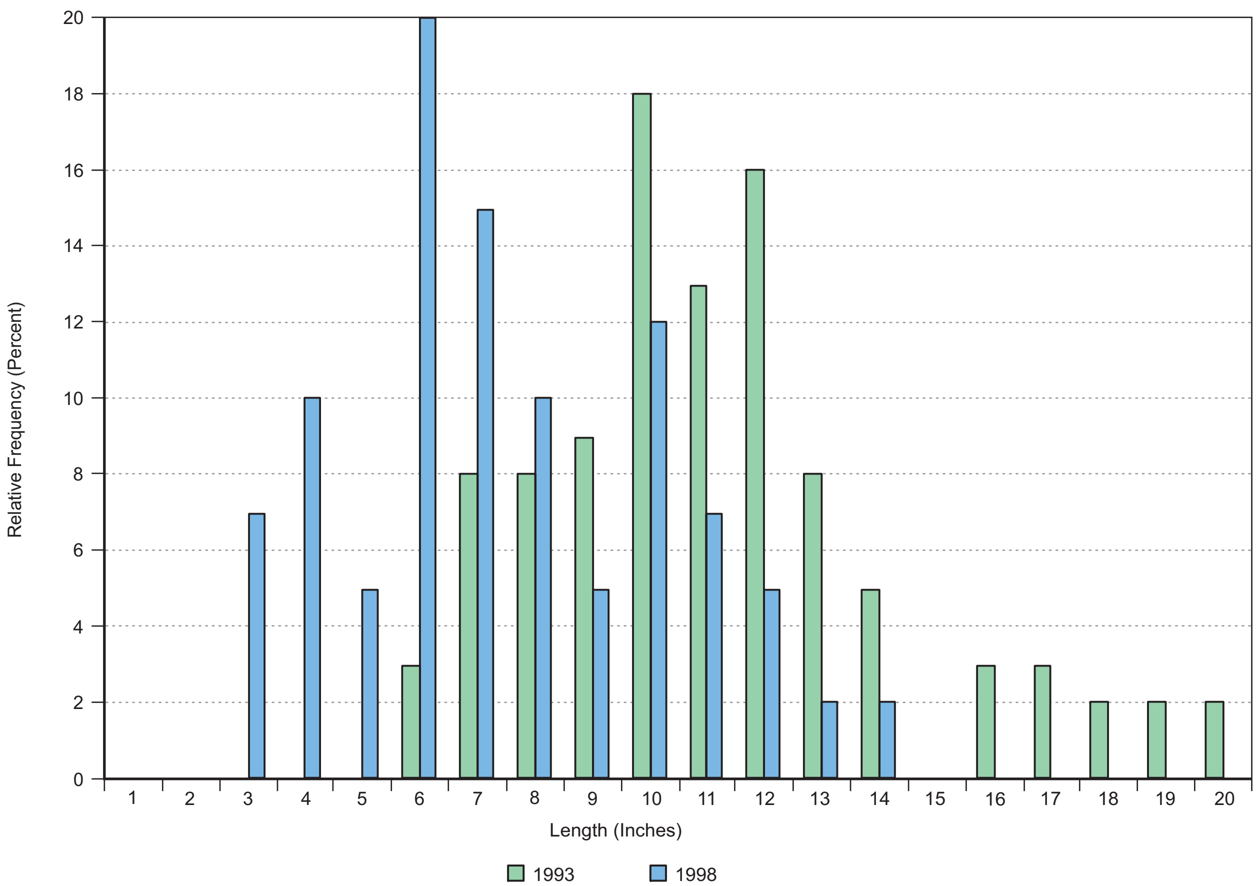
LARGEMOUTH BASS POPULATION ABUNDANCE IN LAC LA BELLE: 1992-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 19

LARGEMOUTH BASS LENGTH DISTRIBUTION IN LAC LA BELLE: 1993-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 29

WALLEYED PIKE STOCKED INTO LAC LA BELLE: 1981-1999

Year	Walleyed Pike (number and size)
1981	2,200,000 fry
1982	68,000 fingerlings
1983	- -
1984	48,930 fingerlings
1985	49,230 fingerlings
1986	40,355 fingerlings
1987	37,700 fingerlings
1988	11,000 fingerlings
1989	42,750 fingerlings
1990	67,366 fingerlings
1991	50,000 fingerlings
1992	50,600 fingerlings
1993	- -
1994	51,330 fingerlings
1995	- -
1996	60,145 fingerlings
1997	- -
1998	116,000 fingerlings
1999	- -
Total	2,200,000 fry, and 693,406 fingerlings

Source: Wisconsin Department of Natural Resources and SEWRPC.

especially in years when fingerling abundances are low and adult populations are high, as in 1999. Stocking could also be providing food for other predatory fishes whose numbers are kept higher by stocking, a phenomenon that has been observed in a number of Wisconsin lakes that were originally bass lakes and subsequently planted with walleye. In those lakes, as walleye declined, the bass increased, which is what has been observed in Lac La Belle.[31] The oligo-mesotrophic character of Lac La Belle, and low abundances of yellow perch in the Lake also may contribute to the low abundances of walleye, despite the intensive stocking efforts. This suggests that Lac La Belle is unlikely to be able to sustain an abundant and productive walleye population.

Similar to the trend observed statewide, the average size of walleye in Lac La Belle has decreased since the early 1990s, as shown in Figure 22. Walleye ranged in length from six inches to 26 inches during the 1992 and 1993 surveys, with all size ranges represented, although fishes greater than 20 inches were rare. During the more recent surveys, no individuals greater than 19 inches in length were recorded, most likely due to the intensive angling pressure at Lac La Belle.[32] During this period, the average size of walleye decreased from about 15 inches to about 13.5 inches in length, which is also consistent with the statewide trends summarized above. This suggests that the 20-inch size limit for walleyes, in effect since 1991, led, initially, to an increase in the number of adult walleye, especially females, but that, over time, angling mortality has been shifted toward the larger, predominantly female walleye. These females will have had at least two to three spawning seasons before being vulnerable to angling. In this regard, there is evidence that some natural reproduction is occurring. Since 1993, a small population of fingerlings has been recorded during the WDNR surveys, as shown in Figure 20. However, given the angling pressure on Lac La Belle, it is unlikely that this level of reproduction is sufficient to maintain a fishable walleye population without supplemental stocking.[33] Consequently, the WDNR increased the stocking of walleye fingerlings from a rate of 50 fingerlings per acre to a rate of 100 fingerlings per acre,[34] with fingerlings being stocked annually through 1993 and in alternate years since. Stocking success has been variable, as shown in Figure 20.

Although the adult walleye population has been fluctuating over time, the sex ratio has remained highly skewed toward males. In 1989, 78 percent of the adult population was male, with a sex ratio of one female for every 3.5 males. In 1993, male walleye made up more than 71 percent of the adult population, with a sex ratio of one female for every 2.5 males. The greatest fraction of adult females was observed in 1992 when females made up about 37 percent of the adult population. During this time, the sex ratio was one female for every 1.7 males. The

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[31] *G.C. Becker,* op. cit.

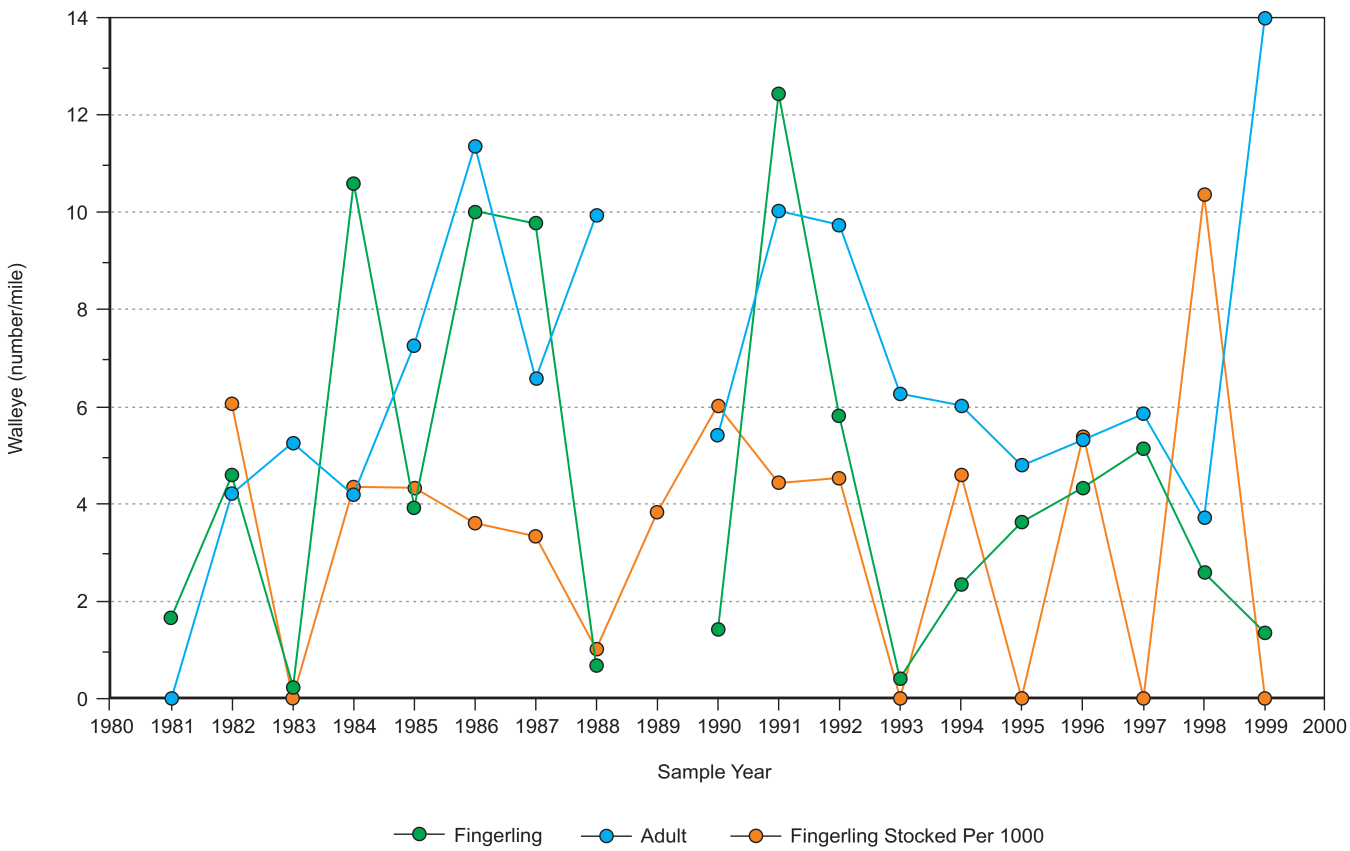
[32] *R. Schumacher and S. Beyler, 1999*, op. cit.

[33] *Sue Beyler and Steve Gospodarke, 2000,* op. cit.

[34] *R. Schumacher and S. Beyler, 1999,* op. cit.

Figure 20

RELATIVE ABUNDANCE OF FINGERLING, ADULT, AND STOCKED FINGERLING WALLEYE NUMBERS PER MILE WITHIN LAC LA BELLE: 1981-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

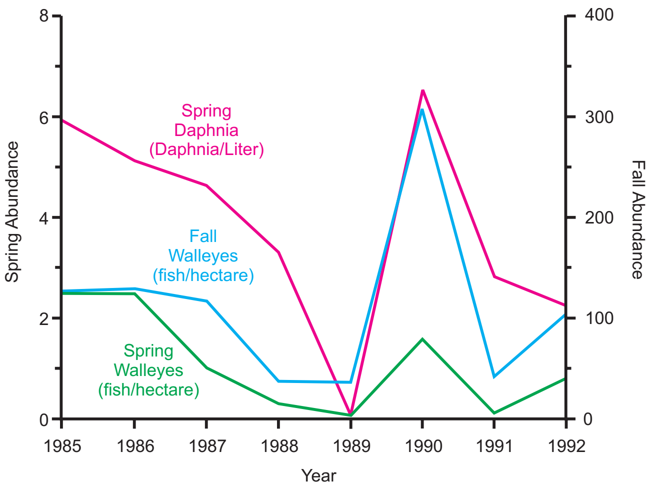
cause of this skew is not clear. While most of the walleye harvested during 1992 were females, the numbers harvested were too low to account for this difference. In 1992, only 27 legal-sized walleye were harvested from Lac La Belle.

The surveys conducted between 1987 and 1993 were in part designed to evaluate the effectiveness of artificial spawning reefs placed to enhance the walleye population abundance within Lac La Belle. As shown on Map 18, there were three sites used as natural reef control or reference sites, including the Islandale, Kohl's Point, and Monastery site. Two sites created in 1989, the Dam and Blackhawk sites, were artificial reef sites. Figure 23 shows the walleye catch rates (number per net-night) from the two artificial reef sites between 1989 and 1993 compared to the rates from the three natural sites. The results indicate that Kohl's Point is not an attractive natural spawning site, never achieving a density of more than one fish per net-night over all years sampled. However, two of the natural control sites, Islandale and Monastery, attracted more walleye than any other site, generally containing double the number of walleye spawning compared to any other site. The artificial spawning sites, Dam and Blackhawk, have not been successful in attracting adult walleye. While the Blackhawk reef attracted a greater percentage of females than the Dam reef, the sex ratio was generally heavily skewed toward males, suggesting that very little natural reproduction is occurring on the artificial reefs. Consequently, these reefs are not significantly contributing to natural reproduction of walleye within Lac La Belle.

Yellow bass and white bass (*Morone chrysops*) are cyclical in their abundance within Lac La Belle. During the spring of 1992, there were in excess of 1,000 yellow bass in a single net haul, and the population seemed to be

Figure 21

SPRING AND FALL ABUNDANCE OF AGE-0 WALLEYES AND SPRING ABUNDANCE OF DAPHNIA WITHIN ESCANABA LAKE, WISCONSIN: 1985-1992



Source: Wisconsin Department of Natural Resources and SEWRPC.

dominated by a single year class of about seven inches in length. Yellow bass far exceeded white bass abundance. Few yellow bass were reported in earlier surveys, and they are not included in the WDNR survey of 1981,[35] or in the 1982 creel survey.[36] Subsequently, during the 1993 fyke net survey, only one yellow bass and two white bass were captured, but, during 1998 and 1999, yellow bass once again became the most abundant gamefish, with no white bass being captured. The average lengths of yellow bass have decreased from about seven inches in 1992 to about four inches in 1999, as shown in Figure 24, and these fishes are no longer desirable for anglers.[37]

Panfish

Black crappie populations are small in Lac La Belle, as shown in Figure 25. Spring fyke net lifts in 1992 and 1993 averaged about five black crappie per night and electrofishing CPE averaged about four black crappie per hour. The 1998 and 1999 surveys indicated an average electrofishing CPE of about two black crappie per hour. While the WDNR stocked nearly one-half million bluegill into the Lake between 1987 and 1991 to enhance the forage base, the number of black crappie has dropped to pre-stocking population levels.[38] Black crappie ranged in size from 3.8 to 10.6 inches in length in 1993. In 1998, the length distribution ranged from 2.8 to 3.5 inches, as shown in Figure 26. Only one fish, of 8.1 inches in length, was captured in 1999. Growth rates computed for the spring of 1993 and spring of 1994 show that these fishes were growing one year behind the statewide average rates of growth for black crappie.[39] Several factors may be responsible for the below-average growth rate and decline in numbers of the black crappie population, including limitations of food and/or aquatic habitat.

Bluegill populations are relatively small in Lac La Belle, as shown in Figure 27. Spring fyke net lifts in 1992 and 1993 averaged about 13 bluegill per net-night and electrofishing CPE averaged about nine per hour. Similarly, during 1998 and 1999, the electrofishing CPE averaged about 16 per hour, which shows that bluegill abundances have remained relatively constant over this period. Bluegill ranged in size from three to eight inches in length in 1993, as shown in Figure 28. By 1999, however, there were no fish greater than six inches in length. The absence of large adult bluegill could be the result of intensive fishing pressure, with the larger fish being harvested from the Lake. The lack of aquatic vegetation also may be responsible for low recruitment into the population.

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[35]*Donald Fago, Fish Distribution Survey, Bureau of Fisheries, Research Section, 1981.*

[36]*Randy Schumacher and Rick Randall,* Results of a Summer, 1982, Random/Stratified Creel Census on Lac La Belle, Waukesha County, *Wisconsin Department of Natural Resources Memorandum, March 1985.*

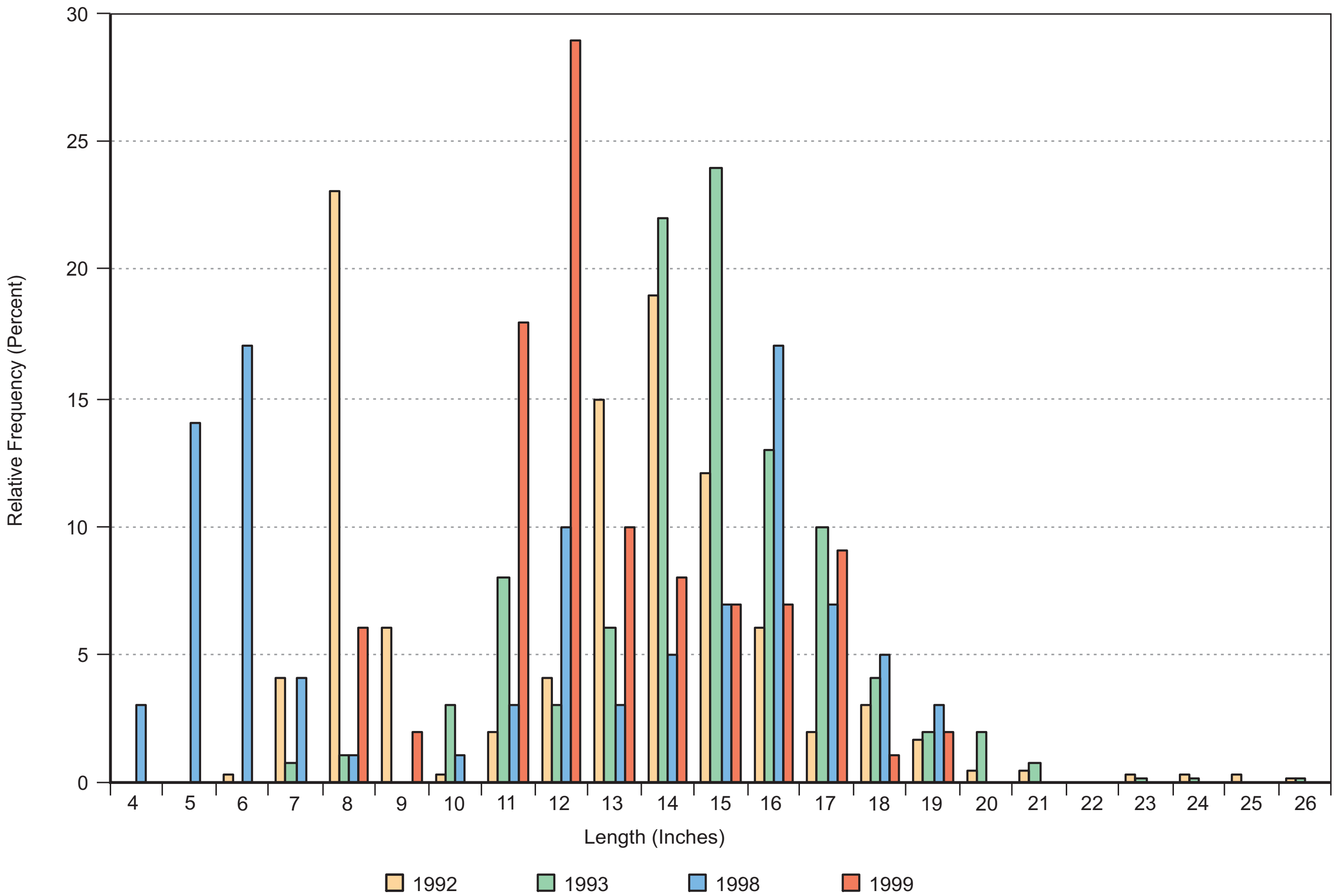
[37]*Sue Beyler and Steve Gospodarek, 2000,* op. cit.

[38]*R. Schumacher and S. Beyler, 1999*, op. cit.

[39]*R. Schumacher and S. Beyler,* Lac La Belle Fyke Net Survey, Spring 1993, *Wisconsin Department of Natural Resources Memorandum, July 1994.*

Figure 22

WALLEYE LENGTH DISTRIBUTION IN LAC LA BELLE: 1992-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Yellow perch populations continue to remain relatively low in Lac La Belle, as shown in Figure 29. Spring fyke net lifts in 1992 and 1993 averaged about 0.2 yellow perch per night. The 1998 and 1999 electrofishing CPE averaged about 38 yellow perch per hour of sampling. Yellow perch ranged in size from three to nine inches in length in 1993, as shown in Figure 30. By 1998, however, there were no individuals greater than five inches in length, mostly likely due to heavy predation by walleye and/or intensive harvesting by anglers.[40] During this time, the average size of yellow perch decreased from about eight inches to about three inches. Consequently, the yellow perch fishery does not seem to be self-sustaining and is poorly represented, most likely due to heavy predation.

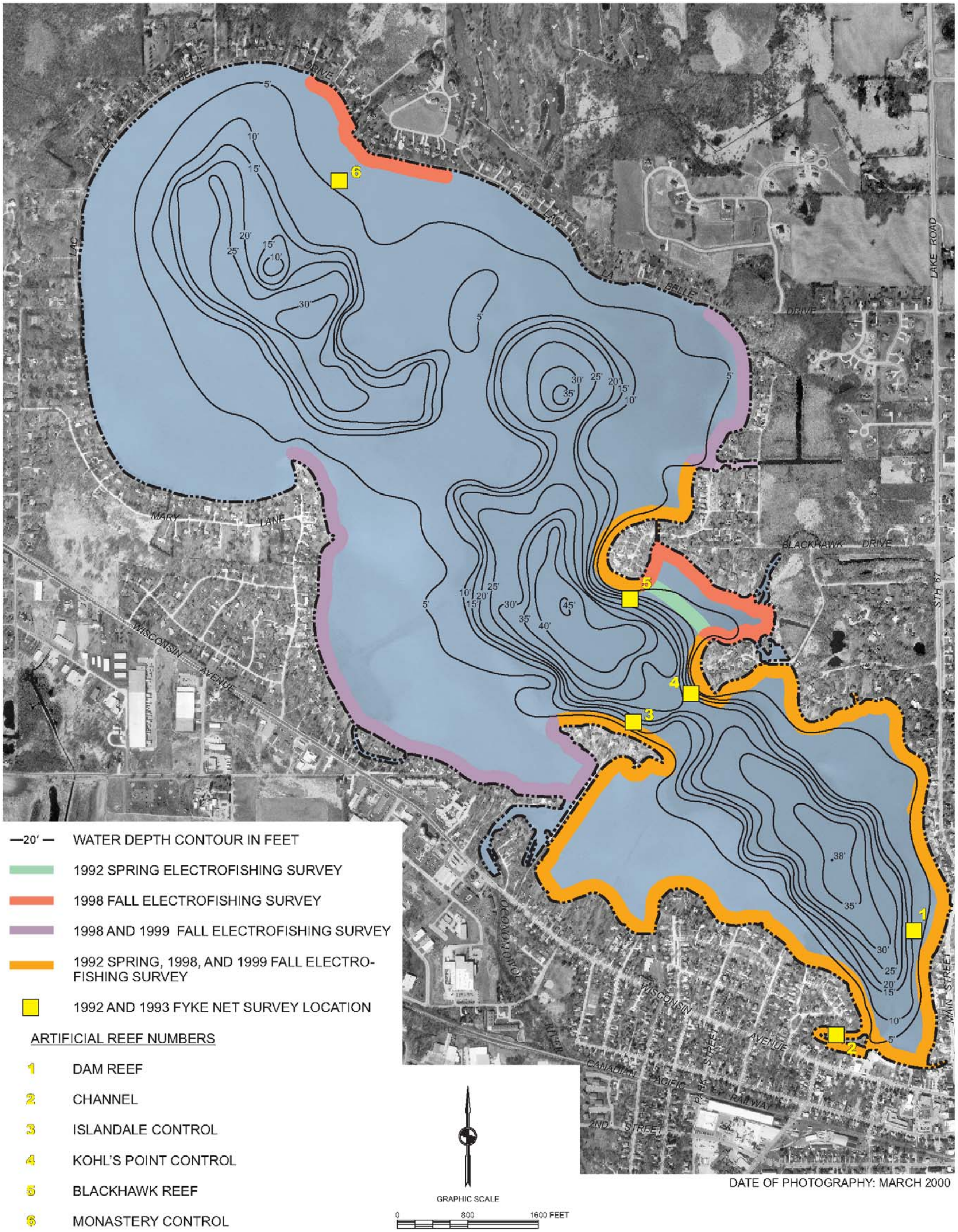
Roughfish

Common carp in Lac La Belle have been an ongoing concern. During 1986 and 1987, the Department treated the Lake with rotenone for carp control and removed 58,000 of these fish. In addition, flathead catfish were introduced during 1989 and 1990 as a natural carp predator. Despite these efforts, the carp population continued to increase. Carp appeared to be more abundant following the 1998 fishery rehabilitation project, with large numbers of young carp being observed in the population, as shown in Figure 31, suggesting that natural

[40]*R. Schumacher and S. Beyler, 1993,* op. cit.

Map 18

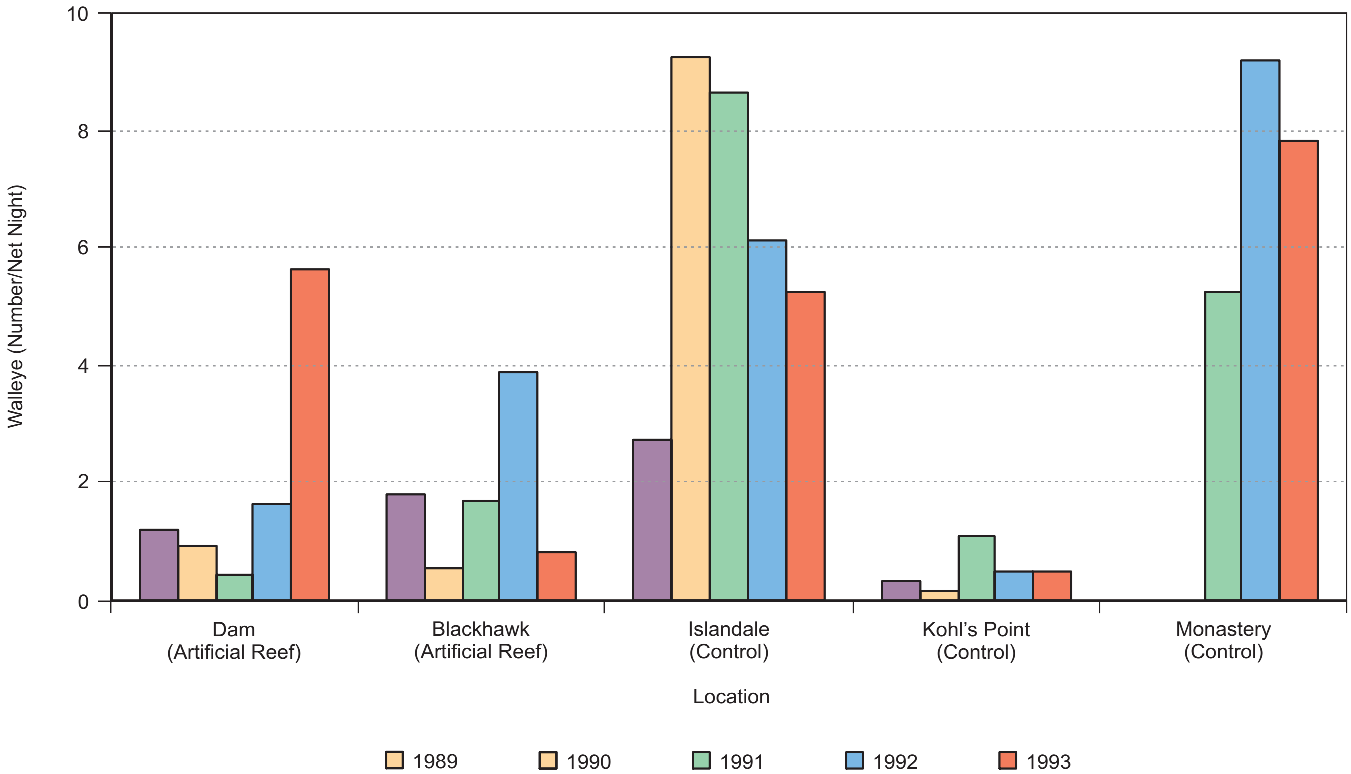
LOCATIONS OF ARTIFICIAL REEFS IN LAC LA BELLE: 1993



Source: SEWRPC.

Figure 23

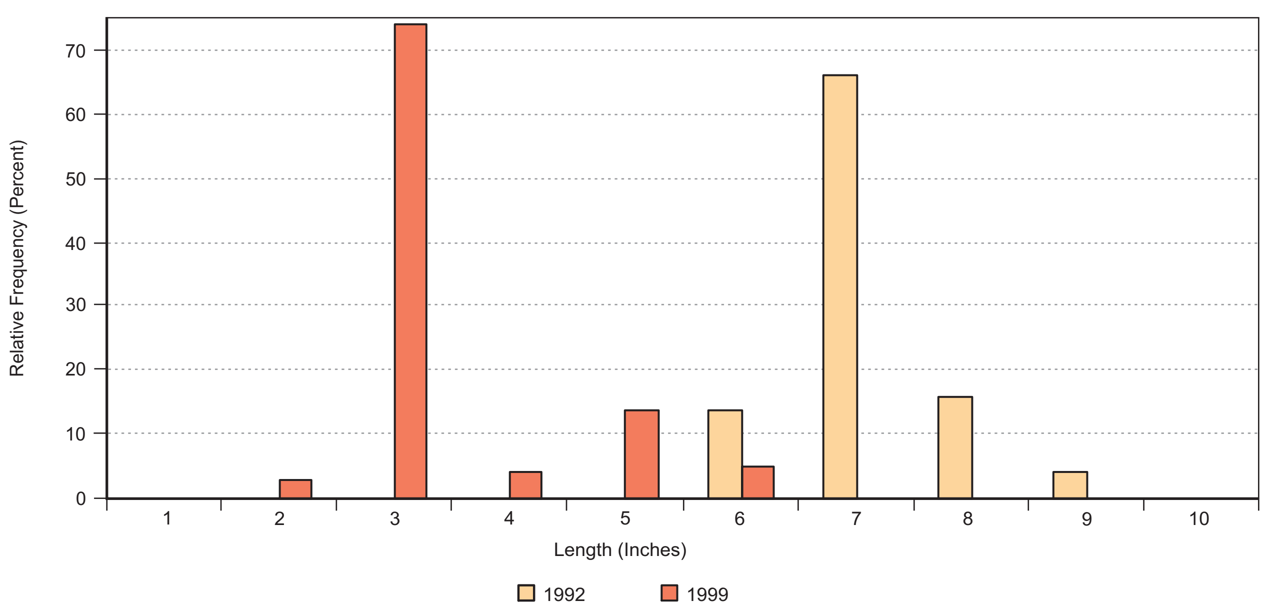
WALLEYE ABUNDANCE AMONG NATURAL REEF (CONTROL SITES) AND ARTIFICIAL REEF SITES WITHIN LAC LA BELLE: 1989-1993



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 24

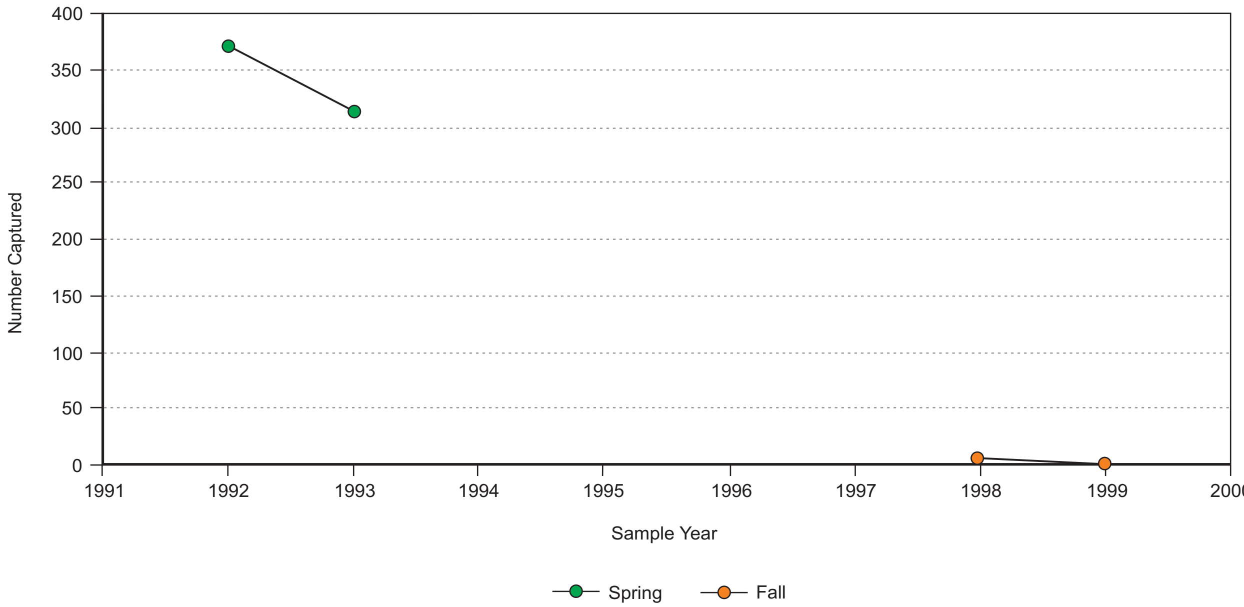
YELLOW BASS LENGTH DISTRIBUTION IN LAC LA BELLE: 1992-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 25

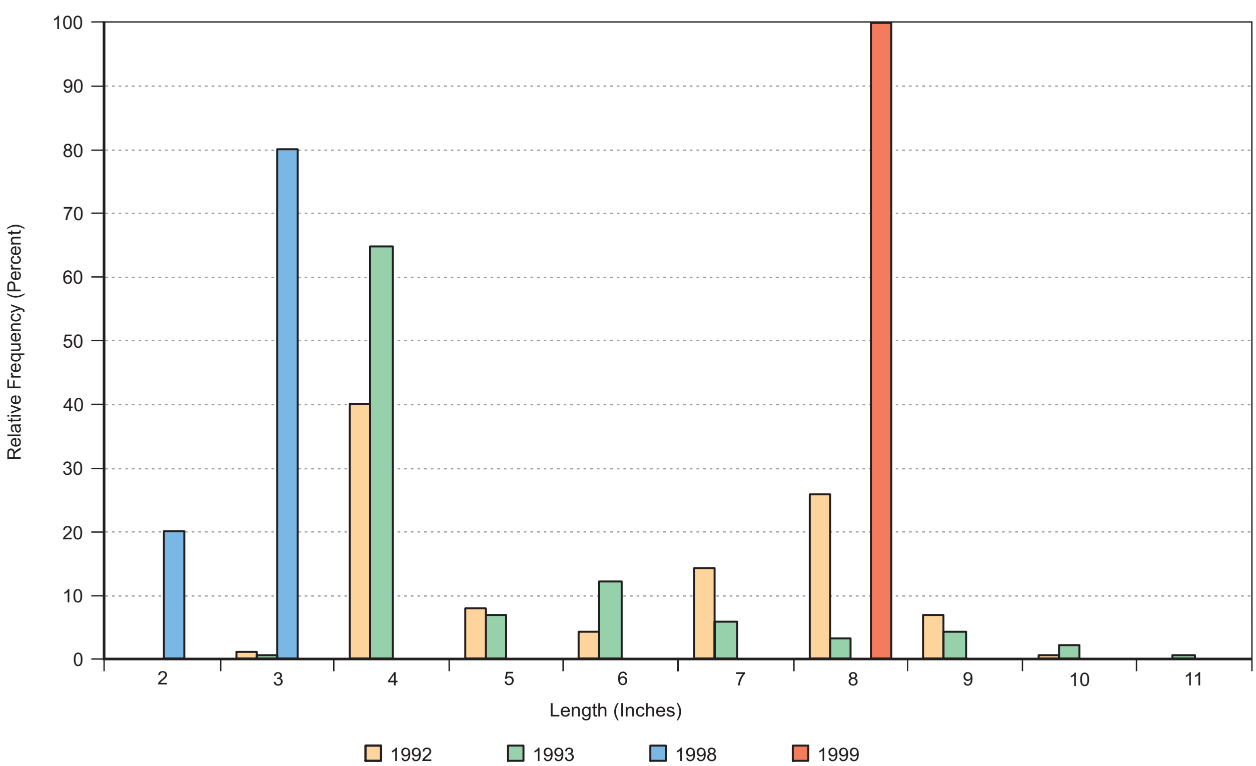
BLACK CRAPPIE POPULATION ABUNDANCE IN LAC LA BELLE: 1992-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 26

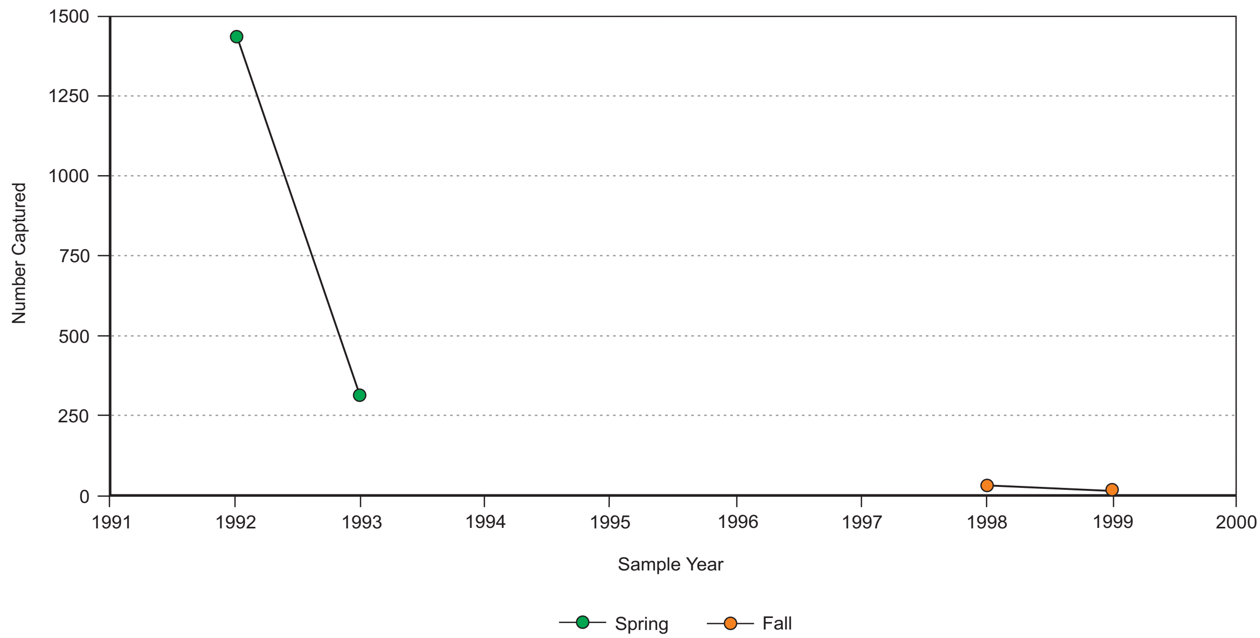
BLACK CRAPPIE LENGTH DISTRIBUTION IN LAC LA BELLE: 1992-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 27

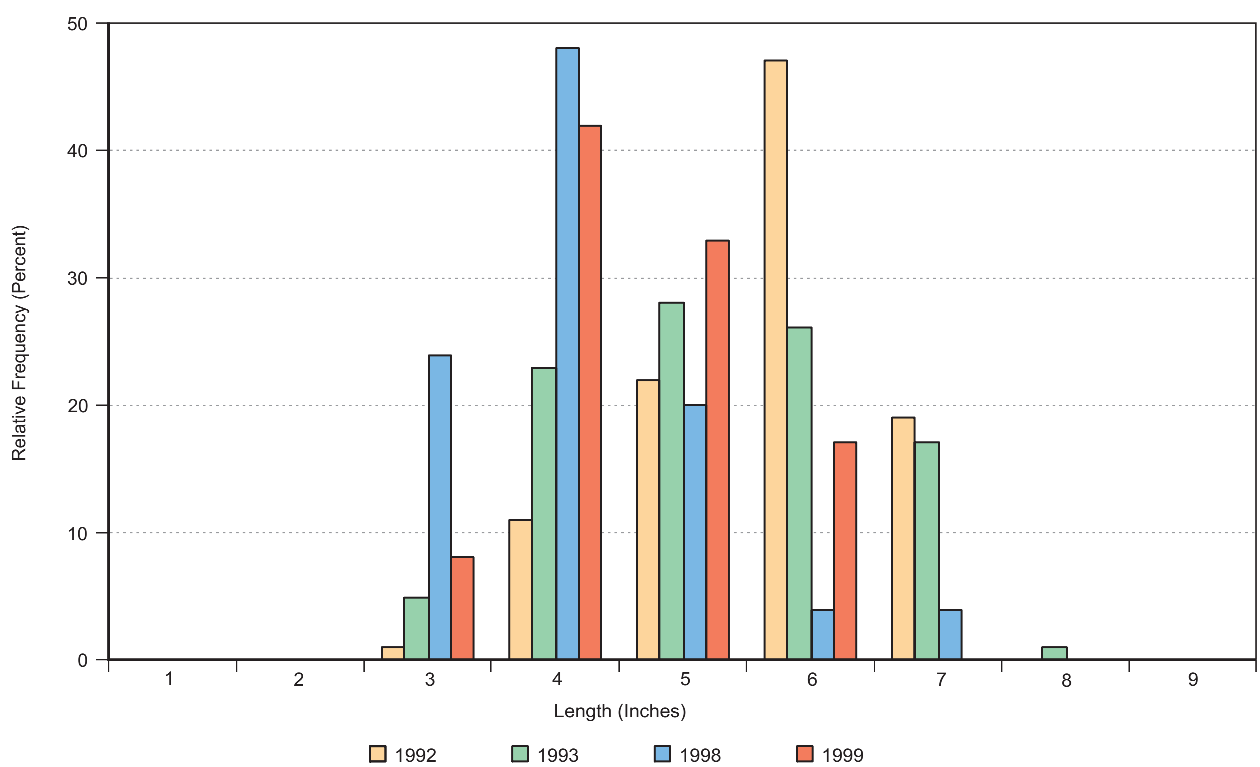
BLUEGILL POPULATION ABUNDANCE IN LAC LA BELLE: 1992-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 28

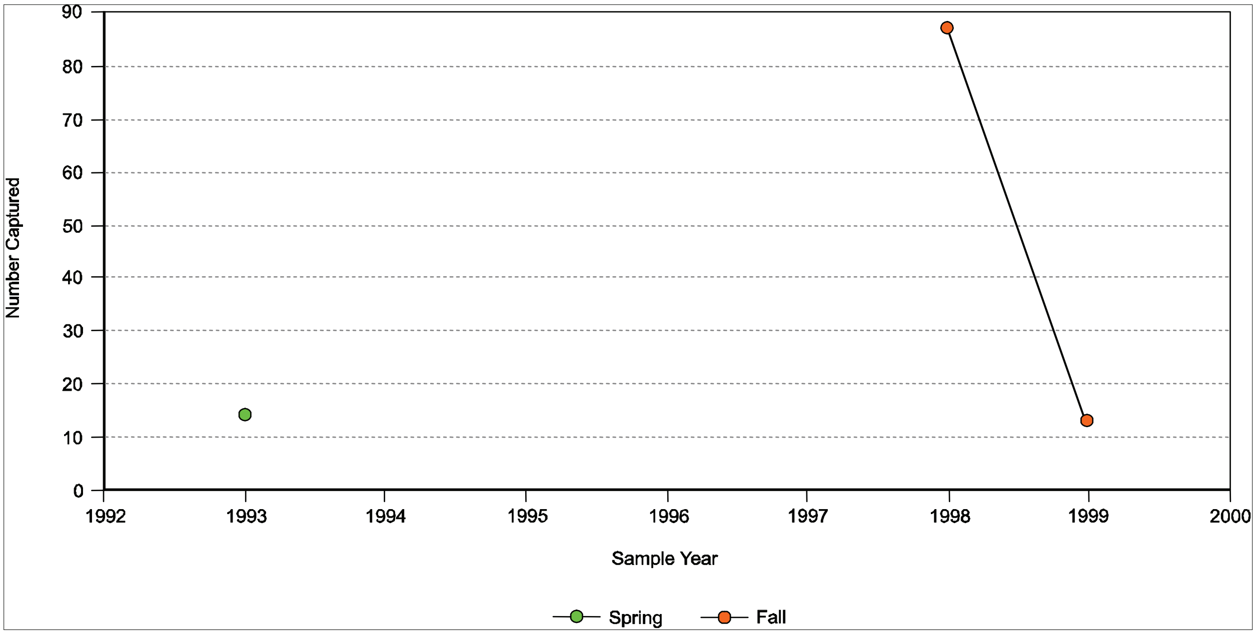
BLUEGILL LENGTH DISTRIBUTION IN LAC LA BELLE: 1992-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 29

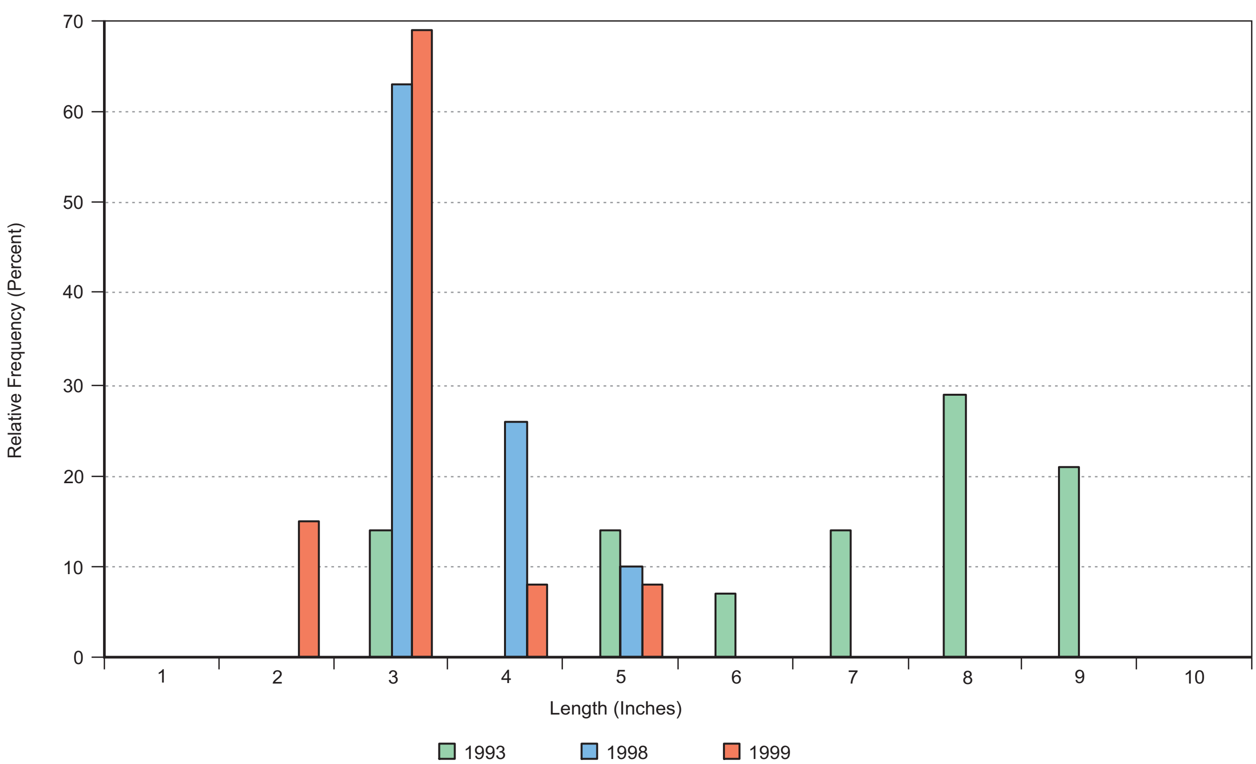
YELLOW PERCH POPULATION ABUNDANCE IN LAC LA BELLE: 1993-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 30

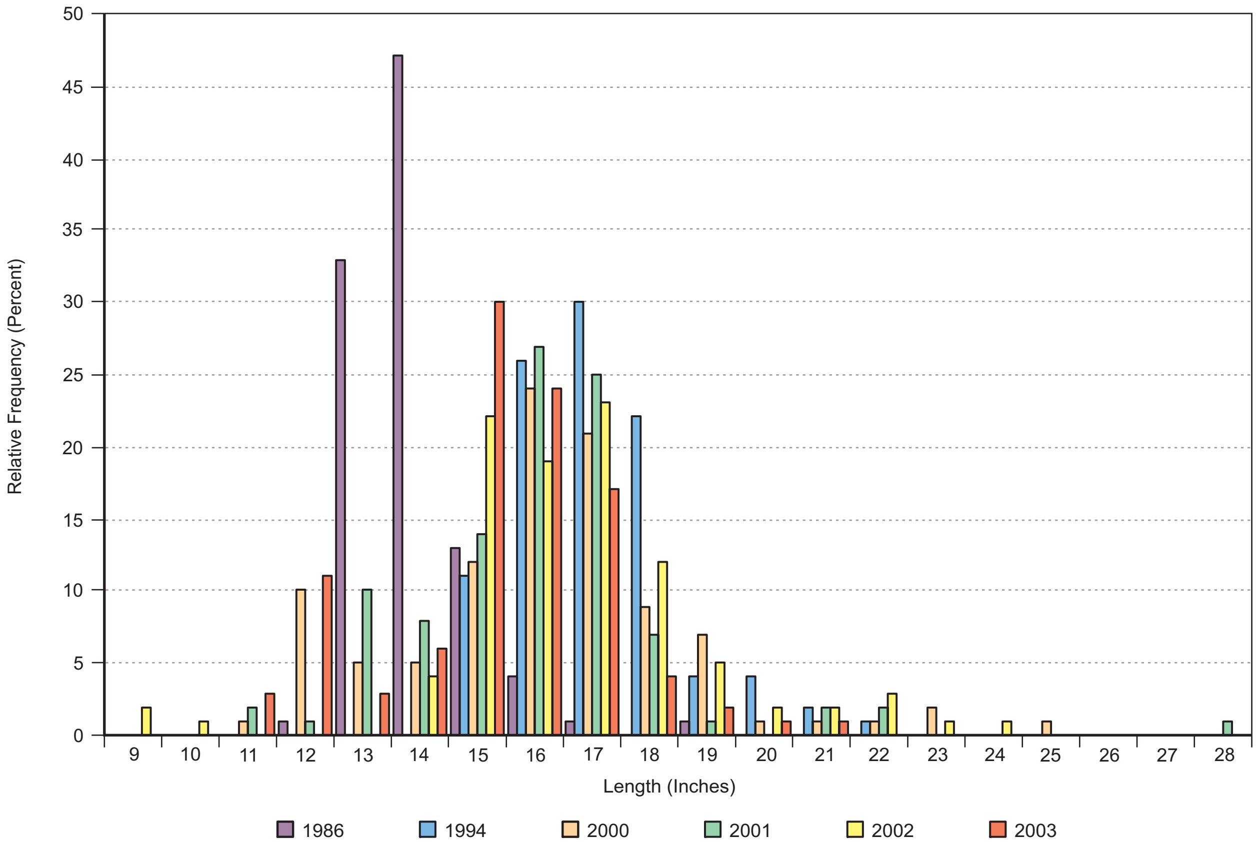
YELLOW PERCH LENGTH DISTRIBUTION IN LAC LA BELLE: 1993-1999



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 31

CARP LENGTH DISTRIBUTION IN LAC LA BELLE: 1986-2003



Source: Wisconsin Department of Natural Resources and SEWRPC.

reproduction is occurring. Since 1984, the mean length of carp has increased from 14.7 inches to approximately 17 inches, as shown in Figure 32, with a concomitant increase in average weight to about two pounds (one kilogram). This suggests that not only are the carp growing quickly, but that they are also very healthy. This led to increased efforts by WDNR staff to limit the carp population in Lac La Belle through the construction of the electric barrier and the conduct of rotenone treatments throughout the Lake.

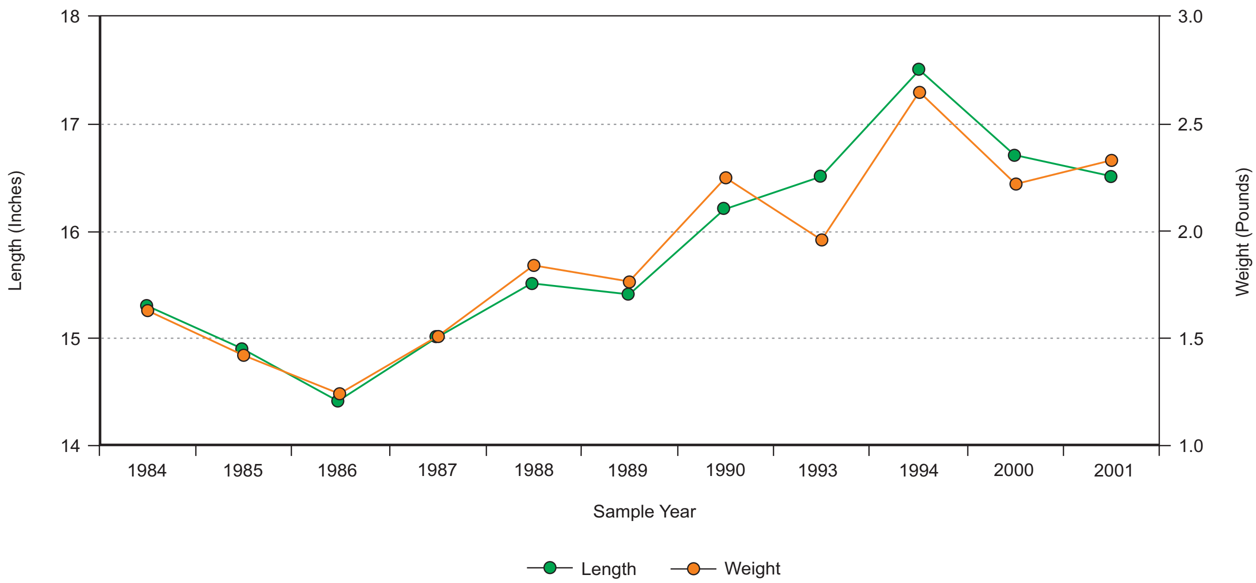
Since the 1992 creel survey, there has been a dramatic decrease in the number and abundance of roughfish species in Lac La Belle. During the early 1990s, there were six species of roughfishes reported, including bowfin, catfish, carp, gar, and sucker, as summarized in Table 27. During the more recent surveys, common carp and flathead catfish were the only roughfish species recorded in Lac La Belle. Declines in these fishes, with the exception of carp, are most likely related to low productivity and limited habitat within the Lake.

Fisheries Management

Fisheries management in Lac La Belle has focused on two aspects; namely, maintenance of the gamefishery and control of the carp population. The Lake has been regularly stocked, with bluegill, bullhead, largemouth bass, smallmouth bass, walleye and crappie being stocked into the Lake prior to 1946, and walleye being stocked periodically since 1946. Walleye were stocked as fingerlings in 1951, 1952, 1957, and 1960, and during recent years since 1982, with the exception of 1983, 1984, 1993, 1997, and 2000; and, as fry between 1962 and 1981, as summarized in Table 30. As of 1999, ongoing stocking was recommended by the WDNR, given the angling pressure experienced on Lac La Belle.

Figure 32

COMMON CARP MEAN LENGTH AND WEIGHT IN LAC LA BELLE: 1984-2001



Source: Wisconsin Department of Natural Resources and SEWRPC.

The WDNR has engaged in carp control on Lac La Belle since 1974, when the first—mechanical—carp barrier was installed on the Oconomowoc River; an electrical carp barrier was subsequently installed at this site during 1987. A chemical eradication of carp was conducted in the Oconomowoc River downstream of the Lake during 1974, and an in-lake and instream treatment was conducted during 1986 and 1987, with an estimated 60,000 carp being removed during the latter treatment period. A further electric carp barrier was installed in 2003 to prevent the migration of carp from the Oconomowoc River into the Lake, and additional chemical treatments for carp control were initiated by the WDNR during 2004 in the Oconomowoc River between the outlet of Lac La Belle and the fish barrier. Rotenone treatment of about 128 acres of lake surface area, in seven locations, is planned.

Based upon the comprehensive fishery and creel surveys conducted in Lac La Belle, the WDNR proposed the following ongoing fisheries management measures in Lac La Belle:[41]

- Continued, alternate year stocking of walleye at a rate of 100 fingerlings per acre to maintain the fishery and provide carp control through predation; however, reduction of this stocking rate to 35 fingerlings per acre is proposed beginning in the year 2005;
- Continued, fall walleye fingerling surveys as part of the WDNR baseline monitoring program, which includes fall electrofishing and mini-fyke netting during summer at 6-year intervals, beginning in 2005;
- Continued stocking of northern pike at a rate of about two fingerling per acre each year;
- Field transfer of yellow perch, if sources and funding are available;

[41]*Sue Beyler, Fisheries Manager for the Wisconsin Department of Natural Resources Southeast Region, (personal communication), January 2005.*

Table 30

FISH STOCKED INTO LAC LA BELLE: 1950-2003[a]

	Bluegill				Panfish				Largemouth Bass			
Year	Number	Pounds	Size (inches)	Age[b]	Number	Pounds	Size (inches)	Age[b]	Number	Pounds	Size (inches)	Age[b]
1951	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1952	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1957	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1960	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1962	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1963	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1965	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1967	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1976	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1977	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1981	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1982	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1983	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1984	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1985	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1986	- -	- -	- -	- -	- -	- -	- -	- -	13,500	5.3	1.0	Fingerling
1987[b]	6,896	530.5	4.0	Adult	- -	- -	- -	- -	- -	- -	- -	- -
1988	- -	- -	- -	- -	172,649	10,533	4.5	Adult	- -	- -	- -	- -
1989	- -	- -	- -	- -	228,926	722	3.0	Adult	- -	- -	- -	- -
1990	- -	- -	- -	- -	44,965	1,726	5.0	Adult	2,000	12.0	3.0	Fingerling
1991	24,500	700.0	3.0	Adult	- -	- -	- -	- -	- -	- -	- -	- -
1992	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1993	- -	- -	- -	- -	9,345	600	4.0	Adult	- -	- -	- -	- -
1994	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1995	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1996	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1997	- -	- -	- -	- -	- -	- -	- -	- -	300	- -	4.0	Fingerling
1998	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
2000	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
2001	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
2002	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

	Northern Pike				Walleye				Flathead Catfish			
Year	Number	Pounds	Size (inches)	Age[b]	Number	Pounds	Size (inches)	Age[b]	Number	Pounds	Size (inches)	Age[b]
1951	- -	- -	- -	- -	5,245	- -	- -	Fingerling	- -	- -	- -	- -
1952	- -	- -	- -	- -	32,060	- -	- -	Fingerling	- -	- -	- -	- -
1957	- -	- -	- -	- -	20,085	- -	- -	Fingerling	- -	- -	- -	- -
1960	- -	- -	- -	- -	21,000	358.5	3.8	Fingerling	- -	- -	- -	- -
1962	- -	- -	- -	- -	2,500,000	- -	- -	Fry	- -	- -	- -	- -
1963	- -	- -	- -	- -	2,500,000	- -	- -	Fry	- -	- -	- -	- -
1965	- -	- -	- -	- -	2,500,000	- -	- -	Fry	- -	- -	- -	- -
1967	- -	- -	- -	- -	4,200,000	- -	- -	Fry	- -	- -	- -	- -
1976	990,000	- -	- -	Fry	4,000,000	- -	- -	Fry	- -	- -	- -	- -
1977	1,150,000	- -	- -	Fry	2,200,000	- -	- -	Fry	- -	- -	- -	- -
1981	1,100,000	- -	0.5	Fry	2,200,000	- -	1.0	Fry	- -	- -	- -	- -
1982	- -	- -	- -	- -	68,750	125.0	3.0	Fingerling	- -	- -	- -	- -
1983	965	135.0	8.0	Fingerling	- -	- -	- -	- -	- -	- -	- -	- -
1984	- -	- -	- -	- -	48,930	53.0	1.0	- -	- -	- -	- -	- -
1985	1,100	119.0	8.0	Fingerling	49,230	379.0	3.0	Fingerling	- -	- -	- -	- -
1986	2,000	95.0	11.0	Fingerling	40,335	265.0	3.0	Fingerling	- -	- -	- -	- -
1987	- -	- -	- -	- -	37,700	130.0	3.0	Fingerling	- -	- -	- -	- -
1988	- -	- -	- -	- -	11,000	55.0	3.0	Fingerling	- -	- -	- -	- -
1989	2,037	272.0	9.0	Fingerling	167	90.0	12.0	Adult	1,210	4,440	18.0	Adult
	- -	- -	- -	- -	42,750	70.0	2.0	Fingerling	- -	- -	- -	- -
1990	- -	- -	- -	- -	67,000	90.0	2.0	Fingerling	1,280	5,395	20.0	Adult
	- -	- -	- -	- -	366	33.0	7.0	Fingerling	- -	- -	- -	- -
1991	2,500	257.7	8.0	Fingerling	50,000	223.0	2.5	Fingerling	- -	- -	- -	- -
1992	4,990	560.0	8.0	Fingerling	50,600	130.0	2.0	Fingerling	- -	- -	- -	- -
1993	5,092	607.0	8.0	Fingerling	- -	- -	- -	- -	- -	- -	- -	- -
1994	1,559	29.9	4.8	Fingerling	240	30.0	7.5	Fingerling	- -	- -	- -	- -
	- -	- -	- -	- -	25,440	80.0	2.3	Fingerling	- -	- -	- -	- -
	- -	- -	- -	- -	23,980	110.0	2.6	Fingerling	- -	- -	- -	- -
	- -	- -	- -	- -	1,670	8.5	2.9	Fingerling	- -	- -	- -	- -
1995	25	- -	18.0	Fingerling	175	- -	7.0	Fingerling	- -	- -	- -	- -
1996	2,100	30.8	4.3	Fingerling	60,075	64.8	1.6	Fingerling	- -	- -	- -	- -
	20	- -	14.0	Fingerling	70	- -	6.0	Fingerling	- -	- -	- -	- -
1997	75	- -	13.0	Fingerling	- -	- -	- -	- -	- -	- -	- -	- -
1998	5,000	76.0	3.9	Fingerling	116,500	466.0	2.3	Fingerling	- -	- -	- -	- -
2000	5,000	29.2	3.2	Fingerling	82,497	39.8	1.2	Fingerling	- -	- -	- -	- -
	- -	- -	- -	- -	3,303	51.0	1.7	Fingerling	- -	- -	- -	- -
2001	2,477	139.0	- -	Fingerling	- -	- -	- -	- -	- -	- -	- -	- -
	7,070	29.0	- -	Fingerling	- -	- -	- -	- -	- -	- -	- -	- -
2002	- -	29.0	3.1	Fingerling	6,400	25.0	2.3	Fingerling	- -	- -	- -	- -

[a] *In 1987, 202 adult Brown Bullhead 11 inches in length equaling 203 pounds were stocked. From 1950 to 1952, 24,790 fingerling Smallmouth Bass were stocked.*

[b] *A fry is a newly hatched fish, a fingerling is a fish in its first year, a yearling is an immature fish.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

- Consideration of opening a fishing season on the stocked flathead catfish that currently remains closed;[42]

- Continued, annual spring assessments of carp in Lac La Belle and the downstream Oconomowoc River to monitor carp condition, and conduct of periodic partial treatments of the Lake and River using rotenone;

- Continued operation and maintenance of the electrical barrier on the Oconomowoc River downstream of Lac La Belle;

- Continued enforcement of the minimum length limit for walleye of 20 inches, with a daily bag limit of one;[43] and,

- Continued enforcement of the combined total bag limit of 15 for bluegill, crappie, pumpkinseed, and yellow perch.[44]

Other Wildlife

Although a quantitative field inventory of amphibians, reptiles, birds, and mammals was not conducted as part of the Lac La Belle study, it is possible, by polling naturalists and wildlife managers familiar with the area, to complete a list of amphibians, reptiles, birds, and mammals which may be expected to be found in the area under existing conditions. The technique used in compiling the wildlife data involved obtaining lists of those amphibians, reptiles, birds, and mammals known to exist, or known to have existed, in the Lac La Belle area, as inventoried, and projecting the appropriate amphibians, reptile, bird, and mammal species into the Lac La Belle area. The net result of the application of this technique is a listing of those species which were probably once present in the tributary area, those species which may be expected to still be present under currently prevailing conditions, and those species which may be expected to be lost or gained as a result of urbanization within the area.

A variety of mammals, ranging in size from large animals, like the northern white-tailed deer, to small animals, like the least shrew, is expected to be found in the Lac La Belle area. Mink, muskrat, beaver, white-tailed deer, red and grey fox, grey and fox squirrel, and cottontail rabbits are mammals reported to frequent the area. Table 31 lists 38 mammals whose ranges are known to extend into the area.

A large number of birds, ranging in size from large game birds to small song birds, also is expected to be found in the Lac La Belle area. Table 32 lists those birds that normally occur in the drainage area. Each bird is classified as to whether it breeds within the area, visits the area only during the annual migration periods, or visits the area only on rare occasions. The Lac La Belle tributary area also supports a significant population of waterfowl, including mallards and Canada geese. Mallards, wood duck, and blue-winged teal are the most numerous waterfowl and are known to nest in the area. Larger numbers move through the drainage area during the annual migrations when most of the regional species may also be present. Many game birds, songbirds, waders, and raptors also reside or visit the Lake or its environs. Osprey and loons are notable migratory visitors.

Because of the mixture of lowland and upland woodlots, wetlands, and agricultural lands still present in the area, along with the favorable summer climate, the area supports many other species of birds. Hawks and owls function as major rodent predators within the ecosystem. Swallows, whippoorwills, woodpeckers, nuthatches, and

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[42]*WDNR,* Guide to Wisconsin Hook and Line Fishing Regulations 2004-2005*,* op. cit.

[43]Ibid*.*

[44]Ibid*.*

Table 31

MAMMALS OF THE LAC LA BELLE AREA

Scientific (family) and Common Name	Scientific Name
Didelphidae	
Virginia Opossum	*Didelphis virginiana*
Soricidae	
Cinereous Shrew	Sorex cinereus
Short-Tailed Shrew	*Blarina brevicauda*
Least Shrew	*Cryptotis parva*
Vespertilionidae	
Little Brown Bat	*Myotis lucifugus*
Silver-Haired Bat	*Lasisoncteris octivagans*
Big Brown Bat	*Eptesicus fuscus*
Red Bat	*Lasiurus borealus*
Hoary Bat	*Lasiurus cinereus*
Leporidae	
Cottontail Rabbit	*Sylvilgus floridanus*
Sciuridae	
Woodchuck	*Marmota monax*
Thirteen-lined Ground Squirrel (gopher)	*Spermophilus tridencemilineatus*
Eastern Chipmunk	*Tamias striatus*
Grey Squirrel	*Sciurus carolinensis*
Western Fox Squirrel	*Sciurus niger*
Red Squirrel	*Tamiasciurus hudsonicus*
Southern Flying Squirrel	*Glaucomys volans*
Castoridae	
American Beaver	*Castor canadensis*
Cricetidae	
Woodland Deer Mouse	*Peromyscus maniculatus*
Prairie Deer Mouse	*Peromyscus leucopus bairdii*
White-Footed Mouse	*Microtus pennsylvanicus*
Meadow Vole	*Microtus ochrogaster*
Common Muskrat	*Ondatra zibethicus*
Muridae	
Norway Rat (introduced)	*Rattus norvegicus*
House Mouse (introduced)	*Mus musculus*
Zapodidae	
Meadow Jumping Mouse	*Zapas hudonius*
Canidae	
Coyote	*Canis latrans*
Eastern Red Fox	*Vulpes vulpes*
Gray Fox	*Urocyon cinereoargenteus*
Procyonidae	
Raccoon	*Procyon lotor*
Mustelidae	
Least Weasel	*Mustela nivalis*
Short-Tailed Weasel	*Mustela erminea*
Long-Tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
Badger (occasional visitor)	*Taxidea taxus*
Stiped Skunk	*Mephitis mephitis*
Otter (occasional visitor)	*Lontra canadensis*
Cervidae	
White-Tailed Deer	*Odecoileus virginianus*

Source: H.T. Jackson, Mammals of Wisconsin*, 1961, U.S. Department of Agriculture Integrated Taxonomic Information System, National Museum of Natural History, Smithsonian Institute, and SEWRPC.*

flycatchers, as well as several other species, serve as major insect predators. In addition to their ecological roles, birds such as robins, red-winged blackbirds, orioles, cardinals, kingfishers, and mourning doves serve as subjects for bird watchers and photographers. Threatened species migrating in the vicinity of Lac La Belle include the cerulean warblers, the Acadian flycatcher, great egret, and the osprey. Endangered species migrating in the vicinity of Lac La Belle include the common tern, Caspian tern, Foster's tern, and loggerhead shrike.

Amphibians and reptiles are vital components of the ecosystem in an environmental unit like the Lac La Belle tributary area. Examples of amphibians native to the area include frogs, toads, and salamanders. Turtles and snakes are examples of reptiles common to the Lac La Belle area. Table 33 lists the 14 amphibians and 15 reptile species normally expected to be present in the Lac La Belle area under present conditions and identifies those species most sensitive to urbanization. Most amphibians and reptiles have specific habitat requirements that are adversely affected by advancing urban development, as well as by certain agricultural land management practices. The major detrimental factors affecting the maintenance of amphibians in a changing environment are the destruction of breeding ponds, urban development occurring in migration routes, and changes in food sources brought about by urbanization.

The complete spectrum of wildlife species originally native to Waukesha County has, along with their habitats, undergone significant change in terms of diversity and population size since the European settlement of the area. This change is a direct result of the conversion of the land by settlers from its natural state to agricultural and urban uses, beginning with the clearing of the forest and prairies, the draining of the wetlands, and ending with the development of extensive urban areas. Successive cultural uses and attendant management practices, both rural and urban, have been superimposed on the land use changes and have also affected the wildlife and wildlife habitat. In agricultural areas, these cultural management practices include draining land by ditching and tiling and the expanding use of fertilizers, herbicides, and pesticides. In urban areas, cultural management practices that affect wildlife and their habitat include the use of fertilizers, herbicides, and pesticides; the use of road salt for snow and ice control; the presence of heavy motor vehicles traffic that produces disruptive noise levels and air pollution and nonpoint source water pollution; and the introduction of domestic pets.

Table 32

BIRDS KNOWN OR LIKELY TO OCCUR IN THE LAC LA BELLE AREA

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Gaviidae			
Common Loon[a]	- -	- -	X
Podicipedidae			
Pied-Billed Grebe	X	- -	X
Horned Grebe	- -	- -	X
Phalacrocoracidae			
Double-Crested Cormorant	- -	- -	X
Ardeidae			
American Bittern[a]	X	- -	X
Least Bittern[a]	X	- -	X
Great Blue Heron[a]	X	R	X
Great Egret[b]	- -	- -	X
Cattle Egret[a,c]	- -	- -	R
Green Heron	X	- -	X
Black-Crowned Night-Heron[a]	- -	- -	X
Anatidae			
Tundra Swan	- -	- -	X
Mute Swan[c]	X	X	X
Snow Goose	- -	- -	X
Canada Goose	X	X	X
Wood Duck	X	- -	X
Green-Winged Teal	- -	- -	X
American Black Duck[a]	- -	X	X
Mallard	X	X	X
Northern Pintail[a]	- -	- -	X
Blue-Winged Teal	X	- -	X
Northern Shoveler	- -	- -	X
Gadwall	- -	- -	X
American Wigeon[a]	- -	- -	X
Canvasback[a]	- -	- -	X
Redhead[a]	- -	- -	X
Ring-necked Duck	- -	- -	X
Lesser Scaup[a]	- -	- -	X
Greater Scaup	- -	- -	R
Common Goldeneye[a]	- -	X	X
Bufflehead	- -	- -	X
Red-breasted Merganser	- -	- -	X
Hooded Merganser[a]	R	- -	X
Common Merganser[a]	- -	- -	X
Ruddy Duck	- -	- -	X
Cathartidae			
Turkey Vulture	X	- -	X
Accipitridae			
Osprey[b]	- -	- -	X
Bald Eagle[a,d]	- -	- -	R
Northern Harrier[a]	X	R	X
Sharp-Shinned Hawk	X	X	X
Cooper's Hawk[a]	X	X	X
Northern Goshawk[a]	- -	R	X
Red-shouldered Hawk[b]	R	- -	X
Broad-Winged Hawk	R	- -	X
Red-Tailed Hawk	X	X	X
Rough-Legged Hawk	- -	X	X
American Kestrel	X	X	X
Merlin[a]	- -	- -	X

Table 32 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Phasianidae			
Grey Partridge[c]	R	R	- -
Ring-Necked Pheasant[c]	X	X	- -
Wild Turkey	X	X	- -
Rallidae			
Virginia Rail	X	- -	X
Sora	X	- -	X
Common Moorhen	X	- -	X
American Coot	X	R	X
Gruidae			
Sandhill Crane	X	- -	X
Charadriidae			
Black-Bellied Plover	- -	- -	X
Semi-Palmated Plover	- -	- -	X
Killdeer	X	- -	X
Scolopacidae			
Greater Yellowlegs	- -	- -	X
Lesser Yellowlegs	- -	- -	X
Solitary Sandpiper	- -	- -	X
Spotted Sandpiper	X	- -	X
Upland Sandpiper[a]	R	- -	X
Semi-Palmated Sandpiper	- -	- -	X
Pectoral Sandpiper	- -	- -	X
Dunlin	- -	- -	X
Common Snipe	R	- -	X
American Woodcock	X	- -	X
Wilson's Phalarope	- -	- -	X
Laridae			
Ring-Billed Gull	- -	- -	X
Herring Gull	- -	X	X
Common Tern[e]	- -	- -	R
Caspian Tern[e]	- -	- -	R
Forster's Tern[e]	- -	- -	R
Black Tern[a]	- -	- -	X
Columbidae			
Rock Dove[c]	X	X	- -
Mourning Dove	X	X	X
Cuculidae			
Black-Billed Cuckoo	X	- -	X
Yellow-Billed Cuckoo[a]	X	- -	X
Strigidae			
Eastern Screech-Owl	X	X	- -
Great Horned Owl	X	X	- -
Snowy Owl	- -	R	- -
Barred Owl	X	X	- -
Strigidae (continued)			
Long-Eared Owl[a]	- -	X	X
Short-Eared Owl[a]	- -	R	X
Northern Saw-whet Owl	- -	- -	X
Caprimulgidae			
Common Nighthawk	X	- -	X
Whippoorwill	- -	- -	X
Apodidae			
Chimney Swift	X	- -	X

Table 32 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Trochilidae			
Ruby-Throated Hummingbird	X	- -	X
Alcedinidae			
Belted Kingfisher	X	X	X
Picidae			
Red-Headed Woodpecker[a]	X	R	X
Red-Bellied Woodpecker	X	X	- -
Yellow-Bellied Sapsucker	- -	R	X
Downy Woodpecker	X	X	- -
Hairy Woodpecker	X	X	- -
Northern Flicker	X	R	X
Tyrannidae			
Olive-Sided Flycatcher	- -	- -	X
Eastern Wood-Pewee	X	- -	X
Yellow-Bellied Flycatcher[a]	- -	- -	X
Acadian Flycatcher[b]	R	- -	X
Alder Flycatcher	R	- -	X
Willow Flycatcher	X	- -	X
Least Flycatcher	R	- -	X
Eastern Phoebe	X	- -	X
Great Crested Flycatcher	X	- -	X
Eastern Kingbird	X	- -	X
Alaudidae			
Horned Lark	X	X	X
Hirundinidae			
Purple Martin[a]	X	- -	X
Tree Swallow	X	- -	X
Northern Rough-Winged Swallow	X	- -	X
Bank Swallow	X	- -	X
Cliff Swallow	X	- -	X
Barn Swallow	X	- -	X
Corvidae			
Blue Jay	X	X	X
American Crow	X	X	X
Paridae			
Tufted Titmouse	R	R	- -
Black-Capped Chickadee	X	X	X
Sittidae			
Red-Breasted Nuthatch	R	X	X
White-Breasted Nuthatch	X	X	- -
Certhiidae			
Brown Creeper	- -	X	X
Troglodytidae			
Carolina Wren	- -	- -	R
House Wren	X	- -	X
Winter Wren	- -	- -	X
Sedge Wren[a]	X	- -	X
Marsh Wren	X	- -	X
Regulidae			
Golden-Crowned Kinglet	- -	X	X
Ruby-Crowned Kinglet[a]	- -	- -	X
Blue-Gray Gnatcatcher	X	- -	X
Eastern Bluebird	X	- -	X
Veery[a]	X	- -	X

Table 32 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Regulidae (continued)			
Gray-Cheeked Thrush	- -	- -	X
Swainson's Thrush	- -	- -	X
Hermit Thrush	- -	- -	X
Wood Thrush[a]	X	- -	X
American Robin	X	X	X
Mimidae			
Gray Catbird	X	- -	X
Brown Thrasher	X	- -	X
Bombycillidae			
Bohemian Waxwing	- -	R	- -
Cedar Waxwing	X	X	X
Laniidae			
Northern Shrike	- -	- -	X
Loggerhead Shrike[e]	- -	- -	R
Sturnidae			
European Starling[c]	X	X	X
Vireonidae			
Bell's Vireo	- -	- -	R
Solitary Vireo	- -	- -	X
Yellow-Throated Vireo	X	- -	X
Warbling Vireo	X	- -	X
Philadelphia Vireo	- -	- -	X
Red-eyed Vireo	X	- -	X
Parulidae			
Blue-Winged Warbler	X	- -	X
Golden-Winged Warbler[a]	R	- -	X
Tennessee Warbler[a]	- -	- -	X
Orange-Crowned Warbler	- -	- -	X
Nashville Warbler[a]	- -	- -	X
Northern Parula	- -	- -	X
Yellow Warbler	X	- -	X
Chestnut-Sided Warbler	- -	- -	X
Magnolia Warbler	- -	- -	X
Cape May Warbler[a]	- -	- -	X
Black-Throated Blue Warbler	- -	- -	X
Yellow-Rumped Warbler	- -	R	X
Black-Throated Green Warbler	- -	- -	X
Cerulean Warbler[b]	R	- -	R
Blackburnian Warbler	- -	- -	X
Palm Warbler	- -	- -	X
Bay-Breasted Warbler	- -	- -	X
Blackpoll Warbler	- -	- -	X
Black-and-White Warbler	- -	- -	X
Prothonotary Warbler[a]	- -	- -	R
American Redstart	X	- -	X
Ovenbird	X	- -	X
Northern Waterthrush	- -	- -	X
Connecticut Warbler[a]	- -	- -	X
Mourning Warbler	R	- -	X
Common Yellowthroat	X	- -	X
Wilson's Warbler	- -	- -	X
Kentucky Warbler[b]	- -	- -	R
Canada Warbler	R	- -	X
Hooded Warbler[b]	R	- -	R

Table 32 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Thraupidae			
Scarlet Tanager	X	- -	X
Cardinalidae			
Northern Cardinal	X	X	- -
Rose-Breasted Grosbeak	X	- -	X
Indigo Bunting	X	- -	X
Emberizidae			
Dickcissel[a]	R	- -	X
Eastern Towhee	X	- -	X
American Tree Sparrow	- -	X	X
Chipping Sparrow	X	- -	X
Clay-Colored Sparrow	R	- -	X
Field Sparrow	X	- -	X
Vesper Sparrow[a]	X	- -	X
Savannah Sparrow	X	- -	X
Grasshopper Sparrow[a]	X	- -	X
Henslow's Sparrow[b]	R	- -	X
Fox Sparrow	- -	R	X
Song Sparrow	X	X	X
Lincoln's Sparrow	- -	- -	X
Swamp Sparrow	X	X	X
White-Throated Sparrow	- -	R	X
White-Crowned Sparrow	- -	- -	X
Dark-Eyed Junco	- -	X	X
Lapland Longspur	- -	R	X
Snow Bunting	- -	R	X
Icteridae			
Bobolink[a]	R	- -	X
Red-Winged Blackbird	X	X	X
Eastern Meadowlark[a]	X	R	X
Western Meadowlark[a]	R	- -	X
Yellow-Headed Blackbird	X	- -	X
Rusty Blackbird	- -	R	X
Common Grackle	X	X	X
Brown-Headed Cowbird	X	R	X
Orchard Oriole[a]	R	- -	R
Northern Oriole	X	- -	X
Fringillidae			
Purple Finch	- -	X	X
Common Redpoll	- -	X	X
Pine Siskin[a]	- -	X	X
American Goldfinch	X	X	X
House Finch	X	X	X
Evening Grosbeak	- -	X	X
Passeridae			
House Sparrow[c]	X	X	- -

NOTE: Total number of bird species: 219
Number of alien, or nonnative, bird species: 7 (3 percent)

Breeding: Nesting species
Wintering: Present January through February
Migrant: Spring and/or fall transient

X - Present, not rare
R - Rare

Table 32 Footnotes

[a]*State-designated species of special concern. Fully protected federal and state laws under the Migratory Bird Act.*

[b]*State-designated threatened species.*

[c]*Alien, or nonnative, bird species.*

[d]*Federally designated threatened species.*

[e]*State-designated endangered species.*

Source: Samuel D. Robbins, Jr., Wisconsin Birdlife, Population & Distribution, Past and Present*, 1991; John E. Bielefeldt, Racine County Naturalist; Wisconsin Department of Natural Resources; and SEWRPC.*

WILDLIFE HABITAT AND RESOURCES

Wildlife habitat areas remaining in the Region were inventoried by the Regional Planning Commission in 1985 in cooperation with the WDNR. The five major criteria used to determine the value of these wildlife habitat areas are listed below:

1. Diversity: An area must maintain a high but balanced diversity of species for a temperate climate, balanced in such a way that the proper predatory-prey (consumer-food) relationships can occur. In addition, a reproductive interdependence must exist.

2. Territorial Requirements: The maintenance of proper spatial relationships among species, allowing for a certain minimum population level, can occur only if the territorial requirements of each major species within a particular habitat are met.

3. Vegetative Composition and Structure: The composition and structure of vegetation must be such that the required levels for nesting, travel routes, concealment, and protection from weather are met for each of the major species.

4. Location with Respect to Other Wildlife Habitat Areas: It is very desirable that a wildlife habitat maintain proximity to other wildlife habitat areas.

5. Disturbance: Minimum levels of disturbance from human activities are necessary, other than those activities of a wildlife management nature.

On the basis of these five criteria, the wildlife habitat areas in the drainage area tributary to Lac La Belle were categorized as either Class I, High-Value; Class II, Medium-Value; or Class III, Good-Value, habitat areas. Class I wildlife habitat areas contain a good diversity of wildlife, are adequate in size to meet all of the habitat requirements for the species concerned, are generally located in proximity to other wildlife habitat areas, and meet all five criteria listed above. Class II wildlife habitat areas generally fail to meet one of the five criteria in the preceding list for a high-value wildlife habitat. However, they do retain a good plant and animal diversity. Class III wildlife habitat areas are remnant in nature in that they generally fail to meet two or more of the five criteria for a high-value wildlife habitat, but may, nevertheless, be important if located in proximity to medium- or high-value habitat areas, if they provide corridors linking wildlife habitat areas of higher value or if they provide the only available range in an area.

As shown on Map 19, about 900 acres, or about 20 percent of the drainage area directly tributary to Lac La Belle, were classified during the 1985 inventory as wildlife habitat, and about 20,400 acres, or about one-third of the

Table 33

AMPHIBIANS AND REPTILES OF THE LAC LA BELLE AREA

Scientific (family) and Common Name	Scientific Name	Species Reduced or Dispersed with Full Area Urbanization	Species Lost with Full Area Urbanization
Amphibians			
Proteidae			
Mudpuppy	*Necturus maculosus maculosus*	X	- -
Ambystomatidae			
Blue-Spotted Salamander	*Ambystoma laterale*	- -	X
Spotted Salamander	*Ambystoma maculatum*		
Eastern Tiger Salamander	*Ambystoma tigrinum tigrinum*	X	- -
Salamandridae			
Central Newt	*Notophthalmus viridescens louisianensi*	X	- -
Bufonidae			
American Toad	*Bufo americanus americanus*	X	- -
Hylidae			
Western Chorus Frog	*Pseudacris triseriata triseriata*	X	- -
Blanchard's Cricket Frog[a,b]	*Acris crepitans blanchardi*	X	- -
Northern Spring Peeper	*Hyla crucifer crucifer*	- -	X
Gray Tree Frog	*Hyla versicolor*	- -	X
Ranidae			
Bull Frog[c]	*Rana catesbeiana*	- -	X
Green Frog	*Rana clamitans melanota*	X	- -
Northern Leopard Frog	*Rana pipiens*	- -	X
Pickerel Frog[c,d,e]	*Rana palustris*	- -	X
Reptiles			
Chelydridae			
Common Snapping Turtle	*Chelydra serpentina serpentina*	X	- -
Kinosternidae			
Musk Turtle (stinkpot)	*Sternotherus odoratus*	X	- -
Emydidae			
Western Painted Turtle	*Chrysemys picta belli*	X	- -
Midland Painted Turtle	*Chrysemys picta marginata*	X	- -
Blanding's Turtle[f]	*Emydoidea blandingii*	- -	X
Trionychidea			
Eastern Spiny Softshell	*Trionyx spiniferus spiniferus*	X	- -
Colubridae			
Northern Water Snake	*Nerodia sipedon sipedon*	X	- -
Midland Brown Snake	*Storeria dekayi wrightorum*	X	- -
Northern Red-Bellied Snake	*Storeria occipitomaculata occipitomaculata*	X	- -
Queen Snake[b,e]	*Regina septemvittata*	- -	X
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*	X	- -
Chicago Garter Snake	*Thamnophis sirtalis semifasciata*	X	- -
Eastern Hognose Snake	*Heterodon platyrhinos*	- -	X
Smooth Green Snake	*Opheodrys vernalis vernalis*	- -	X
Eastern Milk Snake	*Lampropeltis triangulum triangulum*	- -	X

[a]*Likely to be extirpated from the watershed.*

[b]*Identified as endangered in Wisconsin.*

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

[d]*Historically documented from Okauchee Lake.*

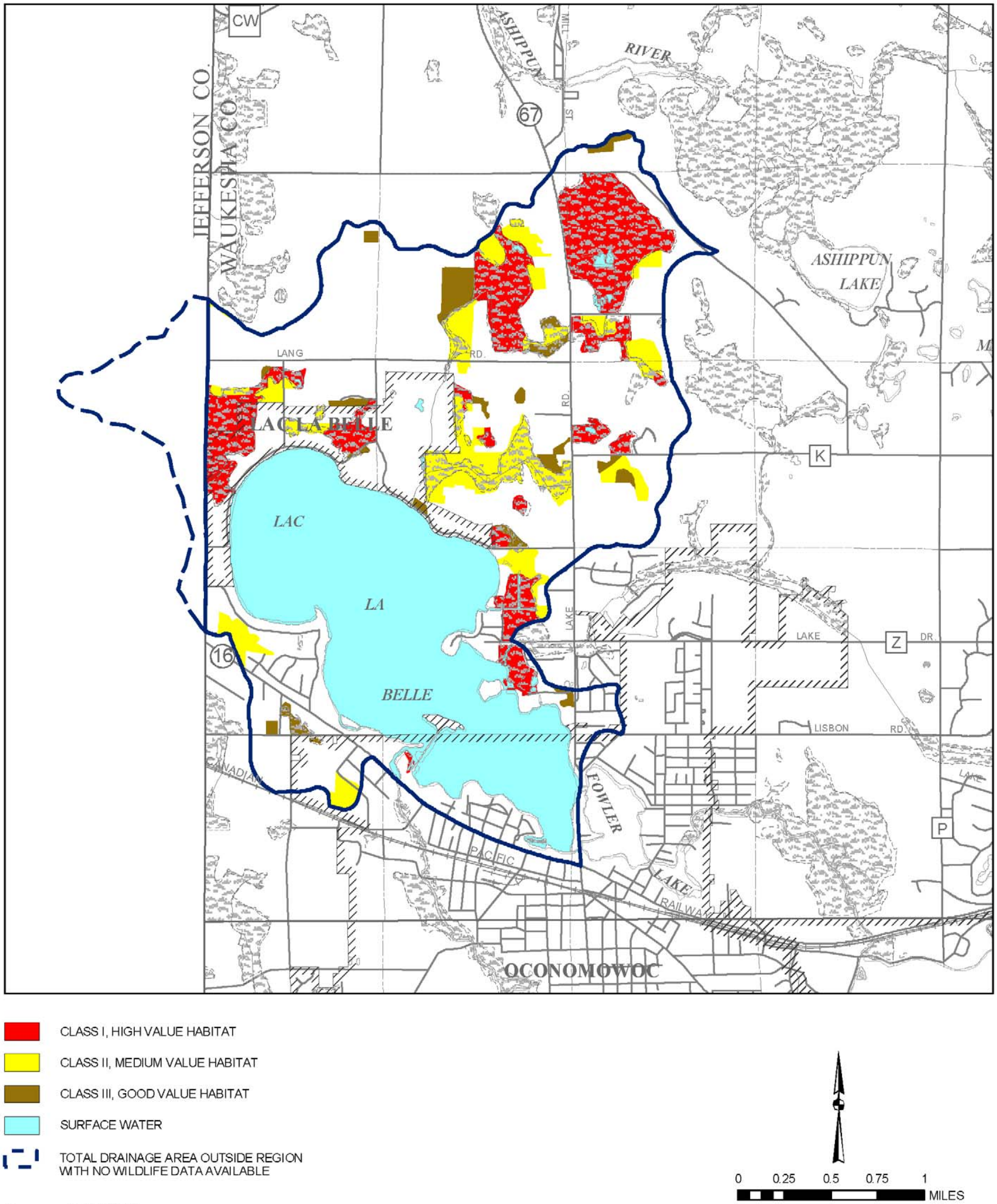
[e]*Identified in the upstream watershed.*

[f]*Identified as threatened in Wisconsin.*

Source: Gary S. Casper, Geographical Distribution of the Amphibians and Reptiles of Wisconsin, *1996, Wisconsin Department of Natural Resources, and SEWRPC.*

Map 19

WILDLIFE HABITAT AREAS WITHIN THE DIRECT DRAINAGE AREA TRIBUTARY TO LAC LA BELLE: 1985



Source: SEWRPC.

total drainage area tributary to the Lake, were classified as habitat. Of this, about 10 percent of the direct and 15 percent of the total drainage areas were considered to be Class I habitat. About 7 percent of the direct, and 10 percent of the total, drainage area was classified as Class II wildlife habitat. The balance of about 2 percent of the direct drainage area, or about 95 acres, and of about 7 percent of the total drainage area, or about 4,300 acres, tributary to Lac La Belle were identified as Class III wildlife habitat.

WETLANDS

Wetlands are defined by the Regional Planning Commission as, "areas that have a predominance of hydric soils and that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions." This definition, which is also used by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency, is essentially the same as the definition used by the U.S. Natural Resource Conservation Service.[45]

Another definition, which is applied by the WDNR and which is set forth in Chapter 23 of the *Wisconsin Statutes*, defines a wetland as "an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation, and which has soils indicative of wet conditions." In practice, the WDNR definition differs from the Regional Planning Commission definition in that the WDNR considers very poorly drained, poorly drained, and some of the somewhat poorly drained soils as wetland soils meeting the State "wet condition" criterion. The Commission definition only considers the very poorly drained and poorly drained soils as meeting the "hydric soil" criterion. Thus, the State definition as actually applied is more inclusive than the Federal and Commission definitions in that the WDNR may include some soils that do not show hydric field characteristics as wet soils capable of supporting wetland vegetation, a condition that may occur in some floodlands.[46]

As a practical matter, experience has shown that application of the WDNR, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, and the Regional Planning Commission definitions produce reasonably consistent wetland identifications and delineations in the majority of situations within the Southeastern Wisconsin Region. That consistency is due in large part to the provision in which Federal wetland delineation manual that allows for the application of professional judgment in cases where satisfaction of the three criteria for wetland identification is unclear.

Wetlands in southeastern Wisconsin are classified predominantly as deep marsh, shallow marsh, southern sedge meadow, fresh (wet) meadow, shrub carr, alder thickets, low prairie, fens, bogs, southern wet- and wet-mesic hardwood forest, and conifer swamp. Wetlands form an important part of the landscape in and adjacent to Lac La Belle in that they perform an important set of natural functions that make them ecologically and environmentally invaluable resources. Wetlands affect the quality of water by acting as a filter or a buffer zone allowing silt and sediments to settle out. They also influence the quantity of water by providing water during periods of drought

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[45]*Lands designated as prior converted cropland, that is, lands that were cleared, drained, filled, or otherwise manipulated to make them capable of supporting a commodity crop prior to December 23, 1985, may meet the criteria of the U.S. Natural Resource Conservation Service wetland definition, but they would not be regulated under Federal wetland programs. If such lands are not cropped, managed, or maintained for agricultural production, for five consecutive years, and in that time the land reverts back to wetland, the land would then be subject to Federal wetland regulations.*

[46]*Although prior converted cropland is not subject to Federal wetland regulations unless cropping ceases for five consecutive years and the land reverts to a wetland condition, the State may consider prior converted cropland to be subject to State wetland regulations if the land meets the criteria set forth in the State wetland definition before it has not been cropped for five consecutive years.*

and holding it back during periods of flood. When located along shorelines of lakes and streams, wetlands help protect those shorelines from erosion. Wetlands also may serve as groundwater discharge and recharge areas, in addition to being important resources for overall ecological health and diversity by providing essential breeding and feeding grounds, shelter, and escape cover for many forms of fish and wildlife.

Wetlands soils are poorly suited for urban uses. This is due to the high compressibility and instability, high water table, low load-bearing capacity, and high shrink-swell potential of wetland soils, and, in some cases, to the potential for flooding. In addition metal conduits placed in some types of wetland soils may be subject to rapid corrosion. These constraints, if ignored, may result in flooding, wet basements, and excessive operation of sump pumps, unstable foundations, failing pavements, broken sewer and water lines, and excessive infiltration of clear water into sanitary sewerage systems. In addition, there are significant site preparation and maintenance costs associated with the development of wetlands, particularly as they relate to roads, foundations, and public utilities.

Table 34 characterizes wetland plant species typically found in the drainage basin. As shown on Map 20, in 2000, wetlands covered about 590 acres, or approximately 15 percent of the drainage area directly tributary to Lac La Belle, and about 7,300 acres, or approximately 12 percent of the total drainage area. The major wetland communities located in the drainage area tributary to Lac La Belle included shallow marsh, sedge meadow, fresh (wet) meadow, shrub carr, southern wet to wet-mesic hardwoods, and bog.

Sedge meadows are considered to be stable wetland plant communities that tend to perpetuate themselves if dredging activities and water level changes are prevented from occurring. Sedge meadows in southeastern Wisconsin are characterized by the tussock sedge (*Carex stricta*) and, to a lesser extent, by Canada blue joint grass (*Calamagrostis canadensis*). Sedge meadows that are drained or disturbed to some extent typically succeed to shrub carrs. Shrub carrs, in addition to the sedges and grasses found in the sedge meadows, contain an abundance of shrubs such as willows (*Salix* spp.) and red osier dogwood (*Cornus stolonifera*). In extremely disturbed shrub carrs, the willows, red osier dogwood, and sedges are replaced by such exotic plants as honeysuckle (*Lonicera* sp.), buckthorn (*Rhannus* sp.), and very aggressive reed canary grass (*Phalaris arundinacea*). Forbes such as the marsh (*Aster simplex*), swamp (*Aster lucidulus*), and New England (*Aster novae-angliae*) asters, and giant goldenrod (*Solidago gigantea*) are the dominant plants with the lowland meadows known as fresh (wet) meadows, while the shallow marsh areas near the lakeshore tend to be dominated by cattails (*Typha* spp.).

WOODLANDS

Woodlands are defined by the Regional Planning Commission as those areas containing a minimum of 17 trees per acre with a diameter of at least four inches at breast height (4.5 feet above the ground). Woodlands are classified as dry, dry-mesic, mesic, wet-mesic, wet hardwood, and conifer swamp forests; the last three also are considered wetlands. The Regional Planning Commission also maintains an inventory of woodlands within the Region that is updated every five years. In the drainage area directly tributary to Lac La Belle, approximately 135 acres of woodland, or about 3 percent of the area, were inventoried as woodlands in 1995. About 12 percent of the total drainage area, or about 7,400 acres, were similarly classified, as shown on Map 20.

Specifically, woodlands in the Lac La Belle drainage basin include southern dry hardwood forests, which are characterized by white oak (*Quercus alba*), shagbark hickory (*Carya ovata*), and black cherry (*Prunus serotina*); southern dry-mesic hardwood forests characterized by northern red oak (*Quercus borealis*) and white ash (*Fraxinus americana*); and southern mesic hardwood forests dominated by sugar maple (*Acer saccharum*) and basswood (*Tilia americana*). Woodlands within the Lac La Belle drainage area occur as scattered woodlots, primarily along the northern portions of the basin. Most of these wooded tracts contain dry to dry-mesic hardwoods.

ENVIRONMENTAL CORRIDORS

One of the most important tasks undertaken by the Regional Planning Commission in its work program has been the identification and delineation of those areas of the Region having concentrations of natural, recreational,

Table 34

EMERGENT WETLAND PLANT SPECIES IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO LAC LA BELLE

Scientific Name	Common Name
Equisetaceae *Equisetum arvense*	 Common horsetail
Typhaceae *Typha latifolia* *Typha augustifolia*[a]	 Board-leaved cattail Narrow-leaved cattail
Gramineae *Poa pratensis* *Phalaris arundinaceae*[b,c]	 Kentucky bluegrass Reed canary grass
Cyperaceae *Eleocharis* sp. *Carex* sp. *Carex vulpinoidea* *Carex stipata* *Carex granularis* *Carex hystericina*	 Spike-rush Sedge Fox sedge Sedge Sedge Bottlebrush sedge
Araceae *Arisaema triphyllum* *Symplocarpus foetidus*	 Jack-in-the-pulpit Skunk cabbage
Lemnaceae *Lemna minor*	 Lesser duckweed
Salicaceae *Populus deltoides* *Salix nigra*	 Cottonwood Black willow
Juglandaceae *Juglans cinerea*	 Butternut
Ulmaceae *Ulmus americana*	 American elm
Papaveraceae *Sanguinaria canadensis*	 Bloodroot
Cruciferae *Hesperis matronalis*[b] *Alliaria officinalis*[b]	 Dames rocket Garlic-mustard
Saxifragaceae *Ribes americanum*	 Wild black currant
Rosaceae *Geum canadense* *Prunus virginiana*	 White avens Choke-cherry
Geraniaceae *Geranium maculatum*	 Wild geranium
Aceraceae *Acer saccharinum* *Acer negundo*	 Silver maple Boxelder
Balsaminaceae *Impatiens biflora*	 Jewelweed
Rhaminaceae *Rhamnus cathartica*[b]	 Common buckthorn
Vitaceae *Vitis riparia* *Parthenocissus quinquefolia*	 Riber-bank grape Virginia creeper
Urticaceae *Urtica dioica*	 Stinging nettle
Polygonaceae *Rumex crispus*[b] *Polygonum persicaria*[b]	 Curly dock Lady's thumb
Ranunculaceae *Ranunculus sceleratus*	 Cursed crowfoot
Viola sp. *Viola* sp.	 Violet
Lythraceae *Lythrum salicaria*[b]	 Purple loosestrife
Onagraceae *Circaea quadrisulcata*	 Enchanters nightshade
Oleaceae *Fraxinus pennsylvanica* *Fraxinus nigra*	 Green ash Black ash
Umbelliferae *Daucus carota*[b]	 Queen Anne's lace
Labiatae *Glechoma hederacea*[b]	 Creeping Charlie
Caprifoliaceae *Lonicera* X *bella*[b]	 Hybrid honeysuckle
Plantaginaceae *Plantago major*[b]	 Common plantain
Compositae *Ambrosia artemisiifolia* *Cirsium arvense*[b] *Taraxacum officinale*[b] *Cichorium intybus*	 Common ragweed Canada thistle Common dandelion Chicory

[a]*Subdominant plant species.*

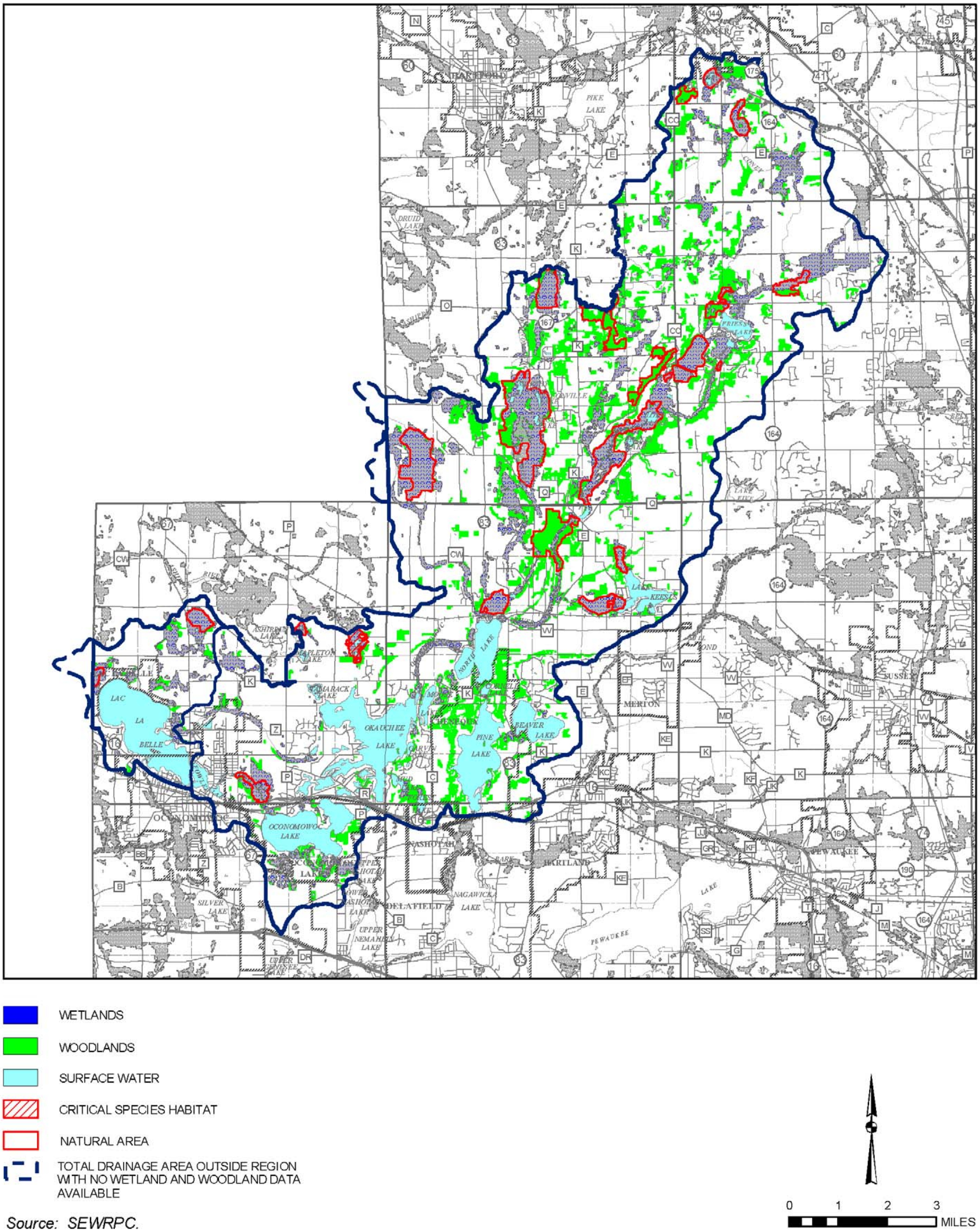
[b]*Alien or nonnative plant species.*

[c]*Dominant plant species.*

Source: SEWRPC.

Map 20

WETLANDS AND WOODLANDS WITHIN THE TOTAL DRAINAGE AREA TO LAC LA BELLE: 2000



Source: SEWRPC.

historic, aesthetic, and scenic resources and which, as such, should be preserved and protected in order to maintain the overall quality of the environment. Such areas normally include one or more of the following seven elements of the natural resource base which are essential to the maintenance of both the ecological balance and the natural beauty of the Region: 1) lakes, rivers, and streams and the associated undeveloped shorelands and floodlands; 2) wetlands; 3) woodlands; 4) prairies; 5) wildlife habitat areas; 6) wet, poorly drained, and organic soils; and 7) rugged terrain and high-relief topography. While the foregoing seven elements constitute integral parts of the natural resource base, there are five additional elements which, although not a part of the natural resource base *per se*, are closely related to, or centered on, that base and, therefore, are important considerations in identifying and delineating areas with scenic, recreational, and educational value. These additional elements are: 1) existing outdoor recreation sites; 2) potential outdoor recreation and related open space sites; 3) historic, archaeological, and other cultural sites; 4) significant scenic areas and vistas; and 5) natural and scientific areas.

The delineations of these 12 natural resource and natural resource-related elements on a map result in an essentially linear pattern of relatively narrow, elongated areas which have been termed "environmental corridors" by the Commission. Primary environmental corridors include a wide variety of the abovementioned important resource and resource related elements and are at least 400 acres in size, two miles in length, and 200 feet in width.

It is important to point out that, because of the many interlocking and interacting relationships between living organisms and their environment, the destruction or deterioration of any one element of the total environment may lead to a chain reaction of deterioration and destruction among the others. The drainage of wetlands, for example, may have far-reaching effects, since such drainage may destroy fish spawning grounds, wildlife habitat, groundwater recharge areas, and natural filtration and floodwater storage areas of the interconnecting lake and stream systems. The resulting deterioration of surface water quality may, in turn, lead to a deterioration of the quality of the groundwater. Groundwater serves as a source of domestic, municipal, and industrial water supply and provides a reservoir to maintain low flows, or base flows, in rivers and streams. Similarly the destruction of woodland cover, which may have taken a century or more to develop, may result in soil erosion and stream siltation, and in more rapid runoff and increased flooding, as well as destruction of wildlife habitat within a drainage area. Although the effects of one of these environmental changes may not, in and of itself, be overwhelming, the combined effects may lead eventually to the deterioration of the underlying and supporting natural resource base, and of the overall quality of the environment for life. The need to protect and preserve the remaining environmental corridors within the drainage area tributary to Lac La Belle thus becomes apparent.

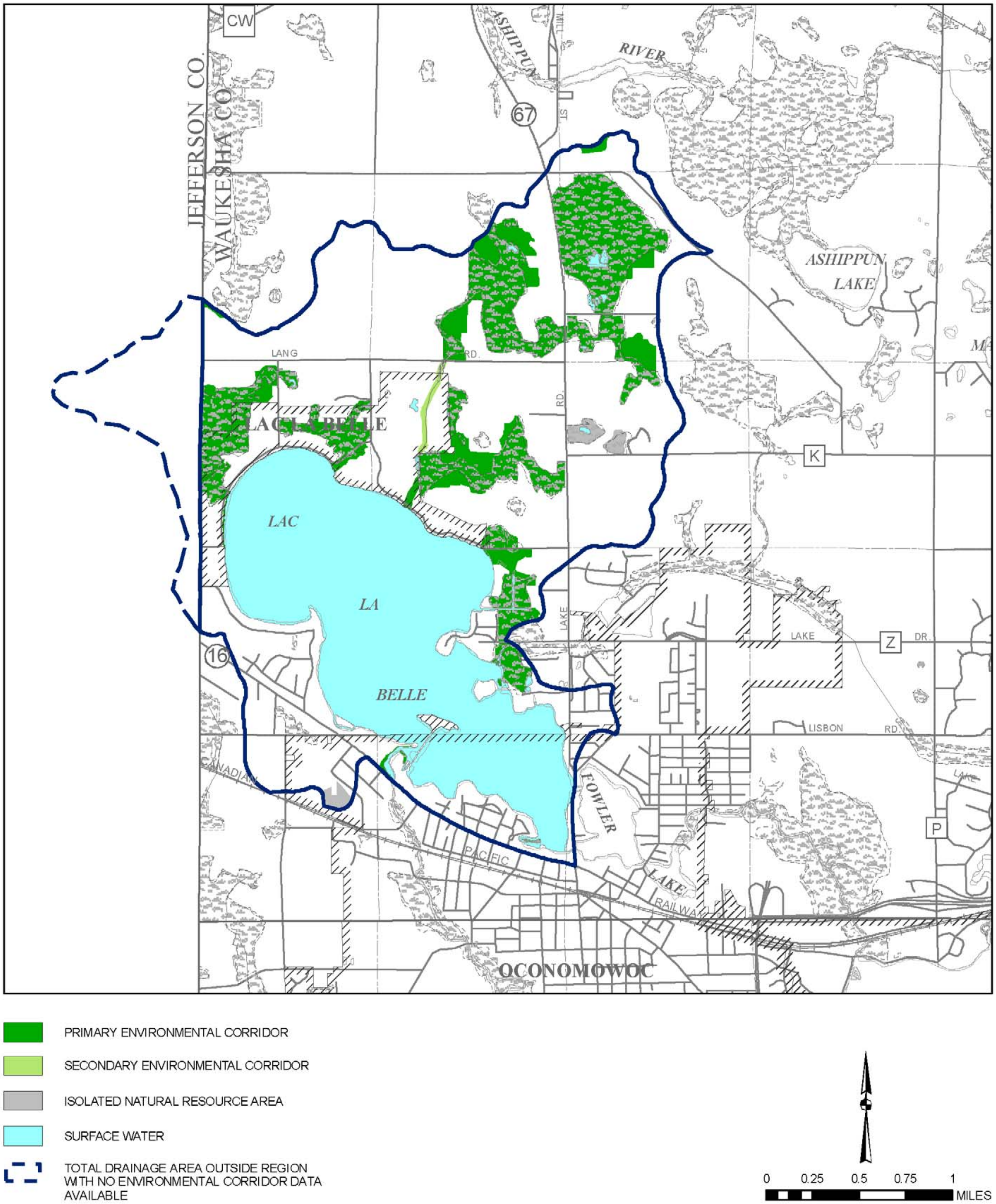
Primary Environmental Corridors

The primary environmental corridors in Southeastern Wisconsin generally lie along major stream valleys and around major lakes, and contain almost all of the remaining high-value woodlands, wetlands, and wildlife habitat areas, and all of the major bodies of surface water and related undeveloped floodlands and shorelands. Primary environmental corridors in the Lac La Belle drainage area are shown on Maps 21 and 22. About 820 acres, or approximately 20 percent of the drainage area directly tributary to Lac La Belle, as shown on Map 21, were identified as primary environmental corridor. About 14,600 acres, or about 25 percent of the total drainage area tributary to Lac La Belle, as shown on Map 22, were similarly classified.

Primary environmental corridors are subject to urban encroachment because of their desirable natural resource amenities. Unplanned or poorly planned intrusion of urban development into these corridors not only tends to destroy the very resources and related amenities sought by the development, but also tends to create severe environmental and developmental problems, as well. These problems include, among others, water pollution, flooding, wet basements, failing foundations for roads and other structures, and excessive infiltration of clear water into sanitary sewerage systems. The preservation of as yet-undeveloped corridors is one of the major ways in which the water quality can be protected and perhaps improved at relatively little additional cost to the taxpayers of the area.

Map 21

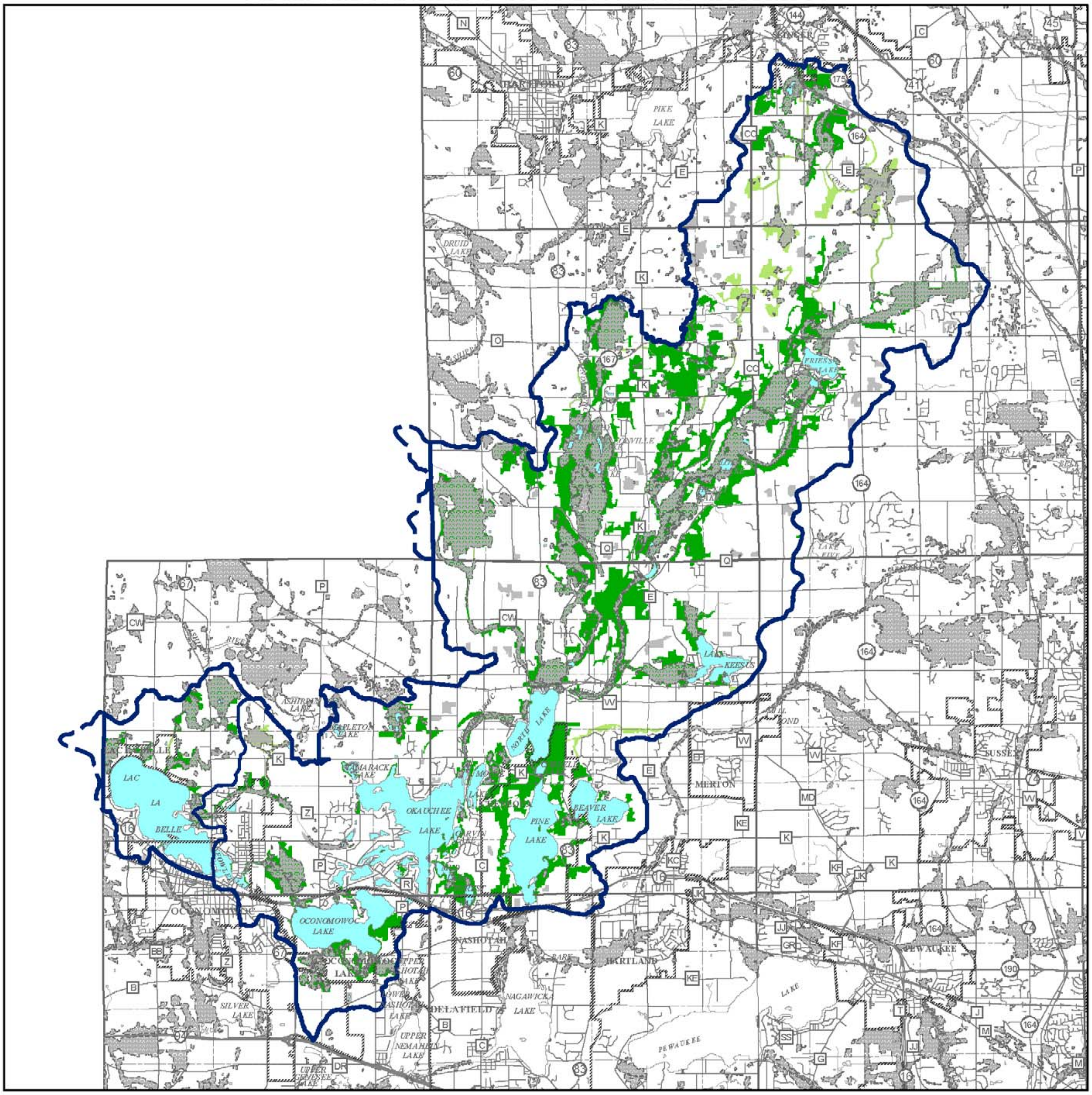
ENVIRONMENTAL CORRIDORS AND NATURAL AREAS
WITHIN THE DIRECT DRAINAGE AREA TRIBUTARY TO LAC LA BELLE: 2000



Source: SEWRPC.

Map 22

ENVIRONMENTAL CORRIDORS AND NATURAL AREAS
WITHIN THE TOTAL DRAINAGE AREA TO LAC LA BELLE: 2000



PRIMARY ENVIRONMENTAL CORRIDOR

SECONDARY ENVIRONMENTAL CORRIDOR

ISOLATED NATURAL RESOURCE AREA

SURFACE WATER

TOTAL DRAINAGE AREA OUTSIDE REGION WITH NO ENVIRONMENTAL CORRIDOR DATA AVAILABLE

0 1 2 3 MILES

Source: SEWRPC.

Within the area tributary to Lac La Belle, the riverbanks and lakeshores located within the environmental corridors should be candidates for immediate protection through proper zoning or through public ownership. Of the areas not already publicly owned, the remaining areas of natural shoreline, and riparian wetland areas are perhaps the most sensitive areas in need of greatest protection. In this regard, the regional natural areas and critical species habitat protection and management plan recommends public acquisition of specific lands. These areas, discussed further below, are shown on Map 20.

Within the portion of the total tributary drainage area within Waukesha County, the Monches Woods, a 322-acre natural area of statewide significance, designated as a NA-1 natural area in the adopted regional natural areas and critical species habitat protection and management plan, is recommended for expansion of the current County ownership. The Lake Keesus Fen-Meadow, 141-acre natural area of countywide or regional significance, designated as a NA-2 natural area in the adopted regional natural areas and critical species habitat protection and management plan, is recommended for expansion of the current WDNR ownership.

The Camp Whitcomb Lowland, a 48-acre, NA-3 designated site, is recommended for expansion of the existing ownership by the Camp, while the Chenequa Wetland Complex, a 111-acre, NA-3 designated site, is recommended for County acquisition. The Lac La Belle Lowlands, a 33-acre, NA-3 designated site, is recommended for acquisition by the Village of Lac La Belle. The Oconomowoc Sedge Meadow, a 19-acre natural area of local significance, designated as a NA-3 natural area in the regional natural areas plan, is recommended for acquisition by a private conservancy organization.

The Stonebank Tamarack Relict, a 166-acre, critical species habitat area, also has been identified in the plan as a habitat area for rare or special concern and uncommon bird species, partially under protective ownership. The remaining portions of this wetland are recommended for acquisition by a private conservancy organization, are the remaining portions of the 100-acre Oconomowoc River Marsh, designated as a NA-3 natural area, and the Raasch Tamarack Swamp, a 95-acre, NA-3 designated site, both currently under partial protective ownership by the WDNR.

Within the portion of the total tributary drainage area within Washington County, the Friess Lake Tamarack Swamp, a 228-acre, NA-2 designated site is recommended for State acquisition. In addition, the NA-2 designated, 256-acre Holy Hill Woods, the 21-acre Daniel Boone Bogs, the 60-acre Glacier Hills Park Bogs and Upland Woods, the 54-acre Mud Lake Upland Woods, and the 59-acre Mud Lake Meadow, are recommended for acquisition by Washington County, as is the 94-acres, NA-3 designated Heritage Trails Bog. The NA-3 designated, 137-acre Donegal Road Woods, and the 11-acre St. Augustine Road Sedge Meadow, both within the Loew Lake Unit of the Kettle Moraine State Forest, are recommended for acquisition by the WDNR. The 182-acre Thompson Swamp, the 100-acre CTH J Swamp, and the 11-acre Hubertus Road Sedge Meadow, are NA-3 designated sites recommended for acquisition by private conservancy organizations.

In addition, the Murphy Lake-McConville Lake Wetland Complex, a 890-acre, NA-1 designated site is recommended for expansion of The Nature Conservancy ownership. The NA-3 designated Mason Creek Swamp, a 432-acre wetland site, is recommended for expansion of the existing ownership by the University of Wisconsin.

Secondary Environmental Corridors

The secondary environmental corridors in the Lac La Belle direct drainage area are located along intermittent streams or serve as links between segments of primary environmental corridors. These secondary environmental corridors contain a variety of resource elements, often remnant resources from primary environmental corridors which have been developed for intensive agricultural purposes or urban land uses. Secondary environmental; corridors facilitate surface water drainage, maintain "pockets" of natural resource features, and provide for the movement of wildlife, as well as for the movement and dispersal of seeds for a variety of plant species. Such corridors, while not as important as primary environmental corridors, should be preserved in essentially open natural uses as urban development proceeds within the direct drainage area, particularly when the opportunity is presented to incorporate the corridors into urban storm water detention areas, associated drainageways, and neighborhood parks. As of 1995, about 10 acres, or less than 1 percent of the drainage area directly tributary to the Lake, remained identified as secondary environmental corridor, as shown on Map 21. About 1,250 acres, or approximately 2 percent of the total drainage area tributary to Lac La Belle, were classified as secondary environmental corridor lands.

Isolated Natural Resource Areas

In addition to environmental corridors, other, small concentrations of natural resource base elements exist within the drainage area tributary to Lac La Belle. These resource base elements are isolated from the environmental corridors by urban development or agricultural uses, and, although separated from the environmental corridor network, have important natural values. Isolated natural resource areas may provide the only available habitat in an area, provide good locations for local parks and nature study areas, and lend aesthetic character or natural diversity to an area. Important isolated natural resource features within southeastern Wisconsin include a geographically well-distributed variety of isolated wetlands, woodlands, and wildlife habitat. These isolated natural resource features should also be protected and preserved in a natural state whenever possible. As of 1995, about 40 acres, or less than 1 percent, of the drainage area directly tributary to the Lake, and about 1,100 acres, or about 2 percent of the total drainage area tributary to Lac La Belle, were identified as isolated natural resource features within the drainage area, as shown on Map 22.

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Chapter VI

CURRENT WATER USES AND WATER USE OBJECTIVES

INTRODUCTION

Nearly all major lakes in the Southeastern Wisconsin Region serve multiple purposes, ranging from recreation to receiving waters for stormwater runoff. Recreational uses range from noncontact, passive recreational activities, such as picnicking and walking along the shoreline, to full-contact, active recreational activities, such as swimming, boating, and waterskiing. To accommodate this range of uses, the State of Wisconsin has developed water use objectives for the surface waters of the State, and has promulgated these objectives in Chapters NR 102 and NR 104 of the *Wisconsin Administrative Code*. Complementary water use objectives and supporting water quality guidelines have been proposed by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) as set forth in the adopted regional water quality management plan for all major lakes and streams in the Region.[1] The current water uses, as well as the water use objectives and supporting water quality guidelines for Lac La Belle, are discussed in this chapter.

RECREATIONAL USES AND FACILITIES

Lac La Belle is located within about a one-half hour drive from much of the metropolitan Milwaukee area. Although Lac La Belle is one of the larger lakes in southeastern Wisconsin, its location, access sites, and degree of shoreline development contribute to a more intensive recreational usage than is found on many other lakes in the Region. The Lake supports a full range of lake uses, including angling during both the summer and winter fishing seasons, recreational boating, swimming, and aesthetic viewing. Winter recreational uses of Lac La Belle include cross-country skiing, ice skating, and snowmobiling.

Angling

As discussed in Chapter V of this report, based upon their 1992 creel survey, the Wisconsin Department of Natural Resources (WDNR) reported that the fishery in Lac La Belle had improved steadily since the previous 1982 creel survey. In order of decreasing popularity, the gamefish species most commonly sought by anglers were smallmouth bass, walleye, and largemouth bass. According to the WDNR, gamefish accounted for 54 percent of the total catch during the 1992 survey. These data suggest that the angling effort had shifted away from panfish toward gamefish since the 1982 survey.

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

The 1992 creel survey also evaluated the catch and harvest rates of both gamefish and panfish species. The WDNR reported that specific catch rates had increased since 1982; however, harvest rates had declined. The WDNR estimated that 2,441 fish, or about 2.1 fish per acre, were harvested from Lac La Belle in 1992. Walleye were reported to be the most commonly caught fish in the Lake. The estimated total catch was 3,302 walleye, although it was estimated that only 27 walleye were harvested due to the size limits imposed. The WDNR further estimated that it took an average of 2.2 hours to catch a walleye and 238 hours to catch one of harvestable size. In contrast to the walleye catch and harvest rates, yellow bass were the most commonly harvested fish in the Lake, it taking only 17 minutes to catch one and approximately the same amount of time to harvest a yellow bass. Based upon the 1992 survey, the total catch rate of bass was about 12 fish per acre, or about 14,367 fish, based upon the observed catch-per-unit-effort (CPUE). However, due to the new size regulations and daily bag limits, the total harvest rate was only 2.1 fish per acre, or 2,441 fish.

Angling pressure changed between 1982 and 1992. The WDNR estimated that angling pressure had increased by 54 percent, from about 13,619 hours, or 11.7 hours per acre, in 1982, to about 20,173 hours, or 17.3 hours per acre, in 1992. The total catch rates also increased during this time, from 8,814 fish in 1982 to 14,367 fish in 1992. During the same period, harvest rates declined from 3,197 to 2,441. Some of this was due to the change in fishing regulations. In 1992, the WDNR reported that angling pressure was the same on weekends, weekdays, and holidays, with the greatest pressure occurring during the month of May. During the 1982 survey, the greatest angling pressure occurred in July, while the lowest pressure occurred in September. It is important to note that angling pressure in Lac La Belle between the months of October and April, the ice fishing season, was not taken into consideration in these surveys. Hence, the angling pressure, as well as catch and harvest rates, are likely to have been underestimated.

Recreational Boating

The WDNR estimated recreational boating traffic on the Lake at the time of their 1992 creel survey. These data, for the approximately 150-day period, are shown in Table 35. WDNR staff counted about 2,400 watercraft in operation or afloat on the Lake during weekends and holidays over this period, or about 55 watercraft in operation on each weekend day observed. Weekday usage during this same period was by about 850 watercraft, or by an average of about eight watercraft per weekday.

During July 2001, recreational use surveys were conducted on Lac La Belle by the Commission staff, during both weekdays and weekend days. Between eight and 28 watercraft of various descriptions were observed to be in operation during a typical weekday morning and afternoon, respectively, and between 36 and 47 watercraft were observed to be in operation during a typical weekend day morning and afternoon, as summarized in Table 36. This suggests that weekday usage has increased, while weekend usage has remained approximately the same.[2] The watercraft in operation included fishing boats; pleasure boats, including pontoon boats, ski boats, sailing vessels, and personal watercraft (or "jet skis"®). The density of high-speed watercraft, assumed to be comprised of pleasure boats, ski boats, and personal watercraft, on the weekend day was approximately one boat per 17 acres of Lake surface, based upon the total daily number of such watercraft reported.

In addition, at the time of the July 2001 survey, 966 watercraft were observed to be moored, docked, or stored on the Lake and lakeshore, as shown in Table 37. About one-third of these watercraft, or about 312 boats, were pontoon boats. Of the balance, about 171 were power boats, about 141 were personal watercraft, and about 102 were fishing boats. In addition, about 45 paddle boats, about 104 sailboats, about 42 canoes, and about 41 kayaks were observed. Seven floating trampolines and one house boat also were observed on the Lake.

[2]*Given that the WDNR staff counted watercraft in usage on holidays as well as more typical weekends, it is reasonable to assume that actual average weekend usage was somewhat less than that stated. Consequently, it appears that weekend recreational boating use of Lac La Belle has remained static while weekday use has increased.*

Table 35

RECREATIONAL USE SURVEY ON LAC LA BELLE: MAY 2 THROUGH SEPTEMBER 30, 1992

Date and Time	Weekend and Holiday Participants							
	Fishing	Pleasure Boating	Skiing	Sailing	Jetskiing	Drifting/ Stationary	Other	Total
May 2 – September 30, 1992								
Morning	206	63	39	135	7	63	5	518
Afternoon	265	637	176	174	72	501	38	1,863
Total	471	700	215	309	79	564	43	2,381
Percent	20	29	9	13	3	24	2	100

Date and Time	Weekday Participants							
	Fishing	Pleasure Boating	Skiing	Sailing	Jetskiing	Drifting/ Stationary	Other	Total
May 2 – September 30, 1992								
Morning	84	18	5	36	3	23	19	188
Afternoon	195	166	70	55	16	141	22	665
Total	279	184	75	91	19	164	41	853
Percent	33	22	9	11	2	19	5	100

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 36

RECREATIONAL USE SURVEY ON LAC LA BELLE: 2001

Date and Time	Weekend Participants							
	Fishing	Pleasure Boating	Skiing	Sailing	Jetskiing	Swimming	Other	Total
August 4, 2001								
Morning	8	17	7	0	4	4	36	76
Afternoon	4	18	14	0	11	114	86	247
Total for the day	12	35	21	0	15	154	122	323
Percent	4	11	7	0	5	48	38	100

Date and Time	Weekday Participants							
	Fishing	Pleasure Boating	Skiing	Sailing	Jetskiing	Swimming	Other	Total
July 12, 2001								
Morning	2	5	0	0	1	5	18	31
Afternoon	1	15	5	3	4	134	15	177
Total for the day	3	20	5	3	5	139	33	208
Percent	1	10	2	1	2	67	16	100

Source: SEWRPC.

Table 37

WATERCRAFT ON LAC LA BELLE: JULY 2001

Type of Watercraft										
Power Boat	Fishing Boat	Pontoon Boat	Canoe	Paddle Boat	Sailboat	Kayak	Wind Surf Board	Personal Water Craft	Other	Total
171	102	312	42	45	104	41	- -	141	8	966

Source: SEWRPC.

Boating activities on the Lake are regulated by State boating and water safety laws, and by a uniform local ordinance, adopted by the riparian municipalities, providing specific regulations for watercraft operating on Lac La Belle. These ordinances are appended hereto as Appendix B.

Park and Open Space Sites

The City of Oconomowoc owns a public boating access site, complete with parking facilities, located on the southeastern shore of the Lake. The City park adjacent to the public boating access offers an approximately 200-foot long beach and associated swimming area. The beach is heavily used throughout the summer and is generally considered to be overcrowded on weekends.[3]

Wisconsin Department of Natural Resources Recreational Rating

In general, Lac La Belle provides a variety of recreational opportunities. Based upon the outdoor recreation rating developed by the WDNR, Lac La Belle received a 58 out of 72 points as shown in Table 38. This rating indicates that the Lake provides a range of recreational opportunities, including good swimming beaches, boat launch sites, water quality conditions conductive to boating, and areas suitable for wildlife observation. Features that were considered to detract from recreational rating included a minor rough fish problem and occasional algae blooms.

WATER USE OBJECTIVES

The regional water quality management plan recommended the adoption of full recreational and warmwater sport-fisheries objectives for Lac La Belle. The findings of the inventories of the natural resource base, set forth in Chapters III through V of this report, indicate that the use of the Lake and the resources of the area are generally supportive of such objectives, although it is expected that remedial measures will be required if the Lake is to fully meet the objectives.

The recommended warmwater sport fishery objective is supported in Lac La Belle by a sport fishery based largely on largemouth bass, walleye, and panfish, as described in Chapter V of this report. These fishes have traditionally been sought after in Lac La Belle.

WATER QUALITY STANDARDS

The water quality standards supporting the warmwater fishery and full recreation use objectives, as established for planning purposes in the regional water quality management plan, are set forth in Table 39. These standards are similar to those set forth in Chapters NR 102 and 104 of the *Wisconsin Administrative Code*, but were refined for planning purposes in terms of their applications. Standards are recommended for temperature, pH, and dissolved oxygen, fecal coliform, and total phosphorus concentrations. These standards apply to the epilimnion of the Lake

[3]Ibid.

Table 38

WISCONSIN DEPARTMENT OF NATURAL RESOURCES RECREATIONAL RATING OF LAC LA BELLE

Space: Total Area 1,164 acres			Total Shore Length = 11.2 miles		
Quality (18 maximum points for each item)					
Fish:					
__ 9	High production	X 6	Medium production	__ 3	Low production
__ 9	No problems	X 6	Modest problems, such as infrequent winterkill, small rough fish problems	__ 3	Frequent and overbearing problems, such as winterkill, carp, excessive fertility
Swimming:					
X 6	Extensive sand or gravel substrate (75 percent or more)	__ 4	Moderate sand or gravel substrate (25 to 50 percent)	__ 2	Minor sand or gravel substrate (less than 25 percent)
X 6	Clean water	__ 4	Moderately clean water	__ 2	Turbid or darkly stained water
__ 6	No algal or weed problems	X 4	Moderate algal or weed problems	__ 2	Frequent or severe algal or weed problems
Boating:					
X 6	Adequate water depths (75 percent of basin more than five feet deep)	__ 4	Marginally adequate water depths (50 to 75 percent of basin more than five feet deep)	__ 2	Inadequate depths (less than 50 percent of basin more than five feet deep)
X 6	Adequate size for extended boating (more than 1,000 acres)	__ 4	Adequate size for some boating (200 to 1,000 acres)	__ 2	Limit of boating challenge and space (less than 200 acres)
__ 6	Good water quality	X 4	Some inhibiting factors, such as weedy bays, algal blooms, etc.	__ 2	Overwhelming inhibiting factors, such as weed beds throughout
Aesthetics:					
__ 6	Existence of 25 percent or more wild shore	X 4	Less than 25 percent wild shore	__ 2	No wild shore
X 6	Varied landscape	__ 4	Moderately varied	__ 2	Unvaried landscape
__ 6	Few nuisances, such as excessive algae carp, etc.	X 4	Moderate nuisance conditions	__ 2	High nuisance condition
Total Quality Rating: 58 out of a possible 72					

Source: Wisconsin Department of Natural Resources and SEWRPC.

and to the streams. The total phosphorus standard applies to spring turnover concentrations measured in the surface waters. Such contaminants as oil, debris, and surface scums; odor, taste, and color-producing substances; and toxins are not permitted in concentrations harmful to the aquatic life, as set forth in Chapter NR 102 of the *Wisconsin Administrative Code*. The adoption of these standards is intended to specify conditions in the waterways concerned that mediate against excessive macrophyte and algal growths and promote all forms of recreational use, including angling, in these waters.

Table 39

RECOMMENDED WATER QUALITY STANDARDS TO SUPPORT RECREATIONAL AND WARMWATER FISH AND AQUATIC LIFE USE

Water Quality Parameter	Water Quality Standard
Maximum Temperature	89°F[a,b]
pH Range	6.0-9.0 standard units
Minimum Dissolved Oxygen	5.0 mg/l[b]
Maximum Fecal Coliform	200/400 MFFCC/100 ml[c]
Maximum Total Residual Chlorine	0.01 mg/l
Maximum Un-ionized Ammonia Nitrogen	0.02 mg/l
Maximum Total Phosphorus	0.02 mg/l[d]
Other	- -[e,f]

[a]*There shall be no temperature changes that may adversely affect aquatic life. Natural daily and seasonal temperature fluctuations shall be maintained. The maximum temperature rise at the edge of the mixing zone above the existing natural temperature shall not exceed 3°F for lakes.*

[b]*Dissolved oxygen and temperature standards apply to the epilimnion of stratified lakes and to the unstratified lakes; the dissolved oxygen standard does not apply to the hypolimnion of stratified inland lakes. Trends in the period of anaerobic conditions in the hypolimnion of stratified inland lakes should be considered important to the maintenance of water quality, however.*

[c]*The membrane filter fecal coliform count per 100 milliliters (MFFCC/100 ml) shall not exceed a monthly geometric mean of 200 per 100 ml based on not less than five samples per month, nor a level of 400 per 100 ml in more than 10 percent of all samples during any month.*

[d]*This standard for lakes applies only to total phosphorus concentrations measured during spring when maximum mixing is underway.*

[e]*All waters shall meet the following minimum standards at all times and under all flow conditions: Substances that will cause objectionable deposits on the shore or in the bed of any body of water shall not be present in such amounts as to interfere with public rights in waters of the State. Floating or submerged debris, oil, scum, or other material shall not be present in such amounts as to interfere with public rights in the waters of the State. Materials producing color, odor, taste, or unsightliness shall not be present in amounts that are acutely harmful to animal, plant, or aquatic life.*

[f]*Unauthorized concentrations of substances are not permitted that alone or in combination with other material present are toxic to fish or other aquatic life. Standards for toxic substances are set forth in Chapter NR 105 of the* Wisconsin Administrative Code*.*

Source: SEWRPC.

Chapter VII

ALTERNATIVE LAKE MANAGEMENT MEASURES

INTRODUCTION

Based upon a review of the inventories and analysis set forth in Chapters II through VI of this report, five issues were identified requiring consideration in the formulation of alternative and recommended lake management measures. These issues are related to: 1) point source pollution; 2) nonpoint source pollution and stormwater; 3) ecologically valuable areas, fisheries, and aquatic plants; 4) water quality; and 5) lake levels. The management measures considered herein are focused primarily on those measures which are applicable within the Lac La Belle Management District, the City of Oconomowoc, the Village of Lac La Belle, and the Town of Oconomowoc, with lesser emphasis given to those measures which are applicable to others with jurisdiction within the broader total drainage area tributary to Lac La Belle.

WATERSHED MANAGEMENT ALTERNATIVES

Point Source Pollution Control

Public Sanitary Sewerage Systems

As recommended in the regional sanitary sewerage system plan adopted by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in 1974, the Oconomowoc sewage treatment plant is proposed to serve as a regional facility providing wastewater treatment service to the Oconomowoc-Lac La Belle, Oconomowoc Lake, Okauchee Lake, North Lake, Pine Lake, Beaver Lake, and Silver Lake sewer service areas.[1] That recommendation was affirmed in the regional water quality management plan adopted by the Commission during 1979.[2] Pursuant to the recommendations set forth in this latter plan, the Oconomowoc wastewater treatment facility was upgraded during 1978 to provide secondary waste treatment, tertiary waste treatment, and auxiliary waste treatment for effluent disinfection, and expanded to provide an average hydraulic design treatment capacity of 4.0 million gallons per day (mgd), with future expansion provided for on the plant site. Extension of sewerage services to existing and proposed urban development around Lac La Belle, Okauchee Lake, North Lake, Pine Lake, Beaver Lake, Silver Lake, and Oconomowoc Lake was envisioned. Portions of these lake communities were reported to have been served by public sanitary sewerage systems as envisioned in the regional plan at the

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[1]*SEWRPC Planning Report No. 6,* A Regional Sanitary Sewerage System Plan for Southeastern Wisconsin*, February 1974.*

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

time that the regional water quality management plan was updated in 1995,[3] although the system had not been fully constructed. These systems and associated point source pollution abatement practice recommendations were further refined and affirmed as part of an overall review of sewerage services in northwestern Waukesha County, with a design year of 2010, as shown on Map 23.[4] As of the year 2000, the Lac La Belle community continues to be served by a public sanitary sewer system and trunk sewer system, as shown on Map 24.[5] Periodic review and refinement of this system remains ongoing.

Onsite Sewage Disposal Systems

While the immediate lakeshore is sewered, and such services are being extended within the upstream drainage area, currently including portions of the lakeshore directly tributary to Okauchee Lake, fourth in the chain of six lakes lying along the Oconomowoc River within the Southeastern Wisconsin Region, much of the drainage area tributary to Lac La Belle upstream of Okauchee Lake continues to be served by onsite sewage disposal systems.[6] Consequently, sewage disposal options within the total drainage area tributary to the Oconomowoc River system and its lakes have implications for water quality, groundwater quality, and property values. Onsite sewage disposal, therefore, is an important consideration in the entire drainage area.

Two basic alternatives are available for abatement of pollution from onsite sewage disposal systems: continued reliance on, and management of, the onsite sewage disposal systems, and, alternatively, the expansion of the existing public sanitary sewer system, as discussed above.

Where onsite sewage disposal systems remain the primary wastewater treatment method, onsite sewage disposal system management programs should be carried out to ensure the continuing operation of such systems to design specifications. Important elements of any such program would be the conduct of an ongoing informational and educational effort, as well as the conduct of periodic inspections of the systems to ensure their proper operation. Homeowners in areas served by onsite systems should be advised of the rules, regulations, and system limitations governing onsite sewage disposal systems, and should be encouraged to undertake preventive maintenance programs. Onsite sewage treatment systems installed since 1980 are required, pursuant to Chapter Comm 83 of the *Wisconsin Administrative Code*, to be inspected at regular intervals to ensure satisfactory operation. Older systems are not subject to this requirement; however, individual communities and special-purpose governmental units have enacted ordinances that require these systems also to be inspected on a regular basis, especially in lakeshore areas not served by public sanitary sewerage systems. Generally, it is recommended that these efforts be undertaken by, or with the assistance of, the County sanitarians. Dodge, Jefferson, Waukesha, and Washington Counties currently have such programs in place.

Nonpoint Source Pollution Control

All human activities upon the land surface result in some degree of mobilization of contaminants and modification of the surface runoff patterns that can affect lakes and streams, their quality, and biotic conditions. Many human activities can be mitigated to a large extent by the implementation of sound planning, appropriate nonpoint source pollution abatement measures, and the actions of an informed public. In the first instance, sound

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

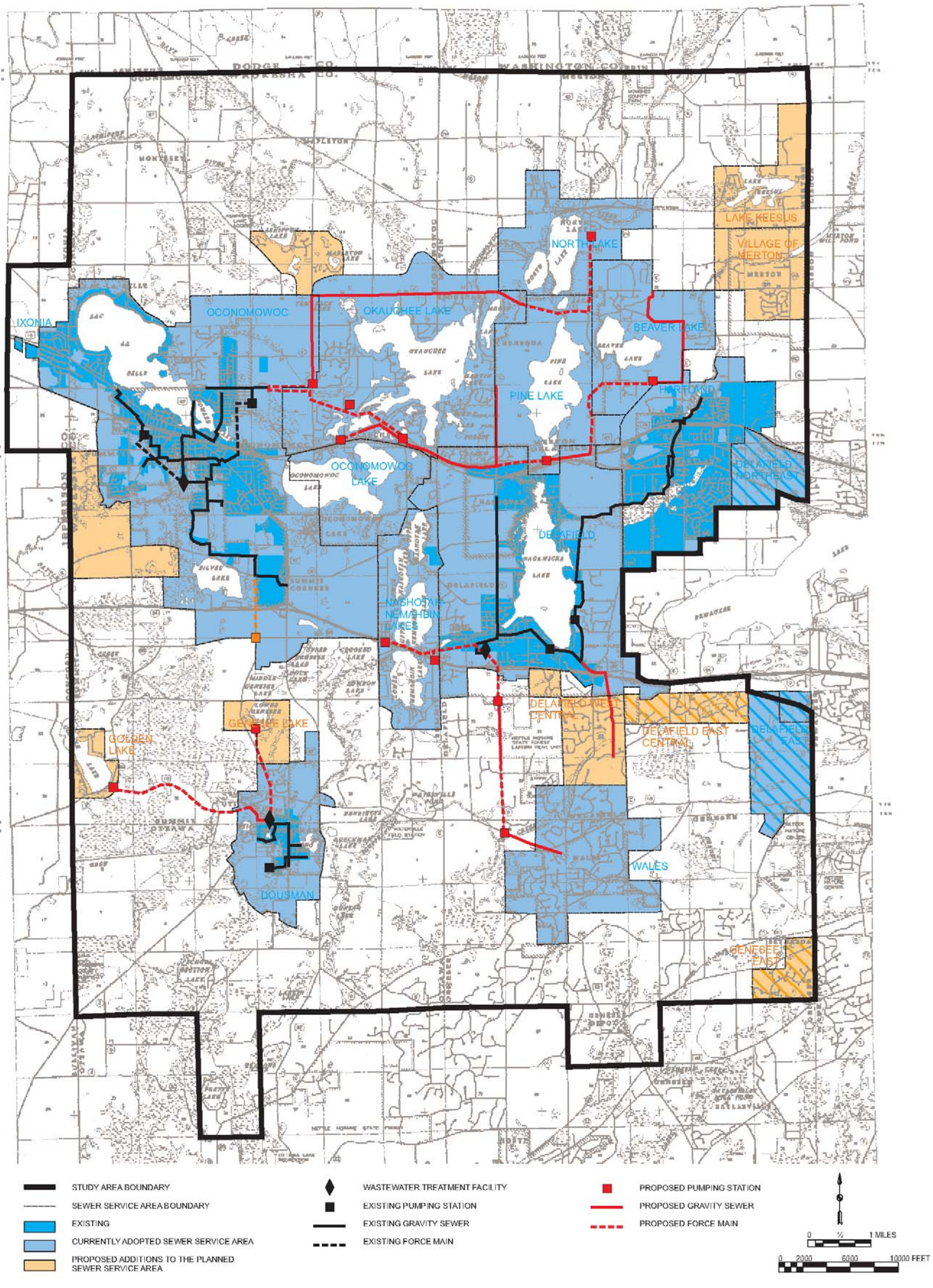
[4]*Black & Veatch Corporation*, Sanitary Sewerage System Plan for the Northwestern Waukesha County Area*, April 2000.*

[5]*SEWRPC,* Amendment to the Regional Water Quality Management Plan: City of Oconomowoc*, December 2001; see also SEWRPC Community Assistance Planning Report No., 172, 2nd Edition,* Sanitary Sewer Service Area for the City of Oconomowoc and Environs, Waukesha County, Wisconsin*, September 1999.*

[6]*Black & Veatch Corporation*, op. cit.

Map 23

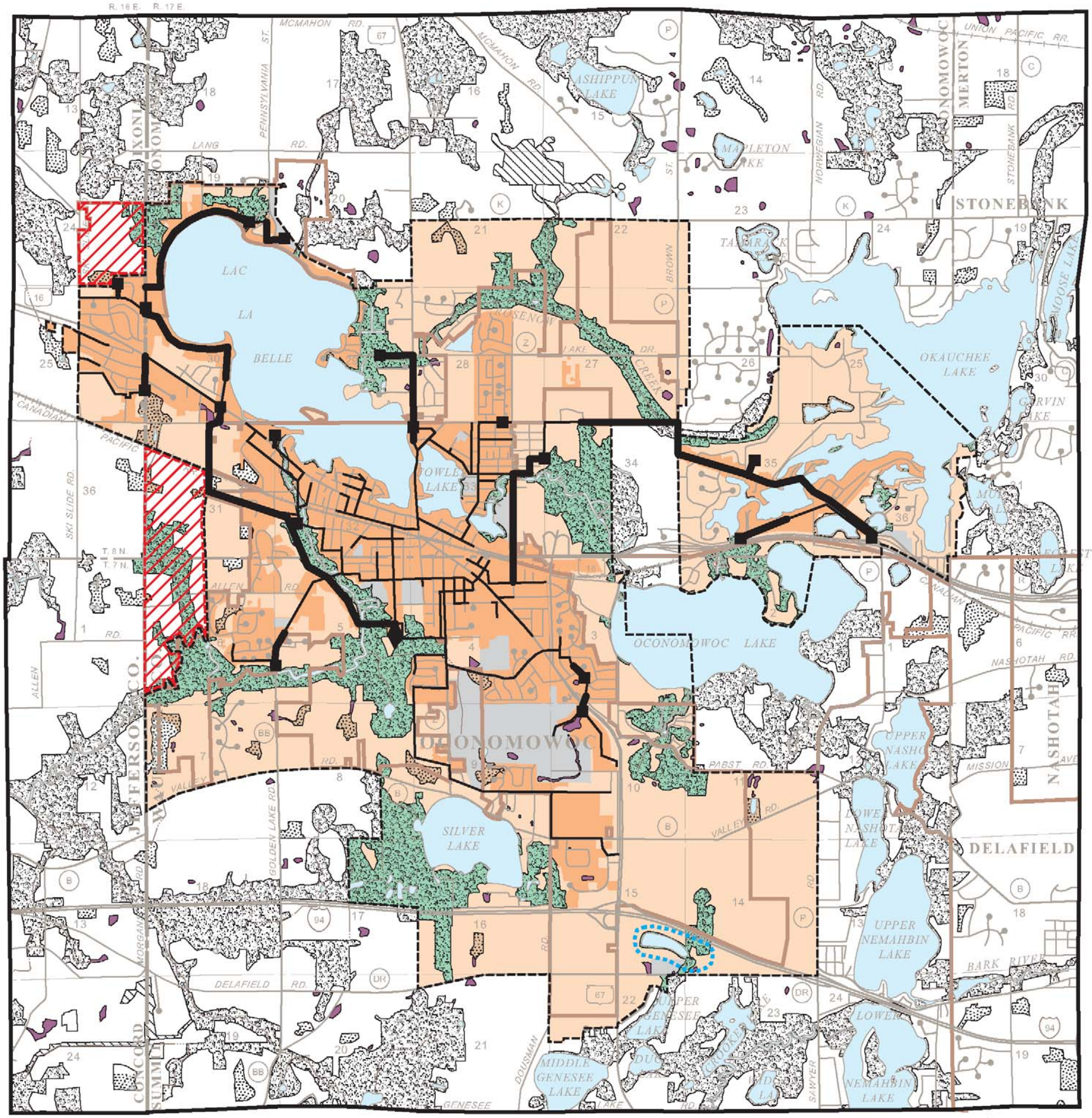
POST-PUBLIC HEARING RECOMMENDED MODIFICATIONS TO THE REGIONAL WATER QUALITY MANAGEMENT PLAN BASED UPON THE NORTHWESTERN WAUKESHA COUNTY SEWERAGE SYSTEM PLAN STUDY AREA



Source: SEWRPC.

Map 24

PROPOSED AMENDMENT TO THE OCONOMOWOC AND ENVIRONS SANITARY SEWER SERVICE AREA



PRIMARY ENVIRONMENTAL CORRIDOR

SECONDARY ENVIRONMENTAL CORRIDOR

ISOLATED NATURAL RESOURCE AREA

WETLANDS AND SURFACE WATER AREAS LESS THAN FIVE ACRES IN SIZE

EXISTING AREA SERVED BY PUBLIC SANITARY SEWER SYSTEM: 2000

PLANNED SANITARY SEWER SERVICE AREA

AIRPORTS, LARGE PARK AND RECREATION SITES, AND SIMILAR USES WITHIN THE SEWER SERVICE AREA

AREAS PROPOSED TO BE ADDED TO THE OCONOMOWOC SANITARY SEWER SERVICE AREA

RESTRICTIONS ON SEWERED DEVELOPMENT

PRIMARY ENVIRONMENTAL CORRIDORS WITHIN THE PLANNED SANITARY SEWER SERVICE AREA: THE EXTENSION OF SEWERS TO SERVE NEW DEVELOPMENT IS CONFINED TO LIMITED RECREATIONAL AND INSTITUTIONAL USES AND RURAL-DENSITY RESIDENTIAL DEVELOPMENT IN AREAS OTHER THAN WETLANDS, FLOODLANDS, SHORELANDS, AND STEEP SLOPES.

PORTIONS OF SECONDARY ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS WITHIN THE PLANNED SANITARY SEWER SERVICE AREA WHICH ARE COMPRISED OF WETLANDS, FLOODLANDS, SHORELANDS, AND STEEP SLOPES: THE EXTENSION OF SEWERS TO SERVE NEW DEVELOPMENT IN THESE AREAS IS NOT PERMITTED.

PLANNED SANITARY SEWER SERVICE AREA BOUNDARY

EXISTING TRUNK SEWER

EXISTING FORCE MAIN

EXISTING PUMPING STATION

AREA ENCOMPASSING PROPOSED CHANGE TO THE PRIMARY ENVIRONMENTAL CORRIDOR

GRAPHIC SCALE

0 ¼ ½ 1 MILE

0 1250 2500 5000 FEET

Source: SEWRPC.

land use development and management in the tributary watershed, and the protection of environmentally sensitive lands, are the fundamental building blocks for protecting lake and stream water quality and habitat, and preserving human use opportunities that will support a broadly based recreational and residential community. In addition, specific nonpoint source pollution control abatement measures should be integrated into land use regulations and promoted by a far-reaching informational and educational program within the drainage areas tributary to individual lakes and streams. Alternative nonpoint source pollution control measures are summarized below.

Land Use Management and Zoning

A basic element of any water quality management effort for a lake is the promotion of sound land use development and management in the tributary watershed. The type and location of future urban and rural land uses in the tributary drainage area to Lac La Belle will determine, to a large degree, the character, magnitude, and distribution of nonpoint sources of pollution; the practicality of, as well as the need for, stormwater management; and, to some degree, the water quality of the Lake. Land use management measures can be applied both within the shoreland area riparian to the Lake and in the drainage area tributary to the Lake. In the case of Lac La Belle, given its location at the downstream end of the Oconomowoc River chain-of-lakes, interventions in both the riparian and tributary drainage areas are likely to be required.

Development in the Shoreland Zone

Existing year 2000 and planned buildout land use patterns and existing zoning regulations in the tributary area to Lac La Belle have been discussed in Chapter II of this report. If the recommendations set forth in the adopted Waukesha County development plan and regional land use plan are followed, under buildout conditions, some additional urban residential development within the drainage area tributary to Lac La Belle would occur.[7] Much of this residential development is likely to occur on agricultural lands. Infilling of existing platted lots and some backlot development, as well as the redevelopment and reconstruction of existing single-family homes and commercial structures on lakefront properties, also may be expected to occur. A substantial proportion of the drainage area directly tributary to Lac La Belle is anticipated to be converted from agricultural land uses to urban land use, primarily for urban residential use, as noted in Chapter III of this report. Accordingly, given the potential impact of lakeshore development on the lake resources, land use development or redevelopment proposals around the shoreline of Lac La Belle and within the drainage area directly tributary to the Lake should be evaluated for potential impacts on the Lake, as such proposals are advanced.

Recent studies of the potential impact of riparian landscaping activities on the nutrient loadings to lakes in southeastern Wisconsin have suggested that urban residential lands can contribute up to twice the mass of phosphorus to a lake when subjected to an active program of urban lawn care than similar lands managed in a more natural fashion.[8] The application of agrochemicals to such lands, in excess of the plant requirements, therefore, results in enhanced nutrient loading directly to the adjacent waterbodies. To address these concerns, a number of communities have enacted ordinances for the control of phosphorus in fertilizers used within urban residential areas, in addition to the public informational programming discussed below; some communities, such as the Big Cedar Lake Protection and Rehabilitation District, also have purchased bulk lots of phosphorus-free lawn and garden fertilizers for resale to riparian landowners.

While various communities have taken a variety of approaches to managing the addition of phosphorus to the aquatic environment from the land surface, the specific approach adopted within a given community has been a

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[7]*SEWRPC Community Assistance Planning Report No. 209,* A Development Plan for Waukesha County, Wisconsin*, August 1996; see also SEWRPC Planning Report No. 45,* A Regional Land Use Plan for Southeastern Wisconsin: 2020*, December 1997.*

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

matter of local discussion. Current regulations do not fully address the issue of the use of phosphorus-based fertilizer products; however, two approaches to regulating the addition of phosphorus to the environment typically have been adopted. These include a low phosphorus alternative which requires that any fertilizer product contain less than 3 percent phosphorus, and a no phosphorus alternative which requires that phosphorus not be included. The low phosphorus alternative permits the use of compost-based products, such as Milorganite®, while the no phosphorus alternative may contain exemptions for such products. Agricultural lands are generally exempted, and both alternatives can include exemptions for cases in which soil tests demonstrate a need for additional phosphorus to be applied, as in the case of newly established lawns. Given the increasing importance of urban land uses within the riparian area of Lac La Belle, and within its drainage area, consideration of a comprehensive program to regulate urban agricultural practices appears to be warranted. Most soils in southeastern Wisconsin contain abundant phosphorus, sufficient for most residential gardening needs, including lawns, flower beds, and vegetable gardens.

Development in the Tributary Drainage Area

The level of development envisioned in the Waukesha County development plan for the total drainage basin tributary to Lac La Belle indicates continuing urban development, generally on large suburban-density lots.[9] Careful review of applicable zoning ordinances to incorporate levels and patterns of development consistent with the plan within the drainage area tributary to Lac La Belle is recommended. Changes in the zoning ordinances could be considered to better reflect the land use patterns recommended in the County development plan. Consideration should be given to minimizing the areal extent of development by providing specific provisions and incentives to cluster residential development on smaller lots, while preserving portions of the open space on each property or group of properties considered for development, utilizing the principles of conservation development.[10]

Similar recommendations apply to lands within Washington County being considered for development. It should be noted, however, that Washington County adopted a refined shoreland, wetland, and floodplain zoning code during 2001 that extends greater levels of protection to those lakes and streams within the County deemed to be more sensitive to disturbances from human activities.[11] The refined ordinance defined three classes of waterbodies, each of which included the application of progressively more stringent land management measures. Class III waterbodies are subject to the State minima set forth in Chapter NR 115 of the *Wisconsin Administrative Code*, while Class I and Class II waters are subject to more restrictive requirements, including limits on setbacks, impervious surface, and land disturbances. The portion of the Oconomowoc River ultimately draining to Lac La Belle from within Washington County, including the Coney River and the Little Oconomowoc River and associated lakes, is designated as a Class II waterbody; Mason Creek is designated as a Class I waterbody; and, Friess Lake is designated as a Class III waterbody.

Stormwater Management on Development Site

Development of stormwater management ordinances reflecting current best practices insofar as the determination of stormwater flows, mitigation of flooding potential, and the control of contaminants from land use activities is one method of minimizing the water quality and flooding impacts often associated with the development of impervious surfaces within drainage basins. With respect to stormwater management on development sites, the

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[9]*SEWRPC Community Assistance Planning Report No. 209,* op. cit.

[10]*SEWRPC Planning Guide No. 7,* Rural Cluster Development Guide*, December 1996.*

[11]*Washington County Code of Ordinances,* Chapter 23: Shoreland, Wetland and Floodplain Zoning*, February 2001; see also SEWRPC Memorandum Report No. 139,* Surface Water Resources of Washington County, Wisconsin: Lake and Stream Classification Project: 2000*, September 2001—a similar initiative is under consideration in Waukesha County, as set forth in part in SEWRPC Memorandum Report No. 145,* Lake and Stream Resources Classification Project for Waukesha County, Wisconsin: 2000*, November 2005.*

application of such management measures as may be required by ordinance can moderate and mitigate the transport of sediments and associated contaminants from exposed soils to aquatic systems. The City and Town of Oconomowoc have adopted stormwater management ordinances. These ordinances reflect current best practices insofar as the determination of stormwater flows, mitigation of flooding potential, and the control of contaminants from land use activities are concerned. Periodic review of these ordinances and their provisions for consistency with best management practices, and to ensure their currency with the state-of-the-art, should be undertaken on a regular basis to facilitate control of urban sourced contaminants likely to be delivered to the Lake. In particular, these ordinances should be reviewed for consistency with Chapter NR 151 and related provisions of the *Wisconsin Administrative Code*.

Pursuant to Chapter NR 151 of the *Wisconsin Administrative Code*, particular attention also should be given to reducing pollutant loadings from high pollutant loading areas, such as commercial sites, parking lots, and material storage areas. Appropriate stormwater management plans, consistent with the standards set forth in Chapter NR 216 of the *Wisconsin Administrative Code*, are required for new development. Proper design and application of structural urban nonpoint source control measures, such as grassed swales and detention basins, requires the preparation of detailed stormwater management systems plans that address stormwater drainage problems and control of nonpoint sources of pollution. In residential areas, the use of rain gardens which infiltrate runoff is becoming increasingly popular with these gardens providing an additional landscaping option for homeowners and householders. These facilities can also be installed as communal facilities within conservation subdivisions. Likewise, to the extent practicable, parking lot stormwater runoff should be diverted to areas covered by pervious soils and appropriate vegetation, rather than being directly discharged to surface waters. Material storage areas may be enclosed or periodically cleaned, and diversion of stormwater away from these sites may further reduce pollutant loadings. Street sweeping, increased catch basin cleaning, stream protection, leaf litter and vegetation debris collection, and stormwater storage and infiltration measures can enhance the control of nonpoint source pollutants from urban and urbanizing areas, and reduce urban nonpoint source pollution loads by up to about 50 percent.

The Village of Lac La Belle does not have a specific stormwater management ordinance. Control of runoff from constructions sites is governed by provisions included within the Village construction ordinance. This ordinance should be reviewed for concurrency with the provisions of Chapter NR 151 and related provisions of the *Wisconsin Administrative Code*, and consideration given to supplementing the construction provisions with ongoing stormwater management provisions that continue beyond the construction phase.

Protection of Environmentally Sensitive Lands

Environmentally sensitive lands within the drainage area tributary to Lac La Belle include wetlands, woodlands, and wildlife habitat areas. Nearly all of these areas within the Lac La Belle drainage area are included in the environmental corridors and isolated natural features delineated by the Regional Planning Commission.[12] Upland areas, woodlands, and wildlife habitat areas, currently, are protected primarily through local land use regulations, while wetlands enjoy wider range of protections set forth in State and Federal legislation.

Wetland protection can be accomplished through land use regulation and, in cases where land use regulations may not offer an adequate degree of protection, through public acquisition of sensitive sites. These wetland areas are currently protected to a degree by current zoning and regulatory programs administered by the U.S. Army Corps of Engineers, Wisconsin Department of Natural Resources (WDNR), and County and municipal authorities under one or more of the Federal, State, county, and local regulations. Wetlands adjacent to lakes and streams help enhance water quality conditions, while preserving desirable open space characteristics for residents of the area to participate in a wide range of resource-oriented recreational activities, and to avoid the creation of new environmental and developmental problems as urbanization proceeds within the watershed.

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

Specific areas within the drainage area tributary to Lac La Belle have been identified for protection in the aforereferenced natural areas and critical species habitat protection and management plan for southeastern Wisconsin. Within the portion of the total tributary drainage area within Waukesha County, the Monches Woods, a 322-acre natural area of statewide significance, designated as an NA-1 natural area in the adopted regional natural areas and critical species habitat protection and management plan, is recommended for expansion of the current County ownership. The Lake Keesus Fen-Meadow, a 141-acre natural area of countywide or regional significance, designated as an NA-2 natural area in the adopted regional natural areas and critical species habitat protection and management plan, is recommended for expansion of the current WDNR ownership. The 33-acre, NA-3 Lac La Belle Lowlands, designated as an NA-3 natural area, is recommended for acquisition by the Village of Lac La Belle.

The Camp Whitcomb Lowland, a 48-acre NA-3 designated site, is recommended for expansion of the existing ownership by the YMCA Camp, while the Chenequa Wetland Complex, a 111-acre NA-3 designated site, is recommended for County acquisition. The Oconomowoc Sedge Meadow, a 19-acre natural area of local significance, designated as an NA-3 natural area in the adopted regional natural areas and critical species habitat protection and management plan, is recommended for acquisition by a private conservancy organization. Likewise, the Stonebank Tamarack Relict, a 166-acre critical species habitat area, identified in the plan as a habitat area for rare or special-concern and uncommon bird species, partially under protective ownership, is recommended for expansion. The remaining portions of this wetland are recommended for acquisition by a private conservancy organization, as are the remaining portions of the 100-acre Oconomowoc River Marsh, designated as an NA-3 natural area, and the 95-acre, Raasch Tamarack Swamp, also designated as a NA-3 natural area. Both of these latter areas currently are under partial protective ownership by the WDNR.

Within the portion of the total tributary drainage area within Washington County, the 228-acre, NA-2 designated Friess Lake Tamarack Swamp is recommended for State acquisition. In addition, the NA-2 designated, 256-acre Holy Hill Woods, the 21-acre Daniel Boone Bogs, the 60-acre Glacier Hills Park Bogs and Upland Woods, the 54-acre Mud Lake Upland Woods, and the 59-acre Mud Lake Meadow, are recommended for acquisition by Washington County, as is the 94-acres, NA-3 designated Heritage Trails Bog. The NA-3 designated, 137-acre Donegal Road Woods, and the 11-acre St. Augustine Road Sedge Meadow, both within the Loew Lake Unit of the Kettle Moraine State Forest, is recommended for acquisition by the WDNR.

The 182-acre Thompson Swamp, the 100-acre CTH J Swamp, and the 11-acre Hubertus Road Sedge Meadow, are NA-3 designated sites recommended for acquisition by private conservancy organizations. In addition, the Murphy Lake-McConville Lake Wetland Complex, a 890-acre, NA-1 designated site is recommended for expansion of The Nature Conservancy ownership. The NA-3 designated Mason Creek Swamp, a 432-acre wetland site, is recommended for expansion of the existing ownership by the University of Wisconsin.

In addition to the preservation of natural areas and critical species habitat, the adopted regional water quality, land use, and transportation plans provide a framework within which the planning for and management of the potential consequences of transportation corridor development impacting streams and lakes can be accomplished.[13] Transportation corridors commonly cross streams, and can modify their behavior. Physical alteration of the streams and their surrounding landscapes can alter flow regimes and contribute to runoff and associated contaminant flows through stormwater drainage systems. If erosion control practices are not integrated into the construction phase of a project, the erosive effects of wind and rain have the potential to negatively impact aquatic systems. Altered streams can increase streambank erosion which, in effect, can limit biological diversity and degrade water resources. Opportunities exist to minimize and/or mitigate the potential impacts of transportation routes on streams and lakes. By utilizing existing stream morphology, dynamics, and pre-construction biological conditions, measures can be incorporated into the project design that will offset adverse impacts.

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[13]*See SEWRPC Planning Report No. 30,* op. cit.*; SEWRPC Planning Report No. 45,* op. cit.*; and, SEWRPC Planning Report No. 46,* A Regional Transportation System Plan for Southeastern Wisconsin: 2020*, December 1997.*

During 2002 through 2004, SEWRPC staff prepared a system-level concept stream protection plan for the Wisconsin Department of Transportation projects proposed or planned for the STH 67 Oconomowoc bypass at Rosenow Creek upstream of Lac La Belle in the vicinity of the City and Town of Oconomowoc in Waukesha County. The SEWRPC staff compiled data on the existing and pre-existing physical, morphological, and biological conditions in order to develop alternatives to protect and manage the stream segments during the construction phase and to prepare the concept stream protection plan for the stream segments, including conceptual design alternatives for the protection, maintenance, and restoration of stream structure and function within the project areas. This plan set forth cost-effective actions necessary to reestablish the natural meanders within a formerly channelized section of the North Branch of Rosenow Creek, and reconnect the stream to its floodplain. The actions were necessary to protect and preserve the trout fishery in this Class I brook and brown trout stream. As of 2005, this stream relocation and associated wetland restoration project had been successfully completed.

Nonpoint Source Pollution Abatement

Watershed management measures may be used to minimize nonpoint sources loadings from the watershed by informing the location of development within a drainage basin. Beyond such actions, specific interventions maybe required to control the mass of contaminants generated by various types of land use activity, and transported to the Lake. Rural sources of contaminants arise as pollutants transported by runoff from cropland and pastureland; urban sources include contaminants transported by runoff from residential, commercial, industrial, transportation, and recreational land uses, and from construction activities. Alternative, watershed-based nonpoint source pollution control measures considered in this report are based upon the recommendations set forth in the regional water quality management plan,[14] in the Oconomowoc River priority watershed plan,[15] and in the Washington and Waukesha County land and water resource management plans.[16]

The regional water quality management plan recommends that the nonpoint source pollutant loadings from the areas tributary to Lac La Belle be reduced by up to 25 percent in urban and rural areas, in addition to implementation of urban construction erosion controls, streambank erosion controls, and onsite sewage disposal system management practices. The Oconomowoc River Priority Watershed plan refined these recommendations, and proposed an overall reduction of phosphorus loadings of about 24 percent, with an additional 5 percent reduction in phosphorus loading indicated if infiltration technologies are utilized in place of surface stormwater basins in urban areas. As described in Chapter IV of this report, the most readily controllable loadings are associated primarily with runoff from urban lands within the direct drainage area tributary to the Lake and from urbanizing lands throughout the total drainage area tributary to the Lake that area linked to the Lake by way of streams and stormwater drainage systems. These urban loadings constituted about 5 percent of the sediment, 35 percent of the total phosphorus, and 100 percent of the heavy metals loadings to Lac La Belle, based upon 2000 land uses. Phosphorus loadings from the remainder of the tributary area, and from direct deposition onto the lake surface, contributed the balance of the total loadings. The contributions of phosphorus, sediment and heavy metals from urban lands are expected to increase as agricultural lands are progressively converted to urban uses.

While some proportion of these contaminant loads may be attenuated within the chain-of-lakes due to in-lake retention of suspended solids to which these contaminants are frequently adsorbed and, as a consequence of the extensive wetland areas within the drainage basin, the ability of wetlands to assimilate pollutants is wholly dependent upon the maintenance of their structure and function within their ecosystems. Likewise, the ability of

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[14]*SEWRPC Planning Report No. 30,* op. cit.*; SEWRPC Memorandum Report No. 93,* op. cit.

[15]*Wisconsin Department of Natural Resources Publication No. WR-194-86*, A Nonpoint Sources Control Plan for the Oconomowoc River Priority Watershed Project, *March 1986.*

[16]*Washington County*, Land & Water Resource Management Plan, *September 2000; Waukesha County*, Land and Water Resource Management Plan: 1999-2002, *January 1999.*

both lake and wetland systems to retain contaminants is a function of their flushing rate; too rapid a through put of water through these systems will transport more contaminants downstream. These features can be overwhelmed by inappropriate land uses that result in the degradation of the wetlands, diminishing their ability to capture contaminants; creating contaminant loads of such magnitude that the wetlands are overloaded; or by creating runoff from increased areas of impervious surface that more rapidly transports contaminants through these systems. Thus, the control of nonpoint sources of water pollution at their origin is an important consideration. Properly applied, such controls can reduce the pollutant loadings to a lake by about 25 percent or more.

Appendix C presents a list of alternative nonpoint source pollution management measures that could be considered for use in the Lac La Belle area to reduce loadings from nonpoint sources of pollution. Information on the cost and effectiveness of the measures is also presented in Appendix C. It should be noted that appropriate public informational programming, described below, provides means of disseminating information on various nonpoint source control measures that can be targeted to specific sectors of the community. Many of the measures are low-cost or no-cost measures that can be implemented by individual landowners. Selected measures are discussed below.

Rural Nonpoint Source Controls

Upland erosion from agricultural and other rural lands is a contributor of sediment to streams and lakes. Estimated phosphorus and sediment loadings from croplands, woodlots, pastures, and grasslands in the drainage area tributary to Lac La Belle were presented in Table 18 in Chapter IV of this report. These data were utilized in determining the pollutant load reduction that could be achieved, the types of practices needed, and the extent of the areas to which the practices need to be applied within the drainage area tributary to Lac La Belle.

Based upon the pollutant loading analysis set forth in Tables 17 and 18 in Chapter IV of this report, a total annual phosphorus load of 3,055 pounds is estimated to be contributed to Lac La Belle. Of that mass, it is estimated that 1,985 pounds per year, or 75 percent of the total loading, excluding direct deposition onto the lake surface, were contributed by runoff from rural land. In addition, it is estimated that 847,800 pounds of sediment, or about 86 percent of the total sediment load to Lac La Belle, were contributed annually from agricultural lands in the drainage area tributary to the Lake. As of 2000, such lands comprised about 30,000 acres, or about 48 percent of the drainage area tributary to Lac La Belle, which area is anticipated to diminish to about 24,000 acres, or less than 38 percent, of the tributary drainage area by the year 2020, as summarized in Tables 7 and 8, respectively, in Chapter III of this report.

While agricultural land uses are anticipated to be a declining form of land usage within the drainage area tributary to Lac La Belle, the agricultural operations that remain within the drainage area will continue to contribute a significant proportion of the sediment load to the waterbody. Table 18 in Chapter IV of this report suggests that, based upon estimated contaminant loadings, agricultural land uses will continue to contribute 80 percent of the total sediment load, or about 667,600 pounds of sediment annually, to Lac La Belle. Thus, detailed farm conservation plans are likely to continue to be required to adapt and refine erosion control and nutrient and pest management practices for individual farm units. Generally prepared with the assistance of staff from the U.S. Natural Resources Conservation Service or County Land Conservation Department, such plans identify desirable tillage practices, cropping patterns, and rotation cycles. The plans also consider the specific topography, hydrology, and soil characteristics of the farm; identify the specific resources of the farm operator; and articulate the operator objectives of the owners and managers of the land.

Urban Nonpoint Source Controls

As of 2000, established urban land uses comprised about 12,000 acres, or about 20 percent, of the total drainage area tributary to Lac La Belle. The annual phosphorus loading from these urban lands was estimated to be 1,000 pounds, or about 25 percent of the total load of phosphorus to the Lake. This load is anticipated to remain relatively constant under buildout conditions, as shown in Table 17 in Chapter IV of this report, although a shift in urban lawn care practices toward more intensive utilization of agricultural chemicals may result in an increasing proportion of the total phosphorus load being delivered to the Lake from urban sources.[17] Those urban-sourced pollutant loadings that are most controllable include runoff from the residential lands adjacent to the Lake, and urban runoff from areas with a high proportion of impervious surface. The potential also exists within the Lac La Belle watershed for significant construction site erosion impacts if development continues in the tributary drainage area as has been the recent trend.

Potentially applicable urban nonpoint source control measures include stormwater management measures, such as detention basins, infiltration facilities, grassed swales, and good urban "housekeeping" practices. Generally, the application of low-cost urban housekeeping practices may be expected to reduce nonpoint source loadings from urban lands by about 25 percent. Public educational programs can be developed to encourage good urban housekeeping practices, to promote selection of building and construction materials which reduce runoff contribution if metals and other toxic pollutants, and to promote the acceptance and understanding of the proposed pollution abatement measures and the importance of lake water quality protection. Urban housekeeping practices and source controls include restricted use of fertilizers and pesticides, improved pet waste and litter control, and substitution of plastic for galvanized steel and copper roofing materials and gutters, proper disposal of motor vehicle fluids, increased leaf collection, and continued use of reduced quantities of street deicing salt.

Particular attention should also be given to reducing pollutant loadings from high pollutant areas, such as commercial sites, parking lots, and material storage areas. To the extent practicable, parking lot stormwater runoff should be diverted to areas covered by pervious soils and appropriate vegetation, rather than being directly discharged to surface waters. Material storage areas may be enclosed or periodically cleaned, and diversion of stormwater away from these sites may further reduce pollutant loadings. Street sweeping, increased catch basin cleaning, stream protection, leaf litter and vegetation debris collection, and stormwater storage and infiltration measures that can enhance the control of nonpoint source pollutants from urban and urbanizing area, and reduce urban nonpoint source pollution loads by up to about 50 percent.[18]

As has been noted above, the City and Town of Oconomowoc have adopted stringent stormwater management ordinances applicable to new development within the areas under their jurisdiction. While these measures limit the potential impacts of new development, they do not address impacts from existing land uses, nor do they address the cumulative impacts of past development. Therefore, additional measures to reduce nonpoint source pollution from existing development would appear to be warranted. To this end, proper design and application of structural urban nonpoint source control measures, such as grassed swales and detention basins, may require the preparation of a detailed stormwater management system plan that addresses stormwater drainage problems and controls nonpoint sources of pollution on either a site-specific, decentralized basis or larger-scale, centralized basis.

Of particular concern to the lake community are the maintenance practices utilized at the Lac La Belle Golf Club. The Lac La Belle Management District, in cooperation with other agencies, including the WDNR and SEWRPC, has engaged in a dialogue with the course operators to promote installation of grassed buffers between the fairways of the golf course and the stream channels running through the course. Maintenance of these streambank vegetated buffer strips, without fertilization, remains an effective management practice for minimizing the transport of agrochemicals to the watercourses. In addition, the course operators have implemented a program of integrated nutrient management within the facility, to minimize applications of agrochemicals, and could consider enrollment in the Audubon Cooperative Sanctuary Program for golf courses. Participation in this or similar programs provides course operators with informational and technical support to implement integrated nutrient and

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[17] *U.S. Geological Survey Water-Resources Investigations Report No. 02-4130,* op. cit.

[18] *See, for example, U.S. Geological Survey Open-File Report No. 03-93,* Data and Methods of a 1999-2000 Street Sweeping Study on an Urban Freeway in Milwaukee County, Wisconsin*, 2003.*

pest management practices in such a way as to minimize environmental impacts associated with the operation of golf course facilities.[19]

Developing Area Nonpoint Source Controls
Developing areas can generate significantly higher pollutant loadings than established areas of similar size. Developing areas include a wide array of activities, including urban renewal projects, individual site development within the existing urban area, and new land subdivision development. While the regional land use and county development plan envision only limited new urban development within the drainage area directly tributary to Lac La Belle, development elsewhere in the drainage area have some potential to influence water quality and habitat conditions in the Lake. While these impacts are moderated by the presence of the upstream impoundments, pollutant loadings from developing areas remain a concern.

Construction sites, especially, may be expected to produce suspended solids and phosphorus loadings at rates several times higher than established urban land uses. Control of sediment loss from construction sites can be provided by measures set forth in the construction site handbook and additional technical standards developed by the WDNR.[20] These controls are temporary measures taken to reduce pollutant loadings from construction sites during stormwater runoff events. Properly installed and maintained, construction erosion controls may be expected to have a significant impact in reducing the total pollutant loadings to the Lake due to the relatively large amount of land proposed to be developed. Such controls are important pollution control measures that can abate localized short-term loadings of phosphorus and sediment from the direct and total drainage areas. The control measures include such revegetation practices as temporary seeding, mulching, and sodding and such runoff control measures as filter fabric fences, straw bale barriers, storm sewer inlet protection devices, diversion swales, sediment traps, and sedimentation basins.

Waukesha County has adopted a stormwater management and erosion control ordinance which is administered and enforced by the County in the unincorporated areas of the area directly tributary to Lac La Belle.[21] Subject to certain specific exemptions, the provisions of this ordinance apply to all development except single- and two-family residential construction. Single- and two-family construction erosion control measures are to be specified as part of the building permit process. The City of Oconomowoc and the Village of Lac La Belle also have adopted construction site erosion control ordinances regulating development within their jurisdictions. Because of the potential for development, some of it, albeit unplanned, in the drainage area tributary to Lac La Belle, it is important that adequate construction erosion control programs, including enforcement, be in place. The City and Village ordinances should be reviewed for consistency with Chapter NR 151 and related provisions of the *Wisconsin Administrative Code*.

IN-LAKE MANAGEMENT ALTERNATIVES

Unlike many of the other major lakes in the Oconomowoc River chain-of-lakes, Lac La Belle can be classified as oligo-mesotrophic, or relatively nutrient poor. One consequence of this condition is an impoverished aquatic plant community characterized by a paucity of aquatic plants in many areas of the Lake. There are a number of issues of concern that impact the water quality of Lac La Belle, including: increasing nonpoint source pollution in

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[19]*Within southeastern Wisconsin, the Lauderdale Lakes Management District, for example, has acquired the Lauderdale Lakes Country Club and have implemented a program of integrated nutrient management within the facility. The golf course is currently enrolled in the Audubon Cooperative Sanctuary Program for golf courses.*

[20]*Wisconsin Department of Natural Resources,* Wisconsin Construction Site Best Management Practices Handbook*, April 1994; see also http://www.dnr.state.wi.us/org/water/wm/nps/stormwater/techstds.htm.*

[21]*Waukesha County Department of Parks and Land Use, Land Resources Division,* Waukesha County Code, Chapter 14, Article VIII, Stormwater Management and Erosion Control Ordinance*, March 2005.*

specific embayments; the presence of nuisance growths of Eurasian water milfoil and other aquatic plants, primarily in the embayments impacted by nonpoint source pollutants, combined with an overall scarcity and lack of diversity of aquatic vegetation in most areas of the main lake basin; and, the apparent decline in the quality of the lake fishery.

In some ways, these issues of concern are interrelated. The overall lack of nutrients limits aquatic plant growth to those portions of the lake basin where there are appropriate substrates and adequate nutrient inputs, such as the embayments into which Rosenow Creek and Golf Course Creek discharge. In these areas, development-related nutrient loads and agricultural runoff, combined with organic-rich substrates, favor the growth of Eurasian water milfoil and other aquatic plants, many of which are considered to be a nuisance by the community. These growths, combined with inputs of organic-rich sediment, also affect the fishery by limiting available breeding habitat and favoring "roughfish," such as carp. The implementation of the aforedescribed nonpoint source pollution abatement measures should help to stabilize the inputs of nutrients and sediments to the bays and prevent further deterioration of lake water quality conditions. However, measures maybe required to restore the ecological balance of the living aquatic system.

In those areas of the Lake where Eurasian water milfoil is abundant, certain recreational uses may be limited, the aesthetic quality of the Lake impaired, and in-lake habitat degraded. This nonnative plant primarily interferes with recreational boating activities by clogging propellers and cooling water intakes, snagging paddles, and slowing sailboats by wrapping around keels and control surfaces. The plant also causes concern amongst swimmers who can become entangled within the plant stalks. Thus, without control measures, these areas can become problematic for boat navigation, fishing, and swimming. Native aquatic plants, generally found at slightly deeper depths, pose fewer potential problems for navigation, swimming, and fisheries. In addition, many native aquatic plants provide fish habitat and food resources and offer shelter for juvenile fishes and young-of-the-year.

Despite areas in the Lake where nuisance growths of Eurasian water milfoil occur, overall, the Lake is limited in terms of the numbers and diversity of aquatic plants. In particular, the Lake lacks a diverse submergent and floating vegetation community. In turn, this lack of diversity is likely to have contributed to an imbalance in the fisheries community within the Lake. At present, there is not enough forage for fish to utilize as a food source, nor enough cover to limit predation on juvenile fishes. This creates a situation which, over time, has begun to have an impact on the fish community. This impact is exacerbated by the presence of an abundant and growing carp population, which historically has been targeted for control utilizing a variety of methods, including piscicides and barriers. Curiously, the Lake maintains a productive walleye fishery, although supplemental stocking is a necessity in this heavily utilized waterbody.

The applicability of specific in-lake rehabilitation techniques is highly dependent on lake-specific characteristics. The success of any lake rehabilitation technique can seldom be guaranteed, and because of the relatively high cost of applying most techniques, a cautious approach to implementing in-lake rehabilitation techniques is generally recommended. Certain in-lake rehabilitation techniques should be applied only to lakes in which: 1) nutrient inputs have been reduced below the critical level; 2) there is a high probability of success in applications of the particular technology to lakes of similar size, shape, and quality; and 3) the possibility of adverse environmental impacts is minimal. Finally, it should be noted that some in-lake rehabilitation techniques require the issuance of permits from appropriate State and Federal agencies prior to implementation.

Alternative lake rehabilitation measures include in-lake water quality management, water level management, and aquatic plant and fisheries management measures. Each of these groups of management measures is described further below.

Water Quality Improvement Measures
This group of in-lake management practices includes a variety of measures designed to directly modify the magnitude of either a water quality determinant or biological response. Specific measures, aimed at managing aquatic plants and the fishery, are separately considered below.

Phosphorus Precipitation and Inactivation

Nutrient inactivation is a restoration measure that is designed to limit the biological availability of phosphorus by chemically binding the element in the lake sediments using a variety of divalent or trivalent cations, or highly positively charged elements. Aluminum sulfate (alum), ferric chloride, and ferric sulfate are commonly used cation sources. The use of these techniques to remove phosphorus from nutrient-rich lake waters is an extension of common water supply and wastewater treatment processes. Costs depend on the lake volume and type of dosage of chemicals used. Approximately 100 tons of alum, costing about $150 per ton, can treat a lake area of about 40 acres. Effectiveness depends, in part, on the ability of the alum flocculent to form a stable "blanket" on the lakebed, and on flushing time turbulence, lake water acidity (pH), and rate of continued sedimentation. Impacts can include the release of toxic quantities of free aluminum into the water. The resulting improved water clarity can also encourage the spread of rooted aquatic plants.

Nutrient inactivation is not recommended for use in Lac La Belle due to the shallow depth of management areas, the susceptibility to wind- and boat motor-induced mixing, and the relatively low overall rate of pollutant loadings which mediate against the effective use of nutrient inactivation.

Nutrient Load Reduction

Nutrient diversion is a restoration measure, which is designed to reduce the trophic state, or degree of over-feeding, of a waterbody and thereby control the growth response of the aquatic plants in the system. Control of nutrients in surface water runoff in the watershed is generally preferable to attempting such control within a lake. Many of the lake management techniques presented in the watershed management section above are designed for this purpose.

In-lake control of nutrients generally involves removal of contaminated sediments or encapsulation of nutrients by chemical binding. Costs are generally high, involving an engineered design and some form of pumping or excavation. Effectiveness is variable, and impacts include the rerelease of nutrients into the environment. While limited deepening of specific areas within the lake basin may be warranted for navigational purposes (see below), the widespread use of in-lake nutrient load reduction measures is not warranted in Lac La Belle, especially given that internal loading from the lake sediments does not appear to be an important nutrient course to the water column. As noted in Chapter IV of this report, the good agreement between predicted and observed phosphorus concentrations in the Lake strongly suggests that the external agreement between predicted and observed phosphorus concentrations in the Lake strongly suggests that the external nutrient load to the Lake accounts for the entire phosphorus concentration in the lake water column.

In-lake nutrient load reduction is not recommended for use in Lac La Belle due to the lack of significant internal loading, moderated by the generally shallow nature of the waterbody. Notwithstanding, nutrient load management within the drainage area tributary to the Lake, as set forth above, remains a recommended watershed management alternative. These latter measures are especially important in maintaining good water quality conditions in the upstream waterbodies along the Oconomowoc River.

Hydraulic and Hydrologic Management

This group of in-lake management measures consists of actions designed to modify the depth of water in the waterbody. Generally, the objectives of such manipulations are to enhance a particular class of recreational uses, to control the types and densities of organisms within a waterbody, or to minimize high water or flooding problems. Consideration can be given to outlet control modifications, drawdown, and dredging.

Outlet Control Operations

The outflow from Lac La Belle is by a dam located at the Oconomowoc River outlet located on the western side of the Lake in the vicinity of STH 16. The outlet structure has a fixed discharge elevation that maintains an operating level governed by the dam operating permit issued by the WDNR. No changes in operating levels are indicated, and maintenance of the current operating regime, therefore, is recommended.

Drawdown

Drawdown refers to the manipulation of lake water levels, especially in impounded lakes, in order to change or create specific types of habitat and thereby manage species composition within a waterbody. Drawdown may be used to control aquatic plant growth and to manage fisheries.[22] With regard to aquatic plant management, periodic drawdowns can reduce the growth of some shoreland plants by exposing the plants to climatic extremes, while the growth of others is unaffected or enhanced. Both desirable and undesirable plants are affected by such actions. Costs are primarily associated with loss of use of the waterbody surface area during drawdown provided there is a means of controlling water level in place, such as a dam or other outlet control structure. Effectiveness is variable with the most significant side effect being the potential for increased plant growth.

Drawdown can also affect the lake fisheries, both indirectly and directly, by reducing the numbers of food organisms, and directly, by reducing available habitat and desiccating (drying out) eggs and spawning habitat. In contrast, increasing water levels, especially during spring, can provide enhanced fish breeding habitat for some species, such as pike; and increase food supply for opportunistic feeders, such as bass; by providing access to terrestrial insects, for example. Costs are primarily associated with loss of use. Effectiveness is better than for aquatic plant control, but the potential for side effects remains high given that undesirable fish species may also benefit from water level changes.

Sediment exposure and desiccation by means of lake drawdown can be used as a means of stabilizing bottom sediments, retarding nutrient release, reducing macrophyte growth, and reducing the volume of bottom sediments. During the period of drawdown, the exposed sediments are allowed to oxidize and consolidate. It is believed that by reducing the sediment oxygen demand and increasing the oxidation state of the surface layer of the sediments, drawdown may retard subsequent movement of phosphorus from the sediments. Sediment exposure may also curb sediment nutrient release by physically stabilizing the upper flocculent, sediment-water interface zone of the sediments which plays an important role in the exchange reaction and mixing if the sediments with the overlying water. Drawdown may, thus, deepen the lake by dewatering and compacting the bottom sediments. The amount of compaction depends upon the organic content of the sediment, the thickness of the sediment exposed above the water table, and the timing and duration of the drawdown.

Possible improvements resulting from a lake drawdown include reduced turbidity from wind action, improved game fishing, and opportunity to collect fish more effectively in fish removal programs, an opportunity to improve docks and dams, and an opportunity to clean and repair shorelines and deepen areas using conventional earthmoving equipment. Limited over-winter drawdowns, conducted pursuant to the dam operating permit, are designed to limit shoreland damage by ice and ice movements during the winter months.

In contrast, depending on the timing and duration of the drawdown, drawbacks include loss of fish breeding habitat, loss of benthic food organisms, and disruption of waterfowl feeding and roosting patterns. Increased turbidity and unpleasant odors from rotting organic matter may occur during the period of drawdown. Other adverse impacts of lake drawdown include algal blooms after reflooding, loss of use of the lake during the drawdown, changes in species composition, and a reduction in the density of benthic organisms following drawdown and reflooding. In some drawdown projects, it has been found that several years after reflooding, flocculent sediments began to reappear because of algae and macrophyte sedimentation. Therefore, to maintain the benefits of a drawdown project, the lake may have to be drawn down every five to 10 years to recompact any new sediments.

As noted above, the water level of Lac La Belle is controlled by a hydraulic control structure located on the western shore of the Lake. A limited drawdown could be obtained by opening the gate on the weir, while a total

[22] *William F. James, Harry L. Eakin, and John W. Barko, "Rehabilitation of a Shallow Lake (Big Muskego Lake, Wisconsin) Via Drawdown: Sediment Response,"* Aquatic Plant Control Technical Note No. EA-04*, U.S. Army Corps of Engineers Research and Development Center, Vicksburg, MS, November 2001.*

breaching of the dam would allow a drawdown of about three feet, exposing about 5 to 10 percent of the lake bottom. However, because of the unpredictability of the results, the impairment of recreational uses, and the temporary nature of the beneficial effects of a drawdown, drawdown is not recommended for Lac La Belle.

Water Level Stabilization

While water level management in a lake is a common technique for managing fish and aquatic macrophytes, the consequences of manipulating lake water levels can be both beneficial and deleterious. The major impacts from the riparian owner's standpoint is that the fluctuating water levels affect shoreline erosion, interfere with proper pier height and placement, as well as the correct placement of shoreline protection structures.

Periodic changes in precipitation and weather patterns between years often results in fluctuations of water loads to the lake. These fluctuations in turn can affect lake levels. Most plant and animal species can cope with this level of water surface fluctuation without experiencing the consequences, both positive and negative, noted above. While artificial stabilization of the water surface is not recommended, it is desirable from the point of view of aquatic plant habitat that water level fluctuations be maintained within natural limits.

Dredging

Sediment removal is a restoration measure that is carried out using a variety of techniques, both land-based and water-based, depending on the extent and nature of the sediment removal to be carried out. For larger-scale applications, a barge-mounted hydraulic or cutter-head dredge is generally used. For smaller-scale operations a shore-based drag-line system is typically employed. Both methods are expensive, especially if a suitable disposal site is not located close to the dredge site. Costs for removal and disposal begin at between $10 and $15 per cubic yard, with the cost of sediment removal alone beginning at between $3.00 and $5.00 per cubic yard. Effectiveness of dredging varies with the effectiveness of watershed controls in reducing or minimizing the sediment sources. Federal and State permits are required for use of this option.

Hydraulic cutterhead dredging is the most commonly employed method in the United States. The dredge is typically a rotating auger or cutterhead on the end of an arm that is lowered to the sediment-water interface. Sediment excavated by the cutterhead is pumped as slurry with a concentration of about 10 to 20 percent solids by a centrifugal pump to the disposal site. This pumping usually limits the distance between the lake and disposal site to less than a mile, even using intermediate booster pumps. Because of the large volume of slurry produced, a relatively large disposal site is typically required. Water returned from the disposal site, whether returned to the lake or a stream, would have to meet effluent water quality standards of the State and would be subject to State permitting.

Dredging is the only restoration technique that directly removes the accumulated products of degradation and sediment from the lake system and can return the lake to a younger "age." If carried to the extreme, dredging can be used, in effect, to construct a new lake with a size and depth to suit the management objectives. Dredging has been used in other lakes to increase water depth; remove toxic materials; decrease sediment oxygen demand, prevent fish winterkills, and nutrient recycling; restore fish breeding habitat; and decrease macrophyte growth.

However, dredging may have serious, though generally short-term, adverse effects on the lake. These adverse effects could include increased turbidity caused by sediment resuspension, toxicity from dissolved constituents released by the dredging, oxygen depletion as organic sediments mix with the overlying water, water temperature alterations, and destruction of benthic habitats. There may also be impacts at upland spoil disposal sites, such as odor problems, restricted use of the site, and disturbances associated with heavy truck traffic. In the longer-term, disruption of the lake ecosystem by dredging can encourage the colonization of disturbed portions of the lakebed by less desirable species of aquatic plants and animals, including Eurasian water milfoil.

In addition, while dredging can result in an immediate increase in lake depth, such increases may be short-lived if the sources of sediment being deposited in the lake are not controlled within the drainage area tributary to the lake. The sediment also may be generated from streambank and shoreland erosion. Many of these sources can be effectively controlled through the adoption, implementation, and maintenance of recommended control measures within the watershed. Such practices should be implemented in the drainage area tributary to the Lake, as noted above, regardless of the likely conduct of any dredging project.

Dredging of lakebed material from navigable waters of the State requires a WDNR Chapter 30 permit and a U.S. Army Corps of Engineers Chapter 404 permit. In addition, current solid waste disposal regulations define dredged material as a solid waste. Chapter NR 180 of the *Wisconsin Administrative Code* requires that any dredging project of over 3,000 cubic yards submit preliminary disposal plans to the WDNR for review and potential solid waste licensing of the disposal site. Because sodium arsenite was applied to Lac La Belle during the 1950s and 1960s, as noted in Chapter V of this report, sediment samples may need to be analyzed to determine the extent and severity of any residual arsenic contamination.

Because of the considerations noted above, extensive dredging of Lac La Belle is not considered a viable alternative at this time. Sediment removal to aid navigation and the hydrological condition of the Lake may be warranted at three sites; namely:

- Sediment removal for maintaining recreational boating navigation would appear to have merit within the constructed channel bordered by STH 16 and Woodland Lane adjacent to the public recreational boating access site on the southeastern shore of the Lake. Sediment removal in this area should be limited to maintenance of the existing waterway as per the initial design specifications and should be predicated upon implementation of appropriate shoreland stabilization measures, especially along the island shores. Such measures are likely to include use of vegetative shoreline protection measures, as well as more traditional structural measures;

- Sediment removal for nutrient management and aquatic plant control may be warranted where Rosenow Creek flows into Lac La Belle to mitigate the in-lake effects of historic sediment deposition from past agricultural erosion within this subwatershed. Removal of organic-rich sediment in this area would restore the embayment to a condition that would disadvantage the growth of Eurasian water milfoil and remove a significant source of this nonnative invasive species within the Lake; and

- Sediment removal for hydraulic management and navigational access in the outlet channel. Removal of organic-rich sediment in this area would maintain the through flow of water out of Lac La Belle and disadvantage the growth of Eurasian water milfoil in this area.

Sediment removal at each of these areas should be predicated upon the control, to the extent possible, of external sediment loadings to these sites through: installation and maintenance of appropriate vegetated shoreland buffer strips, shoreland stabilization measures, and, in the case of Rosenow Creek, appropriate conservation agricultural practices in those portions of the subwatershed that remain in agricultural use. In other portions of this latter subwatershed, appropriate urban management practices, including maintenance of adequate set backs from the streamcourse, should be considered as prerequisites for sediment management measures at the mouth of the Creek.

Aquatic Plant and Fisheries Management

Fisheries Management Measures

Lac La Belle provides habitat for a warmwater fishery. Currently, adequate water quality, dissolved oxygen levels, sand and gravel shorelines, and a diverse, if limited, plant community exist for the maintenance of a sportfish population in the Lake. While winterkills have occurred in the past, winterkill is currently not a problem. The presence of carp in the Lake is cause for concern, especially given that carp can be extremely disruptive to the aquatic vegetation that provides habitat and shelter for more desirable species of fishes. As discussed in Chapter V of this report, Lac La Belle is noteworthy among larger lakes in the Southeastern Wisconsin Region, in that it contains a relative sparse aquatic plant community that currently limits fish habitat in the Lake.

Habitat Protection
Habitat protection refers to a range of conservation measures designed to maintain existing fish spawning habitat, including measures, such as restricting recreational and other intrusions into gravel-bottomed shoreline areas during spawning season. For bass this is mid-April to mid-June. Use of natural vegetation in shoreland management zones and other "soft" shoreline protection options aids in habitat protection. Costs are generally low, unless the habitat is already degraded. Modifications of aquatic plant and shoreland management activities may be considered to support restoration and protection of native aquatic plant beds during the early summer period and maintenance of fish-breeding habitat, including deadfalls and other nearshore "structure." Effectiveness is variable depending, in part, on community acceptance and enforcement. Generally, it is more effective to maintain a good habitat than to restore a habitat after it is degraded.

Loss of habitat should be a primary concern of any fisheries management program. The environmentally valuable areas identified within the Lake and its watershed are the most important areas to be protected. In addition, limiting or restricting certain activities in sensitive areas of the Lake will prevent significant disturbance of fish nests and aquatic plant beds. The areas currently designated by the WDNR as sensitive areas within Lac La Belle, pursuant of authorities granted under Chapter NR 107 of the *Wisconsin Administrative Code*, are shown on Map 25. Within these areas, aquatic plant management measures are restricted, and dredging, filling, and the construction of piers and docks should be discouraged.

It also should be noted that water level fluctuations, other than those consequent to natural climatic variability and water quality conditions, can affect fish habitat and the breeding success of fishes. In this regard, the maintenance of lake water levels within natural limits, and the maintenance of good water quality, cannot be overemphasized as fish habitat protection measures.

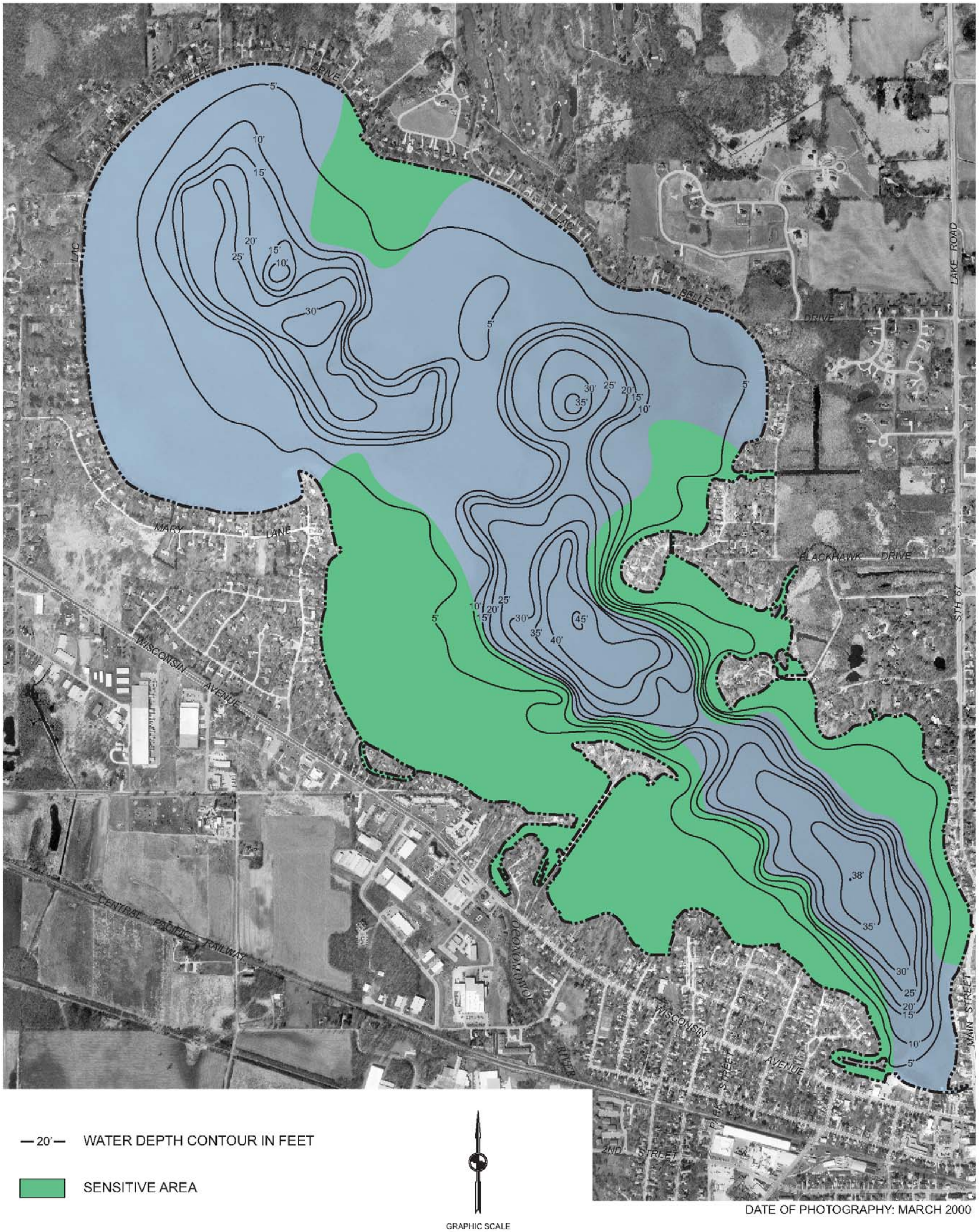
Shoreline Maintenance
Shoreline maintenance refers to a group of measures designed to reduce and minimize shoreline loss due to erosion by waves, ice, or related actions of water. Currently, about 85 percent of the shoreline of Lac La Belle is protected by some type of structural measure, as shown on Map 3 in Chapter II of this report. Five techniques were in use during 2001: vegetative buffer strips, riprap, rock revetments, wooden and concrete bulkheads, and beach. Maintenance of a vegetated buffer strip immediately adjacent to the Lake is the simplest, least costly, and most natural method of reducing shoreline erosion. This technique employs natural vegetation, rather than maintained lawns, within five to 10 feet of the lakeshore and the establishment of emergent aquatic: vegetation from two to six feet lakeward of the shoreline.

Desirable plant species may be expected and encouraged to invade a buffer strip, or which could be planted, include arrowhead (*Sagittaria latifolia*), cattail (*Typha* spp.), common reed (*Phragmites communis*), water plantain (*Alisma plantago-aquatica*), bur-reed (*Sparganium eurycarpum*), and blue flag (*Iris versicolor*) in the wetter areas; and jewelweed (*Impatiens biflora*), elderberry (*Sambucus canadensis*), giant goldenrod (*Solidago gigantea*), marsh aster (*Aster simplex*), red-stem aster (*Aster puniceus*), and white cedar *(Thuja occidentalis*) in the drier areas. In addition, trees and shrubs, such as silver maple (*Acer saccharinum*), American elm (*Ulmus americana*), black willow (*Salix nigra*), and red-osier dogwood (*Cornus stolonifera*), could become established. These plants will develop a more extensive root system than the lawn grass and the above-ground portion of the plants will protect the soil against the erosive forces of rainfall and wave action. A narrow path to the Lake can be maintained as lake access for boating, swimming, fishing, and other activities. A vegetative buffer strip would also serve to trap nutrients and sediments washing into the Lake via direct overland flow. This alternative would involve only minimal cost.

Rock revetments, or riprap, are a highly effective method of shoreline erosion control applicable to many types of erosion problems, especially in areas of low banks and shallow water. Many of these structures are already in place at Lac La Belle. The technique involves shaping of the shoreline slope, the placement of a porous filter material, such as sand, gravel, or pebbles, on the slope and the placement of rocks on top of the filter material to protect the slope against the action of waves and ice. The advantage of rock revetments are that they: are highly flexible and not readily weakened by movements caused by settling or ice expansion, can be constructed in stages,

Map 25

WISCONSIN DEPARTMENT OF NATURAL RESOURCES-DELINEATED SENSITIVE AREAS IN LAC LA BELLE



Source: SEWRPC.

may allow vegetation to grow through the rocks contributing to shoreland habitat; and require little or no maintenance. The disadvantage of rock revetments is that they limit some uses of immediate shoreline. The rough, irregular rock surfaces are unsuitable for walking, require a relatively large amount of filter material and rocks to be transported to the lakeshore, and can cause temporary disruptions to lake access. If improperly constructed, revetments may fail and contribute sediment to the lake because of washout of the filter material. A rock revetment is estimated to cost $25 to $35 per linear foot.

The use of vegetative buffer strips and riprap, as shown in Figure 33, is recommended, especially in those areas of Lac La Belle subject to significant wind-wave, boat-wake, and ice-scour erosion. In those portions of the Lake subject to direct action of wind waves and ice scour, the use of riprap would provide a more robust means of stabilizing shorelines, while elsewhere along the lakeshore creation of vegetated buffer strips would provide not only shoreline erosion protection, but also enhanced shoreland habitat for fish and wildlife. In this regard, it should be noted that the selection of appropriate shoreland protection structures is subject to the provisions of Chapter NR 328 of the *Wisconsin Administrative Code*, which limits shoreline protection to nonstructural, vegetated measures, except in cases where the shoreline can be shown to be subject to natural or boating-induced disturbances that warrant more robust structures. A worksheet is provided within this chapter of the *Wisconsin Administrative Code* to assist in the determination of appropriate shoreline protection measures at specific locations.

Modification of Species Composition

Species composition management refers to a group of conservation and restoration measures that include selective harvesting of undesirable fish species and stocking of desirable species designed to enhance the angling resource value of a lake. These measures also include water level manipulation both to aid in the breeding of desirable species, for example, drawing a lake down to concentrate forage fish and increase predation success and also to strand juveniles and desiccate the eggs of undesirable species. Costs, as with water level management above, are primarily associated with loss of use; effectiveness is good, but by no means certain; and side effects include collateral damage to desirable fish populations.

More extreme measures include organized fishing events and selective cropping of certain fish species, poisoning, and enhancement of predation by stocking. In lakes with and unbalanced fishery dominated by carp and other roughfish, chemical eradication has been used to manage the fishery. Lake drawdown is often used along with chemical treatments to expose spawning areas and eggs and concentrate fish in shallow pools, thereby increasing their availability to anglers, commercial harvesters, or chemical eradication treatments. Fish barriers are usually used to prevent reintroduction of undesirable species from up- or downstream, and the habitat, thus, created will benefit the desired gamefish populations. Chemical eradication is a drastic, costly measure and the end result may be highly unpredictable. Although effectiveness is generally good, such extreme measures are not recommended for Lac La Belle.

Management of the Walleyed Pike Fishery

The WDNR Walleye Management Planning Committee held a series of meetings from 1994 through 1997, with the charge of identifying and addressing key statewide walleye management issues and revising statewide walleye management goals. The Committee identified a number of issues that were important to the members, general public, and other stakeholders. The specific issues are listed later in this report and ranged from habitat protection, hydropower impacts, user conflicts, angler regulations, and the role of stocking. These issues were distilled into seven specific goals for management of the walleye in Wisconsin:

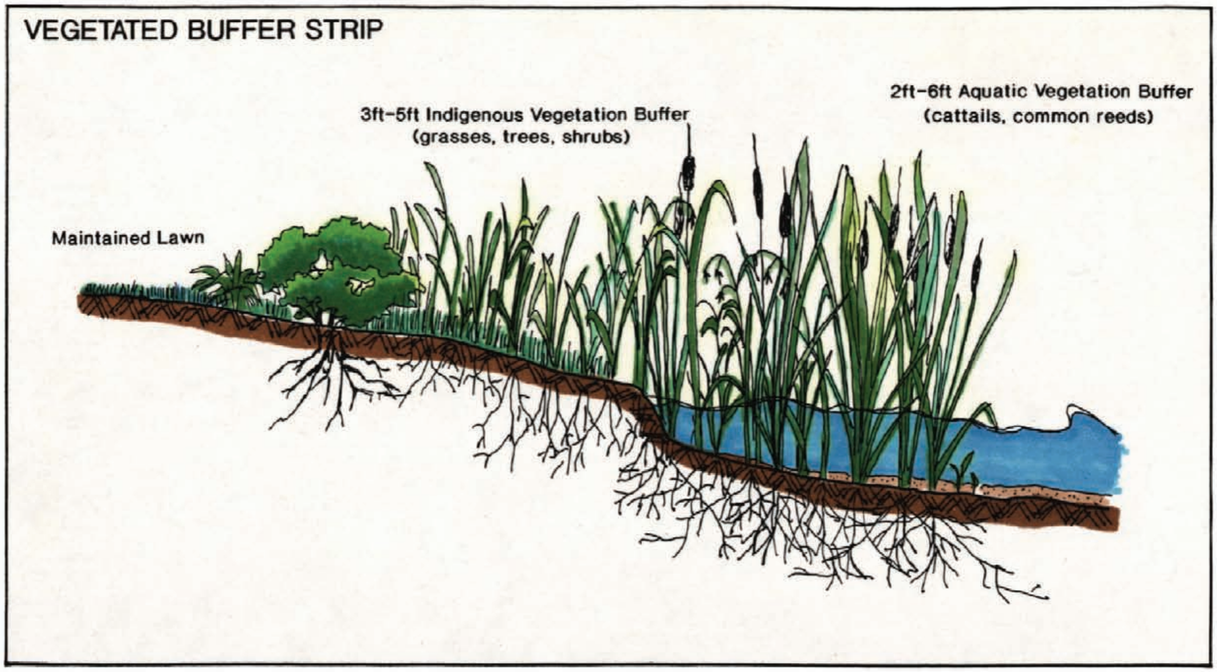
1. Protection, development, maintenance, and restoration of critical habitats for natural stocks of walleye and associated fish and aquatic communities;

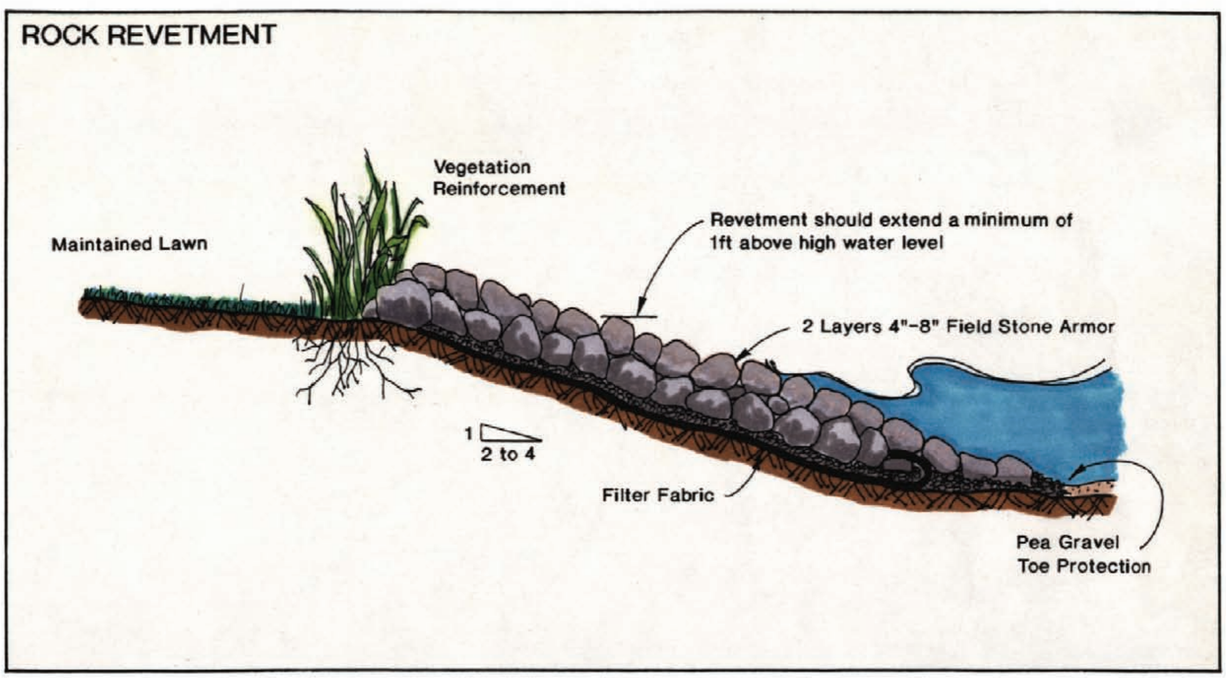
2. Provision of a variety of opportunities for the catch and harvest of walleye (including harvest for food, tribal harvest, quality catch, and trophy opportunities);

3. Ensuring that adequate information on the status and trends of walleye populations, fisheries, and angler preferences is consistently available for decision-making;

Figure 33

RECOMMENDED ALTERNATIVES FOR SHORELINE EROSION CONTROL





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

Source: SEWRPC.

4. Maintenance of the genetic integrity of naturally reproducing walleye populations;

5. Provision of educational opportunities to develop an appreciation for the fisheries resources of Wisconsin and to promote realistic angling expectations based on the productivity of the waters of the State;

6. Development of a biologically sound and cost-effective walleye stocking strategy for Wisconsin; and,

7. Ensuring an integrated propagation program incorporating State, Federal, tribal, private, and cooperative producers.

Reaching these goals was determined to result in enhanced, improved and sustainable fishable populations, where appropriate, within balanced aquatic communities. The Committee concluded that protecting and improving habitat was perhaps the most important key to improving the fisheries resources. The Committee has also proposed a set of regulatory categories to address the variations found in walleye waters within the State. The goal of the regulation categories was determined to be to increase the variety of fishing opportunities for anglers by providing increased opportunities where possible and restricting harvest where necessary to improve the sizes or abundances of adult walleye. The Committee also suggested that the stocking guidelines for walleye be revised and that the cooperation and coordination between all providers within the State be improved.

In developing these goals, the Walleye Management Planning Committee identified 13 initial key issues concerning walleye management in Wisconsin waters. Several additional issues were identified through public input at meetings, angler mail survey responses, or testimony presented at the public meetings held around the State. Finally, an additional set of issues specific to stocking as a management practice were identified. Of the total of 30 issues identified by the subcommittee tasked with reviewing stocking practices, 23 have relevance for Lac La Belle, and are summarized below:

- Issue 1. Habitat loss, poor water quality, and shoreline development are diminishing the productivity of some walleye waters.

- Issue 3. The diversity of Wisconsin waters limits the effectiveness of a single management or regulation strategy.

- Issue 4. Biologists often have insufficient data (including data on community dynamics) upon which to base management decisions, particularly for individual waters.

- Issue 5. In general, most anglers are unfamiliar with walleye population dynamics, management options, and management goals.

- Issue 6. Stocked walleye lakes consistently have lower densities than natural populations.

- Issue 7. Overharvest of walleye may be a factor in overall declines in walleye numbers in many waters.

- Issue 8. Harvest has greatly reduced the numbers of large (“quality size”) walleye in many waters.

- Issue 9. There are not enough opportunities for trophy walleye fishing.

- Issue 11. Walleye populations are naturally variable and, thus, can interact strongly with other components of the fish community; walleye can greatly impact, or be impacted by, other fishes.

- Issue 12. Contaminant levels in fish flesh are a problem in some waters.

- Issue 13. Hooking mortality may be a problem with minimum length limits.
- Issue 14. User conflicts affect the quality of fishing experiences in Wisconsin.
- Issue 15. Anglers are concerned about catching too few walleye overall, and too few large walleye.
- Issue 17. Overexploitation may be occurring seasonally, particularly during spring on river systems and during the ice fishing season.
- Issue 18. Current stocking strategies, including stocking rates and sizes, may not provide the most cost-effective walleye stocking strategy.
- Issue 20. Walleyes are not always stocked in the best waters for success.
- Issue 21. Stocking decisions don't always incorporate the biology of the system and latest survey information.
- Issue 22. The relationship between angler participation and stocking policy should be explored.
- Issue 23. There is a need for stocked walleye waters. Stocking is a useful tool in walleye management.
- Issue 25. Walleye have been historically stocked throughout the State without regard to origin of stock and their effects on native stocks.
- Issue 26. Stocked walleyes have a negative impact on natural reproducing walleye populations.
- Issue 29. The relative role of stocking in walleye management is often misunderstood.
- Issue 30. The impacts of walleye introductions on fish communities are inadequately evaluated and sometimes unpredictable and can sometimes result in negative impacts.

The foregoing statements also can be applied in general to all targeted gamefish and panfish species on Lac La Belle. The fisheries surveys on Lac La Belle indicate that smallmouth bass and carp may be the only species that are sustaining their population levels. All other targeted gamefish and panfish species within Lac La Belle are either being sustained through stocking, such as walleye, or are declining in abundance, or both, such as northern pike. In addition, all of these species are also decreasing in average size, due most likely to limited food and cover, predation, as well as over exploitation from harvesting. It is unclear what exactly is affecting the fishery in Lac La Belle, but it is obvious that the abundance and diversity and quality of the fishery are in decline.

Regulations and Public Information

To reduce the risk of overharvest, the WDNR has placed restrictions on the number and size of certain fish species caught by anglers. The open season, size limits, and bag limits for fish species of Lac La Belle are given in Table 40. Enforcement of these regulations is critical to the success of any sound fish management program.

Aquatic Plant Management Measures

Aquatic plant management refers to a group of management and restoration measures aimed at both removal of nuisance vegetation and manipulation of species composition in order to enhance and provide for recreational water use. Generally, aquatic plant management measures are classed into three groups: physical measures, which include lake bottom coverings and water level management; mechanical removal measures, which include harvesting and manual removal; and chemical measures, which include using aquatic herbicides and biological control measures, which include the use of various organisms, including insects. Of these chemical and biological measures are stringently regulated and require a State permit.

Table 40

WISCONSIN STATE FISHING REGULATIONS: 2005-2006

Species	Open Season	Daily Limit	Minimum Size
Northern Pike	May 7 to March 5	2	26 inches
Walleyed Pike	May 7 to March 5	1	20 inches
Largemouth and Smallmouth Bass	May 7 to March 5	5	14 inches
Bluegill, Pumpkinseed (sunfish), Crappie, and Yellow Perch	Open all year	15	None
Bullhead and Roughfish	Open all year	None	None
Flathead Catfish	Closed	None	None

Source: Wisconsin Department of Natural Resources Publication No. PUB-FH-301 2005, Guide to Wisconsin Hook and Line Fishing Regulations 2005-2006, *2005, and SEWRPC.*

The costs of aquatic plant management measures range from minimal for manual removal of plants using rakes and hand-pulling to upwards of $100,000 for the purchase of a mechanical plant harvester and ancillary equipment, the operational costs for which can approach $10,000 to $20,000 per year depending on staff and operating policies. Harvesting is probably the best applicable to larger areas while chemical controls may be best suited for use in confined areas and for initial control of invasive plants. Planting of native plant species is largely experimental in the Lake, but can be considered a specialized shoreland management zone at the water's edge.

Physical controls and mechanical harvesting may have side effects in expansion of plant habitat and the spread of reproductive fragments.

Aquatic Herbicides

Chemical treatment with aquatic herbicides is a short-term method of controlling heavy growths of aquatic macrophytes and algae. Chemicals are applied to the growing plants in either liquid or granular form. The advantages of using chemical herbicides to control aquatic macrophyte growth are the relatively low cost and the ease, speed, and convenience of application. However, the disadvantages associated with chemical control include the following:

1. The short-term, lethal effects of chemicals are relatively well known. However, properly applied, chemical applications should not result in such effects. Potential long-term, sublethal effects, especially on fish, fish-food organisms, and humans, are relatively unknown.

2. The elimination of macrophytes eliminates their competition with algae for light and nutrients. Algal blooms may then develop, unless steps are taken simultaneously to control the sources of nutrient input.

3. Since much of the dead plant materials are left to decay in the lake, nutrients contained in them are rapidly released into the water and fuel the growth of algae. The decomposition of the dead plant material also consumes dissolved oxygen and increases the potential for fish kills. Accretion of additional organic matter in the sediments as a result of decomposition also increases the organic content of the soils and predisposes the sediments toward reintroduction of other (or the same) nuisance plant species. Long-term deposition of plant material may result in the need for other management measures, such as dredging.

4. The elimination of macrophyte beds destroys important cover, food sources, and spawning areas for desirable fish species.

5. Adverse impacts on other aquatic organisms may be expected. At the concentrations used for macrophyte control, Diquat has been known to kill the zooplankton *Daphnia* and *Hyalella*, both important fish foods. *Daphnia* is the primary food for the young of nearly all fish species found in the Region's lakes.[23]

6. Areas generally must be treated again in the following season and weedbeds may need to be treated more than once in a summer, although certain herbicides may give relief over a period of up to three years in some lakes.

7. Many of the chemicals available are nonselective, often affecting nontarget, desirable species, as well as the "weeds."

The advantages and disadvantages of chemical macrophyte control also apply to the chemical control of algae. Copper, the active ingredient in algicides, may accumulate in the bottom sediments, where excessive amounts are toxic to fish and benthic animals. Fortunately, copper is rapidly eliminated from human systems and few cases of copper sensitivity among humans are known.[24]

Costs of chemical treatments vary widely. Large, organized treatments are more efficient and tend to decrease unit costs for commercial applications compared to individual treatments. Other factors, such as the type of chemical used and number of treatments needed are also important. Estimated costs for lakes in southeastern Wisconsin range from $249 to $480 per acre. Chemical treatments must be permitted by the State under Chapter NR 107 of the *Wisconsin Administrative Code*.

Chemical treatment is considered to be a viable management option only in limited, nearshore areas of the Lake, around piers and structures. Widespread use of chemical herbicides is not recommended.

Aquatic Plant Harvesting

Aquatic macrophytes are mechanically harvested with specialized equipment consisting of cutting apparatus which cuts up to five feet below the water surface and conveyor system that picks up the cit plants and hails them to shore. Advantages of macrophyte harvesting include the following:

1. Harvesting removes the plants from the lake. The removal of this plant biomass decreases the rate of accumulation of organic sediment. A typical harvest of submerged macrophytes from eutrophic lakes in southeastern Wisconsin can yield between 140 and 1,100 pounds of biomass per acre per year.[25]

2. Harvesting removes plant nutrients, including nitrogen and phosphorus, which would otherwise "refertilize" the lake as the plants decay. A typical harvest of submerged macrophytes from eutrophic lakes in southeastern Wisconsin can remove between four and 34 pounds of nitrogen and 0.4 to 3.4 pounds of phosphorus per acre per year. In addition to the physical removal of nutrients, plant harvesting may reduce internal nutrient recycling. Several studies have shown that aquatic macrophytes can act as nutrient pumps, recycling nutrients from the bottom sediments into the water column. Ecosystem modeling results have indicated that a harvest of 50 percent of the macrophytes in

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[23]*P.A. Gilderhus, "Effects of Diquat on Bluegills and Their Food Organisms,"* The Progressive Fish-Culturist*, Vol. 2, No. 9, 1967, pp. 67-74.*

[24]*J.A. Thornton, and W. Rast, "The Use of Copper and Copper Compounds as an Algicide,"* Copper Compounds Applications Handbook*, H.W. Richardson, ed., Marcel Dekker, New York, 1997.*

[25]*James E. Breck, Richard T. Prentki, and Orie L. Loucks, editors,* Aquatic Plants, Lake Management, and Ecosystem Consequences of Lake Harvesting*, Proceedings of Conference at Madison, Wisconsin, February 14-16, 1979.*

Lake Wingra, Wisconsin, could reduce instantaneous phosphorus availability by about 30 percent, with a maximum reduction of 40 to 60 percent, depending on the season.

3. Repeated macrophyte harvesting may reduce the regrowth of certain aquatic macrophytes. The regrowth of milfoil has been reported to have decreased as harvesting frequency was increased.

4. Where dense growths of filamentous algae are closely associated with macrophyte stands, they may be harvested simultaneously.

5. The macrophyte stalks remaining after harvesting provide cover for fish and fish-food organisms, and stabilize the bottom sediment against wind erosion.

6. Selective macrophyte harvesting may reduce stunted populations of panfish in lakes where excessive cover has adversely influenced predator-prey relationships. By allowing an increase in predation on young panfish, both gamefish and the remaining panfish may show increased growth.[26]

7. The cut plant material can be used as mulch.

The disadvantages of macrophyte harvesting include the following:

1. Harvesting is most effective in water depths greater than two feet. Large harvesters cannot operate in shallow water or around docks and buoys. Operation of harvesting equipment in shallow waters can result in significant increases in turbidity and disruption of the lake bottom and lake bottom-dwelling fauna.

2. The reduction in aquatic macrophytes by harvesting reduces their competition with algae for light and nutrients. Thus, algal blooms may develop.

3. Fish, especially young-of-the-year bluegills and largemouth bass, as well as fish-food organisms, are frequently caught in the harvester. As much as 5 percent of the juvenile fish population can be removed by harvesting. A WDNR study found that four pounds of fish were removed per ton of plants harvested.[27]

4. The reduction in aquatic macrophyte biomass by harvesting or chemical control can reduce the diversity and productivity of macroinvertebrate fish-food organisms feeding on the epibiota. Bluegills generally move into the shoreline area after sunset, where they consume these macroinvertebrates. After sunrise they migrate to open water, where they graze, primarily on zooplankton. If harvesting or chemical control shifts the dominance of the littoral macroinvertebrate fauna to sediment dwellers, the macroinvertebrate component of the bluegill diet could be restricted.[28] This would increase predation pressure on zooplankton and reduce the growth rate of the panfish; it could eventually lead to undesirable ramifications throughout the food web in a lake.

5. Macrophyte harvesting may influence the community structure of macrophytes by favoring such plants as milfoil (*Myriophyllum* spp.) that propagate from cut fractions. This may allow these plants to spread into new areas through the rerooting of the cut fractions.

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[26]*James E. Breck, and J.F. Kitchell, "Effects of Macrophyte Harvesting on Simulated Predator-Prey Interactions," edited by Breck et al., 1979, pp. 211-228.*

[27]*Wisconsin Department of Natural Resources,* Environmental Assessment Aquatic Nuisance Control (NR 107) Program*, 3rd Edition, 1990, 213 pp.*

[28]*James E. Breck,* et. al.*,* op. cit*.*

6. Certain species of plants, such as coontail, are difficult to harvest due to lack of root system.

7. The efficiency of macrophyte harvesting is greatly reduced around piers, rafts, and buoys because of the difficulty in maneuvering the harvesting equipment in those restricted areas. Manual methods have to be used in these areas.

8. High capital and labor costs may be associated with harvesting programs. These costs are largely staff costs and operating costs, such as fuel, oil, and maintenance. The cost of new harvesting equipment, when needed, would be about $282,500.

A harvesting program should be designed to provide optimal benefits and minimal adverse impacts. Small fish are common in dense macrophyte beds, but larger fish, such as largemouth bass, do not utilize these dense beds.[29] Narrow channels may be harvested to provide navigational access and "cruising lanes" for predator fish to migrate into the macrophyte beds to feed on smaller fish. "Shared access" lanes may also be cut, allowing several residents to use the same lane. Increased use of these lanes should keep them open for longer periods than would be the case if a less directed harvesting program was followed. "Clear cutting" aquatic plants and denuding the lake bottom of flora should be avoided. However, top cutting of plants, such as Eurasian water milfoil, as shown in Figure 34, is suggested. The harvest of water lilies and other emergent native plants, however, should be avoided.

Protecting native aquatic plant communities from disturbances can help prevent Eurasian water milfoil from spreading within a lake. Recent studies show that nonnative plants out compete native plants when the lake's ecosystem is stressed.[30] Stress can be brought on by watershed pollution, shoreline development, changing water levels, boating activity, carp, and aquatic nuisance controls. This maintenance of a healthy aquatic plant community has been found to be the most efficient way of managing aquatic plants, as opposed to other means of managing problems once they occur. Furthermore, native aquatic plant communities contribute most effectively to the maintenance of good water quality by providing suitable habitat for desirable fish and other aquatic organisms which promote stable or increased property values and quality of life.[31]

Harvesting is considered a viable continued management option. Mechanical harvesting of aquatic plants must be permitted by the State under Chapter NR 109 of the *Wisconsin Administrative Code*.

Manual Harvesting
Due to water depth limitations imposed by the size and maneuverability of the harvesters, it is not always possible for harvesters to reach the shoreline of every property. Likewise because of the cost and other concerns relating to the use of chemical herbicides, alternative measures for control of aquatic plant growth in specific areas of the Lake should be considered. A number of specially designed rakes are available from commercial outlets to assist lakefront homeowners in manually removing aquatic plants from the shoreline area. The advantage of these rakes is that they are easy and quick to use, and result in an immediate result, in contrast to chemical treatments that involve a waiting period. This method also removes plants from the Lake, avoiding the accumulation of organic matter on the lake bottom. Manual harvesting does offer a reasonable level of aquatic plant control in the vicinity of docks and piers, and is therefore considered a viable option. Manual harvesting beyond a 30-foot-wide

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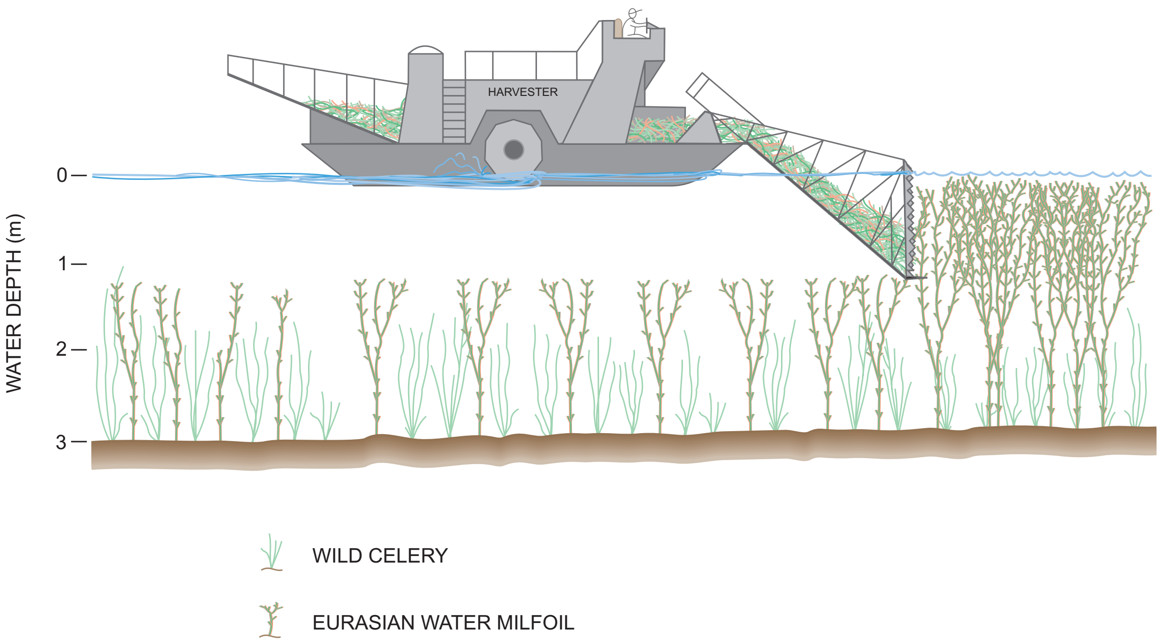
[29]*S. Nichols, Wisconsin Department of Natural Resources Technical Bulletin No. 77,* Mechanical and Habitat Manipulation for Aquatic Plant Management: A Review of Techniques*, 1974.*

[30]*Wisconsin Department of Natural Resources,* Eurasian Water Milfoil in Wisconsin: A Report to the Legislature*, 1992.*

[31]*Roy Bouchard, Kevin J. Boyle, and Holly J. Michael,* Water Quality Affects Property Prices: A Case Study of Selected Maine Lakes*, Miscellaneous Report 398, February 1996.*

Figure 34

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.

recreational corridor must be permitted by the State under Chapter NR 109 of the *Wisconsin Administrative Code.* Pursuant to the provision of this Chapter, piers and other recreational areas must be placed within the 30-foot-wide recreational corridor.

Biological Controls

Another alternative approach to controlling nuisance weed conditions, in this particular case Eurasian water milfoil, is biological control. Classical biological control has been successfully used to control both weeds and herbivorous insects.[32] Recent documentation states that *Eurhychiopsis lecontei*, an aquatic weevil species, has the potential as a biological control agent for Eurasian water milfoil. In 1989, the weevil was discovered during a study investigating the decline of Eurasian water milfoil growth in a Vermont pond. *Eurhychiopsis* proved to have significant negative effects on Eurasian water milfoil in the field and in the lab. The adult weevil feeds on the milfoil causing lesions which make the plant more susceptible to pathogens, such as bacteria or fungi, while the weevil larvae burrows in the stem of the plant causing enough tissue damage for the plant to lose buoyancy and collapse.[33] The few studies that have been done since that time have indicated the following potential advantages to use of this weevil as a means of Eurasian water milfoil control:

[32]*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; C.B. Huffacker and R.L. Rabb, editors,* Ecological Entomology*, John Wiley, New York, New York, USA.*

[33]*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.*

1. *Eurhychiopsis lecontei* is known to cause fatal damage to the Eurasian water milfoil plant and over a period of time has the potential to cause a decrease in the milfoil population.

2. *Eurhychiopsis lecontei* larvae are easy to produce.

3. *Eurhychiopsis lecontei* are not known to cause damage to existing native aquatic plants.

The potential disadvantages of using *Eurhychiopsis lecontei* include:

1. The studies done on *Eurhychiopsis* are recent and more tests are necessary to determine if there are significant adverse effects.[34]

2. Since the upper portion of the Eurasian water milfoil plant is preferred by the weevil, harvesting would have to be extremely limited or not used at all in conjunction with this type of aquatic plant management control.

Relatively few studies have been completed using *Eurhychiopsis lecontei* as a means of aquatic plant management control. These have resulted in variable levels of control, and, while priced competitively with aquatic herbicides, are not recommended as being practical for Lac La Belle at this time. Use of biological control agents must be permitted by the State under Chapter NR 109 of the *Wisconsin Administrative Code*.

In contrast to the experience with the use of biological control agents for the management of Eurasian water milfoil, the use of the beetles *Hylobius transversovittatus*, *Galerucella pusilla*, *Galerucella calmariensis*, *Nanophyes brevis*, and *Nanophyes marmoratus* to control infestations of purple loosestrife in wetlands and along shorelands has been shown to be beneficial in most circumstances. Use of these insects to control the growths of purple loosestrife is recommended. In many communities, growing stocks of beetle inocula is a project undertaken by school-based environmental clubs or service organizations within the community. Assistance in growing and transplanting beetle stocks into wetlands having an abundance of purple loosestrife can be provided by the WDNR.

The use of the grass carp, *Ctenopharyngodon idella*, for aquatic plant control is expressly prohibited.

Lake Bottom Covering

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. They have been used to create swimming beaches on muddy shores, to improve the appearance of lakefront property, and to open channels for motorboating. Sand and gravel are usually readily 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. The screens are flexible and can be anchored to the lakebed in spring or draped over plants in summer.

The advantages of bottom covers and screens are that control can be confined to specific areas, the covers and screens are usually unobtrusive and create no disturbance on shore, and the covers are relatively easy to install over small areas. The disadvantages of bottom covers and screens are that they do not reduce eutrophication of the lake, they are expensive, they are difficult to spread and anchor over large areas or obstructions, they can slip on step grades or float to the surface after trapping gases beneath them, and they may be difficult to remove or relocate.

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[34]*The use of* Eurhychiopsis *sp. on an experimental basis to control Eurasian water milfoil was monitored in selected Wisconsin lakes by the Wisconsin Department of Natural Resources and the University of Wisconsin-Stevens Point from 1995 through 1998. These results indicated mixed success, suggesting that this organism has specific habitat requirements that limit its utility as a Eurasian water milfoil control agent within Wisconsin.*

Screens and covers should not be used in areas of strong surfs, heavy angling, or shallow waters where motor boating occurs. They should also not be used where aquatic vegetation is desired for fish and wildlife habitat. To minimize interference with fish spawning, screens should be placed before or after spawning. A permit from the WDNR is required for use of sediment covers and light screens. Permits require inspection by the WDNR staff during the first two years, with subsequent permits issued for three-year periods. Annual removal of such barriers is generally required as a permit condition.

The estimated cost of lake bottom covers that would control plant growth along a typical shoreline property, an area of about 700 square feet, ranges from $100 for burlap to $300 for "aquascreen." Placement of lake bottom screens requires a WDNR permit pursuant to Chapter 30 of the *Wisconsin Statutes*. Because of the limitations involved, placement of lake bottom covers as a method to control aquatic plant growth is not recommended for Lac La Belle.

Use of sand blankets and pea gravel deposits has also been proposed as a physical barrier to aquatic plant growth in certain situations. Placement of materials on the bed of navigable lake or waterway also requires a WDNR permit pursuant to Chapter 30 of the *Wisconsin Statutes*, and the use of these materials is generally confined to the creation and augmentation of swimming beaches. Use of these materials for aquatic plant management purposes is not recommended as deposition of sediments above the sand or gravel layer limits the longer-term viability of this technique.

Public Informational Programming

Aquatic plant management usually centers on the eradication of nuisance aquatic plants for the improvement of recreational lake use. The majority of the public views all aquatic plants as "weeds" and residents often spend considerable time and money removing desirable plant species from a lake without considering their environmental impacts. As shown, in Table 22 in Chapter V of this report, many aquatic plants have ecological value within the lake ecosystem, and most native aquatic plants rarely interfere with human water uses. Thus, the public information is an important component of an aquatic plant management program and should include informational programming on:

1. The types of aquatic plants in Lac La Belle and their value to water quality, fish, and wildlife;

2. The preservation of existing stands of desirable plant species;

3. The identification of nuisance species and the methods of preventing their spread; and

4. Alternative methods for controlling existing nuisance plants including the positive and negative aspects of each method.

An organized aquatic plant identification/education day is one method of providing hands-on education to lake residents. Other sources of information and technical assistance include the WDNR and the University of Wisconsin-Extension. The aquatic plant species lists provided in Chapter V of this report, and the illustrations of common aquatic plants present in Lac La Belle appended hereto as Appendix A, may serve as a checklist for individuals interested in identifying the plants near their residences. Residents can observe and record changes in the abundance and types of plants in their part of the lake on an annual basis.

Of the submergent floating aquatic plant species found in Lac La Belle, Eurasian water milfoil is one of the few species likely to cause lake use problems. Eurasian water milfoil, unlike most aquatic plants, can reproduce from fragments and often forms dense, monotypic beds with little habitat value for fish or waterfowl. Lakeshore residents should be encouraged to collect fragments that wash ashore after storms and, especially, from weekend boat traffic. The plant fragments can be used as mulch on flower gardens or ornamental planting areas. Likewise, lake users should be encouraged to inspect boats and trailers, both prior to launch and following recover, as Eurasian water milfoil and other aquatic plants can be transported between lakes as fragments on boats and boat trailers. This effort also limits the likelihood of transporting zebra mussel, *Dreissna polymorpha*, between lakes and into new areas of the Lake.

To prevent unwanted introductions of plants and invasive aquatic animals into lakes, boaters should remove all plant fragments from their boat and trailers when exiting the lake, and allow wet wells, engine water jackets, and bilges to dry thoroughly for up to one week. Alternatively, boaters can run their vessels through a car wash, where high-pressure, high-temperature water sprays can remove and destroy organisms, such as zebra mussel juveniles (veligers).[35] Providing the opportunity for the removal of plant fragments at the boat landing on Lac La Belle and provision of signage at the boat landing, including provision of disposal containers at the boat landing, may help motivate boaters to utilize this practice. Posters and pamphlets are available from the WDNR and University of Wisconsin-Extension that provide information and illustrations of milfoil, zebra mussel, and other nonnative aquatic species; discuss the importance of removing plant fragments from boats; and, remind boaters of their duty in this regard.

Recreational Use Management

Regulatory measures provide a basis for controlling lake use and use of shorelands around a waterbody. On land, shoreland zoning, requiring set backs and shoreland buffers can protect and preserve views both from the water and from land, controls development around a lake to minimize its environmental impacts and manages public and private access to a waterbody. On water, recreational use zoning can provide for safe and multiple-purpose use of lakes by various groups of lake users and protect environmentally sensitive areas of a lake. Use zoning can take the form of allocating times of use, such as the annual fishing season established by the State, or areas of use wherein the types or rate of use is controlled, as in the case of shallow water, slow-no-wake speed limits. A key issue in zoning a waterbody for use is equity; the same rules must apply to both riparian owners/residents and off-lake users. This condition is usually met in situations where use zoning is motivated by the protection of fish habitat, for example, as both on- and off-lake users would appreciate and enhanced fishery. Costs are relatively low, associated with creating and posting the ordinance, and effectiveness can be good with regular/consistent enforcement. Costs increase for measures requiring buoyage.

Currently, personal watercraft are restricted, at all times, to slow-no-wake speeds within approximately 200 feet of shore or 150 feet of pierheads, and, at night, to 10 miles per hour speeds. These areas typically coincide with water depths of less than five feet. Demarcation of WDNR-delineated sensitive areas, Eurasian water milfoil control areas, and similar environmentally valuable or sensitive areas of the Lake is recommended.

Public Informational and Educational Programming

Education and informational brochures and pamphlets, of interest to homeowners and supportive of the recreational use and shoreland zoning regulations, are available from the University of Wisconsin-Extension, the WDNR, and the Waukesha Country Department of Parks and Land Use. These latter cover topics, such as beneficial lawn care practices and household chemical use guidelines. These brochures could be provided to homeowners through local media, direct distribution, or targeted school or public library displays. Other Waukesha County lake organizations, in cooperation with the Waukesha County Department of Parks and Land Use, have compiled and distributed information packets to landowners on water quality protection measures and residential “good housekeeping” practices. Many of these ideas can be integrated into ongoing, larger-scale municipal activities, such as anti-littering campaigns, recycling drives, and similar pro-environment activities.

In addition to public informational programming, or informal educational programming, discussed above, there are a number of school-based educational opportunities that the community can utilize. A number of these programs are currently being implemented through the schools, through the efforts of the science faculty at the Oconomowoc High School, among others. Extension of these educational opportunities at the high school level is recommended. Programs and curricula, such as Project WET, Adopt-A-Lake, and the Waukesha Water Walk program, are available from and supported by the University of Wisconsin-Extension and Waukesha County,

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[35]*See Wisconsin Department of Natural Resources Publication No. PUBL-WR-383 95-REV.,* Zebra Mussel Boater’s Guide*, 1995; Wisconsin Department of Natural Resources Publication No. PUBL-WR-463 96-REV.,* The Facts...On Eurasian Water Milfoil*, February 1996.*

respectively. Through these programs, youth have an opportunity to experience “hands on” the aquatic environment and become better informed about current and future lake issues and concerns.

Finally, the participation of the Lac La Belle community in the WDNR Self-Help Monitoring Program should be continued. Volunteer monitoring under the auspices of the WDNR “Self-Help Monitoring Program” involves citizens in taking Secchi-disc transparency readings in the Lake at regular intervals. The Lake Coordinator of the WDNR-Southeast Region can assist in enlisting volunteers in this program. The information gained at first hand by the public during participation in this program increases the credibility of the proposed changes in the nature and intensity of use to which the Lake is subjected.

SUMMARY

This chapter describes options that could be employed in managing the types of problems recorded as occurring in Lac La Belle and which could, singly or in combination, assist in achieving and maintaining the water quality and water use objectives set forth in Chapter VI of this report of the lake watershed inventory. Selected characteristics of these measures are summarized in Table 41.

An evaluation of the potential management measures for improving the Lac La Belle water quality was carried out on the basis of the effectiveness, cost, and technical feasibility of the measures. Those alternative measures not considered further at this time include: phosphorus precipitation and inactivation, drawdown by water level control modifications, dredging, biological control of aquatic plants, lake bottom covering, and development of alternative institutions. The remaining measures are recommended to be considered further for incorporation in the recommended plan described in Chapter VIII of this report.

Table 41

SELECTED CHARACTERISTICS OF ALTERNATIVE LAKE MANAGEMENT MEASURES FOR LAC LA BELLE

Alternative Measure	Description	Estimated Costs: 2000 Capital	Estimated Costs: 2000 Operation and Maintenance	Considered Viable for Inclusion in Recommended Lake Management Plan
Wastewater Management	Continue to implement and periodically review public sanitary sewerage systems in identified sanitary sewer service areas within the drainage area tributary to Lac La Belle	- -	- -	Yes
	Continue to implement inspection of onsite sewage treatment systems within the drainage area tributary to Lac La Belle	- -	$100 per year per system	Yes[a]
Land Use Management and Zoning	Implement regional land use and county development plans within the watershed	- -	- -	Yes
	Maintain existing density management in lakeshore areas	- -	- -	Yes
	Develop and implement consistent stormwater management ordinances consistent with Chapter NR 151 in all riparian communities	- -	- -	Yes
Protection of Environmentally Sensitive Lands	Implement regional natural areas and critical species habitat protection and management plan recommendations within watershed	- -	- -	Yes
Nonpoint Source Pollution Abatement	Implement regional water quality management plan, Oconomowoc River priority watershed plan, and county land and water resource management plan recommendations within watershed	- -	- -	Yes
Rural Nonpoint Source Controls	Develop farm conservation plans that encourage conservation tillage, contour farming, contour strip cropping, crop rotation, grassed waterways, and pasture and streambank management in agricultural areas of the watershed	- -	- -	Yes[b]
Urban Nonpoint Source Controls	Promote urban housekeeping practices, public educational programming, and grassed swales	- -	- -	Yes[b]
	Implement additional urban nonpoint source controls, including street sweeping, catch basin cleaning, leaf litter and garden refuse collection, materials storage facility protection, and stormwater management measures in urban areas of the watershed	- -	- -	Yes[b]
Developing Area Nonpoint Source Controls	Enforce construction site erosion control ordinances requiring soil stabilization, surface roughening, barriers, diversion swales, sediment traps and basins	$250 per acre	$25 per acre	Yes

Table 41 (continued)

Alternative Measure	Description	Estimated Costs: 2000		Considered Viable for Inclusion in Recommended Lake Management Plan
		Capital	Operation and Maintenance	
In-lake Water Quality Improvement Measures	Conduct alum treatment to achieve phosphorus inactivation in lake sediments	- -	$115,000	No
	Promote nutrient load reduction within the lake basin through sediment management	- -	Variable	No
Hydraulic and Hydrologic Management	Modify outlet control operations	- -	- -	No
	Drawdown	- -	- -	No
	Water level stabilization	- -	- -	No
	Dredging	- -	- -	No
Fisheries Management	Protect fish habitat	- -	- -	Yes
	Maintain shoreline and littoral zone fish habitat	- -	- -	Yes
	Continue stocking of selected gamefish species and monitor roughfish populations	- -	- -	No
	Enforce size and catch limit regulations	- -	$1,200	Yes
Aquatic Plant Management	Use (limited) aquatic herbicides for control of nuisance plants such as Eurasian water milfoil and purple loosestrife	- -	Variable	Yes[c]
	Harvest aquatic plants to provide boating access lanes and fish lanes; remove Eurasian water milfoil canopy to promote growth of native plants	$100,000	$22,000	Yes[d]
	Manually harvest aquatic plants from around docks and piers	$100	- -	Yes
	Employ biological controls using inocula of Eurasian water milfoil weevils	- -	Variable	No
	Employ biological controls using inocula of purple loosestrife beetles	- -	Variable	Yes
	Use sediment covers to shade out aquatic plant growth around piers and docks	- -	$40 to $220 per 700 square feet	No
	Conduct public informational and educational programming on aquatic plants and options for their management	- -	$100 to $300	Yes
Recreational Use Management	Enforce boating regulations to maximize public safety; improve signage	- -	$1,000[e]	Yes
	Develop time and/or space zoning schemes to limit surface use conflicts	- -	- -	No
Public Informational and Educational Programming	Conduct public informational programming utilizing seminars and distribution of informational materials	- -	$1,200	Yes
	Support participation of schools in Project WET, Adopt-A-Lake, etc.	- -	- -	Yes
	Continue participation in Self-Help Monitoring Program	- -	$200	Yes

Table 41 Footnotes

[a]*Onsite sanitary sewage disposal systems installed after 1983 are subject to regular inspection and maintenance requirements under Waukesha County Code; the cost shown represents an average pumping cost per property. (Note: the lakeshore areas of Lac La Belle Lake are served by public sanitary sewers.)*

[b]*Cost of nonpoint source management practices to be determined by detailed farm plans and stormwater management plans.*

[c]*In limited areas when necessary to control exotic, invasive species.*

[d]*Estimated capital cost is for new harvesting equipment to replace existing equipment, when needed.*

[e]*Cost for improved signage.*

Source: SEWRPC.

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Chapter VIII

RECOMMENDED MANAGEMENT PLAN FOR LAC LA BELLE

INTRODUCTION

This chapter presents a recommended management plan for Lac La Belle. The plan is based upon inventories and analyses of land use and land and water management practices, pollution sources in the drainage area tributary to Lac La Belle, the physical quality of the waters of the Lake, recreational use and population forecasts, and an evaluation of alternative lake management measures. The recommended plan sets forth means for: 1) providing water quality conditions suitable for full-body contact recreational use and the maintenance of healthy communities of warmwater fish and other aquatic life; 2) reducing the severity of existing or perceived problems which constrain or preclude desired water uses; 3) improving opportunities for water-based recreational activities; and 4) protecting environmentally sensitive areas. The elements of the recommended plan were selected from among the alternatives described in Chapter VII, and evaluated on the basis of those feasible alternatives, set forth in Table 41, that may be expected to best meet the foregoing lake management objectives.

Analysis of water quality and the biological conditions indicate that the general condition of the water of Lac La Belle is good. There appear to be few impediments to water-based recreation. Based upon review of the inventory findings and consideration of planned developments within the total drainage area tributary to the Lake, as set forth in the adopted Waukesha County development plan and regional land use plan, measures will be required to continue to protect and maintain the high quality of the Lake for future lake users. Therefore, this plan sets forth recommendations for: land use management in the Lac La Belle watershed, protection of environmentally sensitive lands, water quality improvement, hydraulic and hydrologic management, aquatic plant and fisheries management, and recreational use management and informational programming. These measures complement and refine the watershedwide land use controls and management measures recommended in the adopted regional water quality management plan,[1] the Oconomowoc River priority watershed plan,[2] and the Waukesha County land and water resource management plan.[3]

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[1]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000*, Volume Three,* Recommended Plan*, June 1979.*

[2]*Wisconsin Department of Natural Resources Publication PUBL-WR-194-86,* Nonpoint Source Control Plan for the Oconomowoc River Priority Watershed Project*, March 1986.*

[3]*Waukesha County,* Land and Water Resource Management Plan: 1999-2002*, December 1998.*

The recommended management measures for Lac La Belle are graphically summarized on Map 26, and are listed in Table 42. These recommended plan measures are more fully described in the following sections of this report. The recommended management agency responsibilities for watershed land management also are set forth in Table 42.

WATERSHED MANAGEMENT MEASURES

Land Use Control and Management

The fundamental element of a sound water quality and lake management planning program for Lac La Belle is the promotion of a sound land use pattern within the drainage area tributary to the Lake. The type and location of rural and urban land uses in the drainage area will determine, to a considerable degree, the character, magnitude, and distribution of nonpoint sources of pollution; the practicality of, as well as the need for, various land management measures; and, ultimately, the water quality of the Lake. While many of these impacts generated from lands within the total drainage area tributary to Lac La Belle will be moderated to a degree by the upstream lakes that capture and retain significant portions of the sediment, nutrient and metals loads generated from the upper watershed, local land uses and land use changes within the drainage area directly tributary to the Lake may have an important and immediate affect on Lac La Belle. Consequently, despite the buffering affect of the upstream waterbodies, land use management is an important element in the management of water quality in the Lake.

The recommended land use plan for the drainage area tributary to Lac La Belle under buildout conditions is described in Chapter II of this report. The framework for the plan is the regional land use plan as prepared and adopted by the Southeastern Wisconsin Regional Planning Commission (SEWRPC), as refined through the Waukesha County development plan.[4] The recommended regional land use and county development plans envision that urban land use development within the Lac La Belle watershed, outside of established urban centers, will occur primarily at low densities and only in areas that are covered by soils suitable for the intended use; which are not subject to special hazards such as flooding; and which are not environmentally sensitive, that is, not encompassed within the Regional Planning Commission-delineated environmental corridors described in Chapter V of this report.

Development in the Shoreland Zone

A major land use issue which has the potential to affect Lac La Belle is the redevelopment of existing lakefront properties, replacing lower-density uses with higher-density, multi-family dwellings or significantly larger, single-family dwellings with potential for increased roof areas, parking areas, and other areas of impervious surfaces. In the absence of mitigative measures, replacement of a pervious land surface with an impervious surface will increase the rate of stormwater runoff to the Lake, increase pollutant loadings on the Lake, and will reduce groundwater recharge. While these effects can be moderated to some extent through structural stormwater management measures, there is likely to be an adverse impact on the Lake from significant redevelopment in the drainage area tributary to the Lake involving conversion to higher-density land uses. For this reason, maintenance of the historic low- and medium-density residential character of the shoreline of Lac La Belle to the maximum extent practical is recommended.

It is further recommended that lakefront developments, as well as setback and landscaping provisions, be carefully reviewed by the City of Oconomowoc, Village of Lac La Belle Plan Commissions, and Waukesha County on behalf of the Town of Oconomowoc, with advice from the Lac La Belle Management District, as appropriate. Such review would address specific shoreland zoning requirements, and should consider the stormwater and urban nonpoint source pollution abatement practices proposed to be included in shoreland development activities. Provision for shoreland buffers, use of appropriate and environmentally friendly

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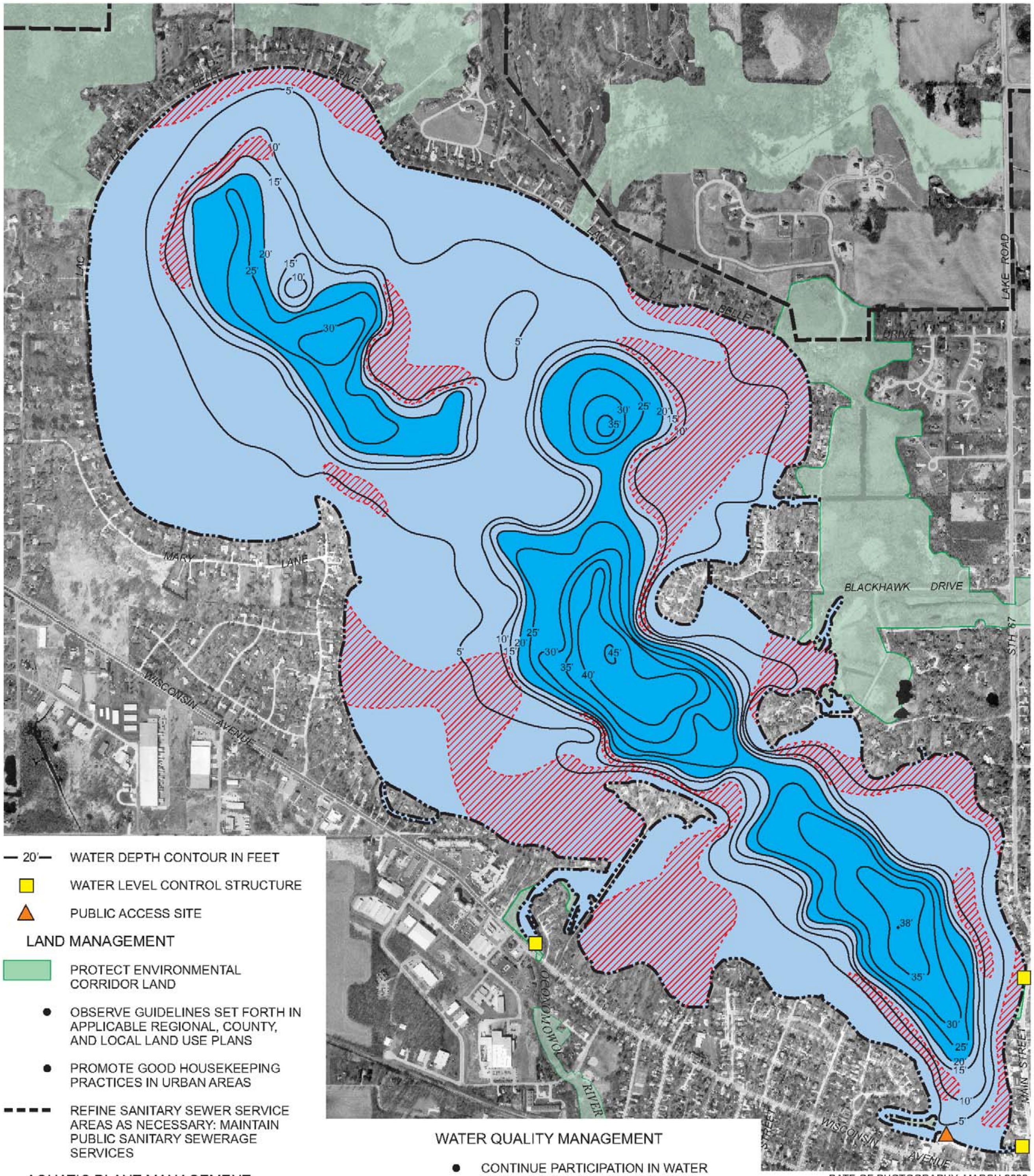
[4]*SEWRPC Community Assistance Planning Report No. 209,* A Development Plan for Waukesha County, Wisconsin*, August 1996.*

Map 26

RECOMMENDED MANAGEMENT PLAN ELEMENTS FOR LAC LA BELLE



— 20'— WATER DEPTH CONTOUR IN FEET

WATER LEVEL CONTROL STRUCTURE

PUBLIC ACCESS SITE

LAND MANAGEMENT

PROTECT ENVIRONMENTAL CORRIDOR LAND

- OBSERVE GUIDELINES SET FORTH IN APPLICABLE REGIONAL, COUNTY, AND LOCAL LAND USE PLANS
- PROMOTE GOOD HOUSEKEEPING PRACTICES IN URBAN AREAS

REFINE SANITARY SEWER SERVICE AREAS AS NECESSARY: MAINTAIN PUBLIC SANITARY SEWERAGE SERVICES

AQUATIC PLANT MANAGEMENT

OPEN WATER: DEPTH GREATER THAN 20 FEET - NO MANAGEMENT MEASURES REQUIRED

EURASIAN WATER MILFOIL: WATCH AND CONTROL AREA

CONTINUE TO MONITOR AQUATIC PLANT COMMUNITIES

WATER QUALITY MANAGEMENT

- CONTINUE PARTICIPATION IN WATER QUALITY MONITORING PROGRAMS

FISHERIES MANAGEMENT

- CONTINUE TO MONITOR FISH POPULATIONS: MODIFY STOCKING/HARVESTING PROGRAM AS NECESSARY

PUBLIC INFORMATIONAL PROGRAM

- CONTINUE PUBLIC AWARENESS PROGRAM

DATE OF PHOTOGRAPHY: MARCH 2000

GRAPHIC SCALE

0 800 1600 FEET

Source: SEWRPC.

Table 42

RECOMMENDED MANAGEMENT PLAN ELEMENTS FOR LAC LA BELLE

Plan Element	Subelement	Location	Management Measures	Management Responsibility
Land Use Control and Management	Land use development planning	Entire watershed	Observe guidelines set forth in the regional land use plan and/or Waukesha County development plan	Waukesha County, Washington County, City of Delafield, City of Oconomowoc, Village of Chenequa, Village of Hartland, Village of Lac La Belle, Village of Merton, Village of Nashotah, Village of Oconomowoc Lake, Village of Slinger, Town of Erin, Town of Hartford, Town of Lisbon, Town of Merton, Town of Oconomowoc, Town of Polk, Town of Richfield, and Town of Summit
	Density management	Lakeshore areas	Maintain historical lake front residential dwelling densities to extent practicable	City and Town of Oconomowoc and Village of Lac La Belle
			Enforce adequate setbacks and promote environmentally friendly landscaping practices in shoreland areas	Waukesha County, City and Town of Oconomowoc, Village of Lac La Belle, and WDNR
	Protection of environmentally sensitive lands	Lac La Belle Lowlands, and other areas as appropriate	Establish adequate protection of wetlands and shorelands, and other environmental corridor lands and isolated natural features, and consider public or private acquisition of features of local or greater significance, as set forth in the regional natural areas and critical species habitat protection and management plan	Washington County, Waukesha County, Village of Lac La Belle, Town of Oconomowoc, Lac La Belle Lake Management District, WDNR, and WisDOT, The Nature Conservancy, YMCA, University of Wisconsin, private conservancy organizations
Point Source Pollution Control	Sewerage system management	Entire watershed	Implement refined regional water quality management plan recommendations to provide sanitary sewerage services to selected urban areas of the lake drainage area	City of Oconomowoc and Delafield-Hartland Water Pollution Control Commission
			Implement onsite sewage disposal system management, including inspection and maintenance	Waukesha County, Washington County, and private landowners
Nonpoint Source Pollution Control	Rural nonpoint source controls	Entire watershed	Promote sound rural land management practices to reduce soil loss and contaminant loadings through preparation of farm conservation plans in accordance with the county land and water resource management plans	USDA, WDATCP, Dodge County, Jefferson County, Washington County, and Waukesha County
	Urban nonpoint source controls	Entire watershed	Promote sound urban housekeeping and yard care practices through informational programming	Counties, Cities, Villages, and Towns and Lac La Belle Lake Management District

Table 42 (continued)

Plan Element	Subelement	Location	Management Measures	Management Responsibility
Nonpoint Source Pollution Control (continued)	Urban nonpoint source controls (continued)	Direct drainage area	Consider development of lawn care management and shoreland protection ordinances	City and Town of Oconomowoc, Village of Lac La Belle, and Lac La Belle Lake Management District
	Construction site erosion control and stormwater management ordinance	Entire watershed	Develop and enforce construction site erosion control and stormwater management ordinances; review ordinances for consistency with Chapter NR 152	Counties, Cities, Villages, and Towns and Lac La Belle Lake Management District
		New residential development in conservation subdivisions	Use conservation subdivision designs and develop integrated stormwater management systems where appropriate densities exist	Cities, Villages, and Towns and Lac La Belle Lake Management District
Stormwater Management	Minimize shoreland impacts on lake water quality and habitat	Lake shoreline	Restrict pollutant loading from stormwater discharges to the Lake through implementation of stormwater management practices	Waukesha County, City and Town of Oconomowoc, and Village of Lac La Belle
			Install construction site erosion control measures as required by local ordinance; enforce construction site erosion control and stormwater ordinance provisions	Private landowners, Waukesha County, City and Town of Oconomowoc, Village of Lac La Belle, and WDNR
Surface Water Management	Lake water quality monitoring	Entire Lake	Continue participation in WDNR Self-Help Monitoring Program; continue participation in U.S. Geological Survey TSI monitoring program—consider participating in coordinated watershed-based sampling	WDNR, USGS, and Lac La Belle Lake Management District
	Stream monitoring	Golf Course Creek, Oconomowoc River, and Rosenow Creek	Continue participation in stream monitoring programs; consider more intensive monitoring of Rosenow Creek and of Golf Course Creek during and following buffer implementation	WDNR, Waukesha County, Lac La Belle Lake Management District, and Oconomowoc School District
	Dam operations and Lake level monitoring	Entire Lake	Maintain outlet structure and monitor water levels	WDNR
Management of Nonnative Species	Aquatic plant and animal monitoring	Shoreland, littoral, and nearshore wetland areas	Continue to monitor for purple loosestrife, Eurasian water milfoil and curly-leaf pondweed, zebra mussel and other nonnative species; conduct control programs as necessary	Lac La Belle Lake Management District, and private landowners
	Biological control of nonnative species	Shoreland areas	Use purple loosestrife beetles and weevils to control purple loosestrife infestations as appropriate	Lac La Belle Lake Management District, Oconomowoc School District, and private landowners
Management of Nonmigratory Species	Management of waterfowl populations	Shoreland areas	Consider application for federal control permits to management nonmigratory goose populations; utilize shore landscaping practices to limit goose incursions onto lakeside lawns	Lac La Belle Lake Management District, USFWS, and private landowners
Fish Management	Fish survey and stocking program	Selected areas of the Lake	Conduct periodic fish surveys to determine management and stocking needs; conduct periodic creel census; enforce size and catch limit regulations	WDNR

Table 42 (continued)

Plan Element	Subelement	Location	Management Measures	Management Responsibility
Fish Management (continued)	Carp control program	Selected areas of the Lake, inflow and outflow	Conduct periodic fish surveys to monitor status of carp populations; maintain carp barrier at Lake outflow; conduct control programs as necessary	WDNR
	Shoreland and habitat protection	Entire lake	Maintain existing shoreline structures and repair as necessary using vegetative means insofar as practicable; reconstruction may require WDNR Chapter 30 permits	Private landowners, Waukesha County, City and Town of Oconomowoc, Village of Lac La Belle, and WDNR
			Encourage shoreline restoration projects and creation of buffer strips, and promote consistency in application of landscaping practices in sensitive shoreland areas, through informational programming and demonstration sites, with a view to enhancing fish habitat within the Lake	Private landowners, Waukesha County, City and Town of Oconomowoc, Village of Lac La Belle, Lac La Belle Lake Management District, WDNR, and UWEX
Aquatic Plant Management	Comprehensive plan refinement	Entire Lake	Update aquatic plant management plan every three to five years	WDNR and Lac La Belle Lake Management District
	Manual harvesting	Littoral areas	Manually harvest around piers and docks as necessary; collect floating plant fragments from shoreland areas to minimize rooting of Eurasian water milfoil and deposition of organic materials in Lake	Private landowners
Recreational Use Management	Boating Access	Public access sites	Maintain recreational boating access from the public access sites pursuant to Chapter NR 7 guidelines	City of Oconomowoc and WDNR
	Maintenance of navigation channels and hydraulic-hydrologic connectivity	"Channel Island" area, and outflow	Stabilize shorelands using vegetative measures pursuant to draft Chapter NR 328 guidelines where appropriate; maintain navigability; maintain hydraulic capacity of outflow channel and floodway	Private landowners, City of Oconomowoc, Lac La Belle Lake Management District, and WDNR
	Recreational boating and vehicular use	Entire Lake	Continue to enforce and periodically review, recreational boating (summer) and vehicular use (winter) ordinances	Waukesha County, City and Town of Oconomowoc, Village of Lac La Belle, Lac La Belle Lake Management District, and WDNR
Informational and Educational Program	Public informational and educational programming	Entire watershed	Continue public awareness and informational programming	Waukesha County, City and Town of Oconomowoc, Village of Lac La Belle, Lac La Belle Lake Management District, WDNR, and UWEX
		Entire Lake	Encourage inclusion of lake studies in environmental curricula (e.g., Project WET, Adopt-A-Lake, Waukesha Water Walk)	Oconomowoc School District, Lac La Belle Lake Management District, UWEX, and Waukesha County

Source: SEWRPC.

landscaping practices, and inclusion of stormwater management measures that provide water quality benefit are practices to be encouraged.

Development in the Tributary Drainage Area

Another land use issue which has the potential to affect the Lake is the potential development for urban uses of the agricultural and other open space lands in the total drainage area. As previously noted, large-lot residential development is occurring in areas of the lake watershed. If this trend continues, much of the open space areas remaining in the drainage area will be replaced over time with large-lot urban development. This may significantly increase the pollutant loadings to the Lake and increase the pressures for recreational use of the Lake. Under the full buildout condition envisioned under the Waukesha County development plan,[5] a significant portion of the undeveloped lands outside of the environmental corridors and other environmentally sensitive areas, could potentially be developed for low-density urban uses.

The existing zoning in the drainage basin permits development, generally on large suburban-density lots, over much of the remaining open lands other than the environmental corridors. Control of shoreland redevelopment, and the related intensification of use, is not specifically addressed in the existing zoning codes. It is recommended that the impact of future land use development on Lac La Belle be minimized through review and modification of the applicable zoning ordinance regulations and zoning district maps to address the concerns noted. Changes in zoning ordinances are recommended to minimize the areal extent of development by providing specific provisions and incentives for the clustering of residential development on smaller lots within conservation subdivisions, thus preserving significant portions of the open space within each property or group of properties considered for development.

Stormwater Management

It is recommended that the City of Oconomowoc, Village of Lac La Belle, and Town of Oconomowoc take an active role in promoting urban nonpoint source pollution abatement. Actions to promote urban nonpoint source pollution abatement would include the conduct of specific stormwater management planning within those portions of the drainage area in each municipality where further urban development or redevelopment is anticipated. Such a planning program should include a review of the stormwater management ordinances, to ensure that the ordinance provisions reflect state-of-the-art runoff and water quality management requirements, and to ensure that there is harmony between the ordinances governing urban density development in each of the municipalities draining to Lac La Belle. Consistency with the requirements of Chapters NR 151 and NR 152 of the *Wisconsin Administrative Code* is recommended. Adoption by all riparian municipalities of common stormwater management ordinance provisions is strongly recommended.

In addition, stormwater runoff is the principle route by which contaminants are transported from the land surface to watercourses, including the Lake itself. Therefore, the foregoing recommendations for the adoption of urban good housekeeping practices, use of shoreland buffers, and management of shoreland densities are relevant to an effective stormwater management program. Where stormwater management practices include the use of detention or retention basins, appropriate landscaping practices can minimize movement of nutrients, sediments, and other contaminants into these basins.[6] Guidance on the types and use of natural landscaping techniques is set forth in the University of Wisconsin-Extension publication on water quality and aesthetic management of stormwater

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[5]Ibid.

[6]*The primary purpose of many stormwater management measures is the control of volume of runoff, although some practices provide both water quantity and water quality benefits. Where practices do not include the improvement of stormwater runoff quality, use of landscape-based measures can reduce the mass of contaminants transported into, and subsequently out of, stormwater basins that are designed to manage water quantity only. Where practices include the provision of water quality benefit, adoption of landscape-based measures can enhance the effectiveness of the stormwater management measures and extend the longevity of the benefit achieved through such practices by reducing maintenance requirements.*

basins.[7] Application of such techniques can contribute to the natural resource base of the drainage area, as well as to the appeal of such basin as landscape features rather than utilitarian structures.

Management of Environmentally Sensitive Lands

Wetland, woodland, and groundwater recharge area protection can be accomplished through land use regulation and public land acquisition of critical lands. Both measures are recommended for the total drainage area tributary to Lac La Belle. The wetland areas within the drainage area tributary to the Lake are currently largely protected through the existing regulatory framework provided by the U.S. Army Corps of Engineers permit program, State shoreland zoning requirements, and local zoning ordinances. Nearly all wetland areas in the Lac La Belle drainage area are included in the environmental corridors delineated by the Regional Planning Commission and protected under one or more of the existing Federal, State, county, and local regulations. Consistent and effective application of the provisions of these regulations is recommended.

Specific areas within the drainage area tributary to Lac La Belle have been identified in the adopted natural areas and critical species habitat protection and management plan for acquisition by state, county, or local governmental bodies and private conservation organizations.[8] The recommendations relevant to the drainage area tributary to Lac La Belle include the acquisition or expansion of current ownership of the following sites:

- By the Wisconsin Department of Natural Resources (WDNR)—The 141-acre Lake Keesus Fen-Meadow, the remaining portions of the 100-acre Oconomowoc River Marsh and the 95-acre Raasch Tamarack Swamp, the 137-acre Donegal Road Woods, the 11-acre St. Augustine Road Sedge Meadow, and the 228-acre Friess Lake Tamarack Swamp;

- By Waukesha County—The remaining portions of the 322-acre Monches Woods and the 111-acre Chenequa Wetland Complex;

- By Washington County—The 256-acre Holy Hill Woods, the 21-acre Daniel Boone Bogs, the 60-acre Glacier Hills Park Bogs and Upland Woods, the 54-acre Mud Lake Upland Woods, the 59-acre Mud Lake Meadow, and the 94-acre Heritage Trails Bog; and

- By the Village of Lac La Belle—The 33-acre Lac La Belle Lowlands.

The natural areas and critical species habitat protection and management plan also recommends that private conservancy organizations acquire or expand their ownerships of the 48-acre Camp Whitcomb Lowland by the YMCA Camp; the 19-acre Oconomowoc Sedge Meadow, 166-acre Stonebank Tamarack Relict, 182-acre Thompson Swamp, the 100-acre CTH J Swamp, and the 11-acre Hubertus Road Sedge Meadow by private conservancy organizations; the 890-acre Murphy Lake-McConville Lake Wetland Complex by The Nature Conservancy; and, the 432-acre Mason Creek Swamp by the University of Wisconsin. To this end, the Lac La Belle Environmental Foundation has acquired some marshlands within the Village of Lac La Belle, and the Waukesha Land Conservancy has purchased portions of the Tamarack Bog.

Point and Nonpoint Source Pollution Control

The recommended watershed land management measures are specifically aimed at reducing the water quality impacts on Lac La Belle of nonpoint sources of pollution within the tributary drainage area. These measures are set forth in the aforereferenced regional water quality management plan, the Waukesha County land and water resource management plan, and the Oconomowoc River nonpoint source pollution abatement plan. As indicated

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[7]*University of Wisconsin-Extension Publication No. GWQ045,* Storm Water Basins: Using Natural Landscaping for water quality & esthetics [sic]*, 2005.*

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

in the lake and watershed inventory set forth in Chapter IV of this report, the only significant sources of phosphorus loading to the Lake that are subject to potential controls are rural and urban nonpoint sources, and onsite sewage disposal systems in the tributary drainage area. The lakeshore areas directly tributary to Lac La Belle are served by a public sanitary sewerage system. Periodic review of the facilities plans for the Oconomowoc wastewater treatment facility is recommended to ensure adequate capacity and appropriate levels of treatment, as noted in Chapter VII of this report, this facility discharges treated sewage effluent to the Oconomowoc River downstream of Lac La Belle.

Portions of the total drainage area tributary to the Lac La Belle continue to be served by onsite sewage disposal systems. While such systems have been estimated to contribute less than 1 percent of the total phosphorus load to the Lake, enforcement of current County ordinance provisions requiring the regular inspection and maintenance of onsite sewage disposal systems is recommended to minimize potential phosphorus loadings from this source. It is recommended that Dodge, Jefferson, Washington, and Waukesha Counties assume the lead in providing the public informational and educational programs to encourage affected property owners to have existing onsite systems inspected and any needed remedial measures undertaken, as appropriate. Homeowners should be advised of the rules and regulations governing, and the limitations of onsite sewage disposal systems, and should be encouraged to undertake preventive maintenance programs, especially of those older systems not yet subject to the inspection requirements of the County ordinance. The typical costs for a basic inspection and maintenance service range from about $100 to $200 per year, although more extensive programs could be more expensive. The costs of the informational programming typically have been included within the operating budget of each County.

With respect to nonpoint source pollution abatement, implementation of measures to reduce nonpoint source pollutant loadings from the areas tributary to Lac La Belle by about 25 percent in urban and rural areas, urban construction erosion controls, streambank erosion controls, stormwater pollution controls, and onsite sewage disposal system management practices are recommended. Implementation of additional measures in agricultural, nonagricultural and transportation facility areas, consistent with the requirements of Chapter NR 151 of the *Wisconsin Administrative Code*, are recommended. These measures would generally affect croplands, pasturelands and feedlots, manure storage facilities, urban lands of one-acre or greater in areal extent, and public highways, airfields, and railway facilities, and require reductions in contaminant transport off such sites by up to 80 percent where applicable.

The most readily controllable loadings are associated primarily with runoff from urban lands within the direct drainage area tributary to the Lake and from urbanizing lands throughout the total drainage area tributary to the Lake that are linked to the Lake by way of streams and stormwater drainage systems. Contributions of phosphorus, sediment and heavy metals from urban lands are expected to increase as agricultural lands are progressively converted to urban uses. Some proportion of these contaminant loads, however, may be attenuated within the chain-of-lakes due to in-lake retention of suspended solids to which these contaminants are frequently adsorbed and, as a consequence of the extensive wetland areas within the drainage basin.

Rural Nonpoint Source Controls

Upland runoff and erosion from agricultural and other rural lands is a contributor of sediment and nutrients to streams and lakes. A total annual phosphorus load of 3,055 pounds per year, and 847,800 pounds of sediment, are estimated to be contributed annually from agricultural lands in the drainage area tributary to the Lake. While agricultural land uses are anticipated to be a declining form of land usage within the drainage area tributary to Lac La Belle, the agricultural operations that remain within the tributary area will continue to contribute a significant proportion of the sediment and phosphorus loads to the waterbody. About 80 percent of the total sediment load, or about 667,600 pounds of sediment annually, is expected to continue to be delivered to Lac La Belle from agricultural lands. Consequently, detailed farm conservation plans are recommended to adapt and refine erosion control and nutrient and pest management practices for individual farm units. Such plans are typically prepared with the assistance of staff from the U.S. Natural Resources Conservation Service or County Land Conservation Department, and identify desirable tillage practices, cropping patterns, and rotation cycles.

Urban Nonpoint Source Controls

As of 1995, established urban land uses comprised about 20 percent of the total drainage area tributary to Lac La Belle, which area is expected to remain relatively constant under buildout conditions. The annual phosphorus loading from these urban lands was estimated to be 1,000 pounds, or about 25 percent of the total load of phosphorus to the Lake. However, a shift in urban lawn care practices toward more intensive utilization of agricultural chemicals may result in an increasing proportion of the total phosphorus load being delivered to the Lake from these urban sources.[9] Those sources that are most controllable include the residential lands adjacent to the Lake and areas with a high proportion of impervious surface. Recommended urban nonpoint source control measures consequently include stormwater management measures utilizing detention basins, grassed swales, and good urban "housekeeping" practices. The application of such low-cost urban housekeeping practices may be expected to reduce nonpoint source loadings from urban lands by about 25 percent. Associated public educational programs to encourage good urban housekeeping practices, to promote selection of building and construction materials which reduce runoff contribution if metals and other toxic pollutants, and to promote the acceptance and understanding of the proposed pollution abatement measures and the importance of lake water quality protection also are recommended.

Urban housekeeping practices and source controls include restricted use of fertilizers and pesticides, improved pet waste and litter control, substitution of plastic for galvanized steel and copper roofing materials and gutters, proper disposal of motor vehicle fluids, increased leaf collection, and continued use of reduced quantities of street deicing salt. Particular attention should also be given to reducing pollutant loadings from high pollutant areas, such as commercial sites, parking lots, and material storage areas. To the extent practicable, parking lot stormwater runoff should be diverted to areas covered by pervious soils and appropriate vegetation, rather than being directly discharged to surface waters. Material storage areas may be enclosed or periodically cleaned, and diversion of stormwater away from these sites may further reduce pollutant loadings. Street sweeping, increased catch basin cleaning, stream protection, leaf litter and vegetation debris collection, and stormwater storage and infiltration measures that can enhance the control of nonpoint source pollutants from urban and urbanizing area, and reduce urban nonpoint source pollution loads by up to about 50 percent.[10]

As has been noted, Waukesha County and the City and Town of Oconomowoc have adopted stringent stormwater management ordinances applicable to new development and redevelopment within the areas under their jurisdiction. While these measures limit the potential impacts of new development, they do not address impacts from existing land uses nor do they address the cumulative impacts of past development. Therefore, additional measures to reduce nonpoint source pollution from existing development, such as the application of structural urban nonpoint source control measures including grassed swales and detention basins, based upon the requirements of Chapter NR 151 of the *Wisconsin Administrative Code* and detailed stormwater management plans to control stormwater drainage problems and nonpoint sources of pollution are recommended. The Village of Lac La Belle should consider development and adoption of a stormwater management ordinance that is consistent with those of the City and Town of Oconomowoc.

Of particular concern to the Lake community are the maintenance practices utilized at the Lac La Belle Golf Club. Maintenance of streambank vegetated buffer strips, without fertilization, remains an effective management practice for minimizing the transport of agrochemicals to the watercourses. In addition, the course operators have implemented a program of integrated nutrient management within the facility, to minimize applications of agrochemicals. Continuation of these practices is recommended. In addition, enrollment in the Audubon Cooperative Sanctuary Program for golf courses is suggested as a means of accessing informational and technical

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[9] *U.S. Geological Survey Water-Resources Investigations Report No. 02-4130,* op. cit.

[10] *See, for example, U.S. Geological Survey Open-File Report No. 03-93,* Data and Methods of a 1999-2000 Street Sweeping Study on an Urban Freeway in Milwaukee County, Wisconsin*, 2003.*

support to implement integrated nutrient and pest management practices in such a way as to minimize environmental impacts associated with the operation of golf course facilities.[11]

Residents of the Lac La Belle community have expressed concern regarding nonmigratory geese,[12] and have sought information on the management of such nonmigratory populations from neighboring lakes; namely, from the Okauchee Lake Management District and Wind Lake Management District who have implemented goose control programs in partnership with the U.S. Fish and Wildlife Service. These control programs include various measures such as destruction of nests and eggs, as well as culling adult animals. The specific measures permitted, and the requirements for obtaining necessary permits, are based upon a site-specific assessment conducted by Federal staff. Given the potential numbers of nonmigratory waterfowl, such a control program is recommended for consideration by the Lac La Belle Management District.

As an additional management measure associated with the management of turf, consideration should be given by the riparian municipalities to the development of lawn care and shoreline management ordinances applicable to residential properties within their jurisdictions. In the first instance, protection of the Lake from runoff waters transporting nutrients and other chemical substances from the land surface to the Lake could take the form of informational materials. In this regard, the Fowler Lake Management District has posted a fact sheet, "Lake-Friendly Lawn Care and Garden Practices," which is equally applicable to lands riparian to Lac La Belle, on the City of Oconomowoc website: http://www.ci.oconomowoc.wi.us/fowler_lake_district_information.htm.

The riparian municipalities could consider the development of ordinances requiring the use of low-phosphorus or no-phosphorus fertilizers within the urban areas surrounding the Lake. No-phosphorus fertilizers are fertilizers that contain no added elemental phosphorus. These are commercially available at certain outlets or can be custom blended for use in specific communities, as has been done for the Big Cedar Lake community in Washington County. Low-phosphorus fertilizers likewise contain no added elemental phosphorus, but, because they are typically composed of compost or sewage sludge, do contain up to about 2.5 percent naturally occurring phosphorus in their organic material. This alternative also meets related public policy goals in that it promotes the reuse of sewage sludge and/or compost in a reasonable manner. In southeastern Wisconsin, an example of this type of fertilizer is Milorganite®, offered by the Milwaukee Metropolitan Sewerage District.

It is recommended that any urban fertilizer applications be predicated upon a soil test to determine appropriate and necessary additions of supplemental nutrients for lawns, flower gardens, and vegetable plots. Soil test kits can be obtained from the University of Wisconsin-Extension, Waukesha County office. There is a nominal charge for such tests, and the laboratory report will indicate the necessity or otherwise of adding fertilizers to the various landscape elements. When communities have adopted phosphorus management ordinances, such ordinances frequently contain exemptions for urban lands where the need for supplemental phosphorus is documented by a soil test. Exemptions also are generally provided for agricultural operations. In this respect, it is recommended that agricultural fertilization be consistent with individual farm plans that include nutrient management planning elements. The City and Town of Oconomowoc should consider development of lawn care management and shoreland protection ordinances as urban nonpoint source control measures, and as measures to reduce contaminant loads to Lac La Belle from urban development. The Village of Lac La Belle already has adopted a turf management ordinance to restrict the application of phosphorus fertilizers within the Village jurisdiction.

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[11] *Within southeastern Wisconsin, the Lauderdale Lakes Management District, for example, has acquired the Lauderdale Lakes Country Club and have implemented a program of integrated nutrient management within the facility. The golf course is currently enrolled in the Audubon Cooperative Sanctuary Program for golf courses.*

[12] *U.S. Department of the Interior, Fish and Wildlife Service, "Migratory Bird Permits: Regulations for Managing Resident Canada Goose Populations," 50 CFR Parts 20 and 21, March 2007: The definition of resident Canada geese states that ''Canada geese that nest within the lower 48 States in the months of March, April, May, or June'' are considered resident Canada geese.*

Control of sediment losses from construction sites is recommended as temporary measures taken to reduce pollutant loadings from construction sites during stormwater runoff events.[13] Although construction site erosion controls may be expected to have only a minimal impact on total pollutant loadings to the Lake due to the relatively small amount of land proposed to be developed, such controls are important pollution control measures that can abate localized short-term loadings of phosphorus and sediment from the drainage area and the upstream tributary area. The recommended control measures include temporary seeding, mulching, and sodding, and use of filter fabric fences, straw bale barriers, storm sewer inlet protection devices, diversion swales, sediment traps, and sedimentation basins. Such measures are required pursuant to the construction site erosion control ordinances adopted by Waukesha County, the City of Oconomowoc, the Village of Lac La Belle, and the Town of Oconomowoc. As recommended above, these ordinances should be reviewed for consistency with Chapter NR 151 and related provisions of the *Wisconsin Administrative Code*.

IN-LAKE MANAGEMENT ALTERNATIVES

The recommended in-lake management measures for Lac La Belle are summarized on Map 26, and are listed in Table 42. The major recommendations include water quality monitoring, fisheries management and habitat protection, shoreland protection, aquatic plant management, recreational use management, and informational and educational programming.

Surface Water Management

Continued water quality monitoring of Lac Le Belle is recommended. Enrollment of one or more lake residents as WDNR Self-Help Monitoring Program volunteers can provide immediate feedback with respect to water quality conditions in the Lake, and is recommended. Enrollment can be accomplished through the Southeast Region Office of the WDNR. A firm commitment of time is required of the volunteers. Such monitoring should be conducted five times a year at a central station in the deepest portion of the lake basin.

With respect to lake levels, it is recommended that the outlet weir be inspected and maintained, as necessary, at regular intervals. Lake levels should be recorded. This monitoring could be conducted by a nearby resident volunteer or by City of Oconomowoc Engineer's Department staff.

In addition to the volunteer monitoring, the Lac La Belle Management District should consider periodic monitoring of the lake water quality by the U.S. Geological Survey under the auspices of their Trophic State Index (TSI) monitoring program, or under the auspices of a similar program. These detailed data provide additional information on the behavior of the waterbody and its responses to environmental stressors, such as nutrient loadings. Such periodic monitoring programs should extend over a minimum period of three years, which timeline is proposed based upon the likelihood of capturing data from both above and below normal periods of precipitation.

Given that a number of lake organizations along the Oconomowoc River utilize the services of the U.S. Geological Survey for detailed water quality monitoring of specific waterbodies within the chain-of-lakes,[14]

[13]*Wisconsin Department of Natural Resources,* Wisconsin Construction Site Best Management Practices Handbook*, April 1994; see also http://www.dnr.state.wi.us/org/water/wm/nps/stormwater/techstds.htm.*

[14]*These organizations include, from upstream to downstream: the Friess Lake Advancement Association (Washington County), the Fowler Lake Management District (Waukesha County), the Lake Keesus Management District and Lake Keesus Advancement Association (Waukesha County), the North Lake Management District and North Lake Environmental Protection Association (Waukesha County), the Okauchee Lake Management District (Waukesha County), the Village of Oconomowoc Lake (Waukesha County), the Fowler Lake Management District (Waukesha County), and the Lac La Belle Management District (Waukesha County). With the exception of Lake Keesus, all of the waterbodies represented by the foregoing lake organizations comprise major lakes of greater than 100 acres in areal extent located on the mainstem of the Oconomowoc River.*

consideration of the conduct of a coordinated watershed-based sampling program on the Oconomowoc River throughout the system is recommended. Under such a program, participating lakes would be sampled within a similar timeframe.[15] The benefits of such a sampling program include an understanding of the movement of contaminants through the system, including phosphorus contents not only of the lake basins, but also of the major tributary streams. A series of such measurements, obtained over the period of a number of hydrological cycles, approximately three years, would provide a comprehensive picture of the sources and movement of phosphorus within this river system. Knowledge of how materials move through the chain-of-lakes will provide insight into the prioritization and application of remedial efforts so as to maximize their effectivity within the chain. Implementation of lake management actions within the chain can be staged such that actions being implemented elsewhere in the chain-of-lakes are enhanced, taking advantage of the synergies inherent in working within a wider watershed area. As noted above, an immediate output of such a program would be the identification of the probable sources of phosphorus contributing to the increasing trend observed in the U.S. Geological Survey data in many of the lakes, prior to such loadings degrading the water quality of the lakes.

Fisheries Management

Fisheries management measures can be categorized into two major components; namely, management of species composition and management and protection of fish habitat. The former include actions such as managing angling pressures through stocking, size limits and catch-and-release regulations, and bag limits. The latter include actions, such as protecting shoreland and in-lake habitat. Each of these elements is discussed further below.

Management of Species Composition

Three specific actions are recommended with respect to the management of the species composition of the fisheries: 1) the conduct of a fishery survey and the formulation of refined stocking and size and bag limitations; 2) the assessment of angling pressures; and, 3) the analysis of potential contamination of fishes in the Lake.

The fishery survey should be conducted periodically by the WDNR and should have the following objectives:

1. To identify changes in fish species composition that may have taken place in the Lake since the previous surveys;

2. To permit any changes in fish populations, species composition, and condition factors to be related to such known interventions as stocking programs, water pollution control activities, and aquatic plant management programs;

3. To refine and update information on fish spawning areas, breeding success, and survival rates;

4. To confirm the lack of disturbance by roughfish populations; and

5. To determine the need for, and inform the timing of, any additional stocking of gamefish species, as appropriate, by the WDNR, in order to maintain a continuing, viable sportfishery.

The second recommended action relative to a fishery management program is an assessment of angling pressures on the Lake. This assessment should:

[15] *A truly synoptic, watershed-based sampling program would obtain water quality data simultaneously from each of the Lakes and their tributary streams within the Oconomowoc River chain-of-lakes. Such a program would be practically limited by staff availability, water craft availability, and related factors. While these limitations can be overcome to a certain extent by the use of automated equipment, the use of such equipment is likewise limited by availability, cost, and siting requirements. For this reason, this report considers a coordinated sampling program as a variant of a synoptic, watershed-based sampling program for the Oconomowoc River lakes.*

1. Provide data to determine the intensity of public use of the Lac La Belle fishery through creel surveys, citizen reporting activities, and evaluation of the fish survey data; and

2. Provide data to assess the impact of harvesting of fishes from the Lake, relative to the bag limits established for Lac La Belle Lake.

Third, given the fishing pressures on the Lake, it would be desirable to also conduct a one-time analysis of fish tissues for metal and toxic contamination at the time the fisheries survey was conducted.

Consequently, recommended management measures to manage species composition in Lac La Belle include the following:

- Continue to monitor trends in water quality, fish community characteristics, and aquatic life in Lac La Belle;

- Establish monitoring of the littoral zone/shallow water fish assemblage characteristics in the summer to provide critical information on the abundance and composition of the forage fish community upon which the health and quality of the entire fishery depends;

- Continue monitoring of fish assemblage characteristics during the fall to estimate the relative abundance of all fish species sampled, as well as recruitment, population size-structure, and age and growth of targeted gamefish populations;

- Continue enforcement of the minimum length limit on walleye at 20 inches with a daily bag limit of one;

- Consider discontinuing the stocking of walleye and possibly northern pike in Lac La Belle, and consider encouraging the stocking of other gamefish species, such as large and smallmouth bass;

- Continue enforcement of the combined total bag limit of 15 for bluegill, crappie, pumpkinseed, and yellow perch;

- Consider the possibility of protecting the panfish population with more restrictive harvest limits than the existing bag limit of 15, with measures such as a reduced bag limit, size restrictions, or creation of refugia, among others;

- Consider opening the fishing season on the stocked flathead catfish that currently remains closed;

- Continue annual spring assessments of carp on Lac La Belle and downstream in the Oconomowoc River to monitor carp numbers and condition; and

- Continue to conduct partial rotenone treatments to reduce carp numbers, as well as continue to operate and maintain the electrical barrier on the Oconomowoc River downstream of Lac La Belle.

These actions are recommended to provide a sound basis for the District and the WDNR to continue the ongoing stocking program and to revise, as may be found necessary, the current fishing regulations regarding the size and number of fish to be taken seasonally.

Habitat Protection

The habitat protection measures recommended for Lac La Belle are, in part, provided by the recommended aquatic plant management program set forth below. The aquatic plant management plan is designed to provide for habitat protection by avoiding disturbances in fish breeding areas during spring and autumn and by encouraging the growths of native aquatic plants. In particular, this recommendation extends to, and includes, the WDNR-delineated NR 107 environmentally sensitive areas located within the Lake and to the environmentally sensitive lands located within the total area tributary to the Lake.

Much of the shoreline of Lac La Belle is protected and no major areas of wind, wave, and wake erosion which require additional protection were identified during the planning effort. However, adoption of the vegetated buffer strip method of shoreland protection is recommended to be used in lakeshore areas and on tributary waterways wherever practical in order to maintain habitat value and the natural ambience of the lakeshore. Continued maintenance of existing revetments and other protection structures is also recommended. Conversion of bulkheads to revetments or natural vegetated shoreline or combinations is recommended to be considered where potentially viable at such time as major repairs are found necessary. Natural vegetated buffer strips should also be considered for shorelines, where practical. Chapter NR 328 of the *Wisconsin Administrative Code* sets forth a methodology for determining appropriate shoreline protection structures for inland lakes based upon wind/wave action and fetch, substrate, and likely boat-wake action.

Maintenance of a vegetated buffer strip immediately adjacent to the Lake is the simplest, least costly, and most natural method of reducing shoreline erosion. This technique employs natural vegetation, rather than maintained lawns, within five to 10 feet of the lakeshore and the establishment of emergent aquatic vegetation from two to six feet lakeward of the shoreline. Desirable plant species for use in a vegetated buffer strip include: arrowhead (*Sagittaria latifolia*), cattail (*Typha* spp.), common reed (*Phragmites communis*), water plantain (*Alisma plantago-aquatica*), bur-reed (*Sparganium eurycarpum*), and blue flag (*Iris versicolor*) in the wetter areas; and jewelweed (*Impatiens biflora*), elderberry (*Sambucus canadensis*), giant goldenrod (*Solidago gigantea*), marsh aster (*Aster simplex*), red-stem aster (*Aster puniceus*), and white cedar *(Thuja occidentalis*) in the drier areas. In addition, trees and shrubs, such as silver maple (*Acer saccharinum*), American elm (*Ulmus americana*), black willow (*Salix nigra*), and red-osier dogwood (*Cornus stolonifera*), could become established. These plants will develop a more-extensive root system than lawn grass and the above-ground portion of the plants will protect the soil against the erosive forces of rainfall and wave action. A narrow path to the Lake can be maintained as lake access for boating, swimming, fishing, and other activities. A vegetative buffer strip would also serve to trap nutrients and sediments washing into the Lake via direct overland flow.

Recommended management measures to protect and provide shoreland and in-lake habitat include the following:

- Protect and improve the distribution, density and quality of submergent and emergent plant beds in Lac La Belle for the benefit of fish and aquatic life;

- Work with landowners and other partners to protect, improve and enhance riparian, shallow and deep-water habitat, which includes woody debris and aquatic plant communities; and,

- Promote watershed management practices to improve water quality, reduce sedimentation, and enhance fish and aquatic life.

In addition, restoration of vegetated streambank buffers, including maintenance of the buffer zones along Golf Course Creek, and restoration of the natural patterns of meanders, runs, riffles, and pools along channelized streamcourses is also recommended, not only as a means of protection water quality by acting as a biological filter, but also to provide habitat for aquatic life and wildlife that utilize these riparian areas. In particular, the restoration of brook trout habitat along Rosenow Creek is recommended. This restoration is currently underway, building on previous initiatives of the WDNR. The restoration of the North Branch of Rosenow Creek is described in detail in Appendix D.

Aquatic Plant Management

The aquatic plant management strategy set forth below represents a refinement of the ongoing program of aquatic plant management being conducted by the Lac La Belle Management District. The recommended aquatic plant management program recognizes the importance of fishing as a recreational use of Lac La Belle and the associated need to develop and protect fish breeding habitat. A healthy and diverse aquatic plant community is an essential element of a balanced lake ecosystem capable of supporting a variety of diverse recreational uses and economic activities. These recreational uses and economic activities include both passive uses of the Lake as a visual amenity in the lake-centered community, as well as active recreational uses, including both swimming and boating activities. Consequently, the recommended aquatic plant management measures set forth below are directed both toward protecting in-lake habitat, as well as providing adequate navigational access on the Lake in a manner consistent with Chapters NR 103, NR 107, and NR 109 of the *Wisconsin Administrative Code*.

The recommended aquatic plant management plan consists of a program based upon the integrated use of manual harvesting and limited applications of appropriate aquatic herbicides. The plan is designed to minimize the negative impacts on the ecologically valuable areas of the Lake, while providing a level of control needed to facilitate the desired recreational uses of the Lake. In addition, such management measures are recommended to be supplemented by an informational and educational program. In contrast to many other aquatic plant management programs within the Southeastern Wisconsin Region, the recommended aquatic plant management plan for Lac La Belle seeks to increase the abundances and diversity of native aquatic plants in the Lake, while, at the same time, and in a manner similar to most other aquatic plant management plans prepared for the Oconomowoc River chain-of-lakes, seeking to control the undesirable growths of nonnative, invasive aquatic plants, such as Eurasian water milfoil. Maintenance of a healthy aquatic plant community has been found to be the most efficient way of managing aquatic plants while contributing most effectively to the maintenance of good water quality, providing suitable habitat for desirable fish and other aquatic organisms, and promoting stable or increasing property values and enhanced quality of life.

The following management actions are recommended:

1. Chemical herbicides, where necessary, should be limited to controlling nuisance growths of exotic species in shallow water around docks and piers, or in isolated embayments where plant growth is dominated by invasive nonnative species. Only herbicides that are selective in their control, such as 2,4-D and fluridone,[16] should be used. Algicides, such as Cutrine Plus, generally are not recommended as algal blooms are rare in the Lake, and valuable macroscopic algae, such as Chara and Nitella, may be killed by this product.

2. It is recommended that chemical applications, if required, be made in early spring to maximize their effectiveness on nonnative plant species, minimize their impacts on native plant species, and act as a preventive measure to reduce the development of nuisance conditions. Applications for herbicide permits made to the WDNR should be reviewed annually by the Lac La Belle Management District, and the recommended management plan should be updated accordingly.

3. The control of rooted vegetation between adjacent piers is recommended to be left to the riparian owners concerned. It is further recommended that the Lac La Belle Management District obtain informational brochures regarding shoreline maintenance, and information on hand-held specialty rakes for aquatic plant harvesting purpose, to be made available to these residents.

4. The use of biological control agents in the management of the purple loosestrife populations is recommended.

5. It is recommended that ecologically valuable areas be restricted from aquatic plant management activities, especially during fish spawning seasons in early summer and autumn.

6. It is recommended that native plant communities with the Lake be protected from disturbance to the extent practicable. Consideration should be given to placing regulatory or informational buoys around

[16]*Fluridone is currently considered by the WDNR to be largely experimental when used to manage aquatic plant communities in Wisconsin.*

such beds to limit recreational boating traffic through these areas. Placement of regulatory markers must conform to Section NR 5.09 of the *Wisconsin Administrative Code*, and all restrictions placed on the use of the waters of the State must be predicated upon the protection of public health, safety, or welfare. Boating ordinances, enacted in conformity with State law, must be clearly posted at public landings in accordance with the requirements of Section 30.77(4) of the *Wisconsin Statutes*.

7. Continued monitoring of aquatic and wetland plant communities and nonnative species within the Lake and nearshore environment is recommended; species of specific concern include purple loosestrife, Eurasian water milfoil, and curly-leaf pondweed.[17] Periodically review these data and modify management actions accordingly, subject to State permit requirements where applicable. Limited funding for such actions may be available pursuant to Chapter NR 198 of the *Wisconsin Administrative Code*.

8. The incorporation by the Lac La Belle Management District of educational and informational programming within the aquatic plant management program for the Lake is recommended. An organized aquatic plant identification day could be considered as one method of providing effective informational programming to lake residents. Other sources of information and technical assistance include the WDNR Aquatic Plant Monitoring Program and the University of Wisconsin-Extension. The aquatic plant illustrations provided in Appendix A may assist individuals interested in identifying plants near their residences. Residents should be encouraged to observe and document changes in the abundance and types of aquatic plants in their part of the Lake on annual basis.

9. Periodic review of this aquatic plant management plan element should be undertaken at three- to five-year intervals as required in Chapter NR 109 of the *Wisconsin Administrative Code*.

The recommended aquatic plant control areas are shown on Map 26. The control measures in each area are designed to optimize desired recreational opportunities and to protect the aquatic resources.

Recreational Use Management

Regulatory measures provide a basis for controlling lake use and use of shorelands around a waterbody. On land, shoreland zoning, requiring set backs and shoreland buffers can: 1) protect and preserve views both from the water and from land, 2) control development around a lake to minimize its environmental impacts, and 3) manage public and private access to a waterbody. On water, recreational use zoning can provide for safe and multiple-purpose use of lakes by various groups of lake users and protect environmentally sensitive areas. Costs are relatively low, associated with creating and posting the ordinance, and effectiveness can be good with regular/consistent enforcement. Costs increase for measures requiring buoyage. In this regard, demarcation of WDNR-delineated sensitive areas, Eurasian water milfoil control areas, and similar environmentally valuable or sensitive areas of the Lake is recommended. Placement of such buoys should be considered supplemental to the placement of regulatory buoys required for the conduct of safe boating operations. To this end, specific buoys may be required to delimit obstructions and areas where navigation may be impeded.

Limited sediment removal to aid navigation and the hydrological condition of the Lake may be warranted at three sites; namely:

- Sediment removal for maintaining recreational boating navigation would appear to have merit within the constructed channel bordered by STH 16 and Woodland Lane adjacent to the public recreational boating access site on the southeastern shore of the Lake. Sediment removal in this area should be limited to maintenance of the existing waterway as per the initial design specifications and should be predicated upon implementation of appropriate shoreland stabilization measures, especially along the

[17] *Such surveys could also monitor the Lake and nearshore environment for other nonnative species such as zebra mussel.*

island shores. Such measures are likely to include use of vegetative shoreline protection measures, as well as more traditional structural measures;

- Sediment removal for nutrient management and aquatic plant control may be warranted at the debouchment of Rosenow Creek into Lac La Belle to mitigate the in-lake effects of historic sediment deposition from past agricultural erosion within this subwatershed. Removal of organic-rich sediment in this area would restore the embayment to a condition that would disadvantage the growth of Eurasian water milfoil and remove a significant source of this nonnative invasive species within the Lake; and

- Sediment removal for hydraulic management and navigational access in the outlet channel. Removal of organic-rich sediment in this area would maintain the through flow of water out of Lac La Belle and disadvantage the growth of Eurasian water milfoil in this area.

Dredging of lakebed material from navigable waters of the State requires a WDNR Chapter 30, *Wisconsin Statutes*, permit and a U.S. Army Corps of Engineers Chapter 404 permit. In addition, current solid waste disposal regulations define dredged material as a solid waste. Chapter NR 180 of the *Wisconsin Administrative Code* requires that any dredging project of over 3,000 cubic yards submit preliminary disposal plans to the WDNR for review and potential solid waste licensing of the disposal site. Because sodium arsenite was applied to Lac La Belle during the 1950s and 1960s, as noted in Chapter V of this report, sediment samples may need to be analyzed to determine the extent and severity of any residual arsenic contamination. Further, sediment removal in any of these areas should be predicated upon the control, to the extent possible, of external sediment loadings to these sites through: installation and maintenance of appropriate vegetated shoreland buffer strips, shoreland stabilization measures, and, in the case of Rosenow Creek, appropriate conservation agricultural practices in those portions of the subwatershed that remain in agricultural use. In other portions of this latter subwatershed, appropriate urban management practices, including maintenance of adequate set backs from the streamcourse, should be considered as prerequisites for sediment management measures at the debouchment of the Creek into Lac La Belle. Extensive dredging of Lac La Belle is not recommended at this time.

Public Informational and Educational Programming

Education and informational brochures and pamphlets, of interest to homeowners and supportive of the recreational use and shoreland zoning regulations, are available from the University of Wisconsin-Extension, the WDNR, and the Waukesha Country Department of Parks and Land Use, among others. These latter cover topics, such as beneficial lawn care practices and household chemical use guidelines. These brochures could be provided to homeowners through local media, direct distribution, or targeted school or public library displays. Other lake organizations, in cooperation with the state and county agencies, have compiled and distributed information packets to landowners on water quality protection measures and residential “good housekeeping” practices. Many of these ideas can be integrated into ongoing, larger-scale municipal activities, such as anti-littering campaigns, recycling drives, and similar pro-environment activities.

In addition to public informational programming, or informal educational programming, discussed above, there are a number of school-based educational opportunities that the community can utilize. A number of these programs are currently being implemented through the efforts of the science faculty at the Oconomowoc High School, among others. Extension of these educational opportunities at the high school level is recommended. Programs and curricula such as Project WET, Adopt-A-Lake, and the Waukesha Water Walk program are available from and supported by the University of Wisconsin-Extension and Waukesha County, respectively. Through these programs, youth have an opportunity to experience “hands on” the aquatic environment and become better informed about current and future lake issues and concerns.

Finally, the participation of the Lac La Belle community in the WDNR Self-Help Monitoring Program should be continued. Volunteer monitoring under the auspices of that program involves citizens in taking Secchi-disc transparency readings in the Lake at regular intervals. The Lake Coordinator of the WDNR-Southeast Region can assist in enlisting volunteers in this program. The information gained first hand by the public during participation in this program increases the credibility of the proposed changes in the nature and intensity of use to which the Lake is subjected.

PLAN IMPLEMENTATION AND COSTS

The actions recommended in this plan largely represent an extension of ongoing actions being carried out by the Lac La Belle Management District, the City of Oconomowoc, the Village of Lac La Belle, and the Town of Oconomowoc, in cooperation with neighboring municipalities, and county and state agencies. The recommended plan introduces few new elements, although some of the plan recommendations represent refinements of current programs. This is particularly true in the case of the fisheries and aquatic plant management programs, where the field surveys recommended in this plan will permit more efficient management of these resources.

Generally, the aquatic plant and fisheries management practices, such as monitoring, harvesting, and public awareness campaigns currently implemented by the Lac La Belle Management District in partnership with the WDNR and local communities, are recommended to continue with refinements as proposed herein. Some aspects of these programs lend themselves to citizen involvement, for example, through participation in the WDNR Self-Help Monitoring Program, and identification with environmentally sound owner-based land management activities. It is recommended that the Lac La Belle Management District, in cooperation with the local municipalities, assume the lead in the promotion of such citizen actions, with a view toward building community commitment and involvement. Assistance is generally available from agencies such as the WDNR, the University of Wisconsin-Extension County offices, and SEWRPC.

Implementation of the recommended plan would entail a capital expenditure of about $2,116,000 by the Lake Management District and incur an annual operation and maintenance expenditure of about $10,000 by the District, including existing expenditures, over the next 10 years. The current, annual operation and maintenance budget of the District is appropriate to cover this level of future investment. Some of the capital costs could be offset with grants from the Wisconsin Waterways Commission under Chapters NR 7 Recreational Boating Facilities Grant Program, while additional cost share assistance may be available from the Wisconsin Waterways Commission and/or pursuant to the Chapter NR 198, Aquatic Invasive Species Control Grant program, for the conduct of Eurasian water milfoil control programs using chemical herbicides. Additional lake and watershed management measures may be cost-shared through the Chapter NR 191 Lake Protection Grant Program, Chapter NR 120 Nonpoint Pollution Abatement Program, or NR 153/NR 154 runoff management programs.

The suggested lead agency or agencies for initiating program-related activities, by plan element, and the estimated costs of these elements, linked to possible funding sources where such are available, are summarized in Table 43. In general, it is recommended that the Lac La Belle Management District continue to provide a coordinating role for community-based lake management actions, in cooperation with the appropriate local government units.

Lac La Belle is a valuable natural resource in the Southeastern Wisconsin Region. Increases in population, urbanization, income, leisure time, and individual mobility forecast for the Region may be expected to result in additional pressure for development in the drainage area tributary to the Lake and for water-based recreation on the Lake. Adoption and administration of an effective lake management program for Lac La Belle, based upon the recommendations set forth herein, will provide the water quality protection needed to maintain conditions in Lac La Belle suitable for recreational use and for fish and other aquatic life.

Table 43

ESTIMATED COSTS OF RECOMMENDED LAKE MANAGEMENT MEASURES FOR LAC LA BELLE

Plan Element	Subelement	Estimated Cost 2005-2025[a]		Potential Funding Sources[b]
		Capital	Annual Operation and Maintenance	
Land Use Control and Management	Land use development planning	- -	- -	Counties, Cities, Villages, Towns
	Density management in the shoreland zone	- -	- -	City and Town of Oconomowoc, Village of Lac La Belle
	Protection of environmentally sensitive lands	- -	- -	WDNR Lake Protection Grant and Stewardship Grant Programs, Waukesha County Land Conservancy, Lac La Belle Lake Management District, private conservation organizations
Point Source Pollution Control	Public sewerage services	- -	- -	City of Oconomowoc, Delafield-Hartland Water Pollution Control Commission
	Onsite sewerage system management	- -[c]	$100-$200[c]	Counties, private firms, and individuals
Nonpoint Source Pollution Control	Rural nonpoint source controls	- -[c]	- -[c]	Counties, USDA EQIP, and WDNR/WDATCP Runoff Management Program
	Urban nonpoint source controls	- -[c]	- -[c]	Counties, WDNR/WDATCP Runoff Management Program, and WDNR Targeted Runoff Management and Urban Nonpoint Source Grant Programs
	Construction site erosion controls and stormwater management ordinances	- -[c]	$250-$500/acre[c]	Counties, municipalities, private firms, and individuals
Stormwater Management	Stormwater management plan development and implementation	$2,100,000	$1,000	Counties, City and Town of Oconomowoc, Village of Lac La Belle, Wisconsin DOT, WDNR Runoff Management Program, private landowners
Surface Water Management	Water quality monitoring	- -	- -[d]	USGS, WDNR Self-Help Lake Monitoring Program, and Lac La Belle Lake Management District
	Water quantity monitoring and dam operations	- -	- -[e]	Town of Oconomowoc, Lac La Belle Lake Management District, USGS, WDNR
Management of Nonnative Species	Aquatic plant and animal monitoring	- -	- -[d]	Lac La Belle Lake Management District, WDNR
	Biological control of nonnative species, especially purple loosestrife	- -	$1,000/acre	WDNR, Lac La Belle Lake Management District, Oconomowoc School District, private landowners
Management of Nonmigratory Species	Management of waterfowl populations	- -	- -	Lac La Belle Lake Management District, and private landowners
Fish Management	Fish survey and continuation of stocking program; enforce fishing regulations	$16,000[d]	- -[d]	WDNR
	Carp control program	- -	- -	WDNR, and Lac La Belle Lake Management District
	Shoreland protection and maintenance of structures	- -	- -	Private firms, individuals

Table 43 (continued)

Plan Element	Subelement	Estimated Cost 2005-2025[a] Capital	Estimated Cost 2005-2025[a] Annual Operation and Maintenance	Potential Funding Sources[b]
Fish Management (continued)	Minimization of shoreland impacts on lake water quality and habitat	- -	- -	County, municipalities, private firms, individuals, WDNR
Aquatic Plant Management	Comprehensive plan refinement	- -	$1,500[f]	Lac La Belle Lake Management District, and WDNR Lake Management Planning Grant Program
	Manual harvesting around piers and docks	$ 200	- -	Private individuals
Recreational Use Management	Maintain recreational boating access; enforce existing boating and winter use ordinances	- -	$1,000	City of Oconomowoc, and WDNR
	Maintain navigational channels and hydraulic-hydrologic connectivity	- -	- -[g,h]	Private landowners, City of Oconomowoc, Lac La Belle Lake Management District, and WDNR
	Review and enforce recreational boating and vehicular use ordinances	- -	- -	Waukesha County, City and Town of Oconomowoc, Village of Lac La Belle, Lac La Belle Lake Management District, and WDNR
Informational and Educational Program	Public awareness and informational programming	- -	$4,000	Lac La Belle Lake Management District, UWEX/ WDNR/WAL Lakes Partnership, Counties, municipalities
	Educational programming and public participation	- -	$600	Lac La Belle Lake Management District, UWEX/ WDNR/WAL Lakes Partnership, Counties, school districts
Total	- -	$2,116,200	$9,450[h]	- -

[a]*All costs expressed in January 2005 dollars.*

[b]*Unless otherwise specified, USDA is the U.S. Department of Agriculture, USGS is the U.S. Geological Survey, WDNR is the Wisconsin Department of Natural Resources, WDATCP is the Wisconsin Department of Agriculture, Trade and Consumer Protection, County is Waukesha County, City is the City of Oconomowoc, Village is the Village of Lac La Belle, Town is the Town of Oconomowoc, UWEX is the University of Wisconsin-Extension, and WAL is the Wisconsin Association of Lakes. Counties is Washington and Waukesha Counties, municipalities is the City and Town of Oconomowoc and Village of Lac La Belle, and Wisconsin Lakes Partnership is a consortium comprised of WDNR, UWEX, and WAL.*

[c]*Costs vary with the amount of land under development during any given year.*

[d]*The WDNR Self-Help Monitoring Program and proposed creel and nonnative species surveys involve no cost but entail a time commitment from the volunteer(s); monitoring by the USGS can be cost-shared between the Federal agency and local cooperators.*

[e]*Water quantity monitoring could be conducted in conjunction with an hydrologic and water quality analysis of the entire Oconomowoc River system; USGS hydrological monitoring is proposed.*

[f]*Cost-share assistance may be available for lake management planning studies under the NR 190 Lake Management Planning Grant Program.*

[g]*Costs of remedial measures should be developed as part of a detailed engineering design process.*

[h]*Cost-share assistance may be available from the Wisconsin Waterways Commission Recreational Boating Facilities Grant Program.*

Source: SEWRPC.

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APPENDICES

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Appendix A

ILLUSTRATIONS OF COMMON AQUATIC PLANTS FOUND IN LAC LA BELLE

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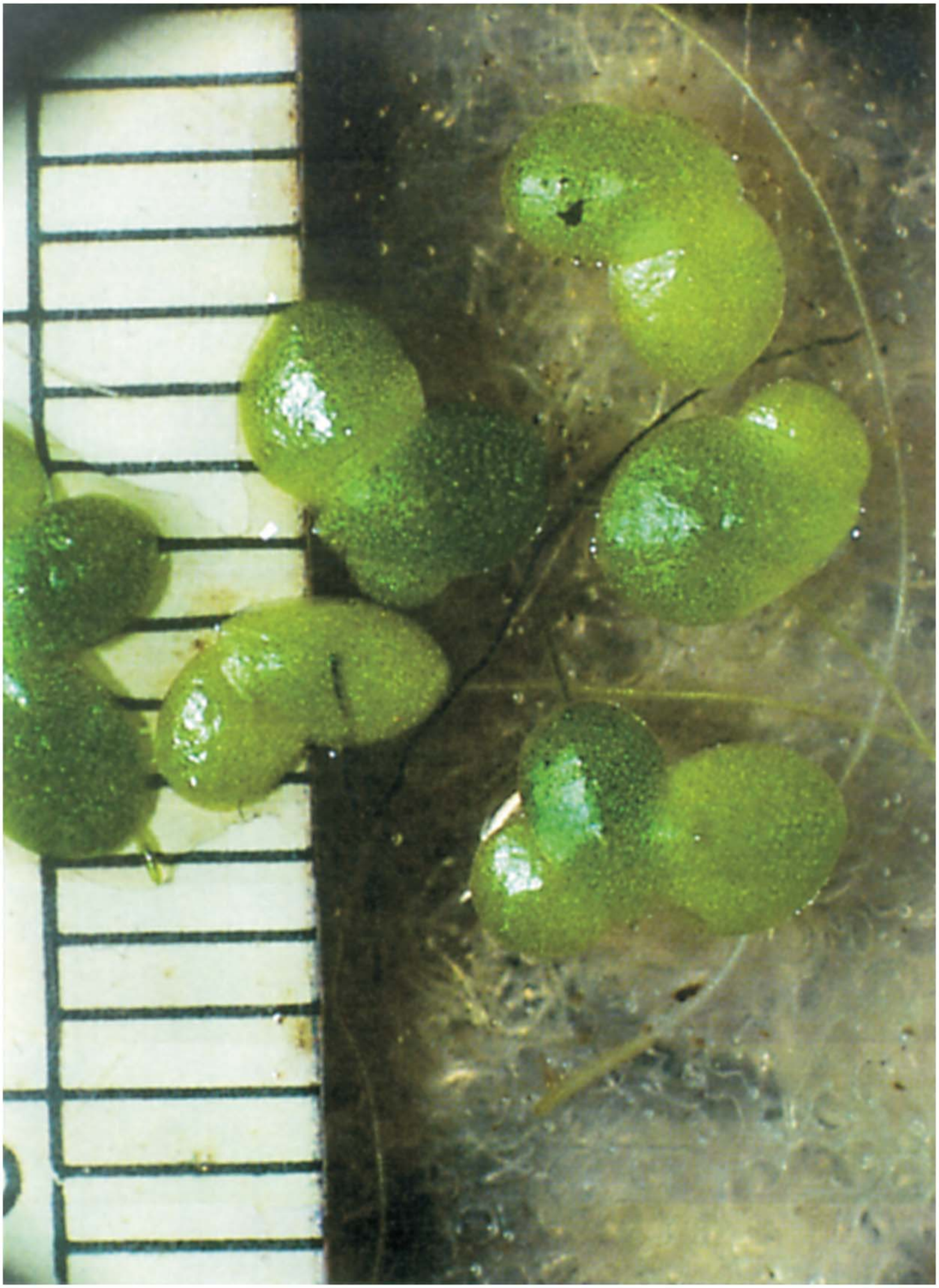
Bushy Pondweed (*najas flexilis*)

Curly-Leaf Pondweed (*potamogeton crispus*)

Eel Grass / Wild Celery (*valisneria americana*)

Eurasian Water Milfoil (*myriophyllum spicatum*)

Illinois Pondweed (*potamogeton illinoensis*)



Lesser Duckweed (*lemna minor*)

NOTE: Plant species in photograph are not shown proportionate to actual size

Source: Steve D. Eggers and Donald M. Reed, Wetland Plants and Plant Communities of Minnesota & Wisconsin, *2nd Edition, 1997*

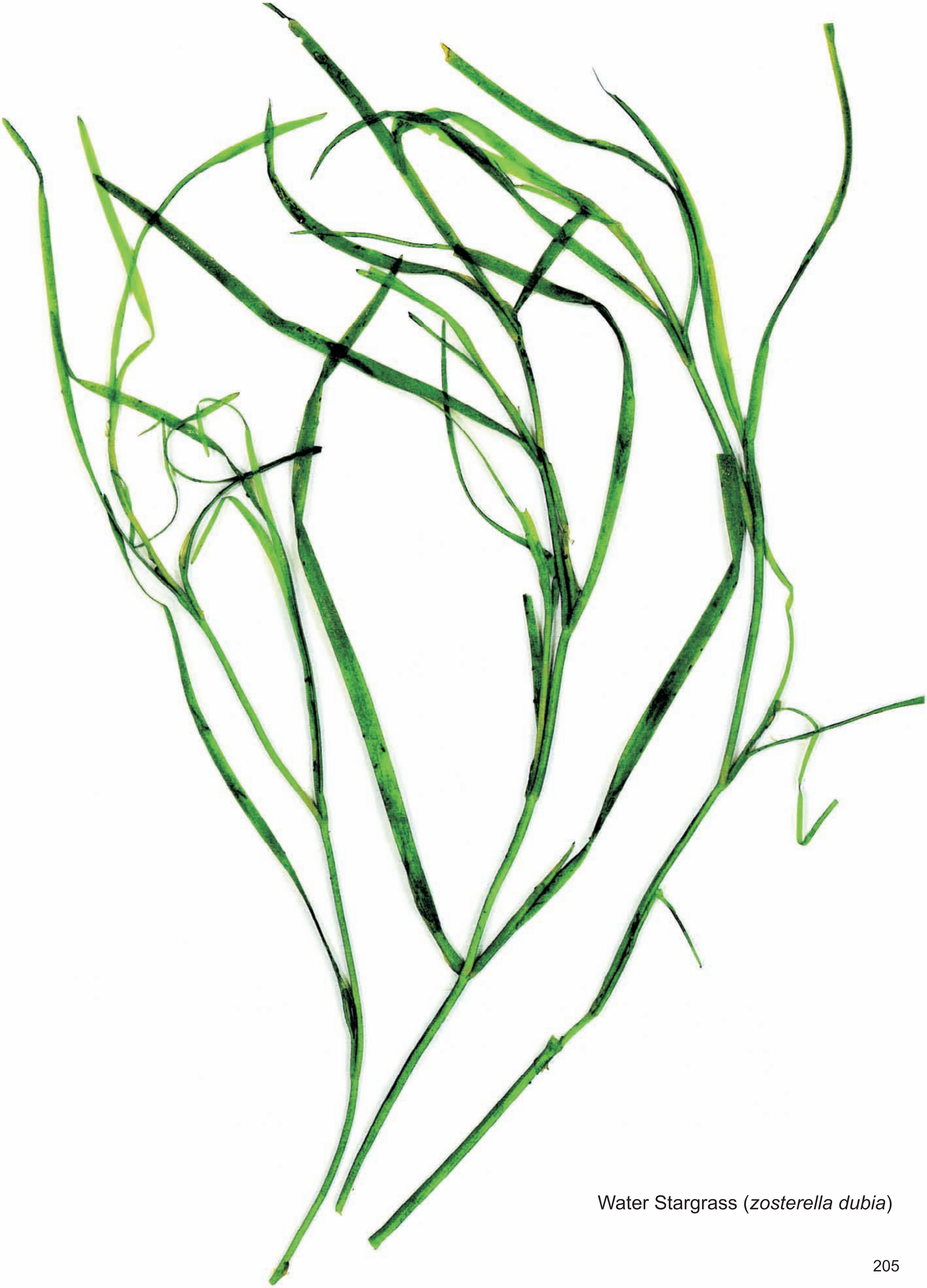
Muskgrass (*chara vulgaris*)

Native Water Milfoil (*myriophyllum* sp.)

Sago Pondweed (*potamogeton pectinatus*)

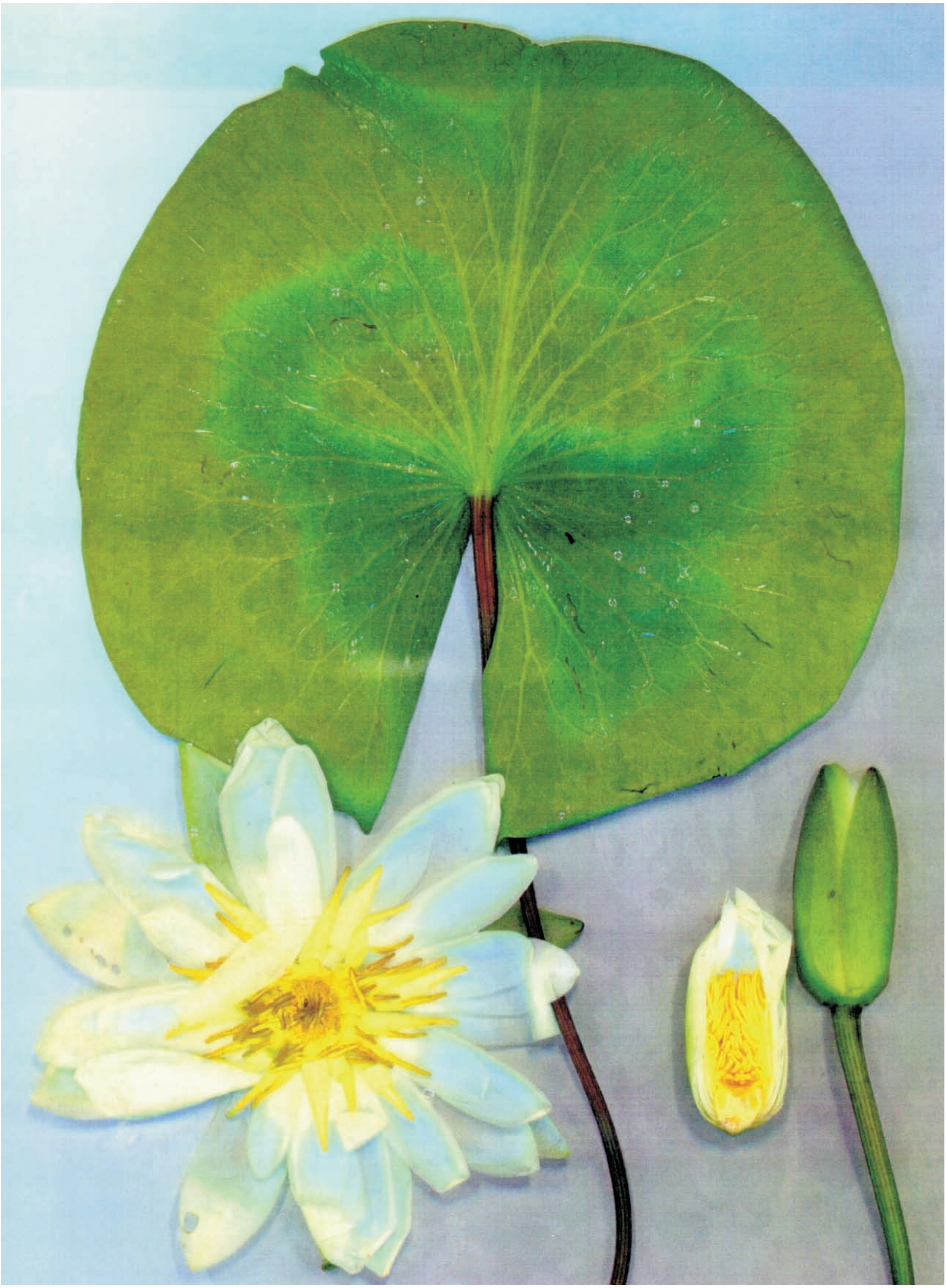
Spiny Naiad (*najas marina*)

Variable Pondweed (*potamogeton gramineus*)



Water Stargrass (*zosterella dubia*)

White Water Crowfoot (*ranunculus longirostris*)



White Water Lily (*nymphaea odorata*)

Yellow Water Lily (*nuphar variegatum*)

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Appendix B

BOATING ORDINANCE FOR LAC LA BELLE

CHAPTER 13

BOATING

VILLAGE OF LAC LA BELLE

WAUKESHA COUNTY

WISCONSIN

TABLE OF CONTENTS

13.01 BOATING REGULATIONS.

1. GENERAL PROVISIONS

a. Intent. The intent of this Ordinance is to provide safe and healthful conditions for the enjoyment of the aquatic recreation consistent with public rights and interest and the capability of the water resources of Lac La Belle located in the Village of Lac La Belle.

b. Applicability and Enforcement. The provisions of this Section shall apply to the waters of Lac La Belle within the jurisdiction of the Village of Lac La Belle. The provisions of this Ordinance shall be enforced by law enforcement officers having jurisdiction on the waters of Lac La Belle.

c. State Boating and Water Laws Adopted. The statutory provisions describing and defining regulations with respect to water traffic, boats, boating and relating water activities and safety as found in Sections 30.50 to 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 Ordinance. Any future amendments, revisions, or modifications of the statutory regulations incorporated herein are intended to be made part of this Ordinance.

2. MISCELLANEOUS BOATING REGULATIONS.
   a. Safe Operation Required. No person shall operate, direct, or handle any watercraft in such a manner as to unreasonably annoy, frighten, or endanger the occupants of his/her or other boats.
   b. Right-of-Way at Docks, Piers, and Wharves. Boats leaving or departing from any pier, dock, or wharf shall have the right-of-way over all other watercraft approaching such dock, pier, or wharf.
   c. Littering and Polluting Prohibiting. No person shall directly or indirectly deposit, place, or throw any can, paper, debris, refuse, garbage, solid waste, or liquid waste into the water of Lac La Belle.
   d. Continuous Circles Prohibited. No person shall repeatedly operate or use any motor boat or personal watercraft in a circuitous course with a diameter of less than 200 feet at a speed in excess of slow-no-wake.

13.02 NIGHTTIME LAKE SPEED LIMIT.

No person shall operate a motor boat on Lac La Belle at a speed in excess of 10 mph between sunset one day and sunrise on the following day.

13.03 - 13.09 RESERVED.

13.10 PENALTIES.

1. Violations of Section 13.01(1).

Violators of section 13.01(1) of this Chapter shall be subject to the Wisconsin State boating penalties as found in Sec. 30.80, Wis. Stats., as amended from time-to-time, which are adopted by reference and are applicable to violations of that Section.

2. Violations of Sections 13.01(2) through 13.09.

Violators of sections 13.01(2) through 13.09 of this Chapter shall be subject to penalties as set forth in Section 15.04 of this Code.

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Appendix C

NONPOINT SOURCE POLLUTION CONTROL MEASURES

Nonpoint, or diffuse, sources of water pollution include urban sources such as runoff from residential, commercial, industrial, transportation, and recreational land uses; construction activities; and onsite sewage disposal systems and rural sources, such as runoff from cropland, pasture, and woodland, atmospheric contributions, and livestock wastes. These sources of pollutants discharge to surface waters by direct overland drainage, by drainage through natural channels, by drainage through engineered stormwater drainage systems, and by deep percolation into the ground and subsequent return flow to the surface waters.

A summary of the methods and estimated effectiveness of nonpoint source water pollution control measures is set forth in Table C-1. These measures have been grouped for planning purposes into two categories: basic practices and additional. Application of the basic practices will have a variable effectiveness in terms of control level of pollution control depending upon the subwatershed area characteristics and the pollutant considered. The additional category of nonpoint source control measures has been subdivided into four subcategories based upon the relative effectiveness and costs of the measures. The first subcategory of practices can be expected to generally result in about a 25 percent reduction in pollutant runoff. The second and third subcategory of practices, when applied in combination with the minimum and additional practices, can be expected to generally result in up to a 75 percent reduction in pollutant runoff, respectively. The fourth subcategory would consist of all of the preceding practices, plus those additional practices that would be required to achieve a reduction in ultimate runoff of more than 75 percent.

Table C-1 sets forth the diffuse source control measures applicable to general land uses and diffuse source activities, along with the estimated maximum level of pollution reduction which may be expected upon implementation of the applicable measures. The table also includes information pertaining to the costs of developing the alternatives set forth in this chapter.[1] These various individual nonpoint source control practices are summarized by group in Table C-2.

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[1]*Costs are presented in more detail in the following SEWRPC Technical Report No. 18,* State of the Art of Water Pollution Control in Southeastern Wisconsin*, Volume Three,* Urban Storm Water Runoff*, July 1977, and Volume Four,* Rural Storm Water Runoff*, December 1976; and SEWRPC Technical Report No. 31,* Costs of Urban Nonpoint Source Water Pollution Control Measures*, June 1991.*

Table C-1

GENERALIZED SUMMARY OF METHODS AND EFFECTIVENESS OF NONPOINT SOURCE WATER POLLUTION ABATEMENT

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Urban	Litter and pet waste control ordinance	Prevent the accumulation of litter and pet wastes on streets and residential, commercial, industrial, and recreational areas	2 to 5	Ordinance administration and enforcement costs are expected to be funded by violation penalties and related revenues
	Improved timing and efficiency of street sweeping, leaf collection and disposal, and catch basin cleaning	Improve the scheduling of these public works activities, modify work habits of personnel, and select equipment to maximize the effectiveness of these existing pollution control measures	2 to 5	No significant increase in current expenditures is expected
	Management of onsite sewage treatment systems	Regulate septic system installation, monitoring, location, and performance; replace failing systems with new septic systems or alternative treatment facilities; develop alternatives to septic systems; eliminate direct connections to drain tiles or ditches; dispose of septage at sewage treatment facility	10 to 30	Replace one-half of estimated existing failing septic systems with properly located and installed systems and replace one-half with alternative systems, such as mound systems or holding tanks; all existing and proposed onsite sewage treatment systems are assumed to be properly maintained; assume system life of 25 years. The estimated cost of a septic tank system is \$5,000 to \$6,000 and the cost of an alternative system is \$10,000. The annual maintenance cost of a disposal system is \$250. An in-ground pressure system is estimated to cost \$6,000 to \$10,000 with an annual operation and maintenance cost of \$250. A holding tank would cost \$5,500 to \$6,500, with an annual operation and maintenance cost of \$1,800
	Increased street sweeping	On the average, sweep all streets in urban areas an equivalent of once or twice a week with vacuum street sweepers; require parking restrictions to permit access to curb areas; sweep all streets at least eight months per year; sweep commercial and industrial areas with greater frequency than residential areas	10 to 20	Estimate curb-miles based on land use, estimated street acreage, and Commission transportation planning standards; assume one street sweeper can sweep 2,000 curb-miles per year; assume sweeper life of 10 years; assume residential areas swept once weekly, commercial and industrial areas swept twice weekly. The cost of a vacuum street sweeper is approximately \$120,000. The cost of the operation and maintenance of a sweeper is about \$25 per curb-mile swept
	Increased leaf and clippings collection and disposal	Increase the frequency and efficiency of leaf collection procedures in fall; use vacuum cleaners to collect leaves; implement ordinances for leaves, clippings. and other organic debris to be mulched, composted, or bagged for pickup	2 to 5	Assume one equivalent mature tree per residence, plus five trees per acre in recreational areas; 75 pounds of leaves per tree; 20 percent of leaves in urban areas not currently disposed of properly. The cost of the collection of leaves in a vacuum sweeper and disposal is estimated at \$180 to \$200 per ton of leaves
	Increased catch basin cleaning	Increase frequency and efficiency of catch basin cleaning; clean at least twice per year using vacuum cleaners; catch basin installation in new urban development not recommended as a cost-effective practice for water quality improvement	2 to 5	Determine curb-miles for street sweeping; vary percent of urban areas served by catch basins by watershed from Commission inventory data; assume density of 10 catch basins per curb-mile; clean each basin twice annually by vacuum cleaner. The cost of cleaning a catch basin is approximately \$10
	Reduced use of deicing salt	Reduce use of deicing salt on streets; salt only intersections and problem areas; prevent excessive use of sand and other abrasives	Negligible for pollutants addressed in this plan, but helpful for reducing chlorides and associated damage to vegetation	Increased costs, such as for slower transportation movement, are expected to be offset by benefits, such as reduced automobile corrosion and damage to vegetation

Table C-1 (continued)

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Urban (continued)	Improved street maintenance and refuse collection and disposal	Increase street maintenance and repairs; increase provision of trash receptacles in public areas; improve trash collection schedules; increase cleanup of parks and commercial centers	2 to 5	Increase current expenditures by approximately 15 percent
	Parking lot stormwater temporary storage and treatment measures	Construct gravel-filled trenches, sediment basins, or similar measures to store temporarily the runoff from parking lots, rooftops, and other large impervious areas; if treatment is necessary, use a physical-chemical treatment measure, such as screens, dissolved air flotation, or a swirl concentrator	5 to 10	Design gravel-filled trenches for 24-hour, five-year recurrence interval storm; apply to off-street parking acreages. For treatment, assume four-hour detention time. The capital cost of stormwater detention and treatment facilities is estimated at $40,000 to $80,000 per acre of parking lot area, with an annual operation and maintenance cost of about $200 per acre
	Onsite storage—residential	Remove connections to sewer systems; construct onsite stormwater storage measures for subdivisions	5 to 10	Remove roof drains and other connections from sewer system wherever needed; use lawn aeration, if applicable; apply dutch drain storage facilities to 15 percent of residences. The capital cost would approximate $500 per house, with an annual operation and maintenance cost of about $25
	Stormwater Infiltration—urban	Construct gravel-filled trenches for areas of less than 10 acres or basins to collect and store temporarily stormwater runoff to reduce volume, provide groundwater recharge and augment low stream flows	45 to 90	Design gravel-filled trenches or basins to store the first 0.5 inch of runoff; provide at least a 25-foot grass buffer strip to reduce sediment loadings. The capital cost of stormwater infiltration is estimated at $12,000 for a six-foot-deep, 10-foot-wide trench, and at $70,000 for a one-acre basin, with an annual maintenance cost of about $10 to $350 for the trench and about $2,500 for the basin
	Stormwater storage—urban	Store stormwater runoff from urban land in surface storage basins or, where necessary, subsurface storage basins	10 to 35	Apply subsurface storage tanks to intensively developed existing urban areas where suitable open land for surface storage is unavailable; design surface storage basins for proposed new urban land, existing urban land not storm sewered, and existing urban land where adequate open space is available at the storm sewer discharge site. The capital cost for stormwater storage would range from $35,000 to $110,000 per acre of basin, with an annual operation and maintenance cost of about $40 to $60 per acre
	Stormwater treatment	Provide physical-chemical treatment which includes screens, microstrainers, dissolved air flotation, swirl concentrator, or high-rate filtration, and/or disinfection, which may include chlorination, high-rate disinfection, or ozonation to stormwater following storage	10 to 50	To be applied only in combination with stormwater storage facilities above; general cost estimates for microstrainer treatment and ozonation were used; some costs were applied to existing urban land and proposed new urban development. Stormwater treatment has an estimated capital cost of from $900 to $7,000 per acre of tributary drainage area, with an average annual operation and maintenance cost of about $35 to $100 per acre
Rural	Conservation practices	Includes such practices as strip cropping, contour plowing, crop rotation, pasture management, critical area protection, grading and terracing, grassed waterways, diversions, woodlot management, fertilization and pesticide management, and chisel tillage	Up to 50	Cost for Natural Resources Conservation Service (NRCS) recommended practices are applied to agricultural and related rural land; the distribution and extent of the various practices were determined from an examination of 56 existing farm plan designs within the Region. The capital cost of conservation practices ranges from $3,000 to $5,000 per acre of rural land, with an average annual operation and maintenance cost of from $5.00 to $10 per rural acre

Table C-1 (continued)

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Rural (continued)	Animal waste control system	Construct streambank fencing and crossovers to prevent access of all livestock to waterways; construct a runoff control system or a manure storage facility, as needed, for major livestock operations; prevent improper applications of manure on frozen ground, near surface drainageways, and on steep slopes; incorporate manure into soil	50 to 75	Cost estimated per animal unit; animal waste storage (liquid and slurry tank for costing purposes) facilities are recommended for all major animal operations within 500 feet of surface water and located in areas identified as having relatively high potential for severe pollution problems. Runoff control systems recommended for all other major animal operations. It is recognized that dry manure stacking facilities are significantly less expensive than liquid and slurry storage tanks and may be adequate waste storage systems in many instances. The estimated capital cost and average operation and maintenance cost of a runoff control system is $100 per animal unit and $25 per animal unit, respectively. The capital cost of a liquid and slurry storage facility is about $1,000 per animal unit, with an annual operation and maintenance cost of about $75 per unit. An animal unit is the weight equivalent of a 1,000-pound cow
	Base-of-slope detention storage	Store runoff from agricultural land to allow solids to settle out and reduce peak runoff rates. Berms could be constructed parallel to streams	50 to 75	Construct a low earthen berm at the base of agricultural fields, along the edge of a floodplain, wetland, or other sensitive area, design for 24-hour, 10-year recurrence interval storm; berm height about four feet. Apply where needed in addition to basic conservation practices; repair berm every 10 years and remove sediment and spread on land. The estimated capital cost of base-of-slope detention storage would be $500 per tributary acre, with an annual operation and maintenance cost of $25 per acre
	Bench terraces	Construct bench terraces, thereby reducing the need for many other conservation practices on sloping agricultural land	75 to 90	Apply to all appropriate agricultural lands for a maximum level of pollution control. Utilization of this practice would exclude installation of many basic conservation practices and base-of-slope detention storage. The capital cost of bench terraces is estimated at $1,500 per acre, with an annual operation and maintenance cost of $100 per acre
Urban and Rural	Public education programs	Conduct regional and county-level public education programs to inform the public and provide technical information on the need for proper land management practices on private land, the recommendations for management programs, and the effects of implemented measures; develop local awareness programs for citizens and public works officials; develop local contract and education efforts	Indeterminate	For first 10 years, includes cost of one person, materials, and support for each 25,000 population. Thereafter, the same cost can be applied for every 50,000 population. The cost of one person, materials, and support is estimated at $55,000 per year
	Construction erosion control practices	Construct temporary sediment basins; install straw bale dikes; use fiber mats, mulching, and seeding; install slope drains to stabilize steep slopes; construct temporary diversion swales or berms upslope from the project	20 to 40	Assume acreage under construction is the average annual incremental increase in urban acreage; apply costs for a typical erosion control program for a construction site. The estimated capital cost and operation and maintenance cost for construction erosion control is $250 to $5,500 and $250 to $1,500 per acre under construction, respectively
	Materials storage and runoff control facilities	Enclose industrial storage sites with diversion; divert runoff to acceptable outlet or storage facility; enclose salt piles and other large storage sites in crib and dome structures	5 to 10	Assume 40 percent of industrial areas are used for storage and to be enclosed by diversions; assume existing salt storage piles enclosed by cribs and dome structures. The estimated capital cost of industrial runoff control is $2,500 per acre of industrial land. Material storage control costs are estimated at $75 per ton of material

Table C-1 (continued)

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Urban and Rural (continued)	Stream protection measures	Provide vegetative buffer zones along streams to filter direct pollutant runoff to the stream; construct streambank protection measures, such as rock riprap, brush mats, tree revetment, jacks, and jetted willow poles, where needed	5 to 10	Apply a 50-foot-wide vegetative buffer zone on each side of 15 percent of the stream length; apply streambank protection measures to 5 percent of the stream length. Vegetative buffer zones are estimated to cost $21,200 per mile of stream and streambank protection measures cost about $37,000 per stream mile
	Pesticide and fertilizer application restrictions	Match application rate to need; eliminate excessive applications and applications near or into surface water drainageways	0 to 3	Cost included in public education program
	Critical area protection	Emphasize control of areas bordering lakes and streams; correct obvious erosion and other pollution source problems	Indeterminate	Indeterminate

[a]*Not all control measures are required for each subwatershed. The characteristics of the watershed, the estimated required level of pollution reduction needed to meet the applicable water quality standards, and other factors will influence the selection and estimation of costs of specific practices for any one subwatershed. Although the control measures costed represent the recommended practices developed at the regional level on the basis of the best available information, the local implementation process should provide more detailed data and identify more efficient and effective sets of practices to apply to local conditions.*

[b]*The approximate effectiveness refers to the estimated amount of pollution produced by the contributing category (urban or rural) that could be expected to be reduced by the implementation of the practice. The effectiveness rates would vary greatly depending on the characteristics of the watershed and individual diffuse sources. It should be further noted that practices can have only a "sequential" effect, since the percent pollution reduction of a second practice can only be applied against the residual pollutant load which is not controlled by the first practice. For example. two practices of 50 percent effectiveness in series would achieve a theoretical total effectiveness of only 75 percent control of the initial load. Further, the general levels of effectiveness reported in the table are not necessarily the same for all pollutants associated with each source. Some pollutants are transported by dissolving in water and others by attaching to solids in the water; the methods summarized here reflect typical pollutant removal levels.*

[c]*For highly urbanized areas which require retrofitting of facilities into developed areas, the costs can range from $400,000 to $1,000,000 per acre of storage.*

Source: SEWRPC.

Of the sets of practices recommended for various levels of diffuse source pollution control presented in Table C-2, not all practices are needed, applicable, or cost-effective for all watersheds, due to variations in pollutant loadings and land use and natural conditions among the watersheds. Therefore, it is recommended that the practices indicated as needed for nonpoint source pollutant control be refined by local level nonpoint source control practices planning, which would be analogous to sewerage facilities planning for point source pollution abatement. A locally prepared plan for nonpoint abatement measures should be better able to blend knowledge of current problems and practices with a quickly evolving technology to achieve a suitable, site-specific approach to pollution abatement.

Table C-2

ALTERNATIVE GROUPS OF DIFFUSE SOURCE WATER POLLUTION CONTROL MEASURES PROPOSED FOR STREAMS AND LAKE WATER QUALITY MANAGEMENT

Pollution Control Category	Level of Pollution[a] Control	Practices to Control Diffuse Source Pollution from Urban Areas[b]	Practices to Control Diffuse Source Pollution from Rural Areas[a]
Basic Practices	Variable	Construction erosion control; onsite sewage disposal system management; streambank erosion control	Streambank erosion control
	25 percent	Public education programs; litter and pet waste control; restricted use of fertilizers and pesticides; construction erosion control; critical areas protection; improved timing and efficiency of street sweeping, leaf collection, and catch basin cleaning; material storage facilities and runoff control	Public education programs; fertilizer and pesticide management; critical area protection; crop residue management; chisel tillage; pasture management; contour plowing; livestock waste control
Additional Diffuse Source Control Practices[c]	50 percent	Above, plus: Increased street sweeping; improved street maintenance and refuse collection and disposal; increased catch basin cleaning; stream protection; increased leaf and vegetation debris collection and disposal; stormwater storage; stormwater infiltration	Above, plus: crop rotation; contour strip-cropping; grass waterways; diversions; wind erosion controls; terraces; stream protection
	75 percent	Above, plus: An additional increase in street sweeping, stormwater storage and infiltration; additional parking lot stormwater runoff storage and treatment	Above, plus: Base-of-slope detention storage
	More than 75 percent	Above, plus: Urban stormwater treatment with physical-chemical and/or disinfection treatment measures	Bench terraces[b]

[a]*Groups of practices are presented here for general analysis purposes only. Not all practices are applicable to, or recommended for, all lake and stream tributary watersheds. For costing purposes, construction erosion control practices, public education programs, and material storage facilities and runoff controls are considered urban control measures and stream protection is considered a rural control measure.*

[b]*The provision of bench terraces would exclude most basic conversation practices and base-of-slope detention storage facilities.*

[c]*In addition to diffuse source control measures, lake rehabilitation techniques may be required to satisfy lake water quality standards.*

Source: SEWRPC.

Appendix D

ROSENOW CREEK RESTORATION PROJECT SUMMARY

BACKGROUND

The Wisconsin Department of Transportation (WisDOT) STH 67 Oconomowoc Bypass Project—Wisconsin Department of Transportation Project I.D. 1372-04-00—necessitated moving approximately 1,000 feet of the existing reach of the North/South Tributary to Rosenow Creek as part of the proposed new roadway. The channel was relocated westward of the new roadway and restored to a length of approximately 1,400 linear feet during the summer of 2004. The North/South Tributary is reported by the Wisconsin Department of Natural Resources (WDNR) to contain both juvenile and adult brook trout. This Tributary also contains critical brook trout spawning habitat located just downstream of the WisDOT project area.

DESIGN CONSIDERATIONS

The Regional Planning Commission staff, in cooperation with staffs of the WisDOT and WDNR, identified two major goals to guide the preparation of the proposed recommendations for the stream restoration design:

1. Protection of the existing biodiversity in the stream corridor, which communities included a reproducing population of brook trout.

2. Improvement of available habitat in the stream system through the enhancement of streambank stability; limitation of instream sediment deposition during pre- and post-construction conditions; implementation of mitigation techniques to moderate the effects of past channelization; and, restoration of instream, wetland, and riparian habitat.[1]

A key aspect of the environmental enhancements associated with the stream restoration in this project area was the relocation of several hundred feet of the North Branch of Rosenow Creek to create a stable and more "natural" channel that is intended to reduce streambank erosion potential, enhance water quality, and improve habitat for wildlife.

[1]*Wisconsin Department of Natural Resources Technical Bulletin No. 169,* A Review of Fisheries Habitat Improvement Projects in Warmwater Streams, with Recommendations for Wisconsin*, 1990. Note also that portions of the main stem of Rosenow Creek downstream of the project area had been enhanced by the WDNR, which stream reaches were required to be protected during the stream reconstruction project.*

This appendix summarizes the recommendations and specifications considered in the stream design that contribute to habitat restoration and water quality enhancement, and illustrates the initial response of the stream to this radical reconstruction. Pursuant to the Memorandum of Understanding between the WisDOT and WDNR with respect to this project, it is anticipated that further portions of the main stem of Rosenow Creek downstream of CTH Z may be restored. Planning of this project was underway at the time of writing utilizing similar principles as discussed below.

These recommendations are consistent with the adopted regional water quality management plan for Southeastern Wisconsin, the Waukesha County land and water resource management plan, and the Oconomowoc River Priority Watershed Plan.[2]

SITE DESCRIPTION

The location of the stream restoration for Rosenow Creek, upstream of Lac La Belle, is shown on Map D-1. SEWRPC staff conducted a survey of the existing stream reach within the project area to determine the physical characteristics of the existing stream reach. Methods utilized to select transect locations and measure appropriate channel features within this stream reach were developed from several sources and modified to meet the objectives of this stream relocation project.[3] A number of transects were established in order to characterize the existing reach and develop appropriate design parameters for the relocated channel, as set forth in the Channel Design Section below. This instream survey data, in combination with detailed site plan information provided by the WisDOT, as well as file information from SEWRPC and the WDNR, were used to characterize site conditions and develop recommendations for the relocation of this reach of the Rosenow Creek, as summarized below.

PREVIOUSLY EXISTING CHANNEL CONDITIONS

The amount, quality, and diversity of available instream fisheries and macroinvertebrate habitat within the North Branch of Rosenow Creek were considered to be generally limited. The North Branch of Rosenow Creek was channelized from CTH K to the confluence with the main stem of the Creek and formed part of the agricultural drainage system serving the former Rosenow farm. It exhibited a relatively constant width, depth and substrate. Given the generally disturbed state of the entire Rosenow Creek drainage system, the nearby undisturbed segments of the adjacent Ashippun River were utilized to establish conditions for the stream dimensions, hereinafter referred to as the "reference reach." Because the stream reach within the project area had been significantly modified, it did not exhibit appropriate physical features to emulate in the stream restoration design.

Stream Morphology and Hydrology

Prior to construction of the WisDOT project, the stream reach of the North Branch of Rosenow Creek within the project limits was approximately 1,000 feet in length with a low sinuosity and slope primarily due to the historic channelization. This resulted in a correspondingly limited pool/riffle structure within this reach.

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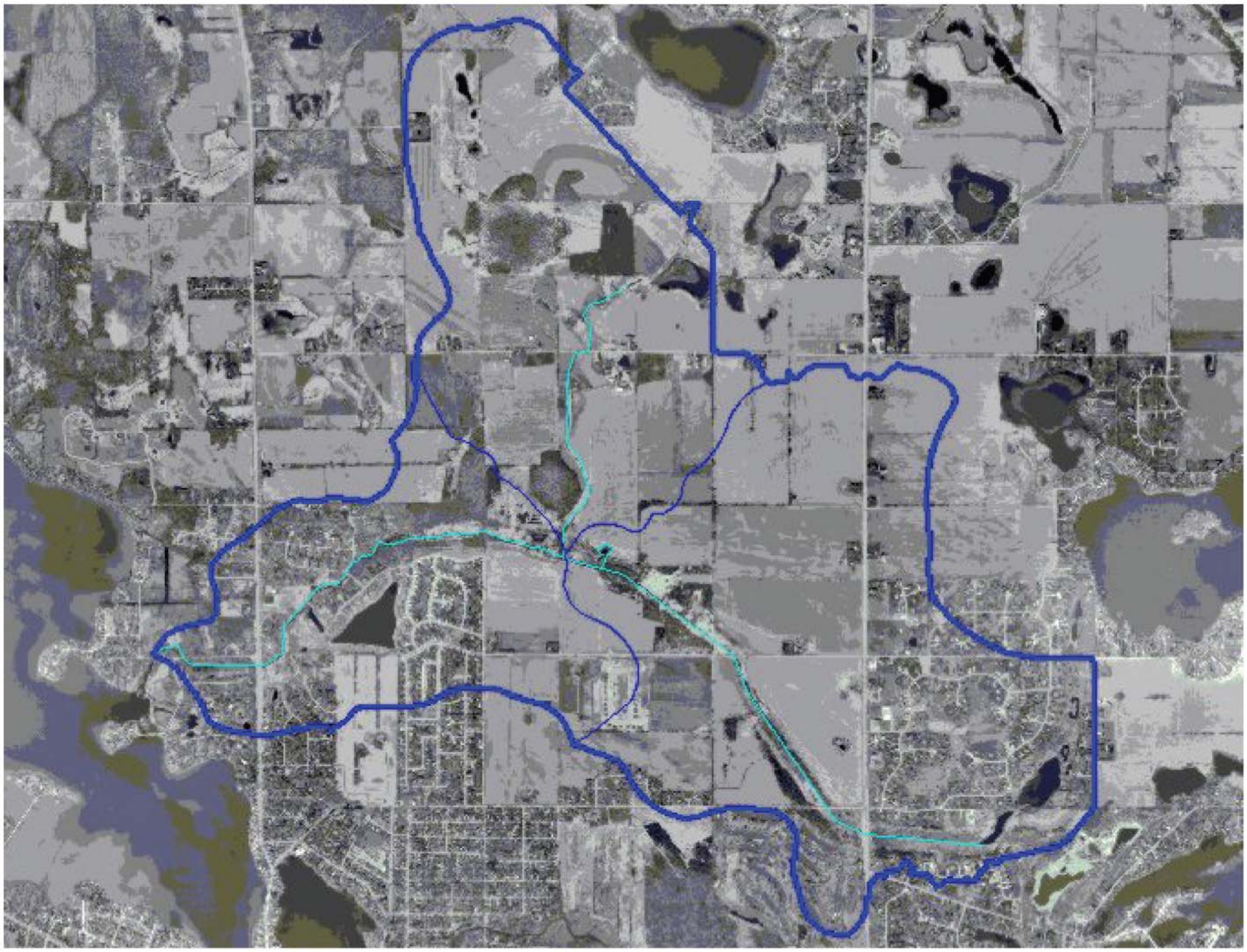
[2]*SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report*, March 1995; Waukesha County Department of Parks and Land Use,* Waukesha County Land and Water Resource Management Plan: 1999-2002*, January 1999; Wisconsin Department of Natural Resources Publication No. WR-194-86,* A Nonpoint Source Control Plan for the Oconomowoc River Priority Watershed Project*, March 1986.*

[3]*United States Department of Agriculture,* Methods for Evaluating Stream, Riparian, and Biotic Conditions*, USDA General Technical Report INT-138, 1983; United States Department of Agriculture,* Guidelines for Evaluating Fish Habitat in Wisconsin Streams*, USDA Forest Service General Technical Report NC-164, 1994; United States Department of Agriculture,* Stream Channel Reference Sites: An Illustrated Guide to Field Techniques*, General Technical Report RM-245, 1994.*

Map D-1

LOCATION OF THE NORTH TRIBUTARY STREAM RECREATION PROJECT
AND ROSENOW CREEK SUBWATERSHED TRIBUTARY TO LAC LA BELLE



Source: SEWRPC.

The streambanks within this reach were moderately stable, having relatively good water quality suggestive of significant groundwater infiltration. This stream segment was slightly entrenched with corresponding moderately steep banks. These channel characteristics generally correspond to an "E5" stream channel type using the Rosgen stream channel classification system.[4]

Due to channelization within the project area, the then-existing stream reach had a sinuosity of less than 1.5. Inspection of historic and current aerial photographs showed no evidence of the likely natural condition of this

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[4]*D.L. Rosgen,* Applied River Morphology, *Wildland Hydrology, Colorado. 1996. The Rosgen classification system includes recognition of specific characteristics of channel morphology and the relationship between the stream channel and its floodplain. An "E5" channel type is characterized by the following features: a gradient of less than two percent; a meandering riffle-pool system with a sinuosity of greater than 1.5; a width to depth ratio of less than 12; a slightly entrenched channel with an entrenchment ratio of greater than 2.2; and a predominantly sand substrate.*

Tributary. Therefore, it was necessary to calculate a more appropriate sinuosity for the North Branch of Rosenow Creek based upon the measured values of channel width, depth, and slope within the reference reach upstream of the study area.[5]

Based upon the "E5" classification, the Rosgen methodology would suggest that the North Branch of Rosenow Creek would be very sensitive to disturbances within the drainage area, but with a good recovery potential. This classification also suggested that the potential for streambank erosion within this system was moderate to very high, with streambank vegetation having a very high controlling influence on moderating this erosion potential.[6] In terms of the potential for enhancing fish habitat, bank-placed boulders and brush bundles or tree revetments were indicated as good for use in "E5" channels; opposing wing-deflectors as fair; and, medium-stage weirs, boulder clusters, and single wing deflectors as poor. Therefore, fish habitat improvements in this system were to be focused on bank-placed boulders, brush bundles, and/or similar treatments, including placement of root wads or tree revetments, as shown in Figures D-1 and D-2 for typical pool and riffle sections of stream, respectively.

STREAM RESTORATION PLAN FOR THE NORTH BRANCH OF ROSENOW CREEK

The foregoing consideration resulted in the preparation of the stream design shown in Figure D-3. This stream segment was constructed by the WisDOT during 2004 and 2005, and brought "on line" during 2005. Subsequent fisheries surveys by SEWRPC and WDNR staff have indicated that the reconstructed stream is currently supporting a viable population of brook trout. The dashed lines in Figure D-3 show the historically channelized portion of the North Branch of Rosenow Creek.

The relocated North/South Tributary to Rosenow Creek was designed and constructed to create a stable and more "natural" channel that is intended to reduce streambank erosion potential, enhance water quality, and improve habitat for wildlife. Several key aspects associated with the environmental enhancements of the stream relocation in this project area include:

- Construction of a retaining wall to protect the remaining wooded lands adjacent to the stream and reducing the amount of excavation on this project site, as shown in Figure D-4;

- Excavation (i.e., lowering) of the adjacent floodplain to reconnect this reach with adjacent riparian lands, alleviating bank erosion and providing wildlife habitat, and restoration of the stream channel meanders, as shown in Figure D-5; and,

- Onsite wetland mitigation plantings adjacent to both the North/South Tributary and mainstem of Rosenow Creek, providing fish and wildlife habitat, as shown in Figure D-6.

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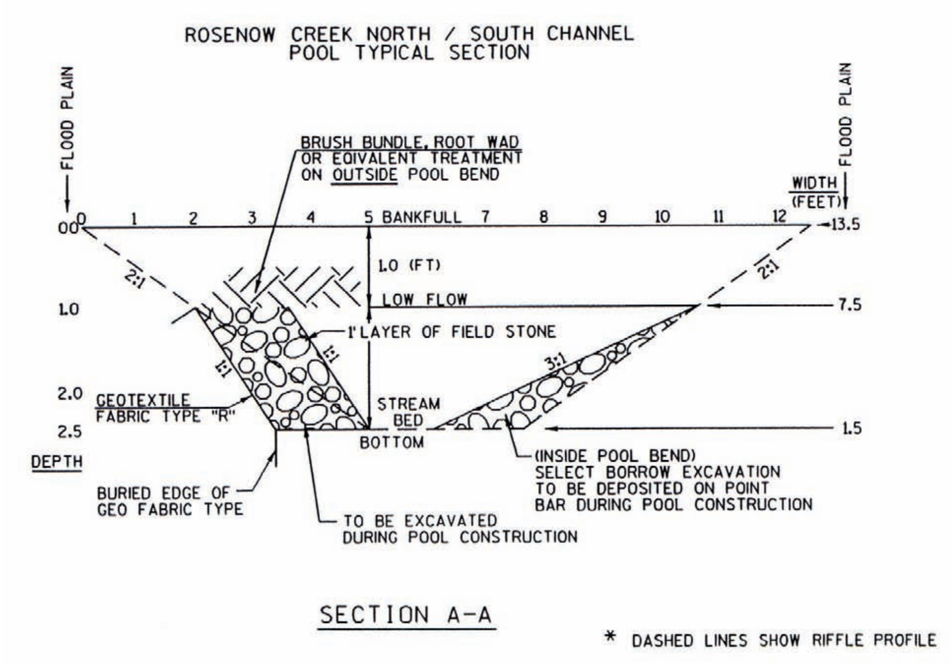
[5]*G.W. Williams, "River Meanders and Channel Size,"* Journal of Hydrology*, Volume 88, 1986, pp. 147-164.*

[6]*D.L. Rosgen, "A Classification of Natural Rivers,"* op. cit.

Figure D-1

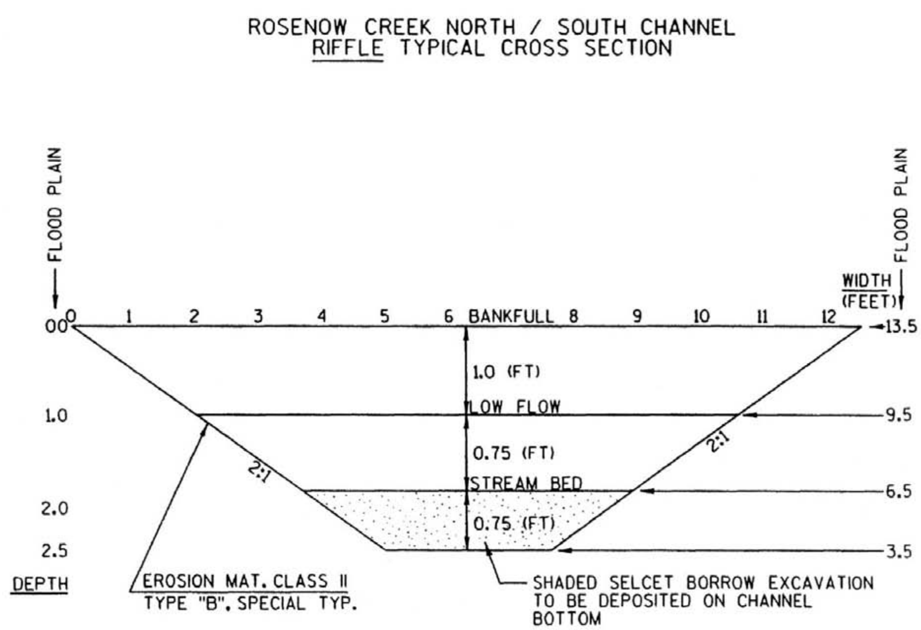
TYPICAL PLANNED POOL CROSS-SECTION FOR THE RESTORED NORTH BRANCH OF ROSENOW CREEK



Source: SEWRPC.

Figure D-2

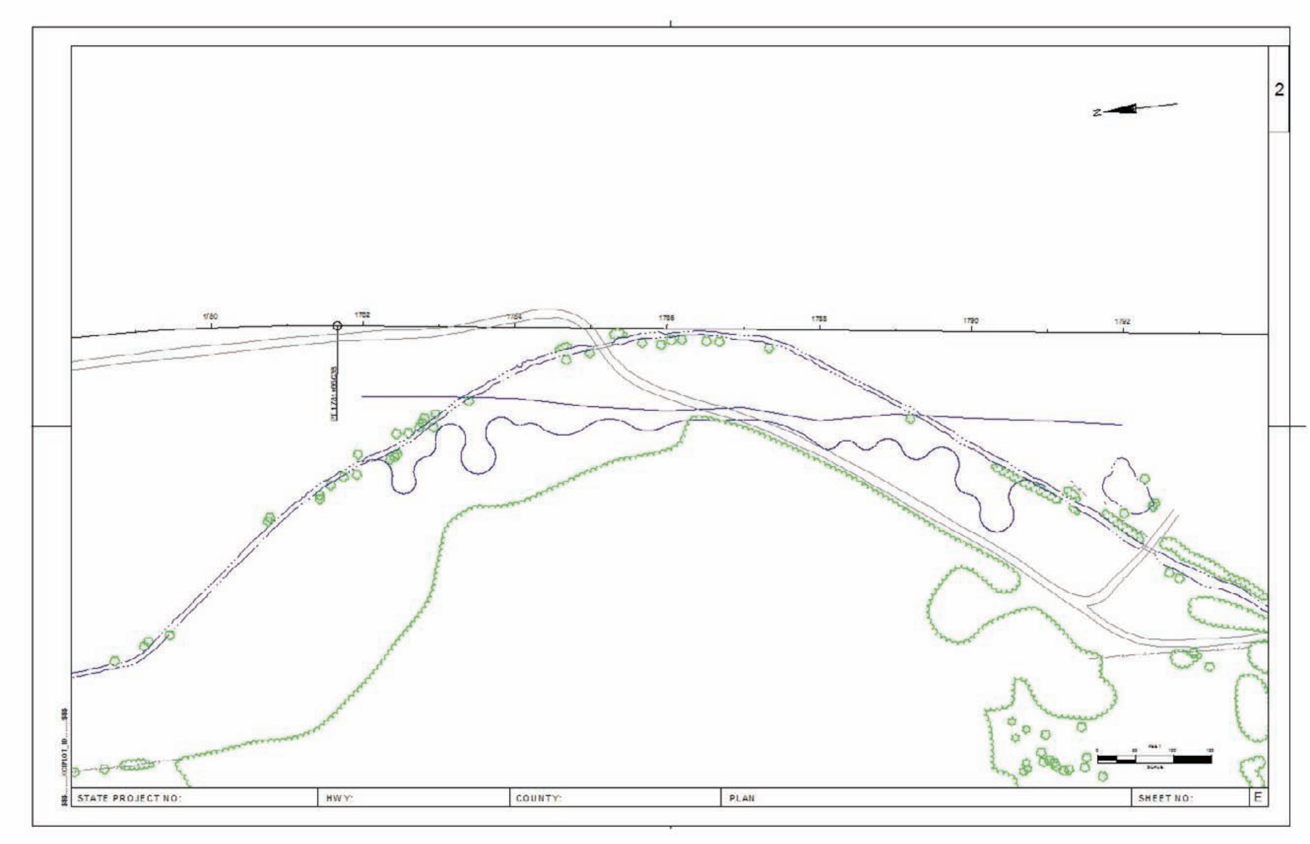
TYPICAL PLANNED RIFFLE CROSS-SECTION FOR THE RESTORED NORTH BRANCH OF ROSENOW CREEK



Source: SEWRPC.

Figure D-3

PLAN VIEW OF THE DESIGN FOR THE RECONSTRUCTED NORTH BRANCH OF ROSENOW CREEK



Source: SEWRPC.

Figure D-4

STABILIZATION OF RIVER BANK SLOPES ALONG THE NORTH BRANCH OF ROSENOW CREEK

Source: SEWRPC.

Figure D-5

RESTORATION OF STREAM CHANNEL MEANDERS WITHIN THE NORTH BRANCH OF ROSENOW CREEK

Source: SEWRPC.

Figure D-6

INSTREAM AND RIPARIAN HABITAT RECREATION ALONG THE MARGINS OF THE NORTH BRANCH OF ROSENOW CREEK

Source: SEWRPC.