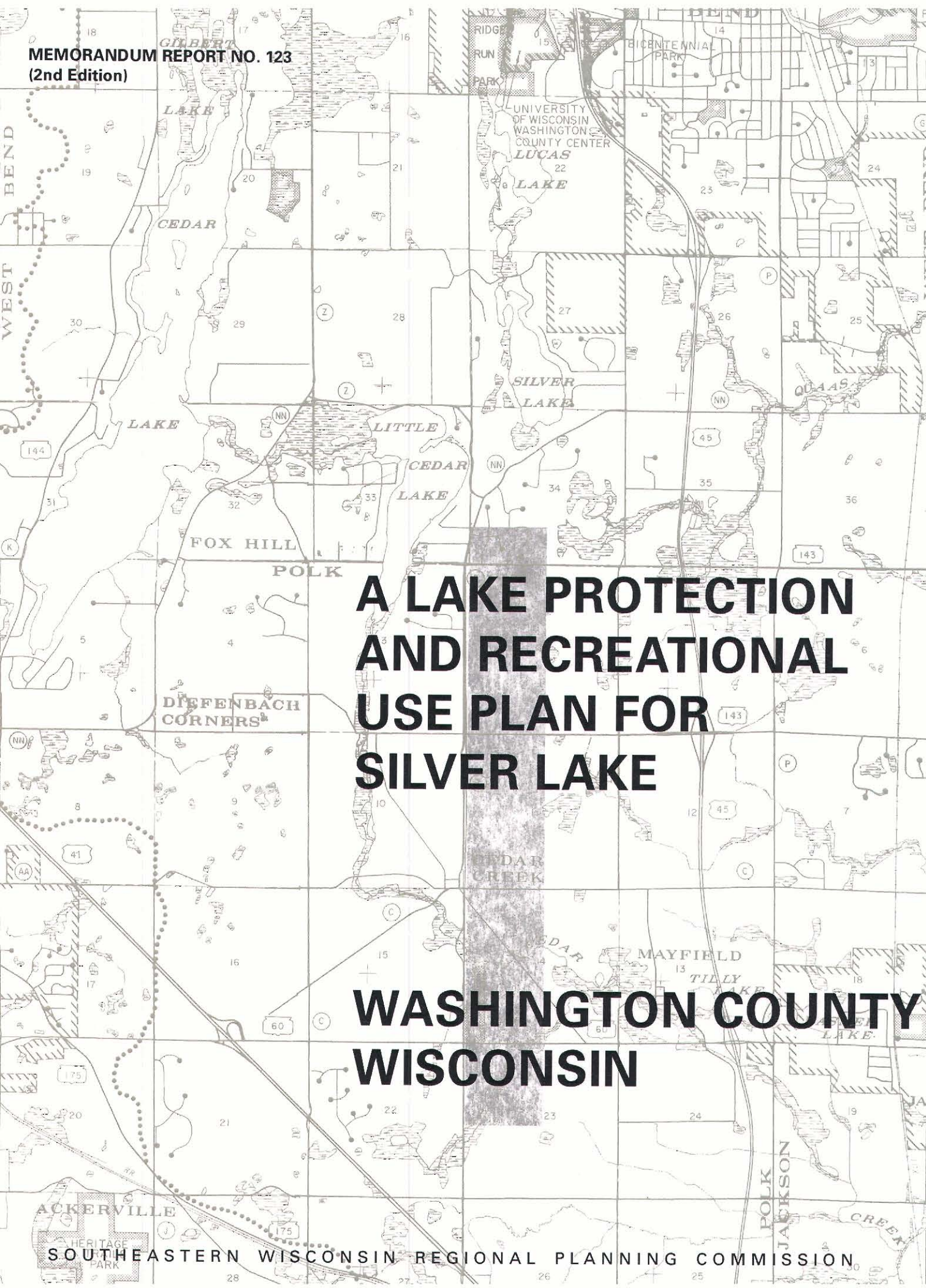
MEMORANDUM REPORT NO. 123
(2nd Edition)



A LAKE PROTECTION AND RECREATIONAL USE PLAN FOR SILVER LAKE

WASHINGTON COUNTY WISCONSIN

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MEMORANDUM REPORT
NUMBER 123, 2nd Edition

A LAKE PROTECTION AND RECREATIONAL USE PLAN FOR SILVER LAKE WASHINGTON COUNTY, WISCONSIN

Prepared by the

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Chapter I

INTRODUCTION

Silver Lake, located in the Town of West Bend, Washington County, Wisconsin, is a valuable resource offering a variety of recreational and aesthetic opportunities to the resident community and its visitors. The Lake is an integral part of this lake-oriented community. However, the recreational and visual value of the Lake is perceived to be threatened by changing land use conditions in the drainage area tributary to Silver Lake.

Seeking to improve the usability and to prevent deterioration of the natural assets and recreational potential of the Silver Lake, the riparian residents formed a Chapter 33, *Wisconsin Statutes*, public inland lake protection and rehabilitation district. Consequently, the Silver Lake Protection and Rehabilitation District was duly created to undertake an ongoing program of community involvement, education, and lake management. One of the activities undertaken by the District was the completion of a lake protection plan for Silver Lake during 1997 in cooperation with the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and with funding provided in part by the Wisconsin Department of Natural Resources (WDNR) through the Chapter NR 190 lake management planning grant program.[1] That plan recommended a series of actions be implemented by the Silver Lake Protection and Rehabilitation District to, among other actions, manage nonnative aquatic plants recorded from within the Lake basin and assess the rate of deposition of marl within the basin prior to considering alternatives for managing these deposits.

This report sets forth a refined lake protection plan for Silver Lake, which plan includes consideration of the studies and surveys completed by the Silver Lake Protection and Rehabilitation District since the publication of the aforereferenced lake protection plan. This plan represents part of the ongoing commitment of the Silver Lake Protection and Rehabilitation District, and the Town of West Bend, to sound planning with respect to the Lake and forms a logical complement to the earlier study conducted by the Commission in 1997. The current plan was prepared by SEWRPC, in cooperation with the Silver Lake Protection and Rehabilitation District, and incorporates the data and analyses developed in the aforementioned lake protection plan as well as pertinent water quality and other data gathered by the United States Geological Survey,[2] the Wisconsin Department of Natural Resources, and private consultants working under contract to the District. This planning project was funded, in part, through a Wisconsin Department of Natural Resources Lake Management Planning Grant awarded to the Silver Lake Protection and Rehabilitation District under Chapter NR 190 of the *Wisconsin Administrative Code*.

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[1]*SEWRPC Memorandum Report No. 123,* A Lake Protection and Recreational Use Plan for Silver Lake, Washington County, Wisconsin, *September 1997.*

[2]*See U.S. Geological Survey Water-Resources Investigations Report No. 02-4204,* Simulation of the Shallow Aquifer in the Vicinity of Silver Lake, Washington County, Wisconsin, Using Analytic Elements, *2003.*

AQUATIC PLANT MANAGEMENT AND RECREATIONAL USE OBJECTIVES

The objectives of this aquatic plant management and lake protection plan for Silver Lake were developed in consultation with the Silver Lake Protection and Rehabilitation District, and are as follows:

1. To protect and maintain the public health, convenience, necessity, and welfare, and promote public comfort, through the environmentally sound management of the vegetation, fish, and wildlife populations in and around Silver Lake;

2. To provide a high-quality, water-oriented urban residential setting with recreational and aesthetic opportunities for residents and visitors to the Silver Lake, and manage the Lake in an environmentally sound manner; and,

3. To maintain the water quality of Silver Lake so as to better facilitate the conduct of water-related recreation, improve the aesthetic value of the resource to the community, and enhance the resource value of the waterbody.

This plan, which conforms to the requirements and standards set forth in the relevant *Wisconsin Administrative Codes*,[3] should serve as an initial guide to achieving these objectives over time.

OVERVIEW OF PLAN REFINEMENTS

The scope of this report is limited to a consideration of those management measures that can be determined to be effective in the protection of lake water quality and lake use based upon the available data. This second edition plan incorporates additional information recommended to be acquired in the adopted lake protection plan for Silver Lake on: the groundwatershed and groundwater flows into Silver Lake, information on the aquatic plant community and the application of aquatic herbicides to control the growth of Eurasian water milfoil in portions of the Lake, and an update on the actions of Washington County to provide public recreational boating access to the Lake. The Washington County Henschke Hillside Recreation Area and boat launch were opened on September 4, 2005, providing Silver Lake with adequate public recreational boating access as defined in Chapter NR 1 of the *Wisconsin Administrative Code*.

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

Chapter II

INVENTORY FINDINGS

INTRODUCTION

Silver Lake is located in U.S. Public Land Survey Sections 27 and 34, Township 11 North, Range 19 East, within the southwestern portion of the Town of West Bend, in central Washington County, as shown on Map 1. Silver Lake is a groundwater-fed, drained lake, receiving water primarily from groundwater-sourced springs located along the western and southern shores of the Lake, as well as surface runoff from lands directly tributary to the Lake. Surface water drains from the northernmost end of the Lake through Silver Creek, a tributary to the Milwaukee River. The Lake also drains, to a lesser degree, as a result of groundwater outflows along the eastern shore.

The drainage area tributary to, or watershed of, Silver Lake is wholly located within the Town of West Bend in Washington County. At the time of drafting of the initial lake protection plan, this drainage area was estimated to be approximately 718 acres in areal extent. Given that portions of this tributary drainage area are internally drained, and consequently do not contribute runoff to Silver Lake, and based upon enhanced topographic mapping acquired since the completion of the previous planning program, the actual land surface draining to Silver Lake as of 2000 is estimated to be approximately 305 acres in areal extent.

As of 2000, the land uses within this 305-acre area remained primarily in lake-oriented residential land use, with significant areas of open lands including wetlands and woodlands.

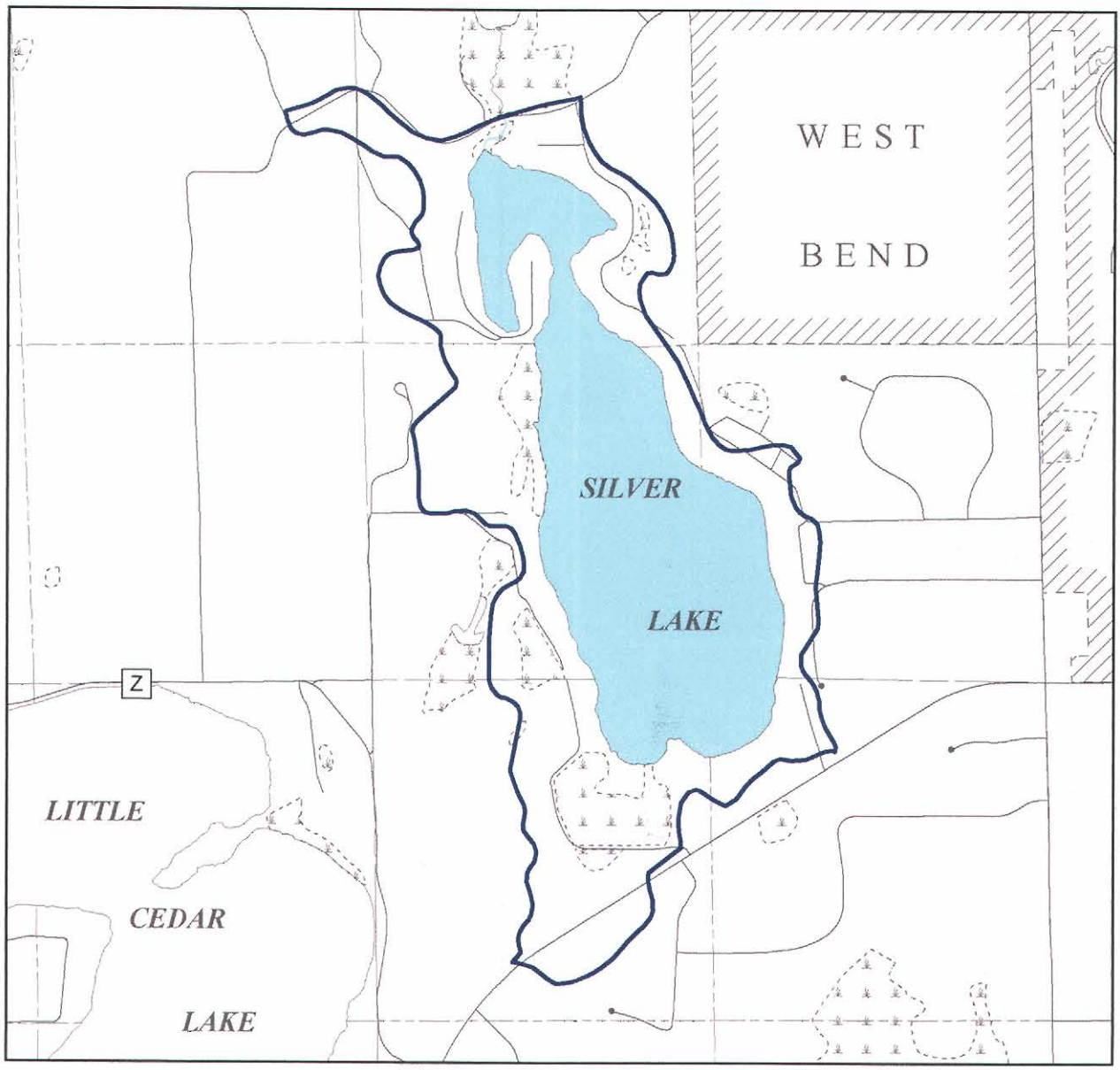
WATERBODY CHARACTERISTICS

Silver Lake is a 118-acre groundwater-fed, drained lake. Surface water sources are the result of localized surface water runoff from the lands immediately surrounding Silver Lake. At the northern end of the Lake, Silver Creek forms the outflow from Silver Lake, draining over a small dam to Paradise Valley Lake and continuing through Lucas Lake to the Milwaukee River. Silver Lake is elongate in shape, oriented in generally a north-south direction, and consisting of a main basin to the south, with two lobes or kettles located at the northern extreme. The deepest portions are located in the southern basin of the Lake, which has a maximum depth of about 47 feet. The mean depth of the Lake is approximately 20 feet and the Lake has a volume of about 2,306 acre-feet. The hydrographic characteristics and bathymetry of the Lake are shown in Table 1 and on Map 2, respectively.

Lake bottom sediment types were surveyed by the Commission staff as one element of the lake water quality survey conducted during the 1995 planning period. The lake bottom sediments were described as a mixture of silt and sand, with the depths of soft sediment ranging from zero to upwards of six inches or more in the shallow western portions of the Lake adjacent to shoreland wetland complexes. The deeper portions of the lakebed of

Map 1

DRAINAGE AREA TRIBUTARY TO SILVER LAKE



Surface Water

Streams

Total Drainage Area Boundary

Source: SEWRPC.

N

0 1,000 2,000 3,000

Feet

Table 1

HYDROGRAPHIC CHARACTERISTICS OF SILVER LAKE

Parameter	Measurement
Size	
Surface Area	118 acres
Volume	2,306 acre-feet
Maximum Depth	47 feet
Mean Depth	20 feet
Tributary Drainage Area[a]	305 acres
Residence Time[b]	2.9 years
Shape	
Maximum Length	0.9 miles
Length of Shoreline	2.7 miles
Maximum Width	0.3 miles
Shoreline Development Factor[c]	1.8
Depth	
Area of Lake Less than Three Feet	12 percent
Area of Lake Greater than 20 Feet	56 percent

[a] *In the initial report, the direct drainage area was reported as 718 acres; subsequent topographical evaluations resulted in the current refined value based upon more accurate topographic mapping.*

[b] *Residence Time: Time required for a volume equivalent to the full volume of the lake to enter the lake from the drainage area.*

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

Source: SEWRPC.

covered with silt ranging in depths from zero to six inches with the remaining shoreline areas either sand or a silt-sand mixture, as shown on Map 3. These deposits were noted to be of apparently recent origin, with causal factors including runoff from the development or redevelopment of lakeshore properties, deposition and decomposition of organic material such as leaves and aquatic plants, and sediment loading from the tributary watershed. Analysis of this sediment by the State Laboratory of Hygiene suggested that a portion of this material was comprised of calcium carbonate, or marl, deposited on the lake bottom as a result of pH changes between the groundwater and lake water which resulted in the precipitation of calcium carbonate carried into the Lake by groundwater.[1] It was further noted, in support of this observation, that the concentration of calcium carbonate in the lake water was high compared to many lakes in the Region, ranging from 35 milligrams per liter (mg/l) to about 50 mg/l. Such concentrations are comparable to other marl lakes in the Kettle Moraine area of Southeastern Wisconsin.[2] Sediment concentrations of marl ranged from 210 grams per kilogram (g/kg) to 360 g/kg.

During 2005, sediments from selected areas of Silver Lake were analyzed for selected pesticides, hydrocarbons (poly-aromatic hydrocarbons or PAHs), and metals. The results of these analyses suggested that the lake sediments were free of contaminants. State of Wisconsin sediment quality guideline values were not exceeded in any of the samples.[3]

POPULATION, LAND USE AND SHORELINE DEVELOPMENT

Population

As of 2000, there were approximately 290 persons residing year round in approximately 90 housing units within the drainage area directly tributary to Silver Lake. During the initial planning program, about 73 percent of the total population in the drainage area was estimated to live year round in the drainage area, with the remaining 27 percent of the population being part-year residents. Urban development adjacent to Silver Lake consisted primarily of residential development that occurred over time, as shown on Map 4.

Land Use

The existing 2000 land use pattern within the drainage area directly tributary to Silver Lake is shown on Map 5, and quantified in Table 2. About 104 acres, or about 34 percent of the tributary drainage area, were devoted to

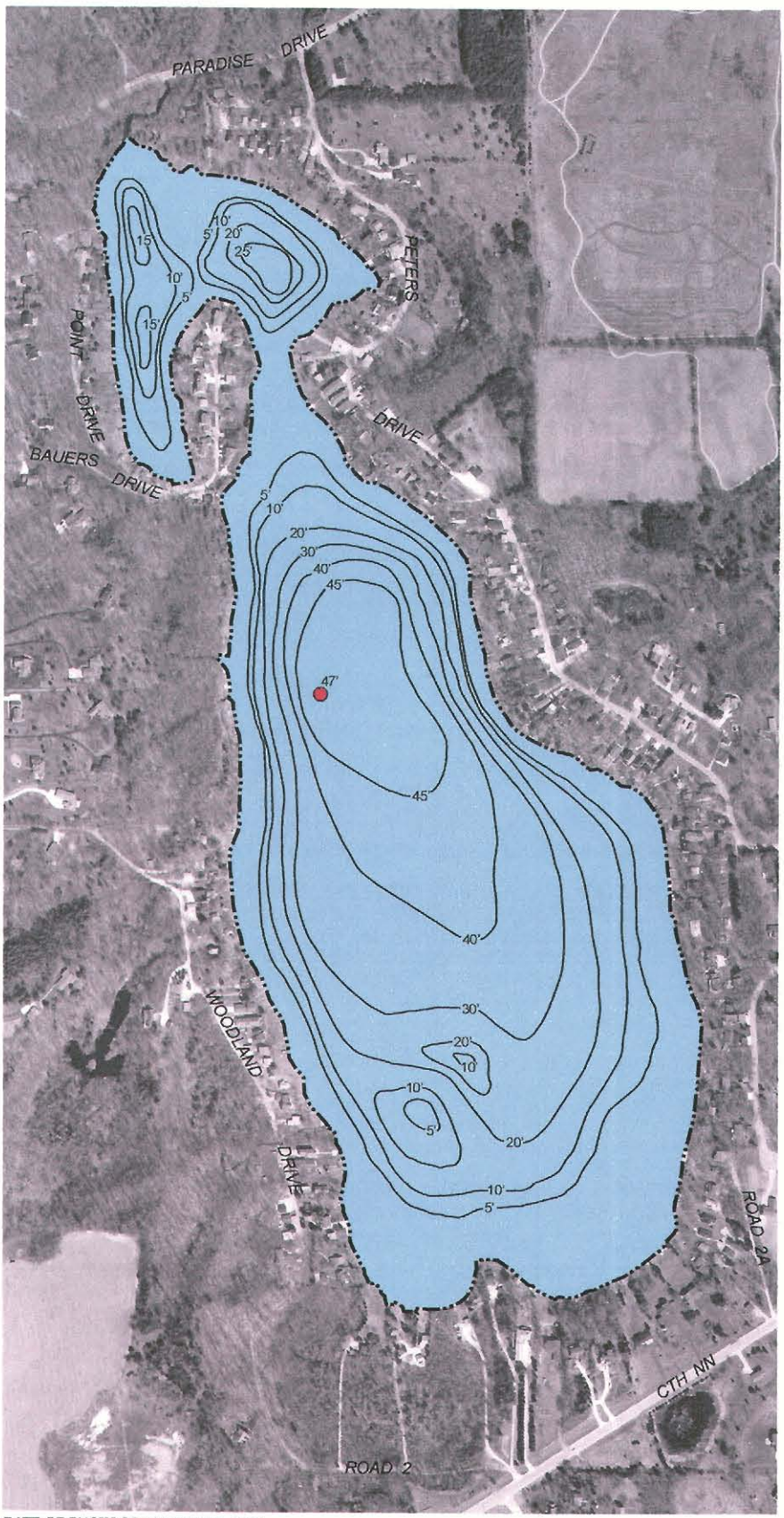
[1] *W. Stumm and J.J. Morgan,* Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters, *Wiley-Interscience, New York, 1970.*

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

[3] *Cooper Environmental Resources, Inc.,* in litt., *August 2005.*

Map 2

BATHYMETRIC MAP OF SILVER LAKE



—20'— WATER DEPTH CONTOUR IN FEET

MONITORING SITE

GRAPHIC SCALE

0 350 700 FEET

DATE OF PHOTOGRAPHY: APRIL 2000

Source: U.S. Geological Survey and SEWRPC.

Map 3

SEDIMENT SUBSTRATE DISTRIBUTION IN SILVER LAKE: 1997

—20'— WATER DEPTH CONTOUR IN FEET

SILT

SAND

SILT/SAND

GRAPHIC SCALE

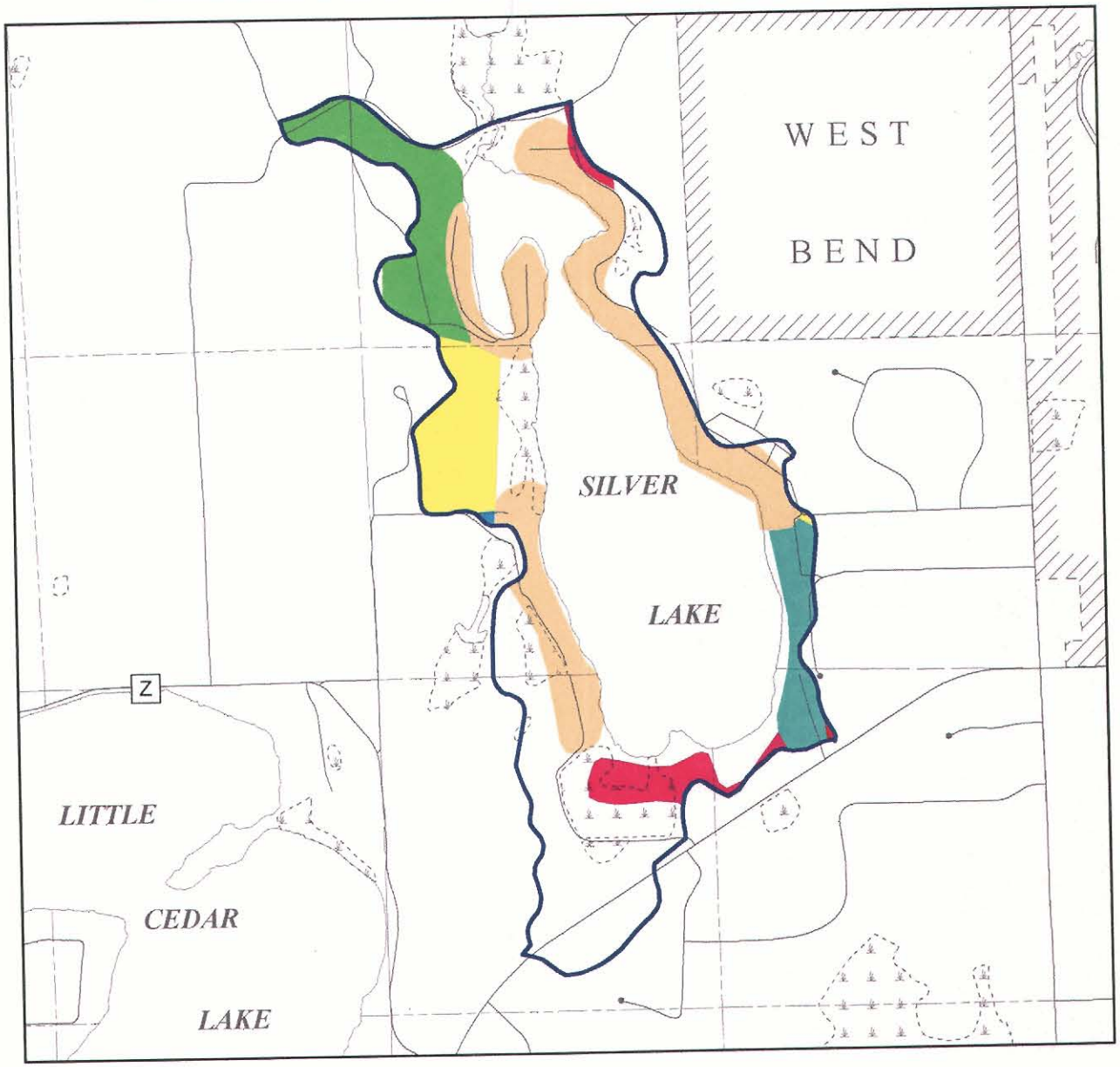
0 350 700 FEET

DATE OF PHOTOGRAPHY: APRIL 2000

Source: SEWRPC.

Map 4

HISTORIC URBAN GROWTH WITHIN THE DRAINAGE AREA TRIBUTARY TO SILVER LAKE



1950
1963
1975
1980
1985
1990
2000

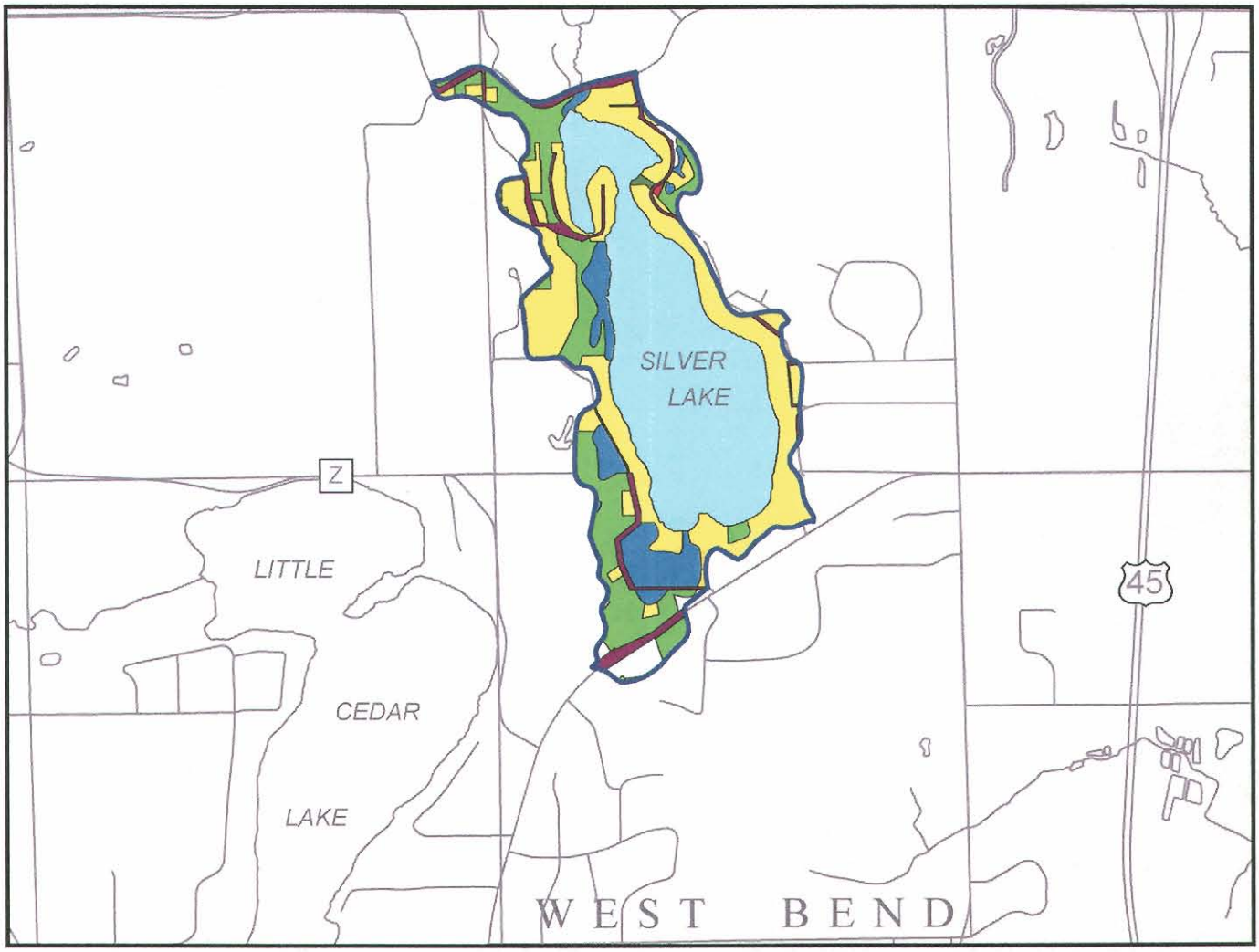
N

0 1,000 2,000 3,000
Feet

Source: SEWRPC.

Map 5

EXISTING LAND USES WITHIN THE DRAINAGE AREA TRIBUTARY TO SILVER LAKE: 2000



SINGLE FAMILY RESIDENTIAL
COMMERCIAL
TRANSPORTATION, COMMUNICATION, AND UTILITIES
RECREATIONAL
WOODLAND
WETLAND
AGRICULTURE AND OTHER OPEN SPACE
SURFACE WATER

N

GRAPHIC SCALE
0 1,000 2,000 3,000 Feet

Source: SEWRPC.

Table 2

EXISTING AND PLANNED LAND USE WITHIN THE DRAINAGE AREA TRIBUTARY TO SILVER LAKE: 2000 AND 2020

Land Use Categories[a]	2000		2020	
	Acres	Percent of Total	Acres	Percent of Drainage Area
Urban				
Residential	88	28.9	89	29.3
Commercial	<1	<1.0	<1	<1.0
Industrial	--	--	--	--
Governmental and Institutional	--	--	--	--
Transportation, Communication, and Utilities	15	4.9	15	4.9
Recreational	1	0.3	1	0.3
Subtotal	104	34.1	105	34.5
Rural				
Agricultural and Other Open Lands	6	2.0	5	1.6
Wetlands	22	7.2	22	7.2
Woodlands	47	15.5	47	15.5
Water	125	41.2	125	41.2
Extractive	--	--	--	--
Landfill	--	--	--	--
Subtotal	200	65.9	199	65.5
Total	304	100.0	304	100.0

[a] *Parking included in associated use.*

Source: SEWRPC.

urban uses. Residential lands uses occupied almost all of the shorelands of Silver Lake with the exception of small, undeveloped wetlands areas located along the southern, western and northern shorelands. Woodlands and wetlands, and some largely fallow agricultural lands, occupied a significant proportion of the lands within the watershed, as shown on Map 5. Residential land uses encompassed about 88 acres, or about 85 percent of the area in urban use. About 200 acres, or about 65 percent of the drainage area, were devoted to rural land uses, with approximately seven acres, or about 2 percent of the rural area, being in agricultural and other open land uses. Woodlands, wetlands, and surface waters, including the surface area of Silver Lake, as shown on Map 6, accounted for approximately 194 acres, or about 97 percent of the rural land uses.

Under planned 2020 conditions, the distribution of land uses within the drainage area tributary to Silver Lake is envisioned to remain essentially unchanged relative to year 2000 conditions, as shown on Map 7.[4] Limited infilling of existing platted lots and redevelopment of existing residential lands within the drainage area tributary to the Lake is likely to occur.

GROUNDWATER RESOURCES

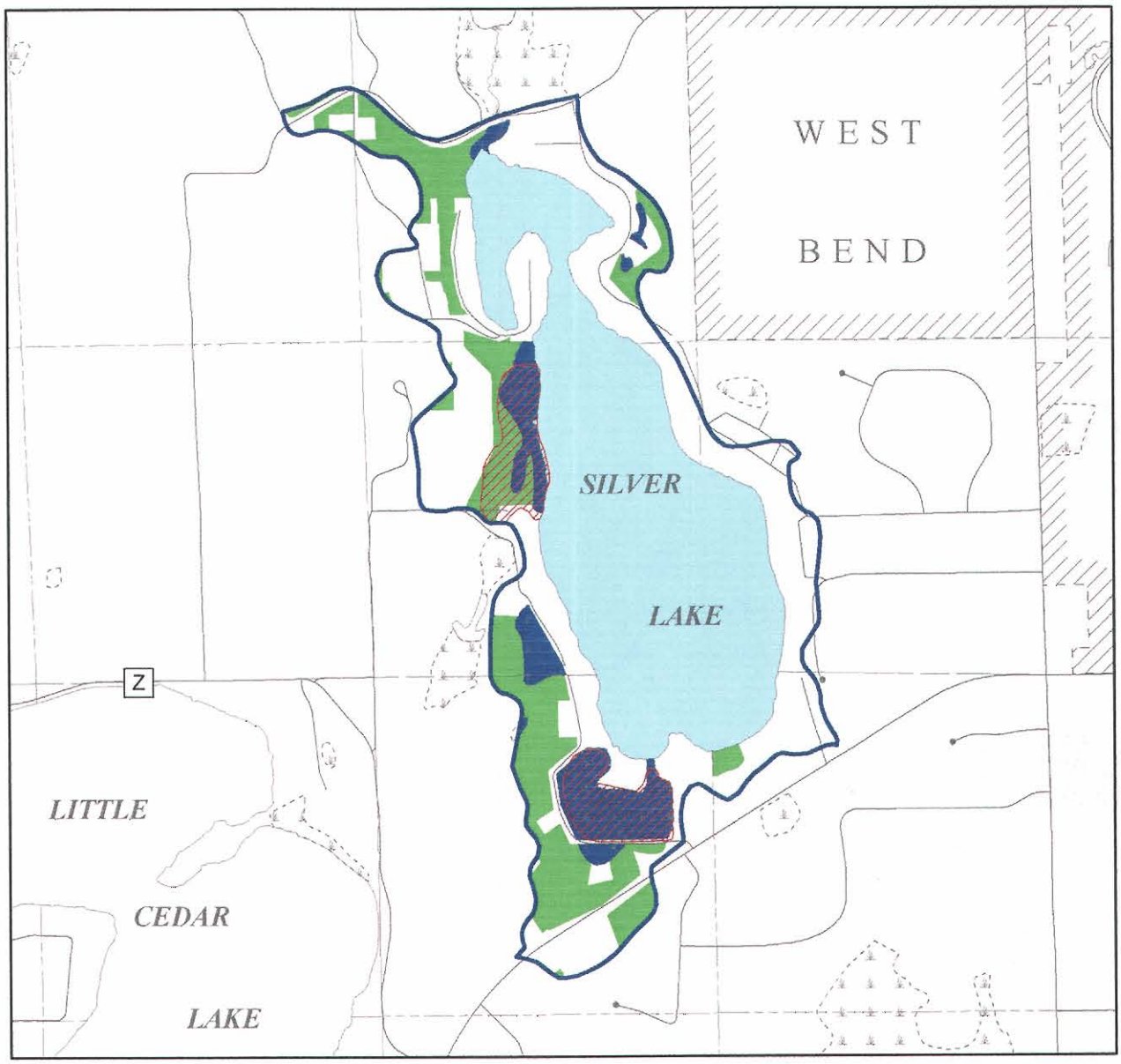
Groundwater resources constitute a valuable element of the natural resource base related to Silver Lake. Groundwater, in the vicinity of the Lake, moves within two distinct systems: a shallow water table system,[5] and a

[4] *SEWRPC Planning Report No. 40,* A Regional Land Use Plan for Southeastern Wisconsin: 2010, *January 1992.*

[5] *The water table is the upper limit of the portion of the ground that is fully saturated with water.*

Map 6

EXISTING WETLANDS, WOODLANDS, AND SURFACE WATERS
WITHIN THE DRAINAGE AREA TRIBUTARY TO SILVER LAKE



Wetlands
Woodlands
Surface Water
Critical Species Habitat

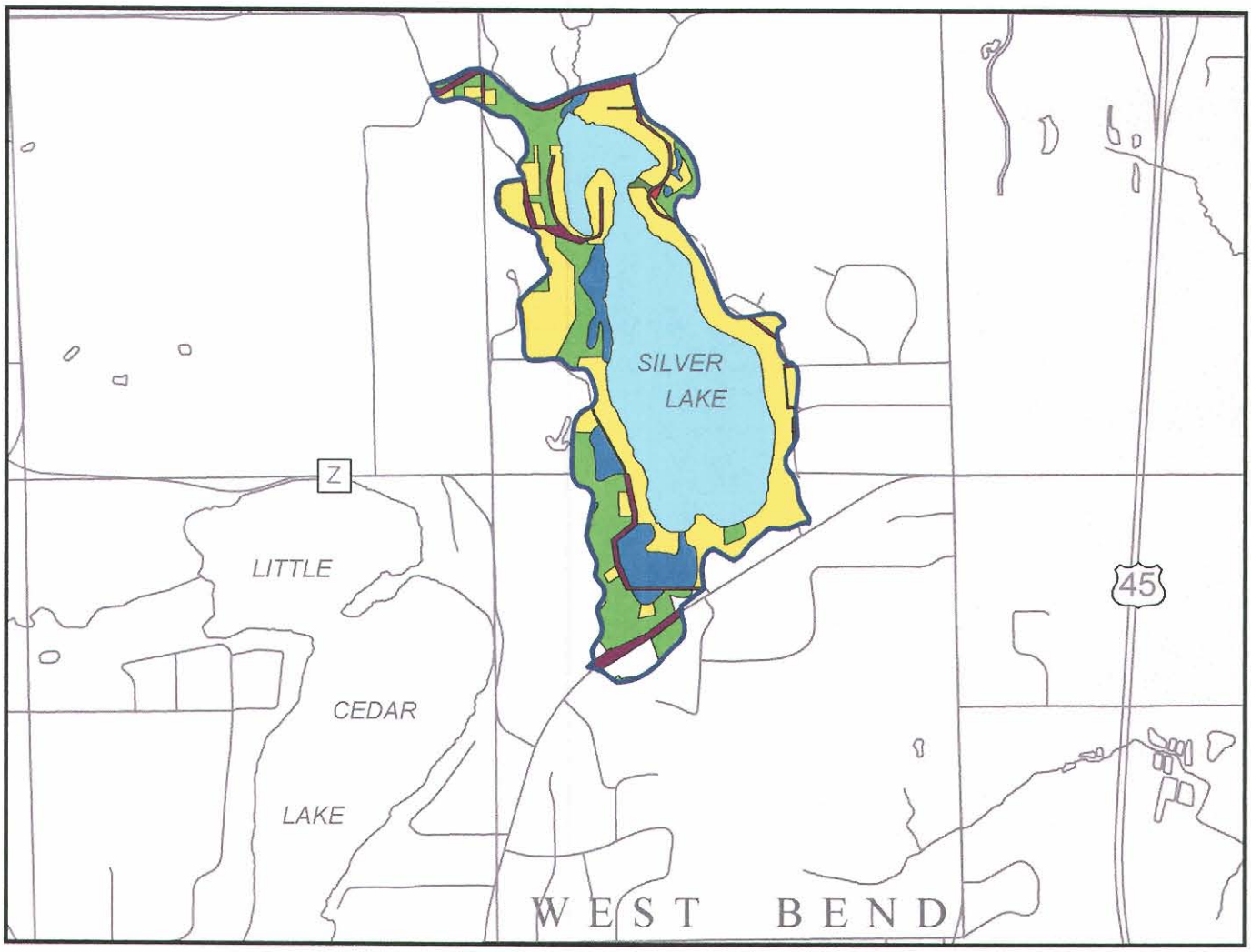
Source: SEWRPC.

N

0 1,000 2,000 3,000
Feet

Map 7

PLANNED LAND USES WITHIN THE DRAINAGE AREA TRIBUTARY TO SILVER LAKE: 2020



SINGLE FAMILY RESIDENTIAL
COMMERCIAL
TRANSPORTATION, COMMUNICATION, AND UTILITIES
RECREATIONAL
WOODLAND
WETLAND
AGRICULTURE AND OTHER OPEN SPACE
SURFACE WATER

N

GRAPHIC SCALE
0 1,000 2,000 3,000 Feet

Source: SEWRPC.

deep sandstone aquifer system.[6] From the land surface downward, the glacial drift aquifer, consisting of water-bearing sand and gravel, extends to almost 200 feet in thickness, in the vicinity of Silver Lake. Next, the dolomite aquifer thickness ranges from 100 to 200 feet in thickness. In contrast, the deep sandstone aquifer ranges from 300 to 400 feet in thickness.

The surfacial, glacial drift aquifer is the most significant groundwater resource in terms of its relationship to Silver Lake and its tributary surface waters and adjacent wetlands. The deep sandstone aquifer is virtually isolated from the surfacial aquifer, in the vicinity of Silver Lake, as a consequence of the relatively impermeable layer of Maquoketa shale situated between the two aquifer systems. Groundwater flows from northwest to southeast through the Lake within the surfacial aquifer, as shown on Map 8.[7]

Because groundwater in southeastern Wisconsin may contain significant concentrations of dissolved minerals and nitrogen (particularly nitrate), such flows may have consequences for the trophic condition of Silver Lake. In part, the magnitude of the concentrations of minerals and nutrients transported by the groundwater system is related to the extent and types of land uses within the recharge area or groundwatershed of the Lake. These land uses also affect the rate of recharge to the aquifer, and, hence, the volumes of the dissolved constituents transported by the groundwater inflows.

The U.S. Geological Survey noted that Silver Lake lies within a basin formed by undifferentiated deposits of sand and gravel laid down during the Pleistocene glaciation about 14,000 years ago. Remnant ice blocks left behind as the glacier retreated formed the depressions and provided the initial water that created the present day Lake. Silver Lake drains through a defined surface channel, Silver Creek, to the north, draining to Paradise Lake and Lucas Lake before discharging to the Milwaukee River in the vicinity of the City of West Bend. Inflow to the Lake is primarily from a system of springs located on the western shore of the Lake. With respect to the groundwatershed, Silver Lake lies downgradient from both Big Cedar Lake and Little Cedar Lake, and it is considered likely that groundwater flows from these waterbodies eastward into the western portion of the Silver lake basin. It also is considered likely that Silver Lake intercepts groundwater from within the surfacial aquifer and discharges this water to Silver Creek; groundwater discharge through the eastern portion of the Silver lake basin is likely to form a further, but minor, outflow from the Lake.

Assuming no change in lake stage, the U.S. Geological Survey estimated that groundwater inflow to the Lake was approximately 1.08 cubic feet per second (cfs). Net precipitation, or the direct precipitation onto the lake surface less evaporative losses, added a further 0.04 cfs of inflow. This was balanced by surface outflows of approximately 1.04 cfs, and groundwater outflows of about 0.08 cfs. These conditions reflect the long-term, steady-state water budget of the Lake. During the 1970s, previous studies of the Lake's hydrologic budget by CDM/Limnetics suggested that groundwater entered the Lake from the primary spring complex at a nearly constant rate of about 0.1 cfs. Additional inflows were unquantified, but included direct groundwater flow into the Lake as well as direct deposition of precipitation onto the lake surface. Outflows were estimated by CDM/Limnetics to be between 0.7 cfs and 5.2 cfs, or essentially similar to the flows reported by the U.S. Geological Survey. Lake stage variations were minimal, with fluctuations of about 0.25 feet being reported by CDM/Limnetics.

In short, Silver Lake acts to intercept groundwater flowing eastward from the Cedar Lakes, converting a majority of the groundwater flow to surface discharge. Groundwater captured by Silver Lake then leaves Silver Lake as

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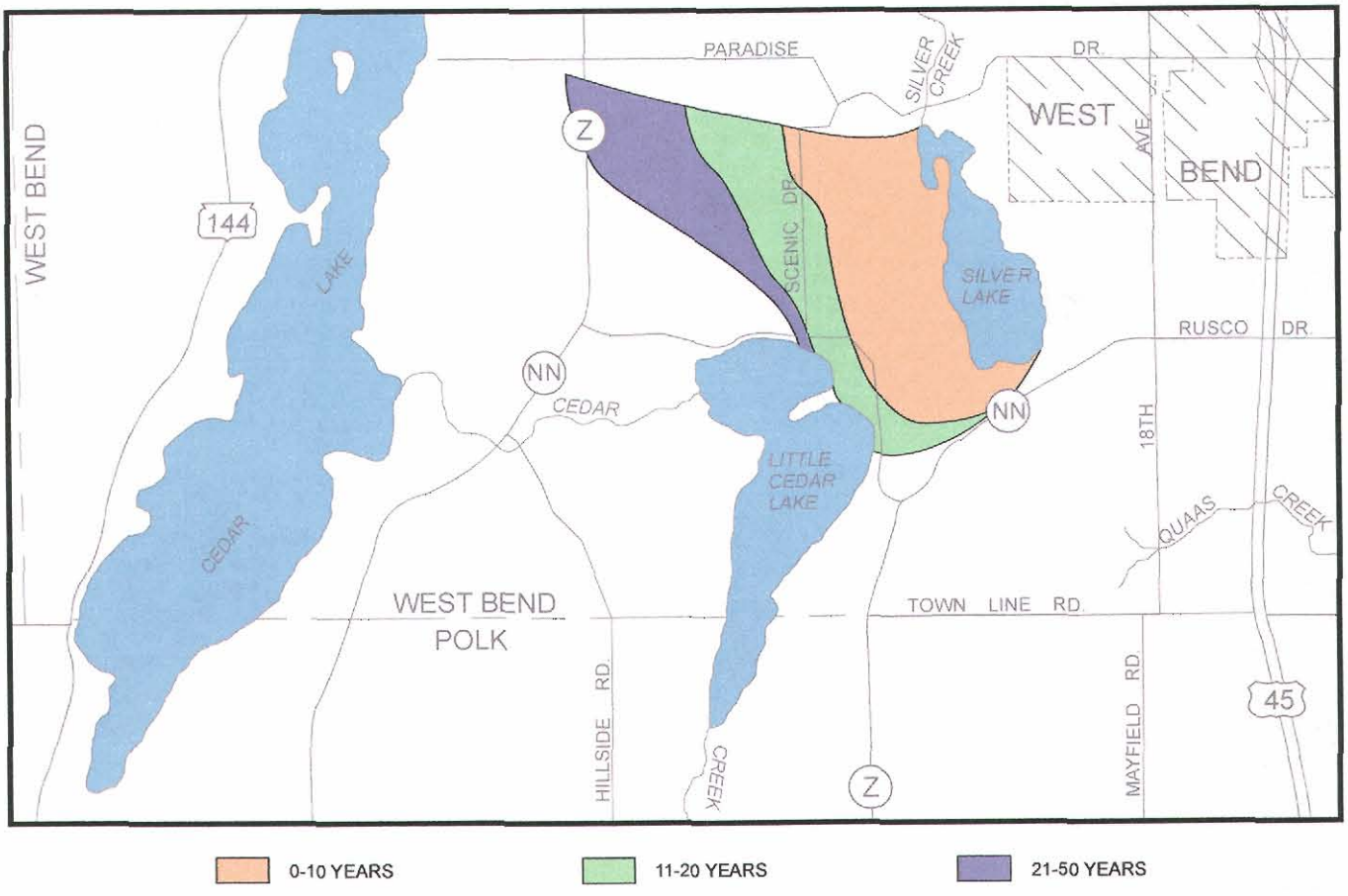
[6] *An aquifer is a water-bearing stratum of rock, sand, or gravel.*

[7] *E.L. Skinner and R.G. Borman, U.S. Geological Survey Hydrologic Investigations Atlas No. HA-432,* Water Resources of Wisconsin—Lake Michigan Basin, *1973; see also C.P. Dunning, J.C. Thomas, and Y.-F. Lin, U.S. Geological Survey Water-Resources Investigations Report 02-4204,* Simulation of the Shallow Aquifer in the Vicinity of Silver Lake, Washington County, Wisconsin, Using Analytic Elements, *2003.*

Map 8

GROUNDWATER RECHARGE AREAS AND TIME OF TRAVEL TO SILVER LAKE, WASHINGTON COUNTY, WISCONSIN



Source: U.S. Geological Survey.

surface outflow through Silver Creek. This outflow continues through Hackbarth or Little Silver Lake and through Lucas Lake, ultimately reaching the Milwaukee River in the City of West Bend.

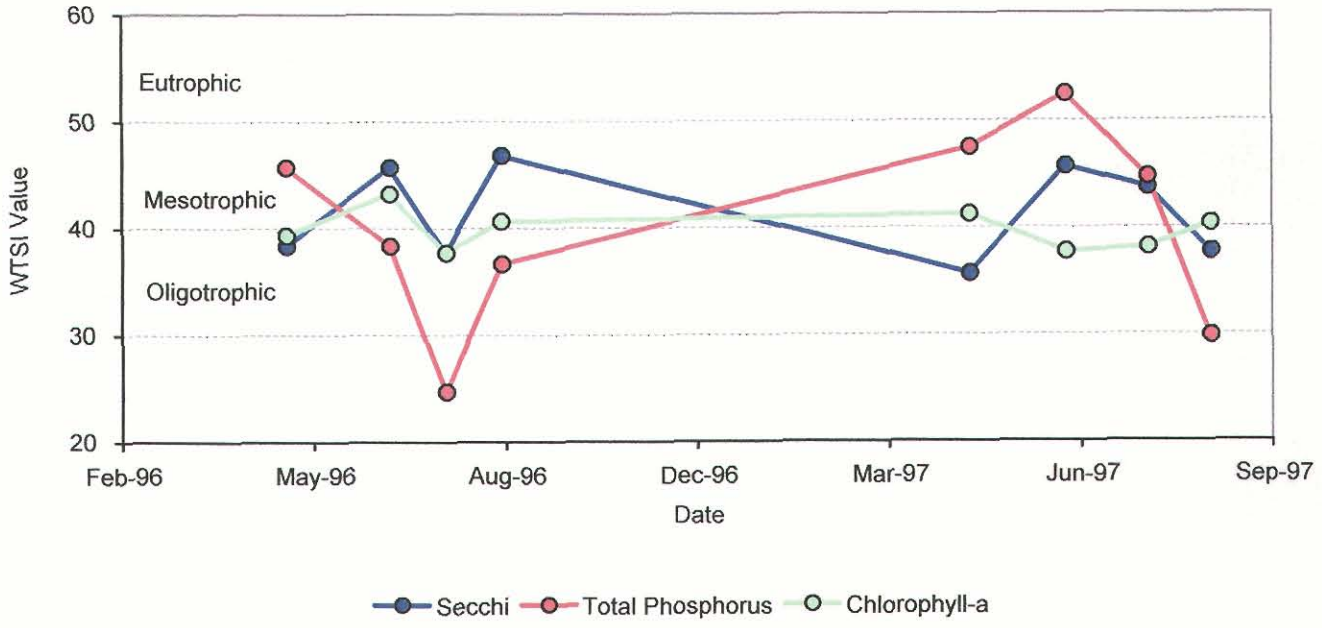
WATER QUALITY

Few water quality data are available on Silver Lake. As shown in Figure 1, Secchi-disc transparency measurements obtained by the U.S. Geological Survey during 1996 and 1997 indicated Silver Lake had good to very good water quality.[8] As shown in Figure 1, Silver Lake had a Wisconsin Trophic State Index (WTSI) value of about 45, based on total phosphorus data collected during 1996 and 1997, indicating that the lake was a mesotrophic waterbody. Chlorophyll-*a* data for 1996 and 1997, as shown in Figure 1, also supported the classification of the Lake as a mesotrophic waterbody. Mesotrophic lakes are moderately fertile lakes that support abundant aquatic plant growths and may support productive fisheries. Nuisance growths of algae and plants

[8] *U.S. Geological Survey Open-File Report 97-123,* Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 1996, *1997; U.S. Geological Survey Open-File Report 98-78,* Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 1997, *1998.*

Figure 1

WISCONSIN TROPHIC STATE INDEX (WTSI) VALUES FOR SILVER LAKE: 1996-1997



Source: U.S. Geological Survey and SEWRPC.

usually are not exhibited by mesotrophic lakes. Many of the cleaner lakes in Southeastern Wisconsin are classified as mesotrophic.[9]

Water quality data acquired by the U.S. Geological Survey during 1996 and 1997 form the most complete characterization of the Lake water quality available. Data for 1996 were reported in the initial study; both 1996 and 1997 data are presented in Table 3. The reported total phosphorus concentration in Silver Lake, during 1997, ranged from approximately five to 24 micrograms per liter (µg/l) near the surface to about 60 to 100 µg/l near the bottom of the Lake. The surface water total phosphorus concentrations generally do not exceed the 20 µg/l surface water total phosphorus concentration guideline recommended by the Regional Planning Commission as the value above which water quality problems are likely to occur. These values are similar to those reported by the U.S. Geological Survey during 1976 and cited in the adopted lake protection plan.

Silver Lake stratifies during the summer and winter months, as is typical of most lakes in the Region, leading to the formation of the other chemical gradients, including a gradient in total phosphorus concentration. Total nitrogen concentrations reported during these studies ranged from about 0.80 milligrams per liter (mg/l) near the surface to 0.89 mg/l near the bottom. Aquatic plants and algae require such nutrients as phosphorus and nitrogen for growth. 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. Where the N:P ratio is greater than

[9] *R.A Lillie, and J.W. Mason,* op. cit.

Table 3

SILVER LAKE WATER QUALITY DATA: 1996 AND 1997

Parameter	1996									
	February 14		May 1		June 24		July 23		August 21	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample (m)	0.5	13	0.5	13	0.5	13	0.5	13	0.5	14
Specific Conductance (µS/cm)	523	583	507	508	463	546	451	566	442	579
pH	8.2	7.6	8.2	7.9	8.5	7.6	8.4	7.4	8.2	7.4
Water Temperature (°C)	2.5	4.0	9.0	7.0	21.0	8.5	23.5	8.5	24.5	9.0
Turbidity (NTU)	--	--	0.50	0.60	--	--	--	--	--	--
Secchi Depth (m)	--	--	4.5	--	2.7	--	4.7	--	2.5	--
Dissolved Oxygen	11.6	1.0	10.8	8.4	10.1	0.3	9.5	0.2	9.0	0.2
Hardness, as $CaCO_3$	--	--	250	260	--	--	--	--	--	--
Calcium, Dissolved	--	--	44	44	--	--	--	--	--	--
Magnesium, Dissolved	--	--	35	36	--	--	--	--	--	--
Sodium, Dissolved	--	--	8.5	8.5	--	--	--	--	--	--
Potassium, Dissolved	--	--	1	1	--	--	--	--	--	--
Alkalinity, as $CaCO_3$	--	--	240	240	--	--	--	--	--	--
Sulfate, Dissolved SO_4	--	--	20	21	--	--	--	--	--	--
Chloride, Dissolved	--	--	19	19	--	--	--	--	--	--
Fluoride, Dissolved	--	--	0.1	0.1	--	--	--	--	--	--
Silica, Dissolved	--	--	12	13	--	--	--	--	--	--
Solids, Dissolved at 180°	--	--	296	294	--	--	--	--	--	--
Nitrogen, $NO_2 + NO_3$	--	--	0.11	0.11	--	--	--	--	--	--
Nitrogen, Ammonia	--	--	0.32	0.43	--	--	--	--	--	--
Nitrogen, Organic Total	--	--	0.48	0.47	--	--	--	--	--	--
Total Phosphorus	--	--	0.015	0.015	0.009	0.046	<0.007	0.072	0.008	0.065
Ortho-Phosphorus	--	--	<0.002	<0.002	--	--	--	--	--	--
Iron, Dissolved (µg/l)	--	--	<10	<10	--	--	--	--	--	--
Manganese, Dissolved (µg/l)	--	--	<0.4	2.0	--	--	--	--	--	--
Chlorophyll-a (µg/l)	--	--	--	--	3.5	--	1.7	--	2.5	--

Table 3 (continued)

Parameter	1997									
	February 13		April 22		June 11		July 24		August 26	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample (m)	0.5	13	0.5	13	0.5	13	0.5	13	0.5	14
Specific Conductance (µS/cm)	511	582	527	526	508	537	472	547	480	598
pH	8.2	7.6	8.2	8.2	8.2	7.5	8.1	7.5	8.2	7.3
Water Temperature (°C)	2.5	4.0	8.0	6.0	22.0	7.0	26.0	7.5	20.5	8.0
Turbidity (NTU)	--	--	0.50	<0.50	--	--	--	--	--	--
Secchi Depth (m)	--	--	--	5.4	--	2.7	--	3.1	--	4.7
Dissolved Oxygen	11.4	0.9	12.4	11.2	10.6	0.1	8.7	0.0	9.6	0.0
Hardness, as $CaCO_3$	--	--	260	250	--	--	--	--	--	--
Calcium, Dissolved	--	--	46	44	--	--	--	--	--	--
Magnesium, Dissolved	--	--	36	35	--	--	--	--	--	--
Sodium, Dissolved	--	--	8.9	8.8	--	--	--	--	--	--
Potassium, Dissolved	--	--	1	1	--	--	--	--	--	--
Alkalinity, as $CaCO_3$	--	--	240	240	--	--	--	--	--	--
Sulfate, Dissolved SO_4	--	--	22	21	--	--	--	--	--	--
Chloride, Dissolved	--	--	19	19	--	--	--	--	--	--
Silica, Dissolved	--	--	13	13	--	--	--	--	--	--
Solids, Dissolved at 180°	--	--	298	294	--	--	--	--	--	--
Nitrogen, $NO_2 + NO_3$	--	--	0.19	0.19	--	--	--	--	--	--
Nitrogen, Ammonia	--	--	0.22	0.25	--	--	--	--	--	--
Nitrogen, Amm. + Org. Total	--	--	0.60	0.70	--	--	--	--	--	--
Nitrogen, Total (as N)	--	--	0.80	0.89	--	--	--	--	--	--
Total Phosphorus	<0.007	0.060	0.017	<0.008	0.024	0.102	0.014	0.094	0.005	0.083
Ortho-Phosphorus	--	--	0.002	0.002	--	--	--	--	--	--
Iron, Dissolved (µg/l)	--	--	<10	<10	--	--	--	--	--	--
Manganese, Dissolved (µg/l)	--	--	<0.4	<0.4	--	--	--	--	--	--
Chlorophyll-a (µg/l)	--	--	2.7	--	1.7	--	1.8	--	2.4	--

NOTE: Unless otherwise indicated, units are mg/l.

Source: U.S. Geological Survey and SEWRPC.

14:1, phosphorus is most likely to be the limiting nutrient. If the ratio is less than 10:1, nitrogen is most likely to be the limiting nutrient. The nitrogen-to-phosphorus concentration ratio in Silver Lake, observed during the 1996 through 1997 sampling period, was 40:1, suggesting that algal growth in the Lake is limited by phosphorus.

Silver Lake exhibits both thermal and dissolved oxygen stratification. Figure 2 shows dissolved oxygen and temperature profiles. These data are typical of lakes in the temperate zone, with the depletion of dissolved oxygen in the hypolimnion or bottom waters of lakes being common in mesotrophic and eutrophic waterbodies.[10] Associated with these periods of hypolimnetic anoxia is the phenomenon of internal loading occurring within the Lake. Internal loading is the result of the release of phosphorus and other elements from the lake sediments as a result of changes in oxidation state of the multivalent cations such as iron, calcium, and aluminum which releases previously bound elements back into the water column.[11] The impact of this internal loading on lake trophic state is related to the rate at which the Lake mixes from top to bottom during the spring and fall overturn events. In spring and fall, differential warming and cooling of the lake surface waters, respectively, alters the density of the lake waters in such a manner as to promote the mixing of lake water. When the mixing process is relatively slow, on the order of days to weeks, minerals and nutrients released from the lake sediments into the hypolimnion of the lake tend to recombine with the multivalent cations in the lake sediments and precipitate out of the water column. Conversely, if the mixing process is relatively rapid, on the order of hours or days, as may occur due to the passage of an intense storm, the minerals and nutrients may be mixed upward into the epilimnion or surface waters where they are available for plant growth.

POLLUTANT LOADINGS

Pollutant loads to a lake are generated by various natural processes and human activities that take place within the drainage area tributary to the lake. These contaminant 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 by direct precipitation. Pollutants transported across the land surface enter the lake as direct runoff and, indirectly, as groundwater inflows.

Nonpoint Sourced Pollutant Loadings

In Silver Lake, pollutants enter the waterbody in runoff from across the land surface directly tributary to the lake and from the shallow groundwater aquifer. These pollutant sources are generally described as nonpoint-sourced pollution. As of the year 2000, most of the residential lands within the tributary drainage area and all of the riparian residential lands are served by public sanitary sewerage systems.[12] There were no known direct discharges, or point sources, of water pollutants within the Silver Lake tributary drainage area. For these reasons, the discussion that follows is based wholly upon the nonpoint source pollutant loadings to Silver Lake, and upon land usage only within the drainage area directly tributary to Silver Lake.

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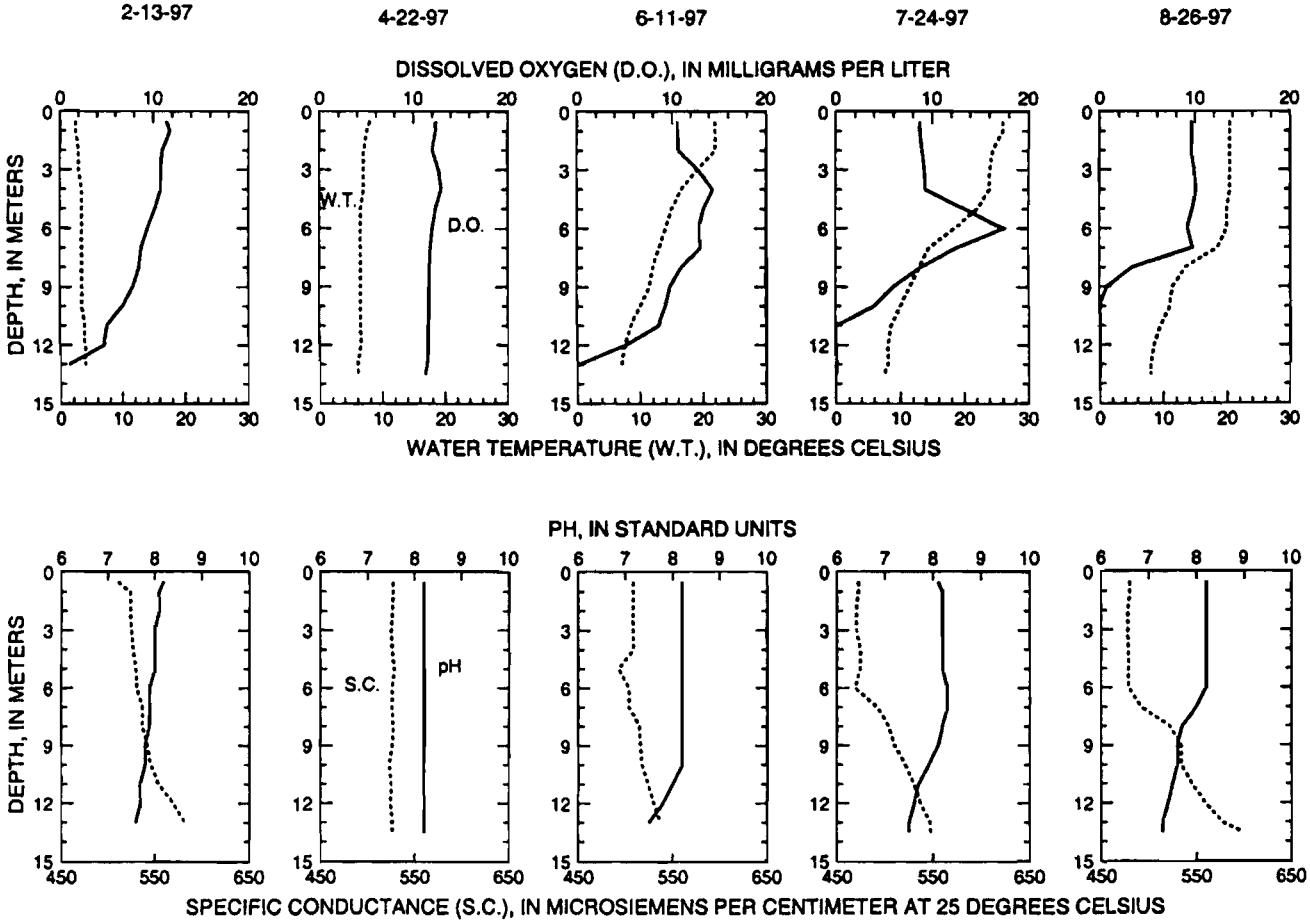
[10] *R.G. Wetzel,* Limnology, *Saunders, Philadelphia, 1975.*

[11] *Werner Stumm and James J. Morgan,* op. cit.

[12] *SEWRPC Memorandum Report No. 93,* op. cit.; *and SEWRPC Community Assistance Planning Report No. 35, 2nd Edition,* Sanitary Sewer Service Area for the City of West Bend and Environs, Washington County, Wisconsin, *June 1998, as amended.*

Figure 2

DISSOLVED OXYGEN AND TEMPERATURE PROFILES FOR SILVER LAKE: 1997



Source: U.S. Geological Survey and SEWRPC.

The nonpoint source pollutant loads to Silver Lake were estimated on the basis of 2000 direct drainage area land use inventory data and unit area load coefficients determined for the Southeastern Wisconsin Region.[13] Annual contaminant loads entering Silver Lake were calculated to be approximately 5,200 pounds of sediment, 45 pounds of phosphorus, a negligible amount of copper, and about two pounds of zinc, as shown in Table 4. Minor changes in land use between 1995 and 2000, did not significantly change these estimated contaminant loads.

Under planned year 2020 conditions within the drainage area directly tributary to the Lake, it is estimated that about 4,800 pounds of sediment, about 34 pounds of phosphorus, a negligible amount of copper, and about two

[13] *Phosphorus loads were calculated using the Wisconsin Lake Modeling Suite, WILMS version 3.0. Phosphorus loads from the drainage area directly tributary to Silver Lake were estimated to range from about 115 pounds per year to 350 pounds per year; under forecast year 2020 land use conditions, phosphorus loads were estimated to range from about 85 pounds per year to 300 pounds per year.*

Table 4

FORECAST ANNUAL POLLUTANT LOADINGS TO SILVER LAKE BY LAND USE CATEGORY: 2000 AND 2020

Land Use	2000					2020				
	Area (acres)	Sediment (pounds)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)	Area (acres)	Sediment (pounds)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban										
Residential	88	1,716	18	0.00	1.06	89	1,736	18	0.00	1.07
Commercial	<1	196	0	0.06	0.37	<1	196	0	0.06	0.37
Transportation, Communications and Utilities	15	293	3	0.00	0.18	15	293	3	0.00	0.18
Recreational	1	24	<1	0.00	0.00	1	24	<1	0.00	0.00
Subtotal	104	2,229	21	0.06	1.61	105	2,248	21	0.06	1.62
Rural										
Water	125	12	16	0.00	0.00	125	12	5	0.00	0.00
Wetlands	22	81	1	0.00	0.00	22	81	1	0.00	0.00
Woodlands	47	174	2	0.00	0.00	47	174	2	0.00	0.00
Agricultural and Other Open Lands	6	2,700	5	0.00	0.00	5	2,250	4	0.00	0.00
Subtotal	200	2,967	24	0.00	0.00	199	2,517	12	0.00	0.00
Total	304	5,196	45	0.06	1.61	304	4,765	34	0.06	1.62

Source: SEWRPC.

pounds of zinc are estimated to be contributed to Silver Lake. Recent evidence provided by the U.S. Geological Survey from the Lauderdale Lake in Walworth County, suggest that phosphorus loads from urban lawns receiving fertilization treatments may be up to two times greater than lawns not treated with chemical additives.[14]

Table 4 shows the relative potential contributions of the various land uses to the pollutant loads to Silver Lake. These data indicate that, based on 2000 land use conditions in the drainage area tributary to Silver Lake, about 35 percent of the phosphorus load to the Lake is contributed by atmospheric deposition onto the Lake; about 11 percent is from agricultural lands and other rural open lands within the tributary drainage area; about 47 percent from urban areas; and, the balance from wetlands and woodlands. Under planned year 2020 conditions, these contributions are expected to remain essentially the same.

Under 2000 land use conditions, about 47 percent of the sediment load to Silver Lake is estimated to be generated from urban sources; about 47 percent from agricultural lands and other rural open lands; and about 6 percent from woodlands, wetlands, and direct deposition onto surface waters, as set forth in Table 4. As in the case of phosphorus, this distribution of source areas is expected to remain essentially unchanged under year 2020 conditions.

Control of contaminants from both urban and rural sources, therefore, is proposed to be effected through the variety of measures set forth in Chapter IV.

Groundwater Inputs of Calcium Carbonate

Based upon the estimated groundwater inflows to Silver Lake, the U.S. Geological Survey forecast solute fluxes toward Silver Lake. Based upon data obtained by CDM/Limnetics and set forth in the aforereferenced Water-Resources Investigations Report, the U.S. Geological Survey calculated that, based upon the average groundwater inflow rate of 1.08 cfs, about 21 pounds of nitrogen, 72 pounds of chloride, and 0.1 pound of phosphorus were

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

transported daily into Silver Lake. In terms of the estimated phosphorus loads of 45 and 34 pounds per year in years 2000 and 2020, respectively, this rate of loading, through the groundwater system, may be considered negligible.

Notwithstanding, these estimates provide limited insight into the rate at which calcium carbonate is being transported into Silver Lake through the groundwater system. In order to address the issue of marl deposition within the Lake, and to partially quantify the rate of deposition of marl within the lake basin, the sedimentation issue that was identified as an issue of concern to the electors of the Silver Lake Protection and Rehabilitation District, the Regional Planning Commission staff applied a similar analysis to that described above. Based upon calcium carbonate concentrations reported by CDM/Limnetics and groundwater flow rates reported by the U.S. Geological Survey, Commission staff computed a calcium carbonate loading to the Lake.

In-lake calcium carbonate concentrations reported by CDM/Limnetics ranged from about 193 mg/l $CaCO_3$ to about 293 mg/l, with an average in-lake concentration of 230 mg/l. Specific conductance during this same period ranged from about 250 micro-Siemens per centimeter (µS/cm) to 520 µS/cm, with an average conductivity of about 390 µS/cm. Groundwater conductivity values during this study ranged from about 140 µS/cm to about 1,650 µS/cm, with an average value of about 460 µS/cm. Assuming that these values are essentially similar and that the observed conductivity values reflect approximately similar ionic compositions in both surface and ground waters, the estimated groundwater-borne transport of carbonate into Silver Lake can be estimated using the same geohydrological data as in the case of the contaminants analyzed by the U.S. Geological Survey. Thus, the estimated daily flux of calcium carbonate into Silver Lake becomes approximately 1,350 pounds per day. Assuming that this mass is distributed evenly across the lakebed, or over some approximately 118 acres (= 5.1 million ft^2) in areal extent, with a density of between approximately 40 pounds per cubic foot, dry weight (lb/ft^3) and 80 lb/ft^3, the approximate annual accumulation of calcium carbonate on the lakebed would be between about 0.03 and 0.01 inches per year.

While this is a negligible loss of lake depth, it could be argued that the deposition does not occur across the entire surface area of the lake but, rather, is concentrated in the southern and western portions of the Lake, thus reducing the area of deposition to that portion of the Lake along the western shoreline. Assuming this to be the case, and that deposition occurs in the shoreland area or in waters with a depth of less than 3 feet, it may be assumed that the effective area of deposition is reduced to about seven acres (= 0.3 million ft^2). Under these conditions, the depositional depth approaches between about 0.50 inches per year and 0.25 inches per year. While this suggests a more substantial rate of deposition, the accumulation of several inches of "muck" along the western and southern shores would represent several decades or more of deposition. Nevertheless, this could potentially represent a noticeable accumulation during a typical period of residence on the Lake.

It should be noted, too, that marl deposition is not the sole contributor to sedimentation in Silver Lake; disposal of yard waste and leaf litter as well as natural leaf falls into the near shore area also contribute to the accumulation of organic and inorganic materials within this littoral zone, as does runoff from building sites and from the roadway system. The contributions from these sources are less well quantified as they are more site and practice specific.

SOIL TYPES AND CONDITIONS

In addition to land uses, as described above, soil type, land slope, and land management practices are among the more important factors determining lake and groundwater quality conditions. Soil type, land slope, and vegetative cover are also important factors affecting the rates, amounts, and quality of stormwater runoff and infiltration of precipitation to the groundwater (recharge). The soil texture and soil particle structure influence the permeability, infiltration rate, and erodibility of soils, while land slopes are important determinants of stormwater runoff rates and of susceptibility to erosion.

The U.S. Natural Resources Conservation Service, under contract to the Southeastern Wisconsin Regional Planning Commission, completed a detailed soil survey of the Silver Lake area in 1966.[15] Using the regional soil survey, an assessment was made of the hydrologic characteristics of the soils in the drainage area tributary to the Silver Lake. Soils within the drainage area tributary to Silver Lake were categorized into four main hydrologic soil groups, as shown in Table 5. Approximately 2 percent of the total tributary drainage area was covered with well-drained soils, 45 percent with moderately well-drained soils, and 12 percent with very poorly drained soils. The remaining areas of the watershed were comprised of surface water, as shown on Map 9.

AQUATIC PLANTS, DISTRIBUTION, AND MANAGEMENT AREAS

Aquatic Plant Community Composition

Illustrations of the common aquatic plants found in Silver Lake are included in Appendix A. While the aquatic plant community of the Lake includes both microscopic, floating or attached plants called algae or phytoplankton, and macroscopic, rooted plants called macrophytes, only the latter were quantified during the earlier study; during the current reconnaissance, quantification was not a primary focus. Rooted submersed and emergent aquatic macrophytes most commonly are associated with recreational use and aesthetic concerns in Wisconsin lakes. No significant algal problems have been reported from Silver Lake.

A survey of aquatic plants within Silver Lake was conducted by Commission staff during 1995 as reported in the initial study. The results of that survey are presented in Table 6. Of the macroscopic submergent aquatic plants, 10 species were observed in Silver Lake. The Lake had good floral diversity, especially in the eastern portions of the lake basin and along the western wetlands. During the 1995 survey, muskgrass, *Chara vulgaris*, was reported to be abundant and widespread throughout the Lake. This was considered a positive sign since muskgrass is a low-growing plant which acts to stabilize bottom sediments and poses little or no recreational problems. Eurasian water milfoil, *Myriophyllum spicatum*, was also reported as present in the Lake, but not widespread.

Pursuant to a verbal request from the Silver Lake Protection and Rehabilitation District on July 21, 2000, Commission staff conducted a subsequent aquatic plant reconnaissance of Silver Lake utilizing previously identified transects employed during the earlier survey. The results of that reconnaissance were transmitted to the Silver Lake Protection and Rehabilitation District by SEWRPC staff memorandum dated August 15, 2000. As shown on Map 10, in general, the aquatic plant communities observed in the Lake during the latter reconnaissance were similar in composition to those observed during the 1997 planning program. The same species, including various species of pondweed, muskgrass, and white water lily, were observed along the transects previously sampled. Growths of Eurasian water milfoil, *Myriophyllum spicatum*, which previously were observed in the Lake and specifically targeted for management purposes, were also observed. At virtually every location where this latter plant was observed during the 1997 planning program, this invasive plant was observed to have increased in area and frequency of occurrence, and in density, indicating continued growth of this nuisance plant within the Lake.

The growths of Eurasian water milfoil were observed by the Commission staff to be most significant along the western shore of the Lake, adjacent to the wooded areas of the shoreline and especially in the vicinity of those areas of the Lake where shoreland springs discharge into the waterbody. In addition, growths were observed in the "Kettle," again indicating the likely increase in density and frequency of occurrence of the plant. The milfoil beds were generally located in deeper water areas, outside of the extensive beds of white water lilies that were located on the shoreline. Commission staff estimated that the milfoil plants were growing in water of about six to 12 feet in depth. All of the plants sampled by the Commission staff were heavily encrusted with marl, which may contribute to the plant's failure to "top out" at the lake surface as it characteristically does in Southeastern Wisconsin lakes.

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

Table 5

GENERAL HYDROLOGIC SOIL TYPES WITHIN THE DRAINAGE AREA TRIBUTARY TO SILVER LAKE

Group	Soil Characteristics	Direct Tributary Drainage Area (acres)	Percent of Total
A	Well drained; very rapidly to rapid permeability; low shrink-swell potential	7	2
B	Moderately well drained; texture intermediate between coarse and fine; moderately rapid to moderate permeability; low to moderate shrink-swell potential	138	45
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	--	--
D	Very poorly drained; high water table for most of the year; organic or clay soils; clay soils having high shrink-swell potential	36	12
Other	Group not determined	--	--
Water	--	124	41
--	Total	305	100

Source: SEWRPC.

Statistical Analysis

These indices were used to analyze the aquatic plant community species composition presented in Table 6:

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

- The relative density is the sum of the density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 5.0 is assigned to plants that occur at all points sampled at a given depth, the modified Jesson and Lound protocol adopted by the Wisconsin Department of Natural Resources uses four sampling points per depth sampled. The relative density presents an indication of how abundant the growth of a particular plant is throughout the lake. This measure along with the percent occurrence gives a good indication of the distribution of aquatic plant communities in a lake.

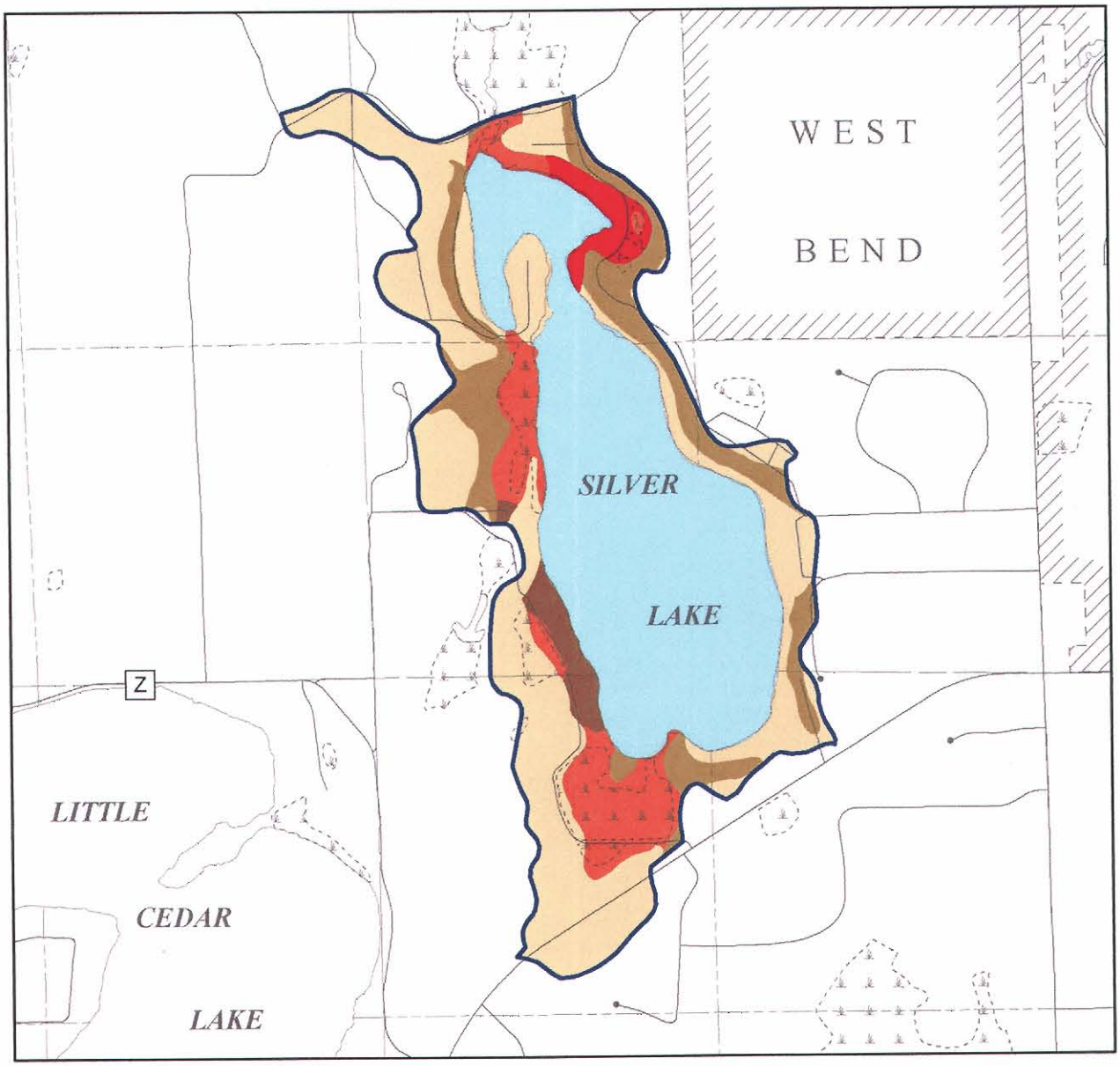
Nonnative Aquatic Plants

The occurrence of Eurasian water milfoil in Silver Lake is cause for concern. Eurasian water milfoil is an exotic species that is known to exhibit "explosive" growth under suitable conditions, such as in the presence of organic-rich sediments or where the lake bottom has been disturbed. It reproduces by the rooting of plant fragments, and has been known to cause severe recreational use problems in lakes in Southeastern Wisconsin. It often outcompetes the native aquatic vegetation in lakes in Southeastern Wisconsin, and, thereby, reduces biodiversity and degrades the quality of fish and wildlife habitats in the lakes.[16]

[16]*Wisconsin Department of Natural Resources,* Eurasian Water Milfoil in Wisconsin: A Report to the Legislature, *1993.*

Map 9

HYDROLOGIC SOIL GROUPS WITHIN THE DRAINAGE AREA TRIBUTARY TO SILVER LAKE



- GROUP A: Well-drained
- GROUP A/B: Well-drained soils/Moderately drained[1]
- GROUP A/D: Well-drained soil/Very poorly drained soil[2]
- GROUP B: Moderately drained soil
- GROUP B/D: Moderately drained soil/Very poorly drained soil[3]
- Surface Water

Source: U.S. Natural Resources Conservation Service and SEWRPC.

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

2 Well-drained soil if water table is lowered through provision of a drainage system. Very poorly drained soil if water table is not lowered.

3 Moderately-drained soil if water table is lowered through provision of a drainage system. Very poorly drained soil if water table is not lowered.

N

0 1,000 2,000 3,000

Feet

Table 6

FREQUENCY OF OCCURRENCE OF SUBMERGENT PLANT SPECIES IN SILVER LAKE: JUNE 1995

Common Name	Scientific Name	Frequency of Occurrence[a] (percent)	Relative Density[b]	Ecological Significance
Bladderwort	*Utricularia* spp.	30.3	0.44	Provides good food and cover for fish
Bushy Pondweed	*Najas flexilis*	0.5	0.02	Stems, foliage, and seeds important wildfowl food and produces good food and shelter for fish
Eel Grass	*Vallisneria americana*	19.7	0.42	Provides good shade and shelter, supports insects, and is valuable fish food
Elodea	*Elodea canadensis*	1.5	0.03	Provides shelter and support for insects which are valuable as fish food
Eurasian Water Milfoil	*Myriophyllum spicatum*	33.3	0.79	None known
Flat-Stem Pondweed	*Potamogeton zosteriformis*	10.6	0.26	Provides some food for ducks
Long-Leaf Pondweed	*Potamogeton americanus*	4.6	0.02	Offers shade, shelter and foraging for fish; valuable food for waterfowl
Muskgrass	*Chara* spp.	95.5	3.45	Excellent producer of fish food, especially for young trout, bluegills, small and largemouth bass, stabilizes bottom sediments, and has softening effect on the water by removing lime and carbon dioxide
Sago Pondweed	*Potamogeton pectinatus*	10.6	0.14	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish
Variable Pondweed	*Potamogeton gramineus*	12.1	0.21	Provides habitat for fish and food for waterfowl, muskrat, beaver and deer

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

[b]*The relative density is the sum of density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 5.0 is assigned to plants that occur at all four points sampled at a given depth and is an indication of how abundant a particular plant is throughout a lake.*

Source: SEWRPC.

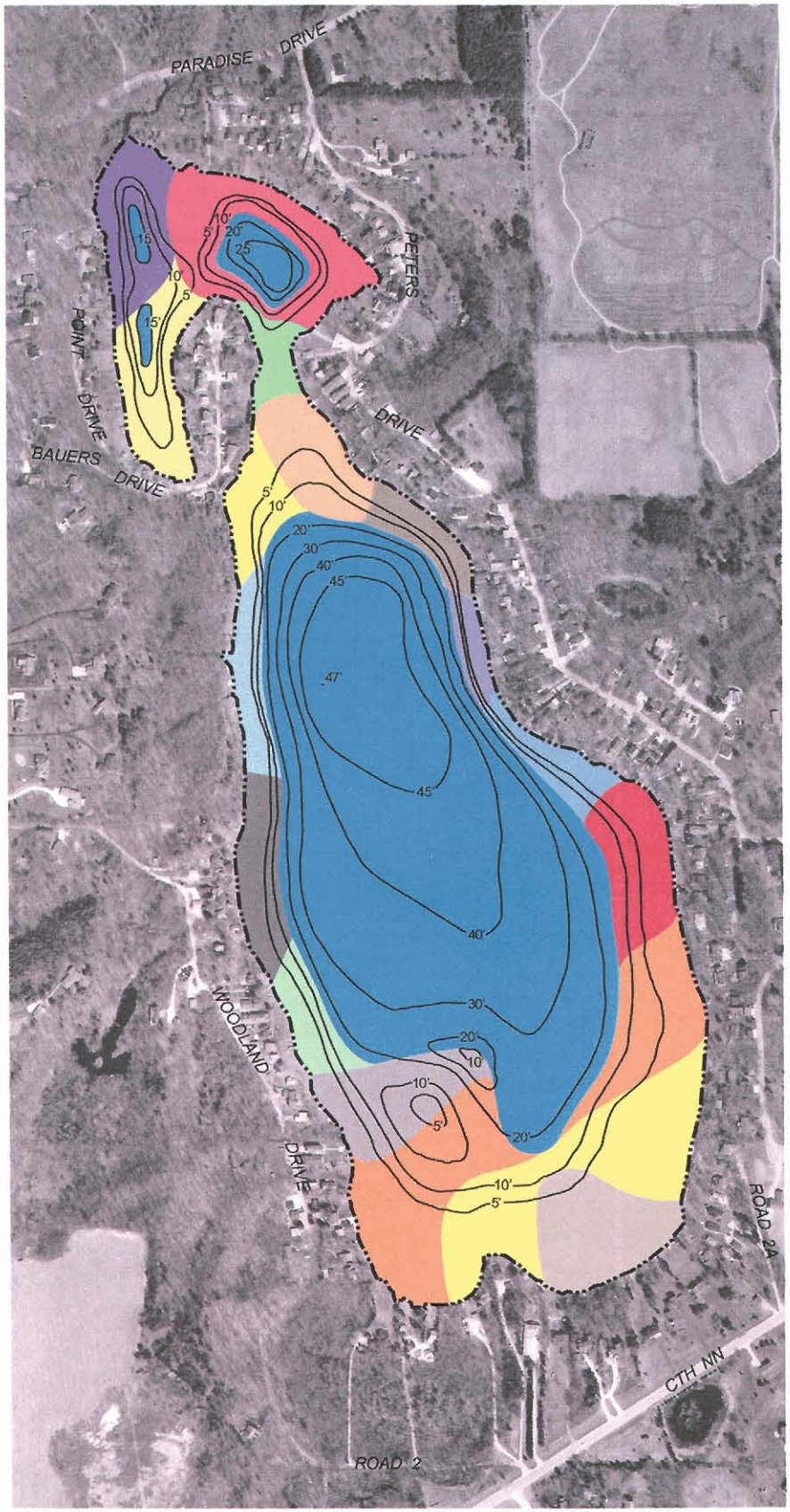
Purple loosestrife, *Lythrum salicaria*, another nonnative, nuisance plant, was also observed to be present in the wetlands and in riparian areas surrounding Silver Lake during the earlier report. Like Eurasian water milfoil, purple loosestrife is known to spread profusely, outcompeting native plant growth and reducing the quality of fish and wildlife habitat while adding little ecological benefit. Purple loosestrife is a declared weed in the State of Wisconsin and is subject to an ongoing eradication program.

Aquatic Plant Management

Although the use of chemicals to control aquatic plants has been regulated in Wisconsin since 1941, records of aquatic plant management efforts on Wisconsin lakes were not maintained by the WDNR prior to 1950. Thus, while previous interventions were likely, the first recorded efforts to manage the aquatic plants in Silver Lake have taken place since 1950. Aquatic plant management activities in Silver Lake can be categorized as chemical macrophyte and algal control. Currently, all forms of aquatic plant management are subject to permitting by the

Map 10

AQUATIC PLANT COMMUNITY DISTRIBUTION IN SILVER LAKE: 2000



—20'— WATER DEPTH CONTOUR IN FEET

DEPTH GREATER THAN 15 FEET

MUSKGRASS

MUSKGRASS AND BLADDERWORT

MUSKGRASS AND EEL GRASS

MUSKGRASS, WATERWEED, EURASIAN WATER MILFOIL, VARIABLE PONDWEED, BLADDERWORT, AND EEL GRASS

MUSKGRASS, EURASIAN WATER MILFOIL, BUSHY PONDWEED, VARIABLE PONDWEED, SAGO PONDWEED, BLADDERWORT, AND EEL GRASS

MUSKGRASS, COONTAIL, WATER STAR GRASS, EURASIAN WATER MILFOIL, VARIABLE PONDWEED, EEL GRASS, LARGE LEAF PONDWEED, AND BLADDERWORT

MUSKGRASS, WATER STAR GRASS, SAGO PONDWEED, EURASIAN WATER MILFOIL, VARIABLE PONDWEED, LARGE LEAF PONDWEED, AND FLAT STEM PONDWEED

MUSKGRASS, BUSHY PONDWEED, SAGO PONDWEED, VARIABLE PONDWEED, AND EEL GRASS

MUSKGRASS, COONTAIL, SAGO PONDWEED, EURASIAN WATER MILFOIL, WATERWEED, BUSHY PONDWEED, LARGE LEAF PONDWEED, FLAT STEM PONDWEED, AND BLADDERWORT

MUSKGRASS, LARGE LEAF PONDWEED, AND SAGO PONDWEED

MUSKGRASS, EURASIAN WATER MILFOIL, BUSHY PONDWEED, VARIABLE PONDWEED, LARGE LEAF PONDWEED, SAGO PONDWEED, FLAT STEM PONDWEED, EEL GRASS, AND BLADDERWORT

MUSKGRASS, EURASIAN WATER MILFOIL, BUSHY PONDWEED, VARIABLE PONDWEED, AND SAGO PONDWEED

MUSKGRASS, WATER STAR GRASS, BUSHY PONDWEED, VARIABLE PONDWEED, AND FLOATING LEAF PONDWEED

MUSKGRASS, WATERWEED, WATER STAR GRASS, EURASIAN WATER MILFOIL, BUSHY PONDWEED, VARIABLE PONDWEED, SAGO PONDWEED, AND EEL GRASS

MUSKGRASS, COONTAIL, WATER STAR GRASS, EURASIAN WATER MILFOIL, LARGE LEAF PONDWEED, SAGO PONDWEED, FLAT STEM PONDWEED, EEL GRASS, AND BLADDERWORT

MUSKGRASS, EURASIAN WATER MILFOIL, BUSHY PONDWEED, VARIABLE PONDWEED, AND EEL GRASS

GRAPHIC SCALE
0 350 700 FEET

DATE OF PHOTOGRAPHY: APRIL 2000

Source: Christine M. Hinz and SEWRPC.

WDNR pursuant to authorities granted the Department under Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code.*

Chemical Control Measures

Perceived excessive macrophyte growths on Silver Lake have historically resulted in the application of a chemical control program. Recorded chemical herbicide treatments that have been applied to Silver Lake from 1950 through 2003 are set forth in Table 7.

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 Silver Lake, and years of application during the period 1950 through the present, are listed in Table 7. The total amount of sodium arsenite applied over this period was about 108 pounds.

Sodium arsenite was typically sprayed onto the surface of Silver Lake 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 five 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 and less biologically active form, much of the arsenic residue was deposited in the lake sediments. When it became apparent that arsenic was accumulating in the sediments of treated lakes and that the accumulations of arsenic were found to present potential health hazards both to humans and aquatic life, the use of sodium arsenite was discontinued in the State in 1969.

As shown in Table 7, the aquatic herbicides diquat, endothall, and 2,4-D have also been applied to Silver Lake 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.), bladderwort (*Utricularia* sp.), 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.).

In addition to the chemical herbicides used to control large aquatic plants, algaecides have also been applied to Silver Lake. As shown in Table 7, copper sulfate (Cutrine Plus) has been applied to Silver Lake, on occasion. Like arsenic, copper, the active ingredient in many algaecides 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 found to be harmful to humans.

The earlier report addressed the presence of Eurasian water milfoil in the Lake and made recommendations based on the relatively discrete locations of the plant at that time. Manual control of aquatic plants in and around docks, the demarcation of motor exclusionary zones encompassing macrophyte beds containing Eurasian water milfoil and possible early spring selective use of chemical herbicides such as 2,4-D to target Eurasian water milfoil infestations were considered viable options at that time. The subsequent increase in Eurasian water milfoil biomass observed during the recent reconnaissance resulted in further recommendations by the Commission. These recommendations included the continued limited use of manual controls in shoreland areas around piers and docks, selective aquatic herbicide treatment in early spring that would target Eurasian water milfoil growth areas and informational programming. To the extent that manual control would be utilized, it was recommended that several specialty rakes could be purchased by the Silver Lake Protections and Rehabilitation District for use by riparian residents.

Table 7

CHEMICAL CONTROL OF AQUATIC PLANTS IN SILVER LAKE: 1950-2003

Year	Total Acres Treated	Algal Control		Macrophyte Control					
		Copper Sulfate (pounds)	Cutrine or Cutrine-Plus (gallons)	Sodium Arsenite (pounds)	2,4-D (pounds)	Fluridone (pounds)	Diquat (gallons)	Endothall (pounds)	Aquathol (gallons)
1950	--	--	--	108	--	--	--	--	--
1951-1973	--	--	--	--	--	--	--	--	--
1974	0.4	7	--	--	--	--	--	100	--
1975-1980	--	--	--	--	--	--	--	--	--
1981	0.8	--	3.1	--	--	--	--	--	--
1982	1.9	--	9.0	--	--	--	--	--	--
1983	--	--	--	--	--	--	--	--	--
1984	2.4	--	7.0	--	--	--	--	--	10.0
1985	1.4	--	7.5	--	--	--	--	--	5.0
1986	3.9	--	10.0	--	--	--	1.0	--	5.0
1987	2.6	--	--	--	--	--		--	--
1988	3.0	--	--	--	1.5	--	2.5	--	--
1989	1.5	--	--	--	--	--		--	--
1990	2.5	--	2.2	--	--	--	1.2	--	1.2
1991	0.8	--	2.0	--	--	--	1.0	--	1.0
1992	1.5	--	1.5	--	--	--	1.5	--	1.5
1993-2000	--	--	--	--	--	--	--	--	--
2001	3.9	--	--	--	--	265	--	--	--
2002-2003	--	--	--	--	--	--	--	--	--
Total	26.6	7	53.8	108	1.5	265	7.2	100	23.7

Source: Wisconsin Department of Natural Resources and SEWRPC.

FISHERIES

As reported in the initial study with respect to the fisheries, the Wisconsin Department of Natural Resources indicated that largemouth bass and panfish were abundant and that northern pike and smallmouth bass were present in Silver Lake. A 1978 lake inventory conducted by the Wisconsin Department of Natural Resources listed over 10 species of fish present in Silver Lake, including bluegills, pumpkinseed, yellow perch and rock bass. An abundant population of freshwater crayfish was also reported in the earlier study. Crayfish serve not only as forage for fish, but also as processors of detritus on the lake bottom.

Silver Lake is considered by the Wisconsin Department of Natural Resources to be a warmwater sport fishing lake, with a game fishery dominated by largemouth bass and panfish, with smallmouth bass and northern pike also present.[17] Stocking of Silver Lake with walleyed pike by the Wisconsin Department of Natural Resources has been proposed during 2006.

[17] *Wisconsin Department of Natural Resources Lake Use Report No. MI-8,* Silver Lake, Washington County, Wisconsin, *1973; Wisconsin Department of Natural Resources Publication No. PUB-FH-800 2001,* Wisconsin Lakes, *2001.*

WILDLIFE AND WATERFOWL

Given the single-family residential nature of much of the Lake's shoreline, and the area of the surrounding woodlands and wetlands in the vicinity, it is likely that the wildlife community is comprised of small upland game animals, such as rabbit and squirrel; predators, such as fox and raccoon; marsh furbearers, such as muskrat; migratory and resident song birds; marsh birds, such as redwing blackbird and great blue heron; raptors, such as great horned owl and red-tailed hawk; and, waterfowl. White-tailed deer have been reported in the area, as have coyote, turkey, and king fishers. The character of wildlife species, along with the nature of the habitat present in the planning area, has undergone significant change since the time of European settlement and the subsequent clearing of forests, plowing of the prairie, and draining of wetlands for agricultural purposes. Modern practices that adversely affect wildlife and wildlife habitat include: the excessive use of fertilizers and pesticides, road salting, heavy traffic, the introduction of domestic animals, and the fragmentation and isolation of remaining habitat areas for urban and agricultural uses.

Map 11 shows the remaining wildlife habitat areas in the tributary drainage area to Silver Lake as of 1985. These areas generally occur in association with existing surface water, wetland, and woodland areas located along portions of the northern and western shorelands of Silver Lake. Wildlife habitat areas covered about 100 acres, or approximately one-third of the drainage area tributary to Silver Lake. Of this total habitat acreage, about 74 acres, or about 75 percent, were rated as Class II habitat; and about 26 acres, or 25 percent, were rated as Class III habitat. There were no areas of Class I habitat measured during the current study. The habitat areas shown on Map 11 are largely coincident with Commission-delineated environmental corridors within this watershed, which are shown on Map 12.

ENVIRONMENTAL CORRIDORS

Environmental corridors comprise approximately 70 acres, or about 23 percent of the drainage area directly tributary to Silver Lake. All of these corridor lands were considered to be primary environmental corridor; no secondary environmental corridor lands were delineated in the watershed. Additionally, about three acres of isolated natural resource area were delineated, as shown on Map 12. These lands are recommended to be considered for preservation as the process of development proceeds within the Region.[18]

NATURAL AREAS AND CRITICAL SPECIES HABITAT

The Silver Lake area contains Natural Areas and Areas of Critical Species Habitat and is of state, regional and local importance due to its richness of natural habitat and biota. Natural areas are those believed to contain native plant and animal communities representative of the pre-European-settlement landscape. Paradise Lake Fen, Silverbrook Lake Woods and Silver Creek Marsh are three Natural Areas located within the locale of Silver Lake.[19]

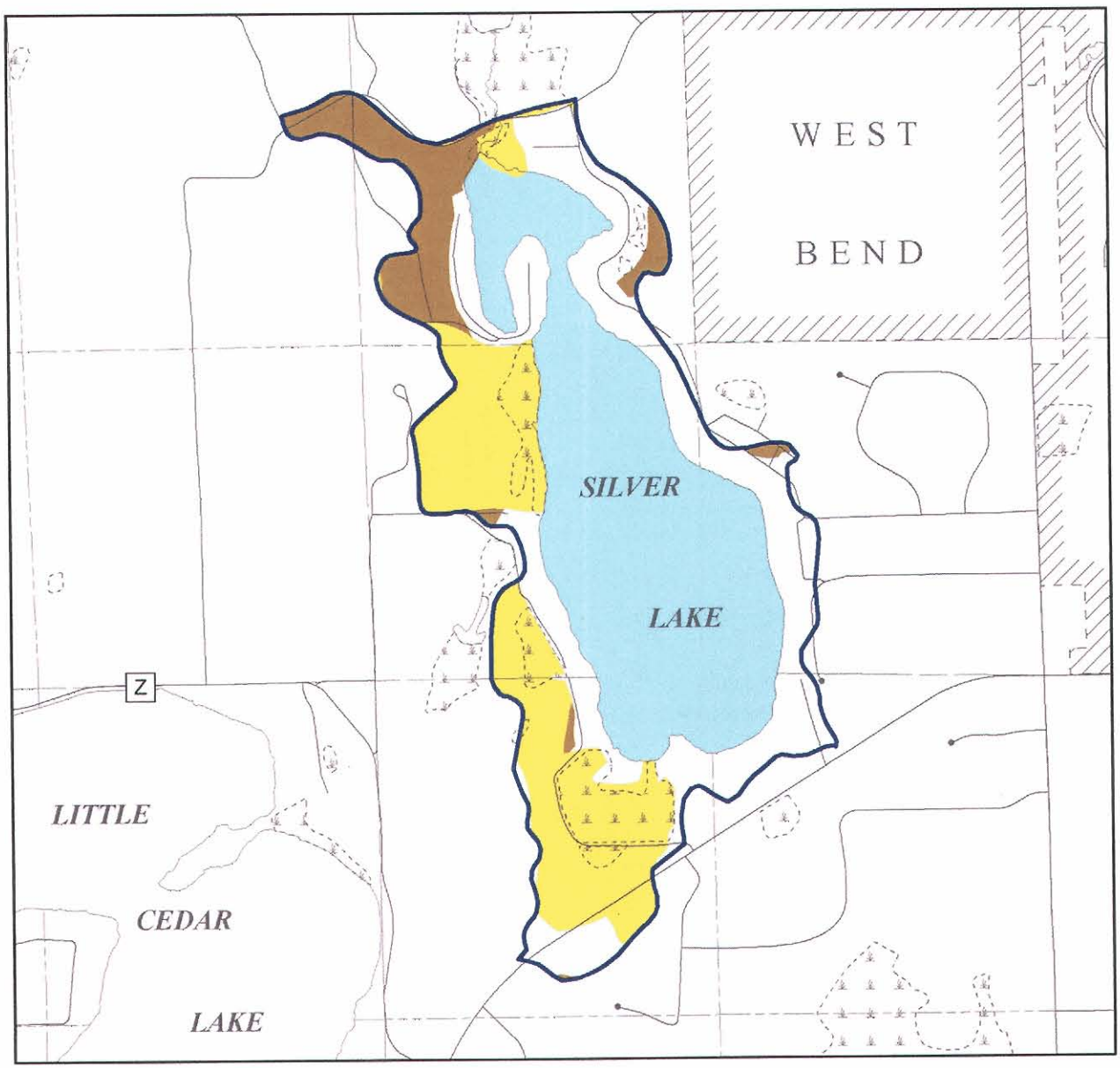
1. Paradise Lake Fen—This 22-acre wetland contains an undeveloped nine-acre lake with good quality calcerous sedge mat and deep and shallow marsh. The fen has been given a rating of NA-1, identifying it as a site of statewide or greater significance. Located along the eastern shorelands of Silver Creek between Silver Lake and Lucas Lake, this 22-acre parcel contains 11 acres already under protective ownership with the remaining 11 acres recommended in the Washington County Park Plan to be acquired by the Wisconsin Department of Natural Resources.

[18]*SEWRPC Planning Report No. 40,* op. cit.

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

Map 11

WILDLIFE HABITAT AREAS WITHIN THE DRAINAGE AREA TRIBUTARY TO SILVER LAKE



Class II, Medium-Value Habitat

Class III, Good-Value Habitat

Surface Water

Source: SEWRPC.

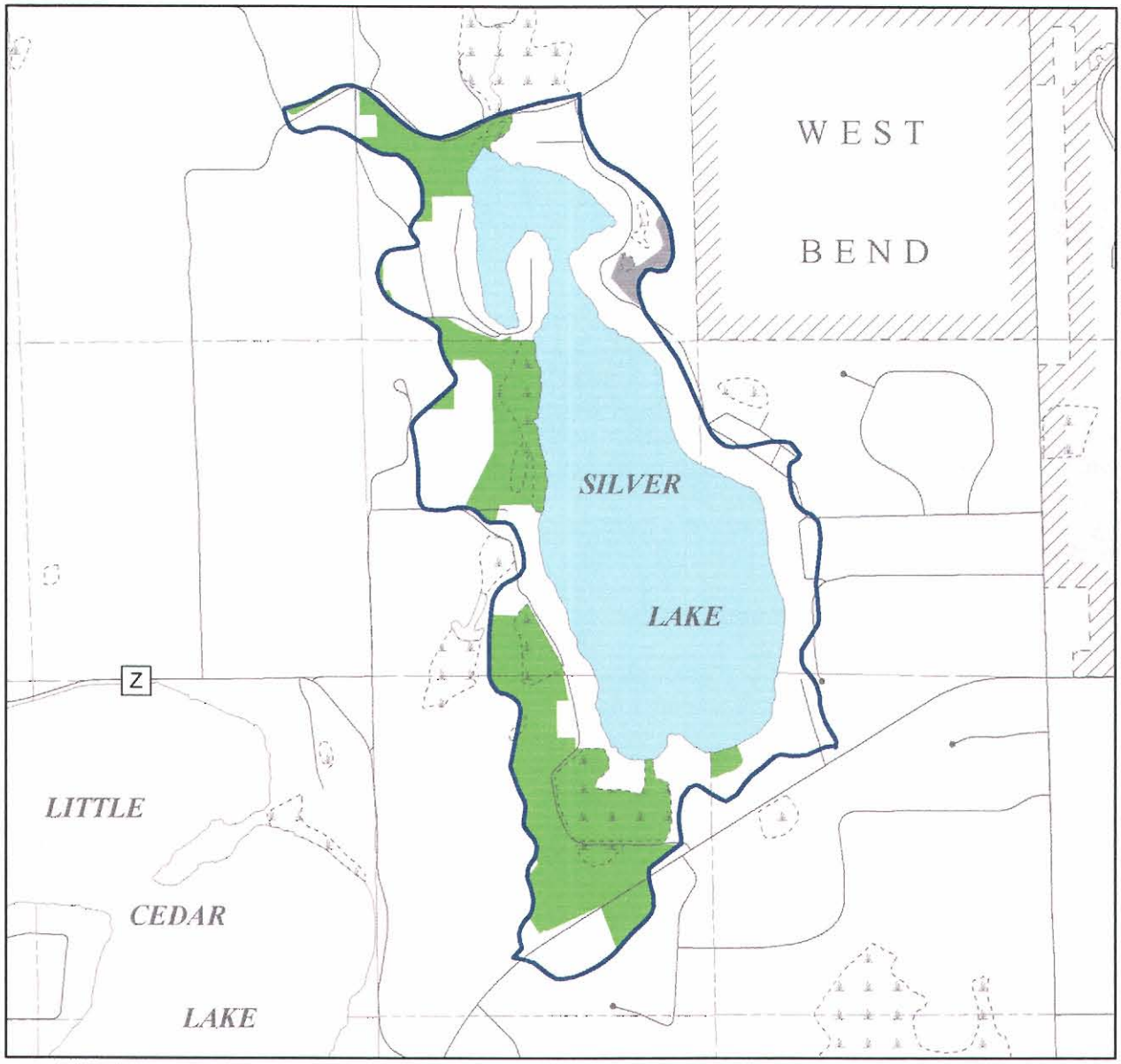
N

0 1,000 2,000 3,000

Feet

Map 12

ENVIRONMENTALLY VALUABLE AREAS WITHIN THE DRAINAGE AREA TRIBUTARY TO SILVER LAKE



Primary Environmental Corridor

Isolated Natural Resource Areas

Surface Water

Source: SEWRPC.

N

0 1,000 2,000 3,000

Feet

2. Silverbrook Lake Woods—This 404-acre woodland has been given a rating of NA-2, identifying it as a site of countywide or regional significance. Comprised of good quality southern mesic to dry-mesic hardwoods, Silverbrook Lake Woods is located along the western shorelands of Lucas Lake, downstream from Silver Lake. Of the 404 acres, 148 are already under protective ownership by the Girl Scouts of Milwaukee Area, Inc., Washington County, the Cedar Lakes Conservation Foundation, and other private owners; the remaining 256 acres are recommended in the Washington County Park Plan to be acquired by the Wisconsin Department of Natural Resources.

3. Silver Creek Marsh—Located about two miles downstream from Silver Lake, this 27-acre wetland has a rating of NA-3, identifying it as a site of local significance. Silver Creek Marsh is a good quality deep and shallow marsh and sedge meadow and is owned by Washington County and private owners.

Critical Species Habitat Areas are those which support, or contain factors believed necessary to support, plant or animal species listed as rare, threatened, or endangered by Federal or State agencies. The wetland areas located along the western and southern shorelands of Silver Lake (see Map 6) are designated as areas of Critical Species Habitat. Silver Lake itself is listed as one of the Critical Lakes of Southeast Wisconsin and has been given an AQ-2 designation identifying it as an aquatic area of countywide or regional significance. This designation was the result of an assessment scheme based on water quality, quality of wildlife habitat, presence of endangered, threatened, or special concern species, shoreline development, and physical attributes such as proximity to critical species habitat. In addition, Silver Lake was recognized as possessing a large and diverse fish community including a State Special Concern species, the Least Darter, *Etheostoma microperca*, and a State Threatened species, the Pugnose shiner, *Notropis anogenus*.

RECREATIONAL USES AND FACILITIES

Silver Lake is a multi-purpose recreational use waterbody serving many forms of recreation, including boating, swimming, and fishing during the summer months, and cross-country skiing, ice fishing, and ice skating during the winter months. The Lake is used year round as a visual amenity; walking and bird-watching being popular passive recreational uses of the waterbody. The Lake is especially valued by its residents for its aesthetic appeal that is enhanced by its natural vistas, perceived good water quality, abundant wildlife, and solitude.

Public recreational boating access to Silver Lake prior to 2004 was limited to an undeveloped site at the Paradise Drive bridge over Silver Creek. Parking facilities were not provided. Subsequent to that year, Washington County acquired the former Henschke property on the eastern shore of the Lake and developed a public recreational boating access and park site which was opened during 2005. Consequently, the Lake is determined to have adequate public recreational boating access as established pursuant to standards set forth in Chapter NR 1 of the *Wisconsin Administrative Code*. A private access site, maintained by the Silver Lake Yacht Club, is located on the eastern side of the Lake across Peters Drive from the Silver Lake Country Inn. Parking is not provided and use of this access site is reserved for members of the Silver Lake Yacht Club.

A boat survey conducted by Commission staff as part of the earlier planning program indicated that 391 boats were either moored in the water or stored on land adjacent to Silver Lake. The types of boats included: speedboats, fishing boats, pontoon boats, paddleboats, rowboats, canoes, sailboats, and personal watercraft (also known as Jetskis®). A more recent boat survey was not conducted for the present study.

SHORELINE PROTECTION STRUCTURES

Erosion of shorelines results in the loss of land, damage to shoreland infrastructure, interference with lake access and use, and degradation of aquatic habitat. Such erosion is usually caused by wind-wave erosion, ice movement, and/or motorized boat traffic.

A survey of the Silver Lake shoreline conducted by Commission staff as part of the initial study indicated that more than half of the shoreline remained in a natural condition, without shoreline protection structures. Erosion

and undercut banks were noted as common, especially along grassed shorelines, with about 60 percent of the shoreline protected by bulkhead or riprap structures. In general, these shoreline protection structures were considered to be in a good state of repair, with few obvious failures noted.

LOCAL ORDINANCES

As reported in the initial study, Silver Lake is subject to a boating ordinance promulgated by the Silver Lake Protection and Rehabilitation District. This ordinance, set forth in Appendix B, provides generally applicable rules for Silver Lake. These rules limit the times during which watercraft may be operated on Silver Lake and allow for the enactment and enforcement of boating restrictions and limitations. This ordinance conforms to State of Wisconsin boating and water safety laws promulgated pursuant to Chapter 30, *Wisconsin Statutes*. In addition, Silver Lake is subject to a winter-use ordinance, also promulgated by the Silver Lake Protection and Rehabilitation District, limiting the operation of motorized vehicles, except for snowmobiles and all-terrain vehicles, on the ice during winter months. The ordinance, set forth in Appendix C, also sets speed limits for vehicles being operated on the ice and established a winter safety patrol.

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Chapter III

ISSUES OF CONCERN

INTRODUCTION

Silver Lake is capable of supporting a variety of recreational water uses. Notwithstanding, there are a number of existing and potential future problems and issues of concern that should be addressed in this protection plan. These concerns include potential deleterious changes in: aquatic plant communities and ecologically valuable areas; land use and water quality; sedimentation in shoreline areas; and, the recreational use of the Lake and its environs.

AQUATIC PLANT COMMUNITIES AND ECOLOGICALLY VALUABLE AREAS

Concerns Related to Aquatic Plant Communities

Localized recreational use problems have been reported to be experienced in various portions of Silver Lake. The nature and extent of those problems depend on the specific uses desired of the Lake. However, the apparent increase in abundance of Eurasian water milfoil since the initial survey is perceived as a nuisance and issue of concern by lake users. These latter plants often grow to the surface of the Lake, limiting certain recreational uses in specific areas of the Lake, and impair not only the aesthetic quality of the Lake, but also limit the habitat for fish and other aquatic life within and adjacent to the Lake. These characteristics interfere with recreational uses, aesthetic enjoyment, and the ecological health of the waterbody.

Recreational boating activities, for example, are impaired by entanglement of propellers and clogging of cooling water intakes, slowing boating activities, and limiting the ability of lake users to navigate in certain areas of the Lake. Without control measures, these areas could become impassable for recreational navigation. In addition, fishing and swimming activities on the Lake also are adversely affected by aquatic plant growth, especially in those areas of the Lake where Eurasian water milfoil occurs at swimming depths. Fishing is affected by the growths of Eurasian water milfoil entangling lines, and by the poor quality habitat and food stocks provided within the stands of Eurasian water milfoil. Native aquatic plants pose less severe potential problems for swimming and provide positive ecological benefits to the Lake, as noted in Table 6. Consequently, the management of aquatic plant communities in Silver Lake, and the increased abundance of Eurasian water milfoil in particular, is an important issue to be considered.

Concerns Related to Ecologically Valuable Areas

Silver Lake and its tributary drainage area contain ecologically valuable areas, including significant areas of diverse, native aquatic vegetation suitable for fish spawning and high quality wildlife habitat, which are located within, and immediately adjacent to, the Lake. The Silver Lake community has expressed concern over the perceived degradation of these resources. Two potential concerns associated with ecologically valuable areas in and near Silver Lake have been identified. These include: the potential loss of wetlands and other ecologically

valuable areas due to urbanization or other encroachments; and the degradation of wetlands and aquatic habitat due to the presence of invasive species, primarily Eurasian water milfoil and purple loosestrife. The currently undeveloped areas of the Lake, generally lying along the western shorelines of the southern basin of the Lake, contain significant stands of native aquatic and wetland plants and shoreland woodlands that add aesthetic value to the community and provide good quality wildlife habitat. Consequently, management of ecologically valuable areas in and adjacent to the Lake is an important issue to be considered.

Environmentally Sensitive Areas

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

Natural Areas and Critical Species Habitat

The Silver Lake area is of ecological importance due its physical features and the richness and diversity of its biota. As aforementioned, there are three areas of special ecological significance within the drainage area tributary of Silver Lake; namely, Paradise Lake Fen, Silverbrook Lake Woods and Silver Creek Marsh. Maintaining the ecological integrity of these areas is an important issue to be considered.

Shorelands

As mentioned earlier, portions of the shoreline of Silver Lake remain in a natural state, especially along the western shores of the southern basin and the north and western shores of the northern basins. As such, these areas are likely to be potentially susceptible to wind, wave, and wake erosion should such vegetative protections be removed or modified. Wherever practical, vegetated buffer strips should be maintained along the lakeshore in order not only to protect these areas from wind and wave erosion, both shoreward and lakeward of the ordinary high-water mark, which mark generally defines the point at which the Lake and shore meet, but also to maintain habitat value and the natural ambience of the shoreland area. During the earlier study period, the Commission staff examined existing shoreline protection structures and shoreland areas for signs of erosion. These shoreland protection structures, mainly comprised of riprap and bulkheads, were deemed by Commission staff to be in a relatively good state of repair. Nevertheless, because of the extensive amount of natural shoreline on Silver Lake, shoreland erosion is a potential issue of concern to be considered.

LAND USE AND WATER QUALITY

Concerns Related to Nonpoint Source Pollution

Nonpoint source pollutants in the surface water drainage area tributary to Silver Lake affect the Lake's water quality. Based upon recommendations set forth in the regional land use plan,[1] only limited future development of open lands within the drainage area tributary to Silver Lake is expected to occur. Such development is anticipated to take the form of residential development on existing platted lots or the redevelopment of existing sites within the drainage area that could have some impact on lake water quality, primarily as a result of erosion during construction and secondarily due to limited increased in impervious surfaces.

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

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

Concerns Related to Water Quality

As of 1997, as described in Chapter II, Silver Lake was within the mesotrophic range, indicating that few water quality problems could be expected in the Lake. Notwithstanding, citizens within the Silver Lake community have expressed concerns regarding surface water quality over the longer term, especially if urban density development occurs within the groundwatershed tributary to Silver Lake as is foreseen in the relevant regional and local land use plans. Because domestic water supplies to households within the Silver Lake community are drawn from the Regional groundwater aquifer system, contamination of this aquifer by pollutants leaching into the groundwater from the land surface is an issue of widespread concern within the Silver Lake community. This concern is shared throughout the Southeastern Wisconsin Region by communities who are dependent upon private wells for their water supply even though they may utilize a public sewage disposal system.[2] Measures taken to minimize water quality degradation in the surface drainage area tributary to Silver Lake should also serve to protect the groundwater resources of the watershed from contamination. Consequently, water quality is an important issue to be considered.

In response to resident concerns expressed over perceived loss of lake depth, primarily along the western and southern shorelines of the southern basin, modeling studies recommended in the aforereferenced lake protection plan to further define possible loss of lake depth were undertaken by the U.S. Geological Survey and reported to the Silver Lake Protection and Rehabilitation District during 2003.[3] Examination of groundwater flows in the area of Silver Lake and analysis of chemical composition of groundwater entering Silver Lake as a result of these flows provided data helpful in quantifying the rate of deposition of marl within the lake basin. Marl deposition, together with other likely contributors to sedimentation in Silver Lake, such as yard waste and leaf litter, natural leaf falls and runoff from the land surface, is an important issue to be considered.

RECREATIONAL USAGE

Many lakes in the Southeastern Wisconsin Region, especially those offering high-quality recreational opportunities within a one- to two-hour drive of the Milwaukee metropolitan area, are commonly perceived to suffer from overcrowding and excessive recreational boating use. In the implementation of recommendations set forth in the current lake protection plan for Silver Lake, a recreational boating access site has been developed at Silver Lake by Washington County. While the Silver Lake community and Town of West Bend have noted concerns over the potential impacts of such an access, including both ecosystem-related concerns and public safety concerns, the completion of this public access site has brought Silver Lake into conformance with the requirements of Chapter NR 1 of the *Wisconsin Administrative Code*, thus, qualifying the Lake for WDNR enhancement services, including fish stocking and access to lake protection grants. Thus, recreational use of Silver Lake remains an issue of concern to be considered.

Concerns Related to Provision of Public Recreational Boating Access

A number of State grant and cost-share programs are available to potentially offset a portion of the local costs of implementing a comprehensive program of lake management on Silver Lake. Utilization of these programs is dependent upon several criteria, one of which is provision of adequate public recreational boating access and associated parking facilities. Requirements contained in Sections NR 1.91(4) and NR 1.91(5), respectively, of the *Wisconsin Administrative Code*, establish minimum and maximum standards for public recreational boating access development that will qualify waters for resource enhancement services provided by the Wisconsin

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

[3]*U.S. Geological Survey Water-Resources Investigations Report No. 02-4204,* Simulation of the Shallow Aquifer in the Vicinity of Silver Lake, Washington County, Wisconsin, Using Analytic Elements, *2003.*

Department of Natural Resources.[4] These standards are based upon open-water surface acres: for lakes with a boatable surface area similar to that of Silver Lake, public recreational boating access sites should accommodate seven car-trailer units, plus one handicapped-accessible unit. In this regard, a public recreational boating access site at Silver Lake has been developed on a property north of the existing Silver Lake Yacht Club site, recently acquired by Washington County. Maintenance of that site should ensure continued eligibility for State enhancement services that are dependent upon the provision of adequate public recreational boating access.

Concerns Related to Recreational Boating

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

Concerns Related to Recreational Opportunities within the Watershed

In addition to the water-oriented recreational opportunities offered by Silver Lake, the drainage area within which the Lake is situated provides numerous views and aesthetic aspects that are favored by the Silver Lake community. In large part, these aspects relate to the currently undeveloped status of the lands to the northeast of the Lake, currently maintained as prairie by the corporate landowners, and to the woodland and wetland systems of the western shorelands of the Lake. Recent urban-density residential development to the southwest of the main Lake basin, and ongoing southward and westward expansion of the City of West Bend, are rapidly changing the landscape within and adjacent to the drainage area tributary to Silver Lake. Recently, the Town of West Bend has adopted a land use map and zoning scheme that has effectively eliminated agriculture in the Town, substituting in its stead suburban density residential land uses on large lots. Such development has the potential to significantly alter the viewshed tributary to Silver Lake, the intensity of the demands for water-based recreational opportunities, and the nature and delivery of nonpoint-sourced contaminants to the Lake. Consequently, preserving the natural aesthetics offered by the Lake is an issue to be considered.

ANCILLARY ISSUES OF CONCERN

Concerns Related to Informational and Educational Programming

It is the policy of the Silver Lake Protection and Rehabilitation District and Town of West Bend to maintain an active dialogue with the community. This is done through the medium of the public press and through various town committees, public meetings and other scheduled hearings. In addition, the Silver Lake Protection and Rehabilitation District and the Silver Lake Protection Association, Inc., hold regular public meetings during which informational programming can be featured. Such educational and informational programming should discourage human disturbances in ecologically valuable areas, except as may be necessary to provide riparian residents with a reasonable level of access to the main body of the Lake, while encouraging the use of good housekeeping practices on riparian properties, sound stewardship of the shared natural resources of the Lake and its drainage basin, and appropriate types and levels of Lake usage.

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[4] *Where exceptional circumstances exist, Section NR 1.91(6) of the* Wisconsin Administrative Code *provides procedures for determining alternative public access standards that may differ from the minimum and maximum standards set forth in Sections NR 1.91(4) and NR 1.91(5). Alternative recreational boating access standards are determined on a site-specific basis, in cases where unusual environmental or development factors preclude provision of access within the standards. Such factors are not present at Silver Lake.*

Lake residents and visitors should be made aware of the invasive nature of species such as purple loosestrife and Eurasian water milfoil, and be encouraged to participate in citizen-based control programs coordinated by the Wisconsin Department of Natural Resources and University of Wisconsin-Extension. Where necessary, personal contacts with homeowners should be made, most likely through the Silver Lake Protection and Rehabilitation District. Developing such a program of informational and educational programming, therefore, is an issue to be considered.

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Chapter IV

ALTERNATIVE AND RECOMMENDED LAKE PROTECTION MEASURES

INTRODUCTION

There are a number of issues of concern affecting the recreational use and protection of the Silver Lake ecosystem. These issues were identified in Chapter III and include: aquatic plant management and protection of ecologically valuable areas; control of nonpoint source pollution and protection of water quality; and, provision of public recreational use opportunities, as well as ancillary concerns relating to the conduct of community-based informational and educational programming. In some ways, these issues of concern are interrelated. For example, in those areas of the Lake where Eurasian water milfoil is abundant, certain recreational uses are limited, the aesthetic quality of the Lake is impaired, and in-lake habitat degraded. From a boating standpoint, the plant primarily interferes with recreational use by restricting propeller movement and clogging 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, areas of abundant growths of Eurasian water milfoil can become problematic with respect to such recreational uses as boating, fishing, and swimming. In this regard, it should be noted that native aquatic plants, generally found at slightly deeper depths, pose fewer potential problems for navigation, swimming, and fishing, especially as the majority of these plants are low-growing and occur at lower densities than the invasive Eurasian water milfoil. In addition, many species of fish have come to be dependent on native aquatic plants for habitat, food resources, and shelter, especially for juvenile and young-of-the-year fishes. Consequently, when native plant species are crowded out and replaced by invasive species like Eurasian water milfoil, negative impacts are experienced throughout the lake ecosystem at all levels, and control measures, such as those discussed in this chapter, are warranted.

In this chapter, alternative and recommended management measures to address the identified issues of concern are presented. These measures include:

- Land use management measures designed to limit the inputs of contaminants, and protect ecologically valuable areas and associated biota;

- Aquatic and shoreland plant management measures designed to encourage native plant communities and limit the spread of nonnative species, as well as reduce erosion-related problems and encourage the establishment of natural, native shoreline vegetation where appropriate;

- Fisheries management measures designed to mitigate the habitat-related impacts of a changing aquatic flora and maintain an ecologically viable system; and

- Recreational use management measures designed to promote safe boating and boating access, curtail the spread of invasive species of aquatic flora and fauna, and provide the potential for the community to gain access to outside funding sources and lake enhancement services.

Alternative and recommended management measures are described below. The alternatives and recommendations set forth herein focus on those measures which are applicable to the Silver Lake Protection and Rehabilitation District, but include recommendations applicable to other governmental units having responsibility for land and water resource management in the drainage area tributary to Silver Lake.

Past and Present Lake Management Actions

Institutional Development Actions

The residents of Silver Lake, in conjunction with the Town of West Bend, have long recognized the importance of informed and timely action in the management of Silver Lake. Consequently, the residents of the community around Silver Lake created the Silver Lake Protection and Rehabilitation District, a Chapter 33, *Wisconsin Statutes*, public inland lake protection and rehabilitation district to address shared concerns with respect to the Lake, its water quality and environment. The District maintains an effective working relationship with the Silver Lake Sanitary District, Town of West Bend, Washington County, and the Wisconsin Department of Natural Resources.

Land and Watershed Management Actions

The Silver Lake Sanitary District took the lead in the construction of a public sanitary sewerage system serving the riparian community of Silver Lake. This sewerage system was completed in 1993, and conveys wastewater from the Silver Lake area to the City of West Bend sewerage system for treatment purposes.[1]

The Silver Creek subwatershed, including Silver Lake, was included in the Milwaukee River Priority Watershed Project planning area.[2] While this plan recommended implementation of significant urban nonpoint source pollution controls within the subwatershed to reduce heavy metal and sediment loads to the watercourse, these measures were directed largely at the urban and urbanizing areas in the lower reaches of this system.

Lake and Water Quality Management Actions

The Silver Lake Protection and Rehabilitation District currently has been enrolled in the water quality monitoring program conducted under the auspices of the Wisconsin Department of Natural Resources (WDNR) Self-Help Monitoring Program. This monitoring has been augmented periodically by a U.S. Geological Survey trophic state index (TSI) water quality monitoring program, conducted in part with funding provided through the Chapter NR 190 Lake Management Planning Grant Program. Information gathered through these sampling programs is regularly reported to the community through meetings of the Silver Lake Protection and Rehabilitation District Board of Commissioners, the annual meeting of the electors and property owners of the Silver Lake Protection and Rehabilitation District, and the local media, as part of an ongoing citizen education and involvement program related to lake management activities. Ongoing involvement of a citizen volunteer in the WDNR Self-Help Program is recommended.

The Silver Lake Protection and Rehabilitation District conducts an active, ongoing public information program. Informational programming is an integral part of the District's annual meeting, which is open to all of the residents of the Silver Lake community and other interested parties. The District uses this opportunity, as well as periodic mailings, to distribute informational materials to District residents. These mailings and programs have

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

[2]*Wisconsin Department of Natural Resources Publication No. PUBL-WR-255-90,* A Nonpoint Source Control Plan for the East and West Branches of the Milwaukee River Priority Watershed Project, *February 1989.*

addressed issues such as aquatic plant management, shoreland management and urban housekeeping, and lake ecology.

Aquatic Plant Management Actions

The relatively clear water of Silver Lake is conducive to the growth of rooted aquatic plants. These conditions facilitate the penetration of sunlight to the lake bottom that is essential for the growth of rooted aquatic plants, the maximum depth of colonization of which was estimated to be about 16 feet using the U.S. Environmental Protection Agency Secchi-disc based algorithm for calculating colonization depth under Wisconsin conditions. A further factor likely to influence the nature of the plant flora would be differences in water chemistry along the western shoreline of the Lake. It is likely that the inflowing water in the vicinity of the spring-fed inflows may have a slightly different nutrient chemistry than the lake waters themselves. It is conceivable that the inflowing water could have a higher concentration of biologically available phosphorus than the lake waters, and be contributing organic material to the nearshore sediments, especially in the vicinity of the shoreline wetlands. The slightly higher organic content of these sediments is likely to positively affect the growth of Eurasian water milfoil, which prefers organic-rich substrates for growth. Additionally, the slightly cooler water temperatures in the nearshore areas around the spring inflows may also advantage Eurasian water milfoil.

Notwithstanding these presumed localized variations in water quality and substrate composition, comparison of the qualitative findings of the reconnaissance conducted on August 2, 2000, with the quantitative results of the aquatic plant survey conducted on June 28, 1995, indicate a significant increase in Eurasian water milfoil biomass in Silver Lake. These recommended measures to manage these populations, set forth in the initial plan, were primarily aimed at the containment of the then sparse populations of Eurasian water milfoil in the Lake, using buoyage and signage to minimize boating traffic through Eurasian water milfoil beds, and the manual removal of the plant from around piers and docks. These measures have not been wholly successful in limiting its abundance at the sites where it was previously identified or controlling its spread to other areas within the Lake. Consequently, additional measures would appear to be necessary to control the spread and occurrence of Eurasian water milfoil in Silver Lake. The refined program, set forth in the refined aquatic plant management plan below, reflects the evolution of aquatic plant management practices in Silver Lake, and continues to be based upon the following alternatives: 1) use of manual controls in shoreline areas around piers and docks; 2) chemical controls using an early spring treatment of Eurasian water milfoil- infested, offshore areas within the Lake using selective aquatic herbicides; and, 3) specific informational programming aimed at encouraging the implementation and maintenance of vegetated buffer strips along the lake shore, adoption of lake-friendly housekeeping practices by riparian residents, and other actions designed to limit the spread of aquatic invasive species in the Lake. However, based upon recent experience with the more extensive use of the aquatic herbicide 2,4-D to reduce the biomass of Eurasian water milfoil during recent years, the refined approach constitutes a more aggressive approach to the management of this nonnative aquatic plant.

CONTROL OF NONPOINT SOURCE POLLUTION AND PROTECTION OF ECOLOGICALLY VALUABLE AREAS

Control of Nonpoint Source Pollution

Silver Lake is a mesotrophic waterbody. As such, it may be considered to be in need of protection to maintain and enhance its current aesthetic and recreational uses should its water quality degrade. The level of urbanization of the watershed, when viewed in light of the recent U.S. Geological Survey findings regarding the potential impacts of suburban lawn care practices on stormwater runoff in urbanized watersheds in Wisconsin,[3] together with perceived loss of lake depth in areas along the western and southern shores and northwestern "kettle," has heightened concern among lakeshore residents that the water quality of the Lake could deteriorate.

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

As described in Chapter II, the primary sources of pollutant loadings to Silver Lake are nonpoint sourced, generated from within the drainage area tributary to the Lake. Watershed management measures may be used to reduce nonpoint source pollutant loadings from such rural sources as runoff from cropland and pastureland; from such urban sources as runoff from residential, commercial, transportation, and recreational land uses; and from construction activities. The alternative, nonpoint source pollution control measures considered in this report are based upon the recommendations set forth in the regional water quality management plan,[4] the Washington County land and water resource management plan,[5] and information presented by the U.S. Environmental Protection Agency.[6]

Since the implementation of public sanitary sewerage services within the drainage area tributary to Silver Lake, the level of point source pollution, previously generated from onsite sewage disposal systems, can be assumed to have diminished. However, periodic review of public sanitary sewerage service area and facility plans is recommended.

Array of Protection Measures

To control nonpoint source pollution to Silver Lake and its tributary drainage area and maintain or improve the water quality of Silver Lake, application of both urban and rural nonpoint source controls is recommended. In addition, measures to control nonpoint source pollution loading during land development activities and consideration of possible increase sedimentation in areas of the lake basin, also are recommended.

Nonpoint Source Pollution Control in Developed Urban Areas

Potentially applicable urban nonpoint source control measures include wet detention basins, stormwater infiltration basins, grassed swales, and good urban housekeeping practices. Public informational programs can be developed to encourage good urban housekeeping practices, to promote the selection of building and construction materials that reduce the runoff contribution of 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. Good urban housekeeping practices and source controls include restricted use of fertilizers and pesticides; improved pet waste and litter control; the substitution of plastic for galvanized steel and copper roofing materials and gutters; proper disposal of motor vehicle fluids; increased leaf collection; street sweeping; and reduced use of street deicing salt. Generally, the application of low-cost urban housekeeping practices may be expected to reduce nonpoint source loadings from urban lands by about 25 percent.

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 controls nonpoint sources of pollution. In residential areas, the use of rain gardens is becoming increasingly

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

[5]*Washington County,* Washington County Land & Water Resource Management Plan: 2000-2005, *September 2000.*

[6]*U.S. Environmental Protection Agency, Report No. EPA-440/4-90-006,* The Lake and Reservoir Restoration Guidance Manual, *2nd Edition, August 1990; and its technical supplement, U.S. Environmental Protection Agency, Report No. EPA-841/ R-93-002,* Fish and Fisheries Management in Lake and Reservoirs: Technical Supplement to the Lake and Reservoirs Restoration Guidance Manual, *May 1993.*

popular with these gardens providing an additional landscaping option for homeowners and householders.[7] 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, as required pursuant to the performance standards set forth in Chapter NR 151 of the *Wisconsin Administrative Code*. 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-sourced pollutants from urban and urbanizing areas, and reduce urban nonpoint source pollution loads by up to about 50 percent.

Stormwater management ordinances are recommended to be reviewed for consistency with the provisions of the recently enacted Chapter NR 151 of the *Wisconsin Administrative Code*. Based upon such a review and refinement, the ordinances should be generally consistent within the drainage area tributary to Silver Lake, and require sound management practices be implemented within the drainage area. Chapter NR 152 of the *Wisconsin Administrative Code* sets forth model construction site erosion control and stormwater management ordinances as Appendices A and B of Chapter NR 152, respectively, which are recommended to serve as guidance for the suggested ordinance review process. Management practices in urban areas implemented to reduce construction site erosion are required under Section NR 151.11 to reduce sediment loss by 80 percent over uncontrolled sediment loads estimated to be generated from the construction site; this level of reduction is to be estimated utilizing technical standards set forth in Subchapter V of Chapter NR 151.[8]

Nonpoint Source Pollution Control in Developing Urban Areas

Developing areas can generate significantly higher pollutant loadings than established areas of similar size. These areas include a wide array of activities, including individual site development within the existing urban area, and new land subdivision development. As previously noted, only limited additional urban development is anticipated within the drainage area directly tributary to Silver Lake. Construction sites may be expected to produce suspended solids and phosphorus loadings at rates several times higher than established urban lands, and control of sediment loss from construction sites is recommended.

Construction erosion controls are important pollution control measures that can minimize localized loadings of phosphorus and sediment from the drainage area, and minimize the cumulative impacts of such loadings. The control measures include such revegetation practices as temporary seeding, mulching, and sodding; such runoff control measures as placement of filter fabric fences, straw bale barriers, storm sewer inlet protection devices, diversion swales, sediment traps, and sedimentation basins; and such site management practices as placement of tracking pads to limit the movement of soils from work sites. Construction site erosion controls may be expected to reduce pollutant loadings from construction sites by about 80 percent.

Rural Nonpoint Source Controls

Upland erosion from agricultural and other rural lands currently is a contributor of sediment and other contaminants within the tributary drainage area to Silver Lake. Estimated phosphorus and sediment loadings from croplands, woodlots, pastures, and grasslands in the drainage area tributary to Silver Lake were presented in Chapter II. As set forth, some of the remaining agricultural lands within the drainage area tributary to Silver Lake will be replaced, over time, with urban-density residential development. While such development could potentially reduce the agro-chemical loadings to Silver Lake, this benefit maybe offset by the fact that urban lands contribute a wider range of contaminants to surface waters and generally increased rates of surface runoff.

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[7] *U.S. Environmental Protection Agency, "Urban Runoff Notes,"* Nonpoint Source News-Notes, *Issue #42, August/September 1995.*

[8] *Applicable design guidance and technical standards are set forth in, among others, Wisconsin Department of Natural Resources Publication No. PUBL-WR-222 93 Rev,* Wisconsin Construction Site Best Management Practice Handbook, *November 1993.*

Recommended Management Measures
In order to provide for the control of nonpoint-sourced pollutants and maintain the water quality of Silver Lake, the following recommendations are made:

- Existing public sanitary sewerage plans providing public sanitary sewer services to urban areas of the drainage area tributary to Silver Lake continue to be monitored and reviewed periodically;

- Construction site erosion control, stormwater management, and development control ordinances pertinent to the drainage area tributary to Silver Lake continue to be enforced;

- Informational programming be developed and delivered to encourage good urban housekeeping practices by landowners within the drainage area tributary to Silver Lake.

- The Silver Lake Protection and Rehabilitation District should reinstate citizen-based monitoring of the Lake in order to provide an early warning of undesirable changes in lake water quality and aquatic species composition. Information can be acquired through participation in programs such as the Wisconsin Department of Natural Resources Self-Help Monitoring. A report on the year's lake monitoring should be featured at the annual meeting of the District.

In addition, where new development or redevelopment is proposed within the shoreland area, it is recommended that the provisions of the relevant Washington County land division and construction site erosion control ordinances be strictly enforced. In this regard, with respect to conservation developments, it is recommended that such development principles be applied especially on rural lands within the drainage area tributary to the Lake at such time as these lands are considered for urban residential development. In these areas, it would be desirable to maintain open space areas within the lake drainage area and cluster the development beyond the drainage area tributary to the Lake. It is also recommended that the relevant performance standards set forth in the adopted County land and water resource management plan be enforced as necessary. These practices would be intended to minimize the impact of development on the surface and ground water flows to Silver Lake.

Protection of Ecologically Valuable Areas
Silver Lake and its tributary drainage area contain a variety of ecologically valuable areas, including diverse aquatic and wetland vegetation, wildlife habitats, and substrates suitable for fish spawning, located within and immediately adjacent to the Lake, as noted in Chapter II. As described in Chapter III, the potential problems associated with ecologically valuable areas in and near Silver Lake include the potential loss of wetlands and other important ecologically valuable areas due to new development, urbanization, and other encroachments; and the degradation of wetlands and aquatic habitat due to nonpoint source pollution, and the presence of invasive species, including Eurasian water milfoil and purple loosestrife.

Array of Protection Measures
Wetlands and Woodlands
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 drainage area tributary to Silver Lake. 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 Silver Lake 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.

Notwithstanding, some wetland and woodland areas have been identified for acquisition in the adopted regional natural areas and critical species habitat protection and management plan, including the Silverbrook Lake Woods,

Silver Creek Marsh, and Paradise Lake Fen.[9] Public acquisition of these lands is recommended. In this regard, implementation of the recommendations of the adopted park and open space plan for Washington County[10] would complement the protection and preservation of these environmentally sensitive lands.

Shoreland Areas

The natural shorelands of Silver Lake, particularly along the western and the southern shorelines of the Lake, offer scenic vistas, valuable wildlife habitat, and important contributions to the natural functioning of the lake ecosystem and its watershed. Protection of these ecologically sensitive and currently undeveloped shorelands needs to be an important part of any lake protection plan. Appropriate shoreland management practices, including acquisition of conservation easements or acquisitions of properties themselves, to help control sources of nonpoint pollution and to maintain the natural functioning and integrity of the Silver Lake aquatic and land systems, represent an important consideration. The purchase of specific critical properties or the acquisition of conservation easements, as a means of protecting them from encroachment or further degradation, or as a means of facilitating their rehabilitation and restoration, is possible through the Chapter NR 50/51 Stewardship Grant and Chapter NR 191 Lake Protection Grant programs. Lands proposed for purchase must be appraised using standard governmental land acquisition procedures as established by the Wisconsin Department of Natural Resources, and must be subject to a land management plan setting forth the processes and procedures for their long-term maintenance and development. The Chapter NR 191 grant program provides State cost-share funding for the purchase up to a maximum State share of $200,000 at up to a 75 percent State cost-share. The Chapter NR 50/51 grant program provides State cost-share funding up to a maximum State share of $100,000 at up to a 50 percent cost-share. Cost-sharing and other state funding assistance programs through the Wisconsin Department of Natural Resources would be contingent, in part, upon the existence of adequate parking facilities to meet the Chapter NR 1 public recreational boating access standards.

A significant portion of the Silver Lake shoreline remains in a natural state, and, as such, is unprotected from erosion. Among the problems associated with the erosion of shorelands are: loss of land, damage to shoreline infrastructure, interference with lake access and use, increased sedimentation on the lake basin with accompanying loss of lake depth and susceptibility to the influx of nonpoint source pollutants. Wind-wave erosion, ice movement, and motorized boat traffic usually cause such erosion. In addition, the absence of native shoreline vegetation adversely affects the aesthetic quality of the Lake and negatively impacts other native biota, as well as contributing to shoreland erosion. Maintenance of the shorelines to limit shoreland erosion is important in order to protect the structure and functioning of the aquatic ecosystem in the Lake, and, especially, to preserve the wetland and nearshore aquatic vegetation in and around the Lake that provided habitat, shelter, and food stocks for a variety of wild and aquatic life. Such protections also contribute to preserving and enhancing water quality and the essential structure and functioning of the waterbody and adjacent areas.

Protection of shorelands can be accomplished using both physical and biological measures. Physical measures involve placing protective barriers along the water line to provide protection to the land immediately behind it. Guidance provided in the 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. Two alternative shoreline erosion control techniques are considered potentially viable: vegetated buffer strips and rock revetments or riprap. Rock revetments and various types of wooden materials are common methods that have been used historically by lakefront property owners across the State. Continued maintenance of existing revetments and other protection structures is of value. Biological methods primarily involve the planting of natural vegetation. In many areas of southeastern Wisconsin, lakefront property owners are encouraged to use vegetative buffer strips where feasible. Typically, such a method involves

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

[10]*SEWRPC Community Assistance Planning Report No. 136, 3rd Edition,* A Park and Open Space Plan for Washington County, *March 2004.*

planting a three- to five-foot-wide strip of indigenous vegetation along the shore above the water line with an adjoining two- to six-foot-wide strip of native emergent vegetation in the water. There are variations of this basic plan. Such a method serves to act not only as a means of erosion control, but has the added advantages of restoring native flora and thus maintaining habitat value, creating a natural ambiance of the lakeshore, and providing a natural filtering and trapping device for possible pollutant runoff.

These alternatives, shown in Figure 3, were considered potentially viable because: they can be constructed, at least partially, by local residents; most of the construction materials involved are readily available; the techniques, in many cases, would enable the continued use of the immediate shoreline; and, the measures are visually "natural" or "semi-natural" and should not significantly affect the aesthetic qualities of the lake shoreline. These measures may be combined with selected regrading of the eroded banks and accumulated soils, designed to facilitate navigation and recreational boating access, on a site-by-site basis. These management measures require permits from the WDNR pursuant to Chapter 30 of the *Wisconsin Statutes*.

Land Use Management

The recommended future land use condition of the drainage area tributary to Silver Lake is set forth in the adopted local and regional land use plans,[11] and the county land and water resource management plan.[12] Those plans recommend the preservation of the designated environmental corridor lands within the drainage area tributary to Silver Lake in essentially natural, open space uses. Such development as may occur is recommended to be at low densities, maintaining as much open space as practicable. Most of the wetlands and other ecological valuable lands adjacent to Silver Lake and within the drainage area tributary to Silver Lake are included within these designated environmental corridors. Hence, the protection and preservation of the environmental corridor lands is to be recommended.

Further, the adopted regional land use plan recommends that all lakes, rivers, streams, wetlands, and associated undeveloped floodlands and shorelands be placed into lowland conservancy or floodplain protection zoning districts. The existing Town of West Bend zoning for the lands in the vicinity of Silver Lake, and in the drainage area directly tributary to Silver Lake, is generally consistent with the recommended future land use pattern set forth in the regional land use plan, and generally provides for conservancy zoning of the wetland portions of the primary environmental corridor. In addition, the development of lake- and stream-front properties within unincorporated areas of Washington County, and lands annexed to incorporated areas, subsequent to February 2001, are governed by the provisions of Chapter 23 of the *Washington County Code*, which sets a graduated scale of performance standards for such development based upon the sensitivity of the waterbody to development related impacts, among other criteria:

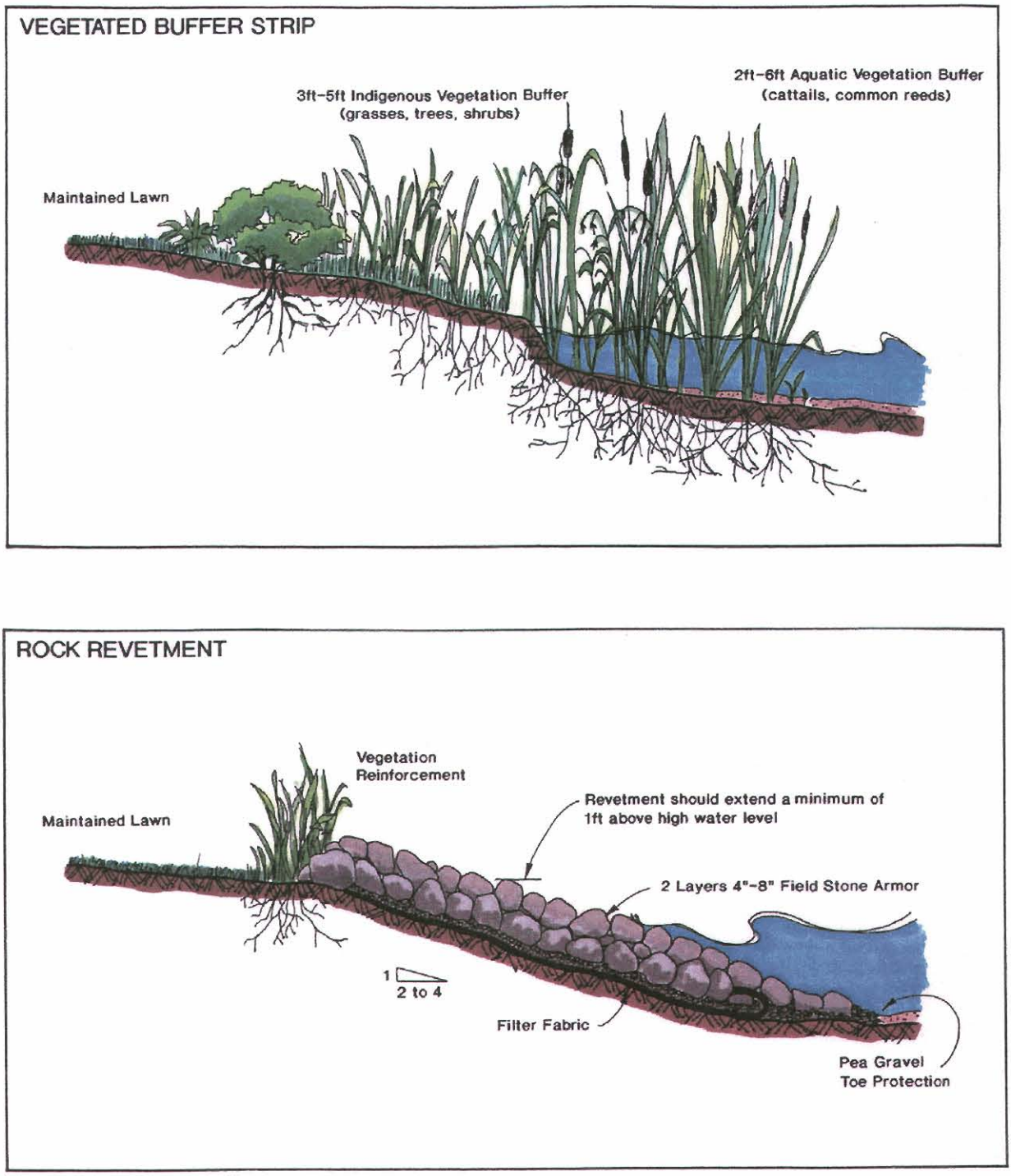
- Silver Creek is a Class I waterbody, which suggests that the stream corridor is relatively undeveloped, and potentially sensitive to development-related impacts. Consequently, lot sizes and setbacks of principle structures exceed statewide minima established pursuant to Chapter NR 115 of the *Wisconsin Administrative Code*. By requiring greater setback distances, among other provisions, the *Washington County Code* seeks to limit runoff of contaminants to the stream, thereby protecting and preserving the biological diversity and water quality of this resource. Provision for shoreland buffers, use of appropriate and environmentally friendly landscaping practices, and inclusion of stormwater management measures that provide water quality benefits are practices to be encouraged and can be considered in mitigation of development impacts on the streambank.

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

[12] *Washington County,* Washington County Land & Water Resource Management Plan: 2000-2005, op. cit.

Figure 3

PLAN 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.

- Silver Lake is classified as a Class III waterbody pursuant to the Chapter 23 of the *Washington County Code*. Class III waterbodies are subject to the statewide minima established pursuant to Chapter NR 115 of the *Wisconsin Administrative Code*. Provision for shoreland buffers, use of appropriate and environmentally friendly landscaping practices, and inclusion of stormwater management measures that provide water quality benefits are practices to be encouraged.

With respect to the future land use pattern within the drainage area tributary to Silver Lake, the adopted County and Town land use plans indicate limited future new development, much of this development being comprised of urban residential lands planned to occur on lands currently in agricultural usage. In the event of such new development occurring, conservation development practices, that maintain open space areas within the developments in the tributary drainage area to the Lake and that cluster the development beyond the shorelands of the Lake, should be encouraged. In addition, any new development within the drainage area tributary to Silver Lake should be closely scrutinized with respect to potential deleterious effects on the Lake, and appropriate and effective stormwater management and construction site erosion control practices implemented.

Some limited infilling of existing, platted lots also would be expected to occur, and the redevelopment and reconstruction of some existing single-family homes on lakefront properties may be anticipated. Such redevelopment also would suggest an increase in urban-density land uses within the drainage area tributary to Silver Lake. Such development will contribute to the subsequent increase in the pollutant loadings to the Lake associated with urbanization, and could potentially increase the pressure for recreational use of the Lake. These land use changes also have the potential to impact the quantity and quality of groundwater inflows to the Lake. To the extent that the urbanization of the drainage area contributes to the generation of urban-sourced nonpoint source pollution, implementation of effective and appropriate management measures is recommended. Recommended nonpoint source pollution control measures and water quality protection measures are set forth below.

Recommended Management Measures

In order to provide protection for ecologically valuable areas and for shoreline erosion protection, encourage natural habitat and enhance the aesthetic qualities of Silver Lake, the following recommendations are made:

- Development within the drainage area tributary to Silver Lake occur at densities consistent with those set forth in the adopted Town and County land use plans, supported by consistent and effective applications of regulations governing protection of wetlands and woodlands;

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

- Residential developments be constructed in accordance with the principles of conservation development, preserving portions of the open space on each property or group of properties considered for development and preserving the natural and cultural resources to the extent practicable;[13]

- Undeveloped areas of shoreland and Natural Areas and Critical Species Habitat be considered for acquisition through conservation easements or purchase in order to protect the viewshed and provide habitat and nonpoint source pollution control, utilizing cost-share opportunities available through the Wisconsin Department of Natural Resources, contingent upon provision of adequate public lake access;

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

- Shoreline protection structures already in existence be repaired and maintained, with new shoreline protection measures or replacement structures being comprised of vegetative buffer strips using native species, where feasible.

AQUATIC AND SHORELAND PLANT MANAGEMENT

The shoreland and aquatic macrophyte management elements of this plan consider alternative management measures consistent with the provisions of Chapters NR 103 and NR 107 of the *Wisconsin Administrative Code*. Further, the alternative aquatic plant management measures are consistent with the requirements of Chapter NR 7 of the *Wisconsin Administrative Code*, and with the public recreational boating access requirements relating to the grant program, set forth under Chapter NR 1 of the *Wisconsin Administrative Code*.

As noted in Chapter III, the presence of Eurasian water milfoil in the Silver Lake basin, and the presence of purple loosestrife in wetlands and shorelands adjoining the Lake, represents an issue of concern particularly in regards to the problems these two invasive species represent to native flora and, consequently, to the entire natural ecosystem. These invasive species also pose direct nuisance threats to humans through their deleterious effects on recreational activities and aesthetic qualities of the lake. Degradation of wetland areas as a result of purple loosestrife infestation can have serious negative consequences on the ability of these areas to perform their natural functions vital to the health of the Silver Lake ecosystem including containment of floodwaters, retention of sediments, and filtering of nonpoint pollutants. The reduction of native in-lake plants as a result of Eurasian water milfoil colonization seriously reduces the biodiversity not only of the Lake's plant population but also of the animal populations that are dependent upon them.

Array of Protection Measures

The presence of nonnative and nuisance aquatic plant species within the lake basin and along the shorelines is indicative of a further loss of ecosystem integrity and function, affecting submergent and emergent lacustrine vegetation. Various in-lake management actions may be considered to mitigate and manage the consequences of aquatic habitat degradation in Silver Lake. Generally, aquatic plant management measures, designed to minimize the environmental and recreational impacts of degraded habitat, are classed into five groups: **physical measures**, which include lake bottom coverings and water level management; **mechanical measures**, which include harvesting; **manual measures**, which include raking and hand-pulling; **chemical measures**, which include the use of aquatic herbicides; and **biological control measures**, which include the use of various organisms including insects. All of these are regulated and require a State permit; chemical aquatic plant controls are regulated under Chapter NR 107 of the *Wisconsin Administrative Code*, and all other aquatic plant management practices are regulated under Chapter NR 109 of the *Wisconsin Administrative Code*. Costs 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, for which the operational costs can approach $2,500 to $15,000 per year depending on staffing and operating policies. Harvesting is probably the measure best suited to large areas of open water, while chemical controls may be best suited for use in confined areas and for the initial control of invasive plants. Controlling Eurasian water milfoil by planting native plant species or by introducing the milfoil weevil, *Eurhychiopsis lecontei*, is largely experimental. The use of other biological controls, such as grass carp, is prohibited in Wisconsin.

Physical Measures

Lake bottom covers and screens, and the use of pea gravel and sand, provide limited control of rooted plants by creating a physical barrier which reduces or eliminates the amount of sunlight available to the plants. Placement of bottom covers on the beds of inland Lake is subject to State permitting requirements. Lake bottom covers and screens must be placed and removed annually, and can be subject to disturbance as a consequence of, among others, recreational boating activities. Placement of pea gravel or sand may require additional permitting pursuant to Chapter 30 of the *Wisconsin Statutes*, in addition to permits required under Chapter NR 109 of the *Wisconsin Administrative Code*. Lake bottom coverings are not considered a viable plant management option for Silver Lake.

Mechanical Measures

Aquatic macrophytes may be mechanically harvested with specialized equipment consisting of a cutting apparatus, which cuts up to five feet below the water surface, and a conveyor system that picks up the cut plants. These harvested plants are transported to shore where they typically are disposed of as compost on farm fields. Mechanical harvesting can be a practical and efficient means of controlling plant growth as it removes the plant biomass and nutrients from a lake. Mechanical harvesting is particularly effective as a measure to control large-scale growths of aquatic plants.

The advantages of aquatic plant harvesting are that the harvester typically leaves enough plant material in the lake to provide shelter for fish and other aquatic organisms, and to stabilize the lake bottom sediments. The disadvantages of mechanical harvesting are that the harvesting operation may cause fragmentation and facilitate the spread of some plants, including Eurasian water milfoil, and may disturb loosely consolidated bottom sediments increasing turbidity and smother fish breeding habitat and nesting sites. Disrupting the bottom sediments by plant removal also could increase the risk that an exotic species, such as Eurasian water milfoil, may colonize the disturbed area. Nevertheless, if done correctly and carefully, harvesting has been shown to be of benefit in ultimately reducing the regrowth of nuisance plants. Aquatic plant harvesting operations are subject to State permitting requirements.

Given the extent of shallow water areas needing aquatic plant management, the loosely consolidated nature of the bottom sediments in these shallow areas, and the species composition with correspondingly dense amounts of Eurasian water milfoil in these same areas, mechanical harvesting is not considered a viable management option as a control of aquatic plants in much of Silver Lake.

Manual Measures

When the water depth is inadequate to operate mechanical harvesting equipment, as in shoreline areas, manual harvesting provides a reasonable alternative technique. Manual aquatic plant harvesting also is subject to State permitting requirements, with the exception that manual harvesting of plants along a 30-foot width of shoreline within which a pier, if any, is situated, can be undertaken without a permit, pursuant to the requirements of Chapter NR 109 of the *Wisconsin Administrative Code*. Manual harvesting involves the use of specially designed rakes to remove aquatic plants. The advantage of the rakes is that they are relatively inexpensive, easy and quick to use, and immediately remove the plant material from the lake, without a waiting period. Removal of the plants from the lake avoids the accumulation of organic matter on the lake bottom, which adds to the nutrient pool that favors further plant growth. Aquatic plants harvested from the lake using manual measures must be removed from the lake. The physical removal of specific types of vegetation by selective harvesting of plants provides a highly selective means of controlling the growths of nuisance aquatic plant species, including purple loosestrife and Eurasian water milfoil.

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

Manual harvesting is recommended for use in Silver Lake when nearshore aquatic plant growths around piers are perceived to interfere with recreational boating and other active recreational activities. Hand pulling of stems, where they occur in isolated stands, also provides a viable alternative means of controlling plants, such as Eurasian water milfoil in the Lake and purple loosestrife on or near the lakeshore.

Chemical Measures

Chemical treatment with aquatic herbicides is a short-term method of controlling heavy growths of aquatic macrophytes and algae. 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.), bladderwort (*Utricularia* sp.), and naiads (*Najas* spp.). Endothall primarily kills pondweeds, but does not control such nuisance species as Eurasian water milfoil (*Myriophyllum spicatum*), while 2,4-D and fluridone are systemic herbicides that are considered to be more selective at recommended dosage rates. Systemic herbicides are absorbed by the leaves and translocated to other parts of the plants. However, 2,4-D also will kill high value species such as water lilies (*Nymphaea* sp. and *Nuphar* sp.), and fluridone will also affect coontail (*Ceratophyllum demersum*) and waterweed. 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. The disadvantages associated with chemical control include unknown long-term effects on fish, fish food sources, and humans; a risk of increased algal blooms due to the eradication of macrophyte competitors; an increase in organic matter in the sediments, possibly leading to increased plant growth, as well as anoxic conditions which can cause fish kills; adverse effects on desirable aquatic organisms; loss of desirable fish habitat and food sources; and, finally, a need to repeat the treatment the following summer due to existing seed banks and/or plant fragments.

To minimize the collateral impacts of deoxygenation, loss of desirable plant species, and contribution of organic matter to the sediments, early spring or late fall applications should be considered. Such applications also minimize the concentration and amount of chemicals used due to the colder water temperatures that enhance the herbicidal effects. Use of chemical herbicides in aquatic environments is subject to State permitting requirements. Widespread chemical treatment is not recommended as a means of controlling aquatic plant growth. Consideration should be given, however, to the use of early spring chemical controls, targeting growths of Eurasian water milfoil. Targeted herbicide applications, specifically aimed at controlling Eurasian water milfoil and purple loosestrife in and around the Lake, form a viable option for the Silver Lake community.

Biological Measures

Biological controls provide an alternative approach to controlling nuisance plants, particularly Eurasian water milfoil. Classical biological control techniques have been successfully used to control both nuisance plants and herbivorous insects.[14] Recent studies have shown that *Eurhychiopsis lecontei*, an aquatic weevil, has potential as a biological control agent for Eurasian water milfoil.[15] However, studies completed by the WDNR in Wisconsin suggest that using *Eurhychiopsis lecontei* as a means of aquatic plant management is not viable in lakes having extensive recreational boating traffic, due to wash-off and subsequent predation by fish. Consequently, it is not recommended to be undertaken on Silver Lake at this time. Biological control of aquatic plant communities is subject to State permitting requirements pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*.

In contrast, the use of biological controls for the management of purple loosestrife has proven very effective. Consequently, consideration should be given to the use of these biological control agents for managing any extensive stands of purple loosestrife that may occur around Silver Lake or along Silver Creek.

Grass carp, *Ctenopharyngodon idella*, another potential biological control, are not permitted for use in Wisconsin.

Recommended Management Measures

The following measures are recommended for implementation in order to provide for aquatic and shoreline plant community protection and management:

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[14]*C.B. Huffacker, D.L. Dahlsen, D.H. Janzen, and G.G. Kennedy,* Insect Influences in the Regulation of Plant Population and Communities, *1984, pp. 659-696; and C.B. Huffacker and R.L. Rabb, editors,* Ecological Entomology, *John Wiley, New York, New York, USA.*

[15]*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.*

- The Silver Lake Protection and Rehabilitation District should continue to monitor the Lake and surrounding wetlands on a three- to five-yearly basis for the presence or spread of nuisance plant species, such as Eurasian water milfoil and purple loosestrife.

- Manual harvesting of plants around piers and docks is the recommended means of controlling milfoil and other nuisance species of plants in those areas given the small size of the Lake. In this regard, the District could consider purchasing several specialty rakes and/or landscape rakes designed for the removal of vegetation from shoreline property and make these available to riparian owners. This would allow the riparian owners to use the rakes on a trial basis before purchasing their own. The rakes cost approximately $90 each, and do not require a permit for use when used along no more than a 30-foot length of shoreline within a 100-foot-wide property and the harvested material removed from the Lake.

- Early spring or late fall herbicide treatments to control the growth of Eurasian water milfoil are recommended. Early spring herbicide applications using a selective herbicide such as 2,4-D would specifically target Eurasian water milfoil, as this plant commences its growing period at lower water temperatures than the native plants also affected by these chemical control agents, and early spring herbicide treatments reduce the biomass subject to decomposition and limit the accumulation of organic materials on the lake bottom. The cost of chemical herbicide treatments in Southeastern Wisconsin is about $500 per acre treated. The application of such chemical control agents would require the issuance of a WDNR herbicide application permit, and the application should be carried out by a licensed applicator.

- Recreational boating activity is recommended to be limited in areas where Eurasian water milfoil populations are abundant and fragmentation of the plants from propellers could lead to the spread of this nuisance species. Plant fragments resulting from either manual harvesting or boating activities should be collected and removed from the water.

- It is recommended that the success of the current aquatic plant management program be evaluated every three to five years in order to track the effects of changes in the tributary drainage area that may affect Silver Lake and its aquatic plant community.

- The Silver Lake Protection and Rehabilitation District, through an educational and informational program, should promote awareness of good urban housekeeping practices and the invasive nature of such exotic, nonnative species as Eurasian water milfoil and purple loosestrife among lake residents, visitors, and watershed residents. Participation in citizen-based control programs coordinated by the Wisconsin Department of Natural Resources and University of Wisconsin-Extension should be encouraged.

FISHERIES MANAGEMENT

Few data on the fisheries of Silver Lake are available. Notwithstanding, as is noted in Chapter III, fishing is a popular pastime on Silver Lake. Silver Lake appears to be able to provide a suitable habitat for a warmwater fishery with adequate water quality and dissolved oxygen levels that can contribute to the maintenance of a fish population that is dominated by desirable sport fish. To this end, a more rigorous fisheries survey should be considered in order to better identify fish population composition, length-weight distributions, community age structure, and related life history information, such as proportion of available spawning habitat, spawning success, and juvenile recruitment, that will be important for making stocking-related decisions. Assistance in stocking programs and fisheries management is available through the Wisconsin Department of Natural Resources, as well as privately available from local commercial hatcheries. Fish stocking may require a Wisconsin Department of Natural Resources permit.

Array of Protection Measures
Habitat protection refers to a range of conservation measures designed to maintain existing fish spawning habitat. These measures include restricting recreational and other intrusions into gravel-bottomed shoreline areas during the spawning season (for bass this is spring, mid-April to mid-June), use of natural vegetation in shoreland management zones, and other "soft" shoreline protection options that aid in habitat protection. These latter measures are discussed further below, in respect to their use in shoreline protection and management.

Species composition management refers to a group of conservation and restoration measures that include the stocking of desirable species designed to enhance the angling resource value of a lake. The mixture of species is determined by the stocking objectives. These are usually to: supplement an existing population, maintain a population that cannot reproduce itself, add a new species to a vacant niche in the food web, replace species lost to a natural or man-made disaster, or establish a fish population in a depopulated lake. Enforcement of state fishing regulations is important to the success of any sound fish management program. Such requirements provide an opportunity for both game and forage fish population to reach a sustainable level.

In addition, the conduct of periodic creel surveys using volunteer monitors can provide a cost-effective means of obtaining additional data on the fish populations and fisheries in Silver Lake. Alternative approaches to the conduct of this type of survey could include creel census-takers stationed at the boat access site, the distribution of questionnaires to riparian households, and similar voluntary reporting mechanisms. A sample citizen-based survey is provided in Appendix D.

Recommended Management Measures
The following measures are recommended in order to assess and manage the fish community of Silver Lake:

- Periodic monitoring of fish populations is recommended to be conducted to determine when adequate food stock populations for predatory fishes have been established and are stable.

- Residents should consider participating in volunteer creel surveys so that an ongoing monitoring of the fish population in Silver Lake can be carried out.

- Wisconsin fishing regulations should continue to be enforced by the Wisconsin Department of Natural Resources.

Fish surveys and other fisheries services offered by the Wisconsin Department of Natural Resources would be contingent, in part, upon the existence of adequate parking facilities to meet Chapter NR 1 public recreational boating access standards.

PROVISION OF PUBLIC RECREATIONAL USE OPPORTUNITIES

In addition to the structural shoreline protection measures set forth above, consideration could be given to adoption of a refined recreational boating ordinance. The proposals concerning the establishment of slow-no-wake zones within the shallow areas of the Lake, those areas with a water depth of less than five feet, should be considered to protect sensitive shorelines from erosion and human disturbances and contribute to the quality recreational experiences afforded by the waterbody. In addition, provision of additional recreational opportunities within the lake-oriented community should be considered, as discussed below.

Provision for Navigation
In response to resident concerns over perceived loss of lake depth, primarily along the western and southern shorelines and in the northwestern "kettle," modeling studies to further define possible loss of lake depth were undertaken by the U.S. Geological Survey and reported to the Silver Lake Protection and Rehabilitation District

during 2003.[16] Examination of groundwater flows in the area of Silver Lake provided data helpful in quantifying the rate of deposition of marl within the lake basin. Marl deposition, together with yard waste and leaf litter, natural leaf falls and development site runoff, may pose a sedimentation problem in Silver Lake with concomitant impacts of recreational boating and related water uses.

Array of Protection Measures

The impact of sediment accumulation on recreational boating access to Silver Lake was a major concern to residents. Subsequently, affected homeowners and householders have proposed removal of sediments to enhance recreational boating access from private piers. Removal of materials from the bed of a navigable stream or lake requires a Wisconsin Department of Natural Resources permit pursuant to statutory authority set fourth in Chapter 30 of the *Wisconsin Statutes*, as elaborated pursuant to Chapter NR 347 of the *Wisconsin Administrative Code*.

Prior to consideration of dredging as a lake management alternative for Silver Lake, it is recommended that the shoreline protection measures set forth above be implemented to the fullest extent practicable. That being accomplished, it is recommended that consideration be given to the extension of piers and docks into deeper water. Wisconsin Department of Natural Resources guidance suggests that piers of up to six feet in width may generally be extended to a water depth of about three feet without a permit. A permit may be required if the pier is deemed to potentially obstruct navigation, extend beyond the owner's riparian zone, exceed the typical density of piers and docks for a portion of shoreland, or involve any unusual dimensions, materials, or designs. It should be noted that, while placement of a pier is generally inherent in a landowner's riparian rights, the Wisconsin Department of Natural Resources may withhold a permit in cases where it is determined that the placement of a pier may negatively affect navigation, aquatic and wildlife habitat, and other "public interests" in a waterway.[17]

Implementation of the foregoing nonpoint source management measures will address future delivery of sediments and other contaminants to the Lake, and minimize further loss of lake depth consequent on these loadings. However, in those portions of the lake basin where past loadings continue to limit recreational boating access to Silver Lake, the landowners may consider the construction of a shared boating channel of not more than 50 feet in width and five feet in depth to facilitate access to the deeper water portions of the Lake.[18] As noted, such an action would require a Wisconsin Department of Natural Resources permit. In making application for such a permit, the affected landowners would have to demonstrate that they have made a reasonable effort, to the extent practicable, to minimize the introduction of new materials into the Lake. Such efforts should include provision of shoreland vegetated buffer strips, and address other regulatory concerns as required pursuant to Chapter NR 347 of the *Wisconsin Administrative Code*.

To this end, consideration of the degree and rate at which marl deposition is occurring becomes an important determinant of the likely efficacy of any dredging project in the Lake. While control of marl formation in the lake basin is not practicable, the rate of deposition of this material is critical to the "success" or otherwise of a dredging project. Based upon the inventory data presented above, it would appear that the removal of accumulated materials along the western and southern shores of the Lake to provide for recreational boating access could be a feasible alternative. Providing recreational boating access consistent with the guidelines would provide relief for a period in excess of 10 years, which period may be considered to be a reasonable period over which a dredging project could be financed. There are currently no grant programs available that provide financial assistance to local homeowners desirous of undertaking a private dredging project.

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[16] *U.S. Geological Survey, Water-Resources Investigations Report 02-4204,* op. cit.

[17] *Paul G. Kent and Tamara A. Dudiak,* Wisconsin Water Law: A Guide to Water Rights and Regulations, Second Edition, *University of Wisconsin, 2001, 212 pp.*

[18] *Wisconsin Department of Natural Resources Publication No. PUBL-CA-004 200 REV,* Guidelines for the Recreational Boating Facilities Program, *2001.*

Cost-share schemes adopted by other lake organizations, such as the Little Muskego Lake Management District and Linnie Lac Lake Management District, both located in Waukesha County, have included contributions by these districts in partnership with the local landowners and other community organizations. These arrangements reflect the fact that provision of navigational channels provides benefit primarily, but not exclusively, to the riparian landowners. Navigational channels also may be presumed to benefit, to a lesser degree, other recreational boating users on the waterbody.

Factors that potentially mediate against the use of widespread dredging as a lake management measure include the paucity of potential dredge spoils disposal sites in close proximity to the Lake. Consideration had been given by the Silver Lake Protection and Rehabilitation District to the acquisition or utilization through easement of vacant lands located in close proximity of the southwestern shoreline of the Lake, within a former gravel quarry located near the intersection of CTH NN and CTH Z. Such lands have been used for disposal of dredge spoils by other lake communities, and the organic rich nature of typical dredge spoils often provides benefit to the quarry owner in restoring and rehabilitating the sand and gravel soils of these quarrying operation sites. However, based upon land development proposals recently submitted to the Town of West Bend, it would appear that this site may no longer be available for such a purpose.

The lack of a dredge spoil disposal site in proximity to the Lake imposes severe constraints on the economic feasibility of dredging as a management measure. Notwithstanding, costs of removal of sediment from the lakebed are estimated to range upwards from about $5.00 per cubic yard, with disposal costs ranging between $10 and $15 per cubic yard of spoils or more, depending upon the distance required to be traveled prior to final disposal. Dredging and disposal of dredge spoil is regulated under Chapter NR 347 of the *Wisconsin Administrative Code*. Where hydraulic dredging is contemplated, a Wisconsin Pollutant Discharge Elimination System (WPDES) permit also may be required pursuant to Chapter 283 of the *Wisconsin Statutes* if the water used to create the dredge slurry and convey the spoils to the disposal site is proposed to be returned to a navigable water of the State. For these reasons, while some small scale shoreline dredging, especially along the southern shore of the Lake and in the navigational channels linking the "kettle" with the main lake basin, may be warranted, large-scale dredging is not recommended.

Additional actions can be undertaken to minimize nutrient and pollutant loadings from source areas within the drainage area tributary to Silver Lake. Based upon the aforereferenced findings of the U.S. Geological Survey, residential lawns can form a major source of phosphorus to watercourses in urban areas. In some cases, this phosphorus source is enhanced as a consequence of the lawn care practices employed by householders within the drainage area. For this reason, informational programming directed at alternative and appropriate lawn care practices should be provided within this rapidly urbanizing drainage area. Such programming should be predicated upon a knowledge of the soil chemistry and soil nutrient requirements for urban residential lawns and gardens. These nutrient requirements can be determined through a relatively simple soil testing procedure conducted by the University of Wisconsin-Extension. Soil test results allow householders to apply appropriate levels of fertilization to their lawns and gardens, generally saving the householder some level of expense and effort, while providing additional protections to the Lake. In addition, distribution of lawn care pamphlets within the drainage area, providing information on composting, yard care, and maintenance of the grassed swale stormwater system, would apprise householders of alternative means of maintaining their properties for water quality purposes.[19]

Programming should also be developed to keep the householders in the Silver Lake community informed of the current state of their Lake's water quality. To this end, participation in the Wisconsin Department of Natural Resources Self-Help Program is recommended as a means of assessing the health of Silver Lake on a regular basis. Such programs not only supplement the more detailed analysis provided by the U.S. Geological Survey TSI water quality monitoring program, but also can provide an early warning of undesirable changes in lake water

[19] *University of Wisconsin-Extension Publication No. GWQ007,* Practical Tips for Home and Yard, *1993, and related publications in the "Yard Care and the Environment" series.*

quality. Additional data compiled from regular, three- to five-yearly interval surveys of the aquatic species composition form an important complementary assessment tool. Review of these data annually by the Silver Lake Protection and Rehabilitation District Board of Commissioners can permit the District, and the Town, to initiate appropriate responses in a timely manner.

Recommended Management Measures
The following measures are recommended to be considered in the establishment and maintenance of navigational access within Silver Lake:

- Consideration should be given to the establishment of navigational lanes of adequate depth to facilitate public recreational boating use within Silver Lake.

- Creation of appropriate public-private partnerships to establish and maintain appropriate water depths within navigational lanes should be considered, taking into account both the public use and private benefits likely to accrue.

Provision of Public Recreational Boating Access
Chapter NR 1 of the *Wisconsin Administrative Code* establishes recreational boating access standards for Wisconsin lakes. These standards define adequate access in terms of maximum and minimum numbers of parking facilities to be provided for public recreational boating access, and are determined based upon the boatable surface acreage of a waterbody.

Array of Protection Measures
Currently, Washington County has constructed a recreational boating access for the Lake, consistent with the recreational boating access standards set forth in Chapter NR 1 of the *Wisconsin Administrative Code,* on the eastern shore of the Lake adjacent to the "Kettle." This site abuts a relatively shallow water area of the Lake. While provision of navigational channels servicing this public recreational boating access site is subject to the same permitting requirements as those applicable to private recreational boating access, cost-share funds may be available to Washington County for construction of a navigational channel under the recreational boating facilities grant program as set forth in Chapter NR 7 of the *Wisconsin Administrative Code*.[20] Thus, while large scale dredging is not recommended, consideration should be given to enhancing public recreational boating access and improving navigational safety in the channel adjacent to the proposed public recreational boating access site linking the main body of the Lake and the "Kettle," by ensuring that adequate depth and area is provided to allow for launching and recovery operations and maneuvering of watercraft in this area. Notwithstanding, while the development of appropriate navigational lanes, as discussed above, appears to be feasible, the lack of a readily accessible spoils disposal site may limit the implementation of such actions. In addition, should such navigational channels be created, provision of appropriate navigational markers, as discussed below, is recommended to ensure that recreational boating traffic remain within the demarcated traffic lanes. Placement of regulatory markers requires that the markers conform to the specifications set forth in Chapter 30 of the *Wisconsin Statutes*, and that such placement be authorized by Wisconsin Department of Natural Resources permit.

Recommended Management Measures
The following measures are recommended to be considered in the provision of public recreational boating access to Silver Lake:

- The proposed Washington County public recreational boating access site should be developed in accordance with applicable Wisconsin Department of Natural Resources guidelines and statutes.

[20]Ibid.

- Consideration should be given to the establishment of adequate depths of water to sustain navigation in and around this site, with placement of appropriate buoyage and signage being included as part of the access site development project.

Regulation of Boating Activity—Ordinance Development and Signage

Array of Protection Measures

The promulgation of more stringent controls on the use of powered watercraft within Silver Lake is one means of regulating the effects of boating activity that could be harmful to ecologically valuable areas of the Lake. Control of boating traffic in the southern portion of the Lake would have the advantage of better regulating the movements of boat traffic in this area. Such regulation would potentially limit the spread of Eurasian water milfoil by minimizing the potential for boat propellers fragmenting the plant and distributing the fragments to new locations in the lake basin.

Boat exclusion areas, slow-no-wake zones, and boating access channels must be designated by approved regulatory markers. Boat exclusion areas are generally preferable to motorboat prohibition areas as the latter can lead to legal challenges based on the right of free use of navigable water. Similarly, slow-no-wake restrictions are preferable to speed limits designated in miles per hour terms owing to implementation and enforcement considerations. 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*. Where necessary, such ordinances should be supported by appropriate regulatory marker buoys.

Placement of regulatory markers must conform to Section NR 5.09 of the *Wisconsin Administrative Code*, and buoys placed within waters of the State of Wisconsin are subject to the requirements set forth in Chapter 30, *Wisconsin Statutes*. Such buoys are white in color, cylindrical in shape, seven or more inches in diameter, and extend 36 or more inches above the water line. Two general types of buoyage exist: *regulatory buoys*, such as those used to demarcate slow-no-wake or exclusionary areas; and *informational buoys*, such as those used to enhance public awareness. Regulatory buoys include buoys used to demarcate restricted areas, prohibit boating or types of boating activity in specific areas, and control the movement of watercraft. Whereas regulatory buoys are enforceable, informational buoys are not. Local authorities have jurisdiction over the waters involved. Although buoyage has the advantages of being visible to recreational boaters and clearly demarcating the affected areas, it can be expensive to obtain, install, and maintain. Funding for aids to navigation and regulatory markers is available to governmental units and qualified lake associations through the Wisconsin Department of Natural Resources in accordance with NR 7.087 of the *Wisconsin Administrative Code.*

Recommended Management Measures

Controls on boat traffic could be put in place using the following options:

- Enforcement of slow-no-wake operation of motorized boats within a specific distance of the shoreline, such as within the "shore zone," which is defined as within 100 feet of pierheads or 150 feet of the shoreline, in the case of personal watercraft, as defined in the Wisconsin Department of Natural Resources boating ordinance guidelines.

- Designation of a navigational watercraft access route to open water from the public boat launch, approximately 50 feet in width, to limit boating impacts on the lake substrate and aquatic vegetation in the shallow southern portion of the Lake.

- Limitation of the speed at which boat traffic travels in the shallow portions of the Lake, by designation of a "slow-no-wake" area or application of some other form of "speed restriction" in water depths of less than five feet, such a zone within Silver Lake could extend up to a distance of approximately 400 feet from the shoreline include the entire northern portion of the Lake known as the "Kettle," and would be designed to avoid damage to aquatic vegetation from motorboat propeller-induced sheer.

It should be noted that provision of fish surveys and other fisheries services offered by the Wisconsin Department of Natural Resources is contingent, in part, upon the existence of adequate parking facilities to meet the Chapter NR 1 public recreational boating access standards.

It is further recommended that the District adopt a complementary ordinance governing the use of the Lake during the winter months.[21]

PUBLIC INFORMATIONAL PROGRAMMING

In addition to the lake management measures specifically identified and set forth above, an ongoing campaign of community information will support the lake management program by encouraging the use of shoreland buffer strips, the responsible use of household and garden chemicals, and the adoption of environmentally friendly household and garden practices to minimize the input of nutrients from these riparian areas is recommended. Lake 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 the environmental impacts. Removal of aquatic vegetation can reduce or eliminate fish and wildlife habitat to the detriment of both active and passive recreational uses of the lake. Thus, public information is an important component of a lake management program. Posters and pamphlets are available from the University of Wisconsin-Extension and Wisconsin Department of Natural Resources that provide information about and illustrations of aquatic plants, detailing their importance in providing habitat and food resources aquatic environments, and explaining the need to control the spread of undesirable and nuisance plant species. Similar information is available to support good urban yard care practices which directly affect the generation and transport of nutrients and other contaminants from riparian lands to a lake. The actions recommended to be supported by a public informational campaign can be undertaken by individual householders and landowners within the drainage area tributary to Silver Lake, and will directly contribute to the lake protection program being implemented by the Silver Lake Protection and Rehabilitation District.

SUMMARY

This plan, which documents the findings and recommendations of a lake protection planning study requested by the Silver Lake Protection and Rehabilitation District, examines existing and anticipated conditions and potential management problems of Silver Lake and presents a recommended plan for the resolution of these problems.

Silver Lake was found to be a mesotrophic, moderately deep water lake of good water quality located in close proximity to the Milwaukee metropolitan area and adjacent to a progressively urbanizing part of Washington County in which its tributary drainage area is entirely located. Surveys indicated that the Lake and the tributary drainage area contain significant areas of ecological value, including numerous wetlands and high-quality wildlife habitat. The Lake has adequate public recreational boating access pursuant to Chapter NR 1 of the *Wisconsin Administrative Code*.

The Silver Lake protection plan, summarized in Table 8 and depicted graphically on Map 13, recommends actions be taken to limit further human impacts on the in-lake macrophyte beds and reduce human impacts on the ecologically valuable areas adjacent to the Lake and in its watershed. The plan recommends only limited aquatic plant management action, including selected manual removal and surveillance activities at this time, mainly in the cases where purple loosestrife and Eurasian water milfoil are present, with the limited use of chemical treatment only to treat such species, if needed. Additional and periodic future fishery surveys are also recommended.

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[21] *The Silver Lake Protection and Rehabilitation District adopted Ordinance 2005-1, "Regulation of Activities on the Ice of Silver Lake, Town of West Bend," on October 20, 2005, pursuant to authorities delegated to the District by the Town of West Bend under Section 30.81 of the* Wisconsin Statutes.

Table 8

RECOMMENDED LAKE PROTECTION PLAN ELEMENTS FOR SILVER LAKE

Plan Element	Subelement	Location	Management Measures	Management Responsibility
Protection of Ecologically Valuable Areas	Land Use Management[a]	Entire watershed	Observe guidelines in the regional and local land use plans, and Washington County land and water resource management plan; protect environmentally sensitive lands and consider public acquisition as recommended in the regional natural areas and critical species habitat protection and management plan; encourage conservation development practices in the lake drainage area; protect and preserve groundwater recharge areas	Washington County, Town of West Bend
		Shoreland areas	Review development proposals for impacts on the Lake; consider acquisition of conservation easements and shoreline properties to protect the viewshed and provide continued nonpoint source pollution control; repair and maintain shoreline protection structures using vegetative buffer strips where feasible	Washington County, Town of West Bend, Silver Lake Protection and Rehabilitation District
Nonpoint Source Pollution Control	Public sanitary sewage system management	Entire watershed	Periodically review current public sanitary sewer service area plan to continue to provide waterborne sewerage services to urban areas	Washington County, Town of West Bend, Silver Lake Sanitary District
	Urban nonpoint source controls	Developed areas	Promote sound urban housekeeping and yard care practices through informational programming	Washington County, Town of West Bend, Silver Lake Protection and Rehabilitation District
		Developing areas	Enforce construction site erosion control, stormwater management, and development control ordinances and programs, as necessary	Washington County, Town of West Bend, Silver Lake Protection and Rehabilitation District
		New clustered developments in conservation subdivisions	Develop and enforce construction site erosion control and stormwater management ordinances; review ordinances for concurrency with proposed NR 152	Washington County, Town of West Bend
	Rural nonpoint source controls	Entire watershed	Promote sound rural land management practices to reduce soil loss and contaminant loadings in accordance with the county land and water resource management plan	WDATCP, Washington County
Aquatic and Shoreland Plant Management	Manual harvesting[b]	Areas of nuisance growth around piers, docks, and beaches; and wetlands	Harvest nuisance plants, including Eurasian water milfoil and purple loosestrife, as required around docks and piers, and in shoreland areas, especially during summer and fall; collect plant fragments arising from boating and harvesting activities; may be subject to WDNR permits	Silver Lake Protection and Rehabilitation District, private lakeshore homeowners, WDNR
	Chemical control	Areas of nuisance growth around piers, docks, and beaches; and wetlands	Consider use of herbicides to control nonnative vegetation in and around the developed portions of the Lake; consider an early spring treatment to control Eurasian water milfoil growth, subject to WDNR permits	Silver Lake Protection and Rehabilitation District, WDNR
	Nonnative aquatic plant management program	Eurasian water milfoil control zone and areas containing purple loosestrife	Limit recreational boating through Eurasian water milfoil areas to minimize the spread of the plant; consider use of herbicides in spring, and manual removal during summer and fall; conduct periodic plant surveys every three to five years to monitor the presence or spread of nuisance species and the effectiveness of the aquatic plant management program; WDNR permits may be required for control actions	Silver Lake Protection and Rehabilitation District, WDNR

Table 8 (continued)

Plan Element	Subelement	Location	Management Measures	Management Responsibility
Protection of Water Quality	Shoreland erosion	Shoreland areas	Construct, maintain and repair structures where needed; where new or replacement of shoreline protective structures are necessary, use vegetative buffer strips where feasible	Silver Lake Protection and Rehabilitation District and private lakeshore homeowners
	Sediment deposition	Western and southern shore areas and northwestern "kettle"	Establish shoreline protection structures to the extent possible to limit inflows of contaminants; extend piers and docks per WDNR guidelines; consider removal of accumulated bottom sediments in limited areas where deposition impinges on recreational boating access	Washington County, Town of West Bend, Silver Lake Protection and Rehabilitation District, WDNR, private lakeshore and shoreland homeowners
	Water quality monitoring	Entire Lake	Participate in the WDNR Self-Help monitoring program; monitor any changes in the aquatic plant community as an indication of changes in water quality	Silver Lake Protection and Rehabilitation District
Recreational Use Management	Public Recreational Boating Access	Eastern shoreline	Maintain the Washington County public boating access site and provide adequate parking facilities to meet Chapter NR 1 public recreational boating access standards; provide adequate water depth, signage and appropriate buoyage	WDNR, Washington County
	Recreational use zoning	Entire Lake	Enforce slow-no-wake ordinance within 100 feet of shoreline; 150 feet for personal water craft; enforce the ice ordinance; develop and refine ordinances as appropriate	WDNR, Town of West Bend, Silver Lake Protection and Rehabilitation District
Fisheries Management	Fisheries	Entire Lake	Conduct periodic fisheries surveys to determine the status of the fishery; consider developing a Lake resident volunteer creel census program; continue to enforce WDNR fishing regulations; protect fish habitat	WDNR, Silver Lake Protection and Rehabilitation District
Informational and Educational Opportunities	Protection of shoreline	Shoreline areas	Provide residents with information on methods of proper construction and maintenance of shoreline protection structures; conduct workshops for riparian homeowners on vegetative buffer strip development/installation	Silver Lake Protection and Rehabilitation District
	Monitoring programs[c,d]	Entire Lake	Periodic expanded WDNR Self-Help program for water quality monitoring; conduct aquatic plant survey every three to five years; conduct fish survey every five to 10 years	WDNR, Silver Lake Protection and Rehabilitation District
	Public informational programming	Direct drainage area tributary to Silver Lake	Continue public awareness and informational programming on good urban housekeeping practices and invasive species	Silver Lake Protection and Rehabilitation District, University of Wisconsin-Extension

[a]*Land use recommendations are those set forth in the regional land use, water quality management, and natural areas and critical species habitat protection and management plans. No specific costs allocated to the Silver Lake Protection and Rehabilitation District.*

[b]*Measures recommended generally involve low or no cost and would be borne by private property owners. Cost is included under public informational and educational component.*

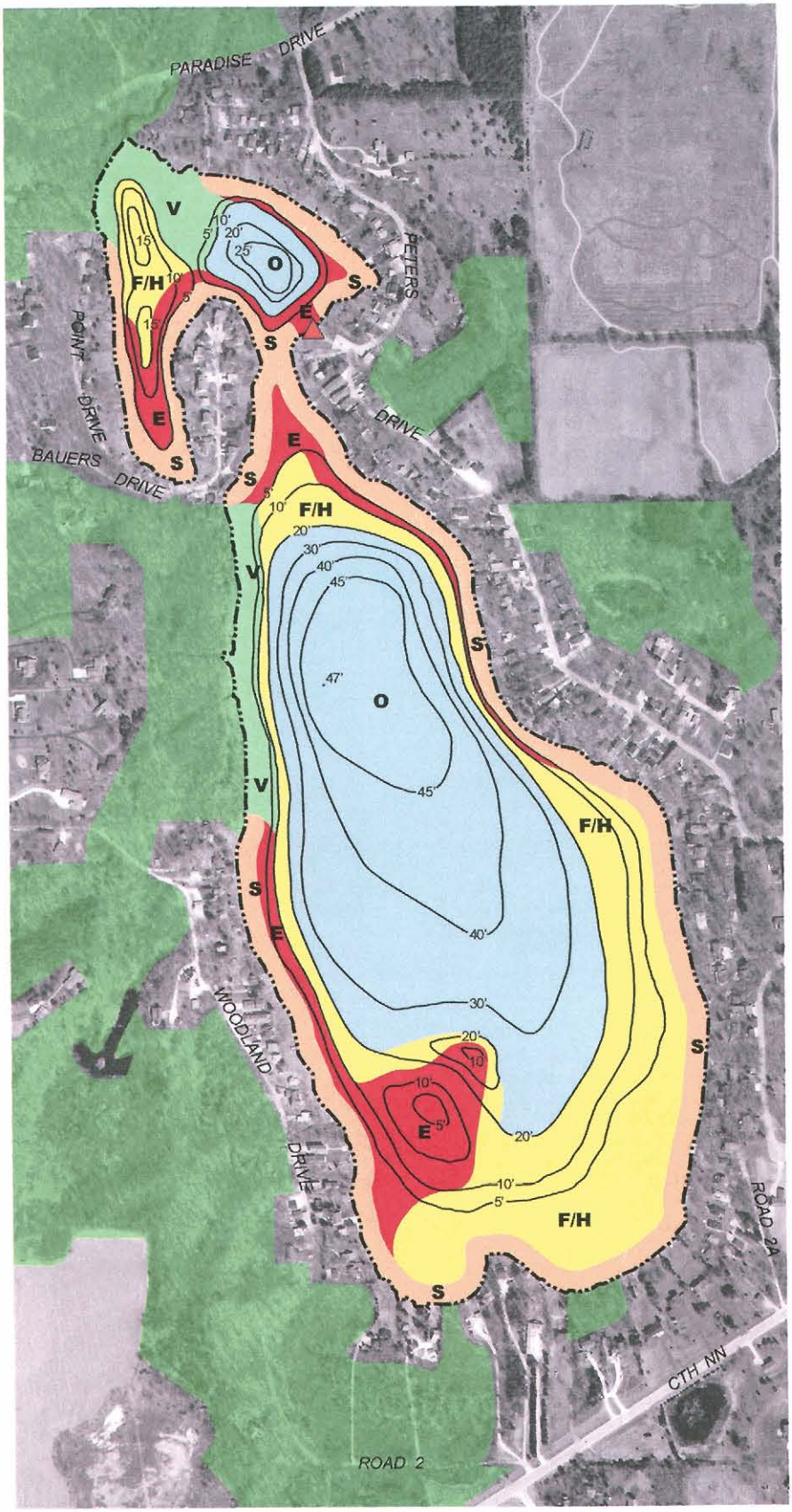
[c]*Partial funding available through the Wisconsin Department of Natural Resources grant programs.*

[d]*Periodic additional surveys are recommended annually for water clarity, and at three- to five-year intervals for aquatic plant communities, and five- to 10-year intervals for fish communities.*

Source: SEWRPC.

Map 13

RECOMMENDED LAKE MANAGEMENT PLAN FOR SILVER LAKE



—20'— WATER DEPTH CONTOUR IN FEET

PROPOSED PUBLIC RECREATIONAL BOATING ACCESS SITE

LAKE MANAGEMENT ZONES

O OPEN WATER RECREATIONAL ZONE

S SHORELAND ZONE
HARVESTING: MANUAL, HIGH PRIORITY
HERBICIDES: LOW/MODERATE PRIORITY

E EURASIAN WATER MILFOIL CONTROL ZONE
HARVESTING: MANUAL, AS NEEDED
HERBICIDES: HIGH PRIORITY

V ECOLOGICALLY VALUABLE ZONE
HARVESTING: NONE
HERBICIDES: NONE (CONTROL OF NONNATIVE SPECIES ONLY)

F/H FISH AND HABITAT ZONE
HARVESTING: LOW PRIORITY
HERBICIDES: NONE (CONTROL OF NONNATIVE SPECIES ONLY)

LAND USE MANAGEMENT

ENVIRONMENTAL CORRIDORS AND VALUABLE AREA

WATERSHED MANAGEMENT

- PROMOTE GOOD URBAN HOUSEKEEPING PRACTICES

WATER QUALITY MANAGEMENT

- CONTINUE MONITORING
- CONDUCT FISH SURVEY

SHORELINE PROTECTION

- MAINTAIN AND REPAIR EXISTING STRUCTURES

INFORMATION PROGRAMMING

- CONTINUE PUBLIC AWARENESS PROGRAM

GRAPHIC SCALE
0 350 700 FEET

DATE OF PHOTOGRAPHY: APRIL 2000

Source: SEWRPC.

The plan includes recommendations for mitigation of perceived loss of water depth in certain areas of the Lake and for continuation of an ongoing program of public information and education providing riparian residents and lake users. For example, additional options regarding household chemical usage, lawn and garden care, shoreland protection and maintenance, and recreational usage of the Lake should be made available to riparian householders, thereby providing riparian residents with alternatives to traditional alternatives and activities. Periodic, ongoing monitoring of lake water quality is recommended as part of this program.

This recommended plan seeks to balance the demand for high-quality residential and recreational opportunities at Silver Lake with the requirements for environmental protection of the Lake.

APPENDICES

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Appendix A

REPRESENTATIVE ILLUSTRATIONS OF AQUATIC PLANTS FOUND IN SILVER LAKE

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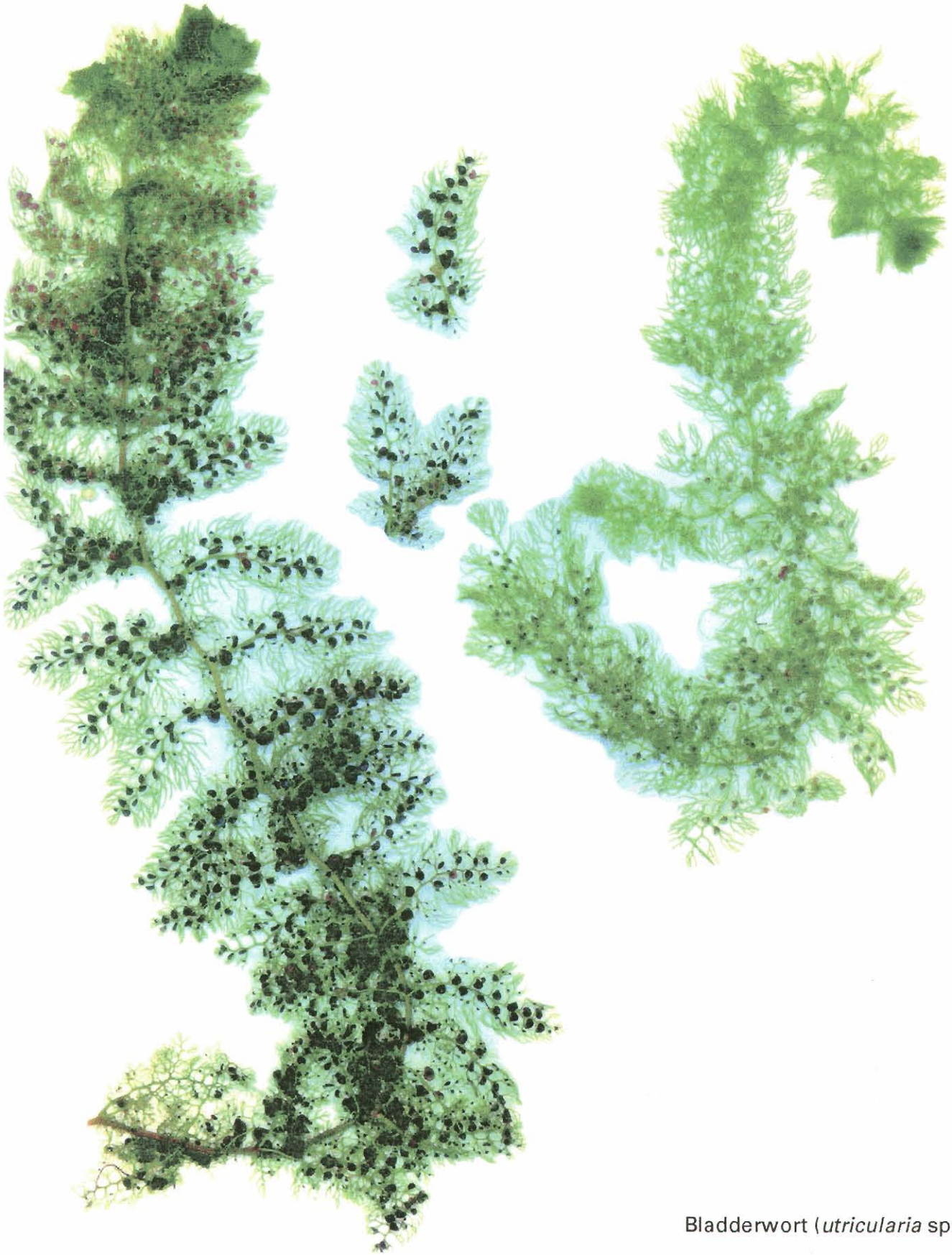
Flat-Stem Pondweed (*potamogeton zosteriformis*)



Bladderwort (*utricularia* sp.)

Floating-Leaf Pondweed (*potamogeton natans*)

Coontail (*ceratophyllum demersum*)

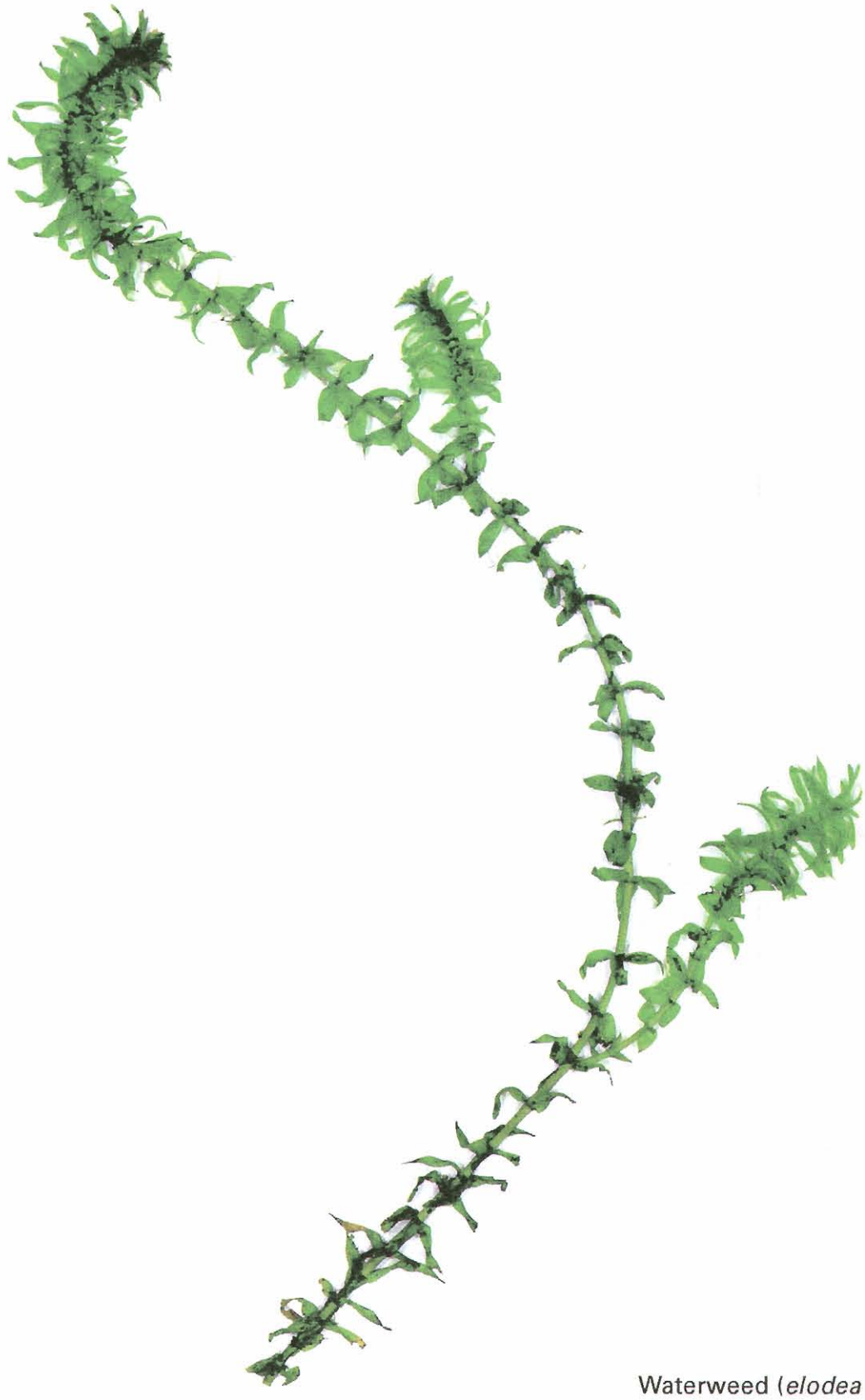
Large-Leaf Pondweed (*potamogeton amplifolius*)

Eel Grass / Wild Celery (*valisneria americana*)

Sago Pondweed (*potamogeton pectinatus*)

Muskgrass (*chara vulgaris*)

Variable Pondweed (*potamogeton gramineus*)



Waterweed (*elodea canadensis*)

Bushy Pondweed (*najas flexilis*)

Water Stargrass (*zosterella dubia*)

Eurasian Water Milfoil (*myriophyllum spicatum*)

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Appendix B

BOATING ORDINANCES APPLICABLE TO SILVER LAKE

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SILVER LAKE

BOATING REGULATIONS

1.01 GENERAL PROVISIONS.

(1) APPLICABILITY. The provisions of this chapter shall apply to the waters of Silver Lake, located in the Town of West Bend, Washington County, Wisconsin.

(2) PURPOSE. The purpose of this chapter is to promote the public health, safety and general welfare of the Silver Lake Protection and Rehabilitation District ("SLPRD").

(3) DISTRICT NAME CHANGE. The name of the District known as the Silver Lake Inland Lake Protection and Rehabilitation District ("SLILPRD") is hereby changed to Silver Lake Protection and Rehabilitation District ("SLPRD").

(4) AUTHORITY. This chapter is adopted by the Silver Lake Protection and Rehabilitation District, exercising the powers granted it by resolution of the Town Board of the Town of West Bend pursuant to §30.77(3)(am)1, of the Wisconsin Statutes.

1.02 INTERPRETATION. The section of this chapter pertaining to the use, operation or equipment of boats, and other vehicles as well as the activities which are regulated by §§30.50 through 30.71 and §30.80 Wis. Stats., and rules and regulations of the Department of Natural Resources established pursuant thereto are hereby adopted by reference and shall be construed and interpreted, if possible, to be consistent with and not contrary to said statute sections, rules and regulations nothing to the contrary herein notwithstanding.

1.03 ENFORCEMENT. The provisions of this chapter shall be enforced by the officers of the Silver Lake Water Safety Patrol ("SLWSP"). The Chief and other members of the SLWSP shall be hired or contracted for by the Board of Commissioners of the SLPRD.

1.04 DEFINITIONS.

(1) BOAT OR VESSEL. Every description of watercraft used or capable of being used as a means of transportation on water, except a seaplane on the water or a fishing raft. A boat or vessel includes a personal watercraft.

(2) PERSON. Includes individual, firm, partnership, corporation or any other association of individuals organized together for any purpose whatsoever.

(3) PERSONAL WATERCRAFT. A motorboat that uses an inboard motor powering a water jet pump or a caged propeller as its primary source of motive power and that is designed to be operated by a person standing on, kneeling on or sitting astride the watercraft.

(4) SHOREZONE. The surface of the lake that is within 150 feet from and parallel to the shore. Provided, however, that on any part of said lake where the distance between the opposite shores is such that the foregoing formula is impossible or impracticable in application, then the shorezone shall be as indicated by buoys placed for that specific purpose. The northern portion of Silver Lake known as the kettle is designated as a shorezone for the purpose of this ordinance.

(5) SLOW-NO-WAKE SPEED. When used herein, slow-no-wake speed means that speed at which a boat moves as slowly as possible while still maintaining steerage control.

(6) WATER SKIING AND WATER SKIER. A person being towed by a motor boat, on water skis, aquaplane, wake boards, tubing or similar device.

(7) WATER TRAFFIC. All moving objects controlled by a person or persons or agent of a person on the surface of the lake.

1.05 WATER TRAFFIC LANES.

(1) DEFINED. The surface of the main lake basin that is beyond 150 feet distant from and parallel to the shore, or 100 feet distant from the projecting extremities of any pier, wharf, raft or other structure built in or over the water, or the greater thereof, provided however, that on any part of said lake where the distance between the opposite shores is such that the foregoing formula is impossible or impracticable in application, then the traffic lane shall be as indicated by buoys placed for that specific purpose.

(2) DIRECTION OF TRAVEL. All motor boats, as defined in §30.50(6), Wis. Stats., or personal watercraft as defined in §30.50(9d), Wis. Stats., traveling over a slow-no-wake speed in the traffic lane, including water skiing or similar activity must travel in a counterclockwise rotation.

1.06 SPEED RESTRICTIONS.

(1) SPEED LIMITS IN TRAFFIC LANES.

(a) Monday through Friday:
10:00 a.m. to 7:00 p.m. -- 35 mph maximum
7:00 p.m. to 10:00 a.m. -- slow-no-wake

(b) Saturday, Sunday and Holidays:
10:00 a.m. to 6:00 p.m. -- 35 mph maximum
6:00 p.m. to 10:00 a.m. -- slow-no-wake

(2) SPEED IN SHOREZONE. When moving in waters that have been designated as the shorezone, the operating speed shall be slow-no-wake speed.

(3) PERSONAL WATERCRAFT. No person may operate a personal watercraft at a speed in excess of slow-no-wake within 100 feet of any other boat or within 200 feet of shoreline of any lake.

1.07 PROHIBITED BOAT OPERATION.

(1) DISTANCES. No person shall operate a motorboat at a speed that is greater than reasonable and prudent, when within 100 feet of a occupied, anchored boat, or a slow moving boat. Such speed shall not endanger the occupants of such boat.

(2) SAFE DISTANCE FROM SWIMMER. No person shall operate any boat within 100 feet of a swimmer, unless they are the accompanying boat, or unless physical conditions make compliance of the aforementioned impossible.

1.08 WATER-SKIING.

(1) TOWING PERSON REGULATED. No person shall operate a boat for the purpose of towing a person on water skis, aquaplane, tubing or similar device unless there is in the boat a competent person, in addition to the operator, in a position to observe the person being towed.

(2) HOURS OF OPERATION. No person shall operate a boat for the purpose of towing a person, aquaplane or similar device or engage in water skiing, aquaplaning or tubing between the following hours on the following days:

(a) Monday through Friday:
7:00 p.m. to 10:00 a.m.

(b) Saturday, Sunday and Legal Holidays:
6:00 p.m. to 10:00 a.m.

(3) NUMBERS OF SKIERS TOWED. No motor boat operator shall tow more than one line or more than two persons, nor shall any person allow themselves to be towed by any motorboat already towing two persons.

(4) SKIER PICKUP OR DROP-OFF. No motor boat operator shall permit a water skier or aquaplaning device to

operate from a dock, pier, raft or another boat, or within a designated swim area.

(5) KITES, SAILS. No motorboat operator shall allow a kite, sail or similar device to be pulled behind a boat for the purpose of flying above the water surface.

1.09 SWIMMING REGULATIONS.

(1) TRAFFIC LANE. No person shall swim in the traffic lane unless accompanied by a manned boat with a U. S. Coast Guard approved flotation device for each swimmer.

(2) HOURS. No person shall swim in the traffic lane from sunset to sunrise unless the accompanying manned boat mentioned in sub. (1), is properly lighted.

1.10 MARKERS AND NAVIGATION AIDS, POSTING ORDINANCE.

(1) DUTY OF SLPRD OR DESIGNEE. The Chief of SLWSP is authorized and directed to supervise placement and maintain suitable markers, navigation aids and signs in such areas as shall be appropriate to advise the public of the provisions of this chapter at all public access points within the jurisdiction of the SLPRD.

(2) STANDARD MARKERS. All markers placed upon the water of the lake shall comply with the Department of Natural Resources rules and regulations.

(3) INTERFERENCE WITH MARKERS PROHIBITED. No person shall, without authority, move, remove, damage, destroy, moor or attach any water craft to any buoy, beacon or any marker that is lawfully placed in the waters of the lake.

1.11 STATE BOATING AND WATER SAFETY LAWS ADOPTED. The statutory provisions describing and defining regulation with respect to water traffic, boats, boating and related water activities in §§30.50 through 30.71, and §30.80, Wis. Stats., and in the rules and regulations of the Department of Natural Resources established subsequent to the enactment of this chapter, for which the penalty is a forfeiture only, including penalties to be imposed and procedure for prosecution, that have not been specifically incorporated by reference in the foregoing sections hereof, are hereby adopted and by reference made a part of this chapter as if fully set forth herein. Any act required to be performed or prohibited by the provisions of any said statute, rule or regulation incorporated by reference herein is required or prohibited by this chapter. For purposes of these regulation, such adjusted statute may be prefixed by "99-1".

1.12 SEVERABILITY. The provisions of these regulations shall be deemed severable and it is expressly declared that the SLPRD would have passed the other provisions of these regulations irrespective of whether or not one or more provisions may be declared invalid. If any provision of these regulations or the application to any person or circumstances is held invalid, the remainder of these regulations and the application of such provisions to other persons or circumstances shall not be affected.

1.13 UNIFORM CITATION METHOD ADOPTED. The SLPRD adopts and authorizes the use of a citation to be issued for violations of this ordinance, including ordinances for which a statutory counterpart exists. The form of a citation shall provide for those items listed in §66.119(1)(b), Wis. Stats..

1.14 PENALTIES AND DEPOSITS.

(1) STATE UNIFORM DEPOSIT AND BAIL SCHEDULE ADOPTED BY REFERENCE. The schedule of cash deposit for violations of state boating and water safety

regulations adopted pursuant to sec. 1 of this code shall be as provided by the State of Wisconsin Revised Uniform Deposit and Bail Schedule for Conservation, Environmental Protection, Boating and DNR Rules and Regulations that are adopted therein by reference.

(2) OTHER VIOLATIONS.

(a) The cash deposit for violations of local boating regulations in sec. 1.05 through 1.11 of this chapter and §30.77, Wis. Stats., not provided for in sub. (1) above shall be $50.00.

(b) In addition to the deposit required in sub. (1) and (2) (a) above, the deposit shall include a penalty assessment if required by §165.87, Wis. Stats., a jail assessment if required by §302.46, Wis. Stats., and any applicable fees and court costs prescribed in Chapter 814, of the Wis. Stats..

(c) Cash deposits are to be made with the Clerk of the Circuit Court for Washington County, Wisconsin and said clerk shall give a receipt for any cash deposits that are made in person, unless the deposit amount is mailed in and in that case, the canceled check will serve as the receipt.

(3) ISSUANCE OF CITATIONS. Citations issued under this chapter may be issued by State Certified Officers hired or contracted for by the SLPRD.

Section 2. This ordinance shall become effective after passage and publication as required by law.

Adopted the 16th day of June, 1999.

Appendix C

WINTER USE ORDINANCES APPLICABLE TO SILVER LAKE

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Ordinance No. 2005-1

Regulation of Activities on the Ice of Silver Lake, Town of West Bend

The Silver Lake Protection and Rehabilitation District Board of Commissioners, Town of West Bend, Washington County, Wisconsin does ordain as follows:

1.01 GENERAL PROVISIONS.

(1) APPLICABILITY. The provisions of this ordinance shall apply to all the icebound waters of Silver Lake within the Town of West Bend, Washington County, Wisconsin.

(2) PURPOSE. The purpose of this ordinance is to promote the health, safety, morals, prosperity and general welfare of the persons and areas affected by this ordinance consistent with public rights and interests and the capability of the water resource.

(3) AUTHORITY. The ordinance is adopted by the Silver Lake Protection and Rehabilitation District, hereinafter referred to as SLPRD, pursuant to the powers granted it by virtue of Wis. Stats. §§30.81, 33.22, 33.235 and 33.29, and Resolution No. 2004-02 adopted by the Town of West Bend on December 8, 2004 which delegated authority of Wis. Stats. §30.81 to regulate the ice surface of Silver Lake.

1.02 ENFORCEMENT. The provisions of this ordinance shall be enforced by State certified law enforcement officers employed or contracted for patrolling by the SLPRD.

1.03 DEFINITIONS.

(1) VEHICLES includes all of the means of conveyance plus any other vehicle powered by motor, as follows.

(a) ATV (All Terrain Vehicle) means any engine driven device as defined in Wis. Stats. §340.01(2g) and any other multi-axle, two or more wheeled vehicles, or combination wheel and track (runner) vehicles, not otherwise defined herein, powered by a motor(s) or fan and designed to be operated on snow, ice, grass, dirt, gravel, sand and wetlands, whether or not required to be licensed by State law.

(b) SNOWMOBILE means any engine driven vehicle as defined in Wis. Stats., §340.0l(58a).

(c) AUTOMOBILE means any motor vehicle as defined in Wis. Stats. §340.01(4} and including mini-vans.

(d) TRUCK means any motor vehicle as defined in Wis. Stats. §340.01(34) and including pickup trucks, sport utility vehicles, regular size vans and combination automobile/trucks.

(e) (RV) (Recreation Vehicle) means any vehicle as defined in Wis. Stats §340.01(6m), (29) and (33m) designed or constructed to operate either under its own power or towed, and defined to be used for temporary habitation.

(f) MOTORCYCLE means any motorized vehicle as defined in Wis. Stats. §340.01(32) including motorized bicycles and scooters.

(g) HOVERCRAFT means any engine driven vehicle that travels across land or water just above a cushion of air provided by a downward thrust as from its engines, propellers, etc. For purposes of this ordinance, a hovercraft shall be considered an ATV and therefore shall be subject to the provisions of Wis. Stats. §23.33, adopted herein by reference in sec. 1.11 below.

(2) ICEBOAT means a sailboat-like structure with runners or wheels intended to be wind powered on a solid surface.

(3) FISHING SHANTIES means those structures parked or erected on the ice for use as warming buildings and ice fishing shelters, and not including automobiles trucks and RVs.

(4) KETTLE means the northerly approximate 15% of Silver Lake separated from the main body of Silver Lake by the channel.

(5) CHANNEL means a narrow body of water approximately 100 feet wide and 600 feet long which separates the Kettle from the main body of Silver Lake.

(6) MAIN BODY of Silver Lake means the southerly approximate 85% of the lake.

1.04 PROHIBITED OPERATIONS.

(1) No person shall operate or park or permit to be operated or parked on the ice surface of Silver Lake any motorized vehicle as defined in sec. 1.01 above, excluding snowmobiles and ATVs, except for the exclusive purpose of shoreline or lake property maintenance or repair with an approved permit issued by the SLPRD.

(2) No person shall operate any vehicle on the ice repeatedly in a tight circuitous course or in a prolonged, repetitive manner in the same area.

(3) No vehicle operated on the ice shall be modified in any manner that will amplify or otherwise increase total noise emission above that emitted by the vehicle as originally constructed, regardless of the date of manufacture.

(4) Reference is made to the Town of West Bend Ordinace 9.06 (3) Loud and Unnecessary Noise Prohibited. "Except for Town employees, between the hours of 10:00 P.M. and 6:00 A.M., no person shall do construction work or operate any chain saw, lawn mower or any other machinery of a similar nature within 300 feet of a residence of another." For the purpose of this ordinance, "machinery" includes powered ice augers.

1.05 LITTERING ICE PROHIBITED. No person shall deposit, place, or throw from any vehicle, iceboat, raft, pier, platform, fishing shanty, structure or shore, any cans, paper, bottles, debris, refuse, garbage, solid or liquid waste, feces or urine onto or through the ice of the lake or onto or into the waters of the lake.

1.06 SPEED LIMITS ON THE ICE.

(1) WITHIN 150 FEET OF SHORELINE. At any time of the day or night, no person shall operate a vehicle on the ice in excess of a speed of 10 miles per hour within 150 feet of the shoreline.

(2) WITHIN 100 FEET OF PERSON OR OBJECT ON THE ICE. At any time of day or night, no person shall operate a vehicle on the ice in excess of a speed of 10 miles per

hour within 100 feet of any peron not in or upon a vehicle, any stationary vehicle, any iceboat, or any fishing shanty.

(3) WITHIN 100 FEET AND BEYOND. No person shall operate a vehicle in excess of the speed limits identified for the conditions designated in pars. (a) and (b) below when traveling 150 feet and beyond from: the shoreline, or 100 feet and beyond from any person not in or upon a vehicle, any stationary vehicle, any iceboat, or any fishing shanty.

(a) From sunrise to sunset, in the main body of Silver Lake south of the channel exiting the Kettle, not in excess of 35 miles per hour.

(b) From sunrise to sunset, in the main body of Silver Lake south of the channel and at all time in the Kettle and channel, not in excess of 10 miles per hour.

1.07 DISORDERLY CONDUCT

(1) No person shall, within the area to which this ordinance applies, engage in violent, abusive, indecent, profane, boisterous, unreasonably loud or otherwise disorderly conduct under circumstances in which the conduct tends to cause or provoke a disturbance.

(2) Public urination or defecation by humans shall be considered disorderly conduct.

1.08 REGULATION OF ICEBOATS.

(1) No person shall operate an iceboat on the ice in a careless manner so as to endanger the person or property of another.

(2) No person shall operate an iceboat on the ice during the hours from sunset to sunrise.

(3) A person operating an iceboat shall reduce the speed of the iceboat to the slowest speed possible under the circumstances within 100 feet of any person not in or upon a vehicle, any vehicle, or fishing shanty.

1.09 RIGHT-OF-WAY BETWEEN VEHICLES AND ICEBOATS. When a vehicle and an iceboat are proceeding in such a direction as to involve the risk of collision, the vehicle shall yield the right of way to the iceboat.

1.10 HOLES IN THE ICE. No person may cut a hole in the ice in excess of 12 inches in diameter, unless such hole is marked until the hole has refrozen and the marker is then removed.

1.11 WISCONSIN STATUTES AND RELATED PROVISIONS OF THE WISCONSIN ADMINISTRATIVE CODE ADOPTED BY REFERENCE. Wis. Stats. §23.33, §346.61, §§346.63 through 346.655, §350.01, §§350.05 through 350.12(3m)(d), §350.135 and §350.15 and the related provisions of Wisconsin Administrative Code, including Chapters NR 6 and NR 64, are adopted herein by reference, including those statutes or rules and regulations related thereto that are adopted the State or the Department of Natural Resources subsequent to the enactment of this ordinance. Any act required to be performed or prohibited by the provisions of any such statute, rule or regulation adopted herein by reference is required to be performed or prohibited by this ordinance.

1.12 WINTER SAFTEY PATROL.

(1) A law enforcement officer operating a duly authorized winter safety patrol vehicle, when responding to an emergency call or when in pursuit of an actual or suspected violator of this ordinance, need not comply with State law or this ordinance fixing maximum speed limits when a siren is being sounded and/or such winter patrol vehicle's oscillating or flashing blue lights are on and if due regard is given to the safety of other persons in the vicinity.

(2) Upon the approach of a duly authorized winter safety patrol vehicle giving an audio or visual signal, the operator of a vehicle referred to in this ordinance or an iceboat shall reduce the speed of that vehicle or iceboat to the slowest possible speed under the circumstances and yield the right-of-way to the winter patrol vehicle until it has passed.

(3) No person operating a vehicle or iceboat referred to in this ordinance may refuse to stop after being requested or signaled to do so by a law enforcement officer.

1.13 CITATION ENFORCEMENT. The SLPRD hereby adopts and authorizes the use of a citation to be issued for violations of this ordinance as provided for in Wis. Stats. §66.0113. Law enforcement officers employed or contracted for patrolling by the SLPRD may issue citations authorized under this ordinance. Nothing herein shall be construed to prohibit the SLPRD from enforcing this ordinance by any other lawful means.

1.14 SEVERABILITY. The provisions of this ordinance shall be deemed severable and it is expressly declared that the SLPRD Board of Commissioners would have passed the other provisions of this ordinance irrespective of whether or not one or more provisions may be declared invalid. If any provision of this ordinance or application to any person or circumstance is held invalid, the remainder of the ordinance and application of such provisions to other persons or circumstances shall not be affected.

1.15 PENALTIES. Any person who violates the provisions of this ordinance shall be subject to a forfeiture of $50 for the first offense and $100 for the second and subsequent offences, plus court costs; however, the higher penalties provided for in Wis. Stats. §§23.33(13)(am) through (13)(f), §346.655, §350.11(1)(b) through (4), plus court costs shall apply for the violations of the provisions referred to therein.

1.16 EFFECTIVE DATE. This ordinance shall become effective upon passage and publication as required by law.

Adopted this 18th day of October, 2005.

Approved:

SIGNED

David F. Berganini, Chairperson

Attest:

SIGNED

John Behrens, Secretary

Appendix D

CREEL SURVEY FORM

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CREEL SURVEY FORM

Lake Name: SILVER LAKE
Date: _____ (Month/Day/Year)
Weather: _____
Air Temperature (°F): _____
Water Temperature (°F): _____
Secchi Depth (ft): _____

Interviewer/person submitting report: _____
Type of Fishing: (1) Boat fishing (2) Shore Fishing
(3)Open-ice fishing (4) Ice shanty
(5) Wading
Number in Fishing Party: _____
Start Fish Time: _____ : _____ am/pm
End Fish Time: _____ : _____ am/pm
Total Fish Time (hour): _____ hrs. _____ min.

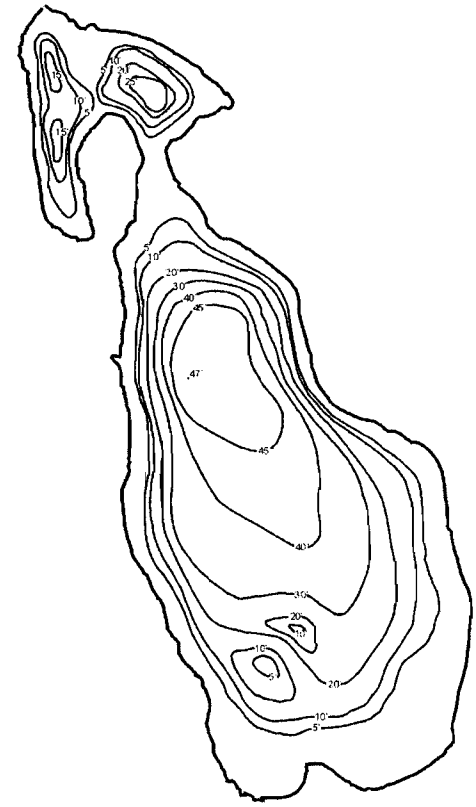
Measurements for all Fish Caught

Species Code	Total Length (in)	Weight (lbs)

Species	Code	% of Time Fished For	# Caught	# Kept
Bluegill	1			
Yellow Perch	2			
Green Sunfish	3			
Pumpkinseed	4			
Rock Bass	5			
Largemouth Bass	6			
Smallmouth Bass	7			
Northern Pike	8			
Walleye	9			
Warmouth	10			
White Sucker	11			
Bullhead	12			
Carp	13			
	14			
	15			

Show location of area fished on lake map:

North



Fish Condition Observations

Species Code	Deformities	Eroded Fins	Lesions/ Tumors	Parasites
	Yes / No	Yes / No	Yes / No	Yes / No
	Yes / No	Yes / No	Yes / No	Yes / No
	Yes / No	Yes / No	Yes / No	Yes / No
	Yes / No	Yes / No	Yes / No	Yes / No