KIRBY LAKE

BARRON COUNTY, WISCONSIN

WATERSHED INVENTORY FINDINGS

PREPARED BY
INTERNATIONAL ENVIRONMENTAL MANAGEMENT SERVICES LIMITED
AND
ARON & ASSOCIATES

FOR THE
KIRBY LAKE MANAGEMENT DISTRICT

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BARRON COUNTY, WISCONSIN
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INTRODUCTION

Kirby Lake, located near the City of Cumberland in Maple Plain Township, Barron County, Wisconsin, is one of a number of valuable ecological resources offering a variety of recreational and visual opportunities to the community and its visitors. Kirby Lake is an integral part of this lake-oriented community. Unfortunately, the recreational and visual value of the lake is perceived as being adversely affected by peri-urban development in the Kirby Lake watershed. Thus, there is a potential for serious water quality degradation to occur in this waterbody despite a continuing and increasing demand for high quality recreational and residential experiences in the area.

Seeking to improve the usability of Kirby Lake, and to prevent deterioration of the natural assets and recreational potential of Kirby Lake, the residents of the watershed formed the Kirby Lake Management District in the summer of 1992. Shortly thereafter, the District began a program of community involvement, education and lake management aimed at maintaining and improving the aspect of this valuable lake. This is the first of a number of proposed studies involving Kirby Lake to be conducted by various private consultants in cooperation with the Wisconsin Department of Natural Resources (DNR). This study is funded in part by the Wisconsin Department of Natural Resources through a Lake Management Planning Grant awarded to the Kirby Lake Management District under the Chapter NR 119 Lake Management Planning Grant Program.

This watershed inventory sets forth a portion of the background information needed to prepare a lake protection plan for Kirby Lake, and represents part of the on-going commitment of the Kirby Lake Management District--and the Town of Maple Plain--to sound environmental planning with respect to the Lake. This inventory was prepared during 1993/94 by a consortium comprising International Environmental Management Services Limited (IEMS Ltd) and Aron & Associates at the request of the Kirby Lake Management District. The watershed survey was conducted by IEMS Ltd staff during May 1994. Additional data were supplied from the files of the District, Wisconsin Geological and Natural History Survey, and DNR.

It is important to note that this report does not represent a comprehensive water quality management plan for Kirby Lake, but, rather, provides information that will contribute to the preparation of such a plan at a later date. A comprehensive lake

management plan for Kirby Lake will require a good deal more water quality and biological data collection and analysis than is required for a watershed inventory. Only after such a complete inventory and analysis can a comprehensive lake management plan be prepared which specifies the land use, pollution control and in-lake management techniques needed to protect or enhance lake water quality.

The scope of this report is limited to the collection of those data which delineate the watershed in which the lake is situated and describe the land uses to which the watershed is subjected. This inventory follows approximately the format adopted by the DNR for nonpoint source pollution control plans pursuant to Chapter NR 120, Wisconsin Administrative Code, insofar as the requirements of that Chapter deal with the acquisition of land use and management information. The inventory data are used in a preliminary analysis of the pollutant loadings to which the lake is exposed. The estimates generated through this analysis are examined in light of information collected by the District under the DNR Self-help Monitoring Program and may ultimately be verified using the field data to be gathered through subsequent water quality studies. These estimates provide an initial basis on which to begin to formulate a strategy to control and manage the external contaminant loads to Kirby Lake.

This inventory is comprised of six main sections: (1) a statement of planning goals and objectives, (2) a description of the lake and its watershed, (3) a statement of the current use problems identified in the watershed and the need for protection actions to be taken within the Kirby Lake watershed, (4) a statement of the actions previously taken to manage the Kirby Lake watershed, and (5) a preliminary description of some alternative means of watershed management that might be considered in a future lake protection plan. Those elements which can be incorporated into on-going public information programs being conducted by the Kirby Lake Management District are identified section (6).

STATEMENT OF LAKE MANAGEMENT GOALS AND OBJECTIVES

The lake use and management goals and objectives for Kirby Lake were developed by the Kirby Lake Management District in consultation with the Town of Maple Plain. The goals and objectives are:

- to protect and maintain public health, and promote public comfort, convenience, necessity and welfare, in concert with the natural resource, through the environmentally sound management of the vegetation, fishery and wildlife populations in and around Kirby Lake;

- to promote a quality, water-based experience for residents and visitors to Kirby Lake consistent with the policies and objectives of the Wisconsin Department of Natural Resources;

- to manage the lakes in an environmentally sound manner, pursuant to the standards and requirements set forth in Administrative Codes NR 103, Water Quality Standards for Wetlands, and NR 107, Aquatic Plant Management, to preserve and enhance its water quality and biotic communities, their habitats, and essential structure and function in the waterbody and adjacent areas;

and,

- to effectively control water quality in the Kirby Lake basin to better facilitate the conduct of water-related recreation, improve the aesthetic value of the resource to the communities, and enhance the resource value of the waterbody.

EXISTING CONDITIONS IN KIRBY LAKE AND ITS WATERSHED

Physical Characteristics

Watershed Characteristics: Kirby Lake is a seepage lake situated just north of the City of Cumberland in Maple Plain Township, Barron County, as shown on Map 1. The Lake lies in an hydrogeologically-complex area immediately north and west of a groundwater divide separating flows toward the Yellow River to the east, Beaver Dam Lake-Hay River to the south, and Sand Creek to the west. Groundwater flow in the area adjacent to Kirby Lake is likely to be westward toward Sand Creek.[1]

The direct tributary drainage area of Kirby Lake--defined as that area which drains directly to Kirby Lake without passing through any other waterbodies (principally wetlands in the case of this seepage lake) and shown as the study area on Map 2--is situated wholly within Maple Plain Township in Barron County, and is approximately 449 acres in areal extent as set forth in Table 1. Field inspections of the watershed boundary conducted by IEMS Ltd staff during May 1994 resulted in minor refinements to this boundary as initially identified from the United States Geological Survey topographic map for Cumberland, 1982. These refinements are incorporated in Map 2.

The total tributary drainage area is coincident with the direct tributary drainage area in this lake. Surface water flows through Kirby Lake parallel the groundwater flows and trend toward the west.[2] Numerous internally-drained wetlands also exist in this area, particularly to the north and south of Kirby Lake, some of

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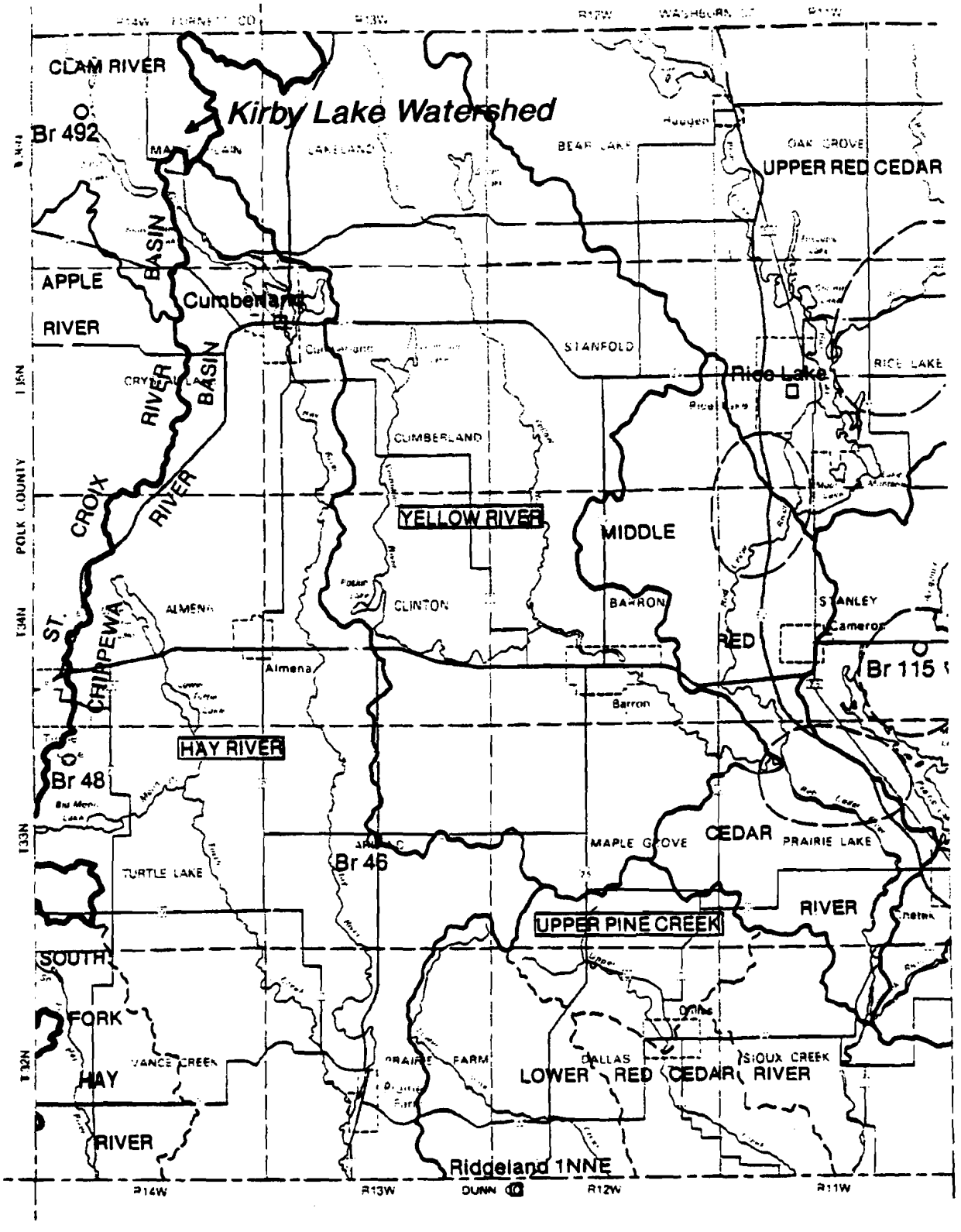
[1] Wisconsin Geological and Natural History Survey Map No. 87-2a./2i., Atlas of Groundwater Resources and Geology of Barron County, Wisconsin, 1987.

[2] ibid.

MAP 1: KIRBY LAKE WATERSHED LOCATION MAP.
Source: Wisconsin Geological and Natural History Survey

Map 1



Monitoring Stations:

- Observation well
- Precipitation station
- Automated agricultural weather station
- Pesticides

- Major divide
- Minor divide
- Subbasin divide
- Priority watershed

MAP 2: KIRBY LAKE STUDY AREA MAP.
Source: United States Geological Survey

Map 2

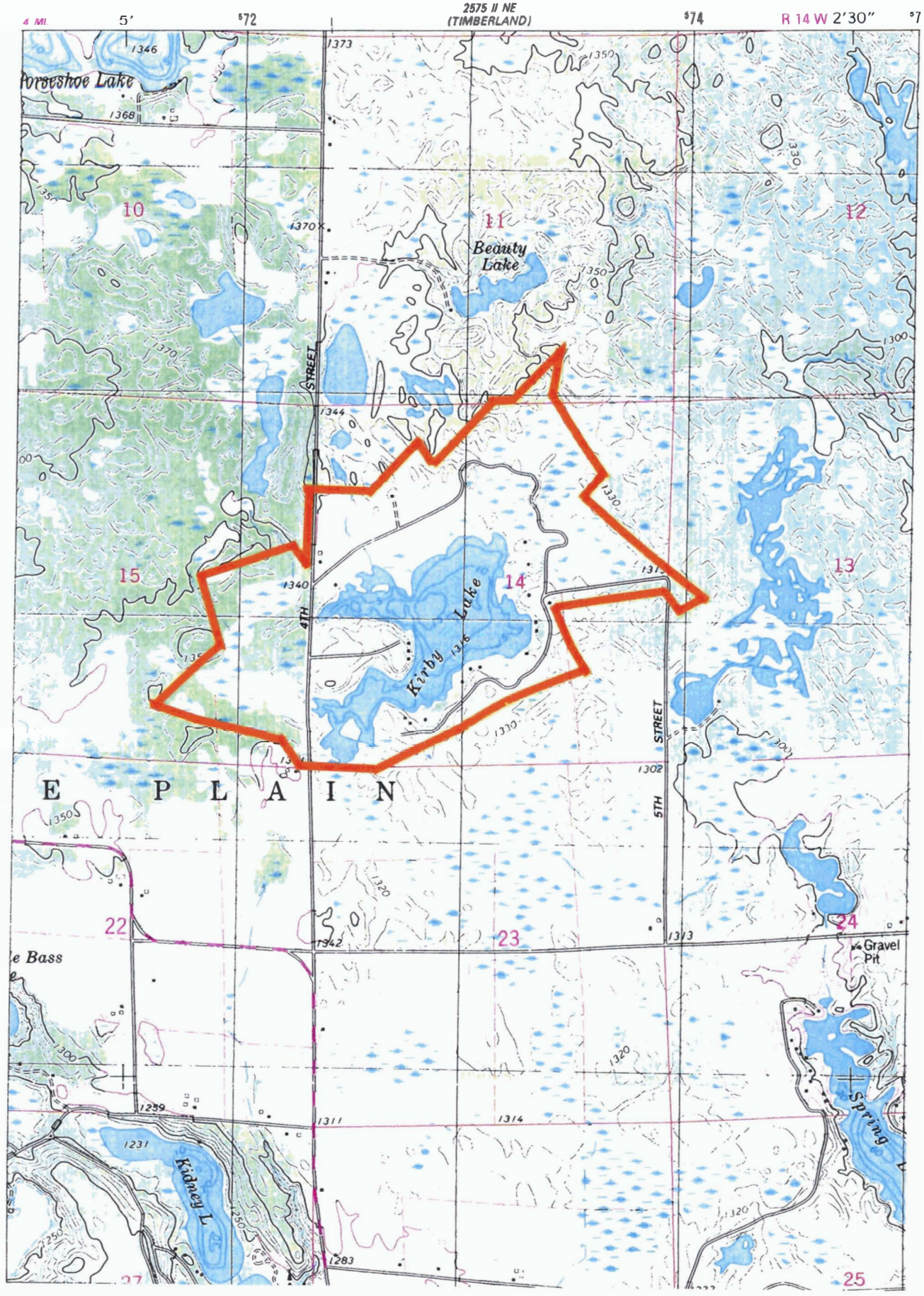

STATE OF WISCONSIN
DIVISION OF HIGHWAYS
GEOLOGICAL AND NATURAL HISTORY SURVEY
2575 II NE
(TIMBERLAND)
R 14 W 2'30"
Horseshoe Lake
Beauty Lake
Kirby Lake
Kidney L
Spring
Gravel Pit
4TH STREET
5TH STREET
E P L A I N
10
11
12
13
14
15
22
23
24
25

TABLE 1: LAND USE IN THE KIRBY LAKE DIRECT DRAINAGE AREA, 1990.

Land Use Category	Direct Drainage Area 1990	
	acres	%
URBAN		
Residential	13	2.9
Transportation/Utilities	5	1.1
Recreational	2	0.5
Subtotal	20	4.5
RURAL		
Woodland}		
Wetland }	337	75.0
Water	92	20.5
Subtotal	429	95.5
TOTAL	449	100%

Source: International Environmental Management Services Ltd

TABLE 2: HYDROGRAPHIC CHARACTERISTICS OF KIRBY LAKE.

Parameter	Units	
Surface Area	acres	92
Volume	acre-feet	720
Maximum Depth	feet	19
Mean Depth	feet	8
Direct Watershed Area	acres	449

Source: Wisconsin Department of Natural Resources

which have been hydraulically connected to Kirby Lake by means of culverts. These areas have been included in the Kirby Lake drainage area used in this study.

At present, the land uses in these areas are primarily rural, although urbanizing areas lie to the south of Kirby Lake. The balance of the watershed is natural--wetlands, woodlands and other open lands. Lake-oriented residential lands and supporting transportation/utility corridors are the principle non-rural features of the Kirby Lake watershed shown on Maps 1 and 2.

Waterbody Characteristics: Kirby Lake is a 92 acre waterbody, the hydrographical characteristics of which are set forth in Table 2. The Lake is a seepage lake, roughly cruciform in aspect, having a well-defined "deep hole" of about 19 feet in depth. The "deep hole" is situated just north and west of center as shown on Map 3. This waterbody has a maximum depth of about 19 feet, a mean depth of 8 feet, and a volume of 720 acre-feet.

Land Use and Shoreline Development

Land Use: As at 1994, and as shown on Map 4 and presented in Table 1, residential lands occupied about three percent of the 449 acre direct drainage area of Kirby Lake. Virtually all of the remaining direct drainage area was occupied by environmental corridor,[3] woodlands and wetlands. Such relatively large natural areas provide lake residents with generally pleasing vistas across the lake. Surface waters covered about 20.5 percent of this area.

The riparian residential areas and access site may be considered to be largely developed, with only limited potential for infilling. Further residential expansion in the vicinity of the lake's watershed is not to be recommended given the limited ability of the soils in the vicinity of Kirby Lake to attenuate pollutants. An exception to this generalization is a small area of land on the western shore of the lake--the western promontory--having a high potential for attenuating pollutants. Notwithstanding, this land, together with the major part of the Kirby Lake watershed--excepting a portion of the eastern shore with a moderate pollution potential--has a high potential for groundwater contamination.

Recreational Use and Public Access: Kirby Lake is a multi-purpose waterbody serving all forms of recreation, including boating, swimming, and fishing during the summer months and snowmobiling and ice-fishing during the winter. The lake is used year-round as a visual amenity--walking, bird-watching and picnicking being popular passive recreational uses of the waterbody.

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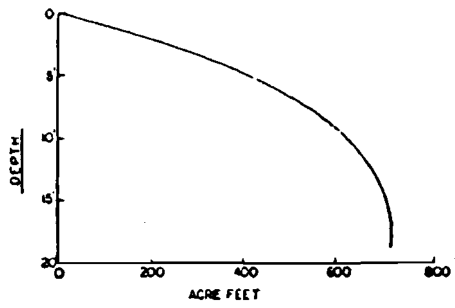
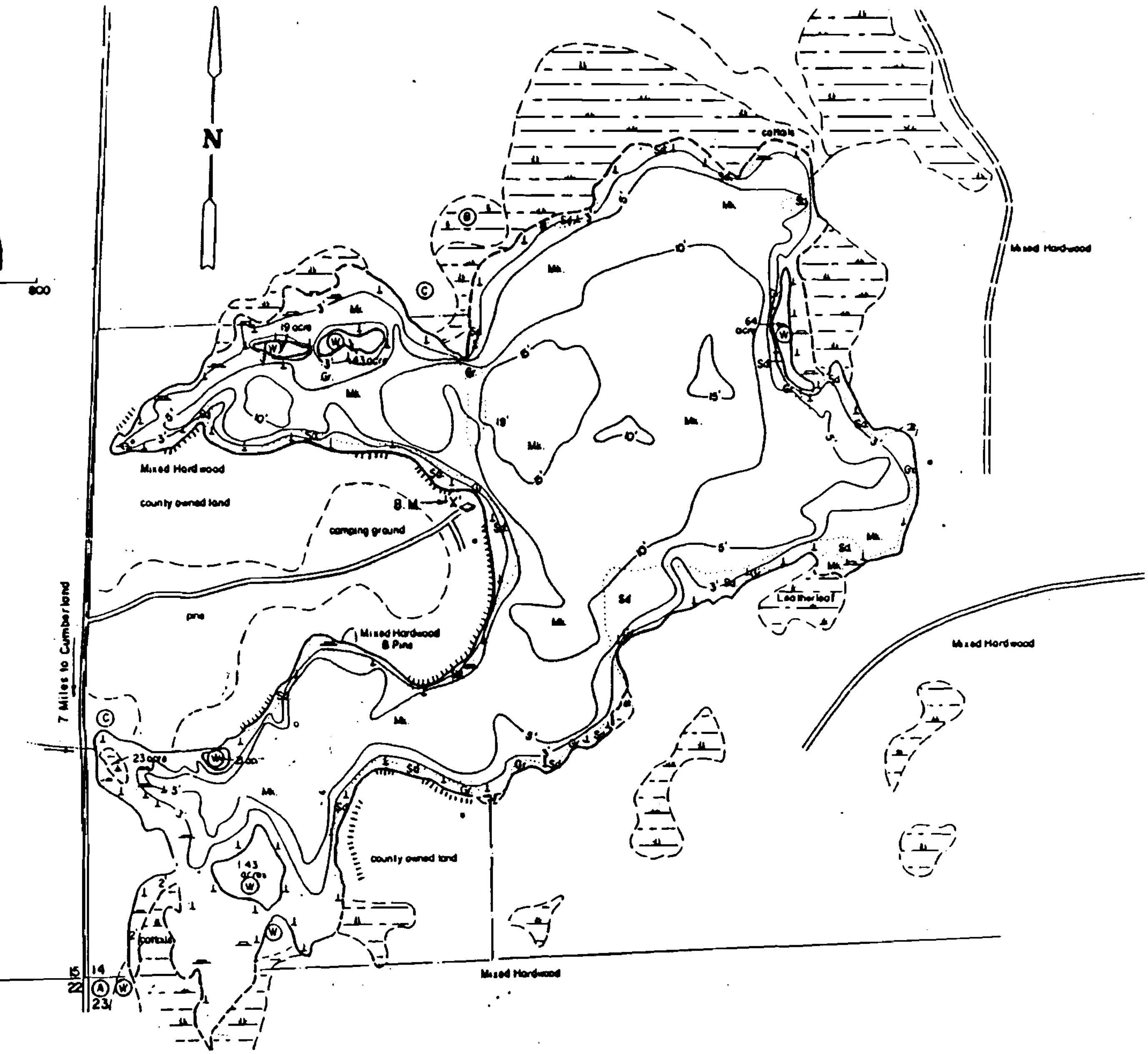
[3] Southeastern Wisconsin Regional Planning Commission (1981). Refining the delineation of environmental corridors in southeastern Wisconsin, Technical Record, 4(2): 1- 22.

MAP 3: BATHYMETRIC MAP OF KIRBY LAKE.
Source: Wisconsin Department of Natural Resources



D.N.R. B.M. 1180-A. is a bronze tablet located 104' west of access at lake edge.
Assumed elevation 100.00'
Water elevation 87.19'

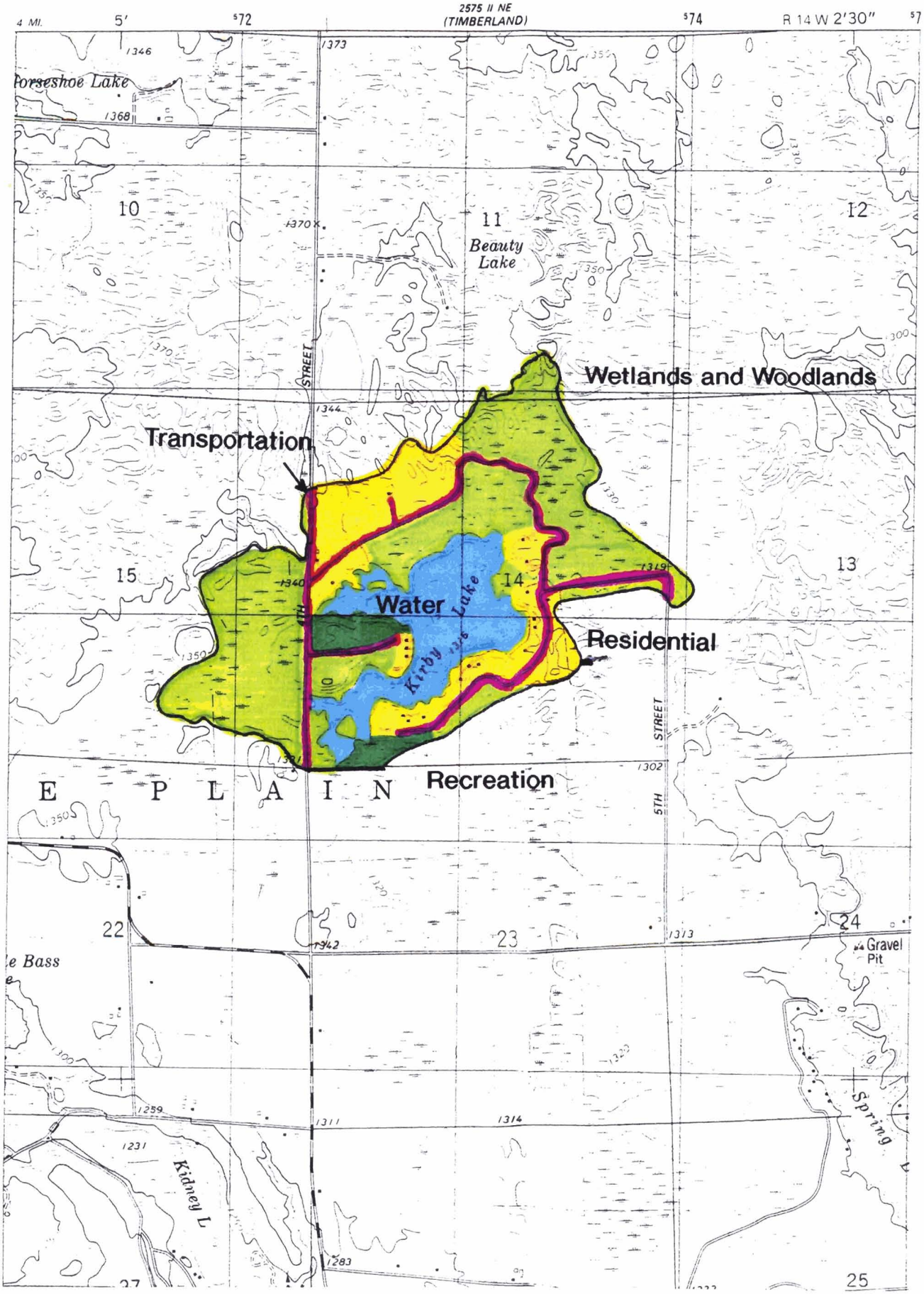


Map 3

MAP 4: LAND USE IN THE KIRBY LAKE DIRECT DRAINAGE AREA.
Source: International Enivornmental Management Services Ltd

Map 4

STATE OF WISCONSIN
DIVISION OF HIGHWAYS
GEOLOGICAL AND NATURAL HISTORY SURVEY



The shoreland of Kirby Lake is used primarily for residential development, although portions of the southern shore have been developed as County parkland. The Lake has a public boat launch and access site situated along the western shore of the Lake. In addition, a number of local retailers in nearby Cumberland specialize in sporting goods, including angling and boating supplies, and cater to the needs of lake users and other recreational visitors.

Local Ordinances: The Kirby Lake watershed, lying within Barron County, is subject to County zoning controls, including a County Construction Erosion control ordinance designed to minimize the water quality impacts of stormwater-related soil and pollutant runoff from construction sites. The Barron County ordinance is based on the model ordinance proposed by the Wisconsin League of Municipalities and the Wisconsin Department of Natural Resources.[4]

Water Quality

Historic Information: Kirby Lake has good water quality, being classified as fair to good, or meso-oligotrophic,[5] based on recent measurements made by the Kirby Lake District under the DNR Self-help Monitoring Program. Secchi disc transparencies ranged from 5.25 feet to 8.5 feet between 1991 and 1993,[6] while total phosphorus concentrations measured during the autumn of 1992 and 1993 ranged from 0.018 mg/l to 0.040 mg/l at the surface, and from 0.018 mg/l to 0.035 mg/l at the bottom, of the Lake. With an average Secchi disc transparency of nearly 7 feet or just over 2 meters, and an average total phosphorus concentration of 0.026 mg/l, Kirby Lake is typical of lakes in northwestern Wisconsin and

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[4] Wisconsin Department of Natural Resources, Wisconsin Construction Site Best Management Practices Handbook, 1989.

[5] Lakes age. Over time, nitrogen and phosphorus enrich a lake, contributing to increased plant growth, which, in turn, contributes organic matter to the lake bottom, encouraging further plant growth. Water transparency and lake depth decrease until the lake becomes a marsh and, later, dry land. Humans can accelerate this eutrophication process, decreasing the time required for a lake to become a marsh from centuries to decades. An eutrophic lake is literally a "well-fed" lake; an oligotrophic lake, a "poorly fed" lake. Most multi-purpose waterbodies are ideally maintained in a mesotrophic or oligo-mesotrophic state to maximize their biological productivity, especially fishes, while minimizing plant growth which reduces the aesthetic appeal of the waterbody.

[6] The relatively low transparencies possibly reflect the highly colored (humic) nature of the waters in Kirby Lake.

similar to most other seepage lakes in the state.[7]

Kirby Lake has been known to stratify during winter, which, when combined with periodic water level fluctuations, has resulted in occasional winter-kills of fish. Installation of a winter aeration system in 1988 by the County, in association with the DNR and Kirby Lake District, has all but eliminated such die-offs. In October 1993, a 2°F temperature difference from surface (50°F) to bottom (48°F) was recorded. Chemical stratification was apparently absent--total phosphorus concentrations were 0.018 mg/l at both surface and bottom. On-going water quality monitoring is recommended.

Watershed Modelling: As an interim measure, and in order to guide future studies of Kirby Lake and its watershed, an initial assessment of the impact of watershed land use on the water quality of Kirby Lake was obtained through the use of simple empirical water quality models--specifically through the use of Unit Area Loads and the OECD models as described by Ryding and Rast.[8]

The water quality of a lake is the summation of the contaminant inputs generated from all of the various land uses within the watershed. These inputs have been quantified in the form of Unit Area Loads--UALs--which reflect the average amount of contaminant generated per unit area of watershed surface under a particular land use. Values for Wisconsin have been tabulated by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and are set forth in Table 3. Similarly, an elementary rainfall-runoff relationship was used as a means of estimating water inflow, the transport mechanism that moves the contaminants into lakes--in this case, groundwater inflows were considered to be included in this estimate. These two variables--mass and flow--were used to derive a range of values for the contaminant loading rates used in the OECD water quality models.

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[7] Wisconsin Department of Natural Resources Technical Bulletin No. 138, Limnological Characteristics of Wisconsin Lakes, 1983; the mean total phosphorus concentrations of lakes in northwestern Wisconsin is reported as 0.028 mg/l, with a median transparency of between 1 and 3 meters--seepage lakes had a mean total phosphorus concentration of 0.021 mg/l and a mean transparency of 2.7 meters.

[8] Ryding, S.-O. and Rast, W., "Chapter 7. Estimating the Nutrient Load to a Waterbody", in UNESCO Man and the Biosphere Series Volume 1, The Control of Eutrophication of Lakes and Reservoirs, Parthenon Press, London, 1989.

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

The results of this modelling under both existing and planned land uses are set forth in Tables 4 through 6. The implications of these results are discussed below.

Surface Inflow Estimates: The estimated inflow, set forth in Table 4, of approximately 310.5 acre-feet per year--or about 0.43 cubic feet per second--is proportionately similar to the values measured by the U S Geological Survey at their gauging station 05368000 located on the Hay River at Wheeler, Wisconsin in Dunn County. After applying a proportionality correction to the USGS values--to correct for the significantly larger watershed area of the Hay River upstream of Wheeler--the total annual measured flow for an area of the size of the Kirby Lake watershed would be about 0.51 cubic feet per second, which is not dissimilar to the estimated value generated from the approximated rainfall-runoff relationship. Therefore, in the absence of measured inflows, this relationship would appear to adequately represent the inflow volume.

Water Loading Rates and Water Residence Times: These variables--especially the water residence times--are used as surrogate values for in-lake sedimentation rates, and are critical determinants of pollutant transmission through the system. An accurate estimate of inflows, from which these values are derived, will enhance the quality of the model results. Given the fairly good agreement between predicted and observed flows as noted above, the estimated water loading rate and water residence time used in the models should be reasonable approximations. The estimated average water residence time for Kirby Lake is about 2.3 years, which is consistent with estimates made for other seepage lakes of similar size within Wisconsin.[9]

Pollutant Loads and Pollutant Loading Rates: The pollutant loads to Kirby Lake during 1990 were estimated to be approximately 19,487 pounds of sediment, 25.5 pounds of phosphorus and 14.6 pounds of lead as set forth in Tables 4 and 6. Lead is used in these analyses as a surrogate value for heavy metals and other pollutants contributed primarily from urban sources. The most important source of lead and metals in runoff is from transportation, which can contribute up to 67 percent of the total load of metals to the environment. Thus, the forecast lead load may accurately reflect the total metal load generated from within the Kirby Lake watershed even though the absolute concentration lead itself may be expected to decline in future years as the use of lead in motor fuels, paints and other commercial products is discontinued.

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[9] Wisconsin Department of Natural Resources Technical Bulletin No. 138, Limnological Characteristics of Wisconsin Lakes, 1983; the mean retention time for seepage lakes in Wisconsin is 2.15 years. This period is the time required for a volume of water equal to the volume of the lake to enter the lake from the watershed.

TABLE 3: UNIT AREA POLLUTANT LOADING RATES USED FOR THE KIRBY LAKE WATERSHED.

Land Use	Unit Area Loading Rates: pounds/acre/year Total Suspended Solids	Phosphorus	Lead[a]
URBAN			
Suburban/Low Density Residential:Swales	8	0.03	0.006
Government/Institutional	214	0.57	0.23
Parks and Recreation	3	0.03	0.001
Construction Sites	20,000	13.0	0.07
RURAL			
Woodland/Open Land	3	0.03	0.004
Wetlands	3	0.03	0.004
Water	188	0.13	0.13

[a] Lead is used as a surrogate variable for urban heavy metals.

Source: Southeastern Wisconsin Regional Planning Commission

TABLE 4: SUMMARIZED MODEL INPUT VARIABLES USED IN THIS STUDY.

Parameter/Units	Magnitude	Notes
Inflow (Q) acre-feet per year	Q_{25} = 310.5	Estimated from the annual average precipitation of 33.2 inches multiplied by the drainage area (AD) from Table 2, using a rainfall-runoff coefficient of 25 percent (Q_{25})
Water Residence Time (Tw) years	Tw_{25} = 2.32	Calculated as lake volume (V) from Table 2 divided by inflow (Q)
Water Loading Rate (qs) meters per year	qs_{25} = 1.05	Calculated as mean depth in meters--from Table 2--divided by the water residence time
Pollutant Loads (J) pounds per year (1990 land use)	J_{sed} = 19,487 J_p = 25.5 J_{Pb} = 14.6	Estimated as the product of watershed area by land use category--from Table 1--and the unit area load (UAL) pollutant export coefficients --from Table 3--for sediment (J_{sed}), phosphorus (J_p), and lead (J_{Pb})
Pollutant Loading Rate (L) pounds per acre per year (1990 land use)	L_{sed} = 211.8 L_p = 0.28 L_{Pb} = 0.16	Calculated as the pollutant load (J) divided by the lake surface area (A)--from Table 2

Source: International Environmental Management Services Ltd

TABLE 5: SELECTED RESULTS FROM THE WATER QUALITY MODELS USED IN THIS STUDY.

Pollutant	Units	Predicted Concentration[a] 1990	Observed Concentration mean (year)
Sediment	mg/l	8.95	---
Phosphorus	mg/l	0.011[b]	0.026 (1992/3)
Lead	mg/l	0.007	---

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[a] The OECD nutrient loading model was used to estimate in-lake concentrations; the generalized form of this model is:

$$[C] = L / qs\ (1 + \{Tw\}^{0.5})$$

where [C] is the concentration in milligrams per liter, L is the pollutant loading rate in grams per square meter of lake surface per year, qs is the water loading rate in meters per year, and Tw is the water residence time in years; qs $(1 + \{Tw\}^{0.5})$ is a surrogate value for in-lake sedimentation. NOTE: Conversions of the data presented in this Table to the metric equivalents, used in the calculations, were made using factors published by the American Society of Civil Engineers.

[b] Phosphorus concentrations have been corrected using the 1982 OECD relationship:

$$[P] = 1.55\ [C]^{0.82}$$

where [P] = the predicted in-lake annual mean total phosphorus concentration, and [C] = the mean annual inflow total phosphorus concentration from footnote a.

Source: International Environmental Management Services Ltd

TABLE 6: SUMMARIZED OUTPUT FROM THE WATER QUALITY MODELS USED IN THIS STUDY.

Water Quality Indicator[a]	Units	Predicted Concentration 1990	Observed Concentration mean (year)
1. INPUT DATA FROM TABLES 4 AND 5			
Secchi Disc Transparency	m	5.8	2.1 (1991/3)
Chlorophyll-a	ug/l	2.5	---
2. INPUT DATA FROM TABLE 7, SCENARIO 3			
Secchi Disc Transparency	m	4.5	2.1 (1991/3)
Chlorophyll-a	ug/l	3.9	---

[a] Secchi Disc Transparencies (SDT) and Chlorophyll-a concentrations (CHL) have been predicted from the flushing-corrected in-lake total phosphorus concentrations using the 1982 OECD relationships:

$$SDT = 14.7\ [C]^{-0.39} \qquad [CHL] = 0.37\ [C]^{0.79}$$

where [C] = the mean annual inflow total phosphorus concentration from Table 5, footnote a.

Source: International Environmental Management Services Ltd

The loads of pollutants to Kirby Lake are expected to remain stable during the planning period--a twenty-year time horizon to the year 2010--primarily as the result of the lands in the watershed reaching a fully developed state. The anticipated cessation of construction activities eliminates a major contributor of sediments and nutrients from the pollutant loading calculations. Construction activities are the largest single generator of contaminants to waterbodies per unit area devoted to such activities, as shown in Table 3.

Although the mass of pollutants is a critical determinant of pollutant concentrations and biotic responses in lakes, the forecast pollutant loads and loading rates set forth in Table 4 reflect the external loadings of the contaminants only. However, it was assumed that both internal (groundwater) loading and atmospheric loading were, to some degree, included in the unit area loads used to calculate the pollutant loads. The close proximity of the groundwater divide and coincidence of the groundwater and surface watersheds supports this assumption. Nevertheless, this assumption should be verified through the conduct of a groundwater sampling program in the watershed.

Forecast Pollutant Concentrations: The resultant concentrations of pollutants determined for the present (and future) land use scenario using the OECD model are set forth in Table 5. Despite few comparative data being available, those that are suggest that the models generally under-estimate the observed concentrations. Such an under-estimation would suggest that the UAL-based loads are too low--resulting in a load estimate that includes too little material--and/or the estimated inflow volumes are too high--resulting in too great a dilution of the material carried into the lake. Given the lack of specific accounting for groundwater inflows, it is likely that both errors contribute to the under-estimation of the pollutant concentrations, although the former should probably be given the more weight; substitution of higher loading rates to account for groundwater-borne pollutants, as set forth in Table 7, results in an in-lake phosphorus concentration that is more representative of the true situation in Kirby Lake.[10] This result reenforces the recommendation that a groundwater

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[10] Scenario 3 implies that the annual average inflow set forth in Table 5 adequately represents both surface and groundwater contributions to the Kirby Lake water budget, but that, in addition to the contaminants carried into the lake from the land surface, a further mass of pollutant (of geological origin?) is contributed by the groundwater flow. All of these scenarios better represent the physical-chemical mechanisms effecting the transport of phosphorus (and metals) into the lake and less realistically reflect the mechanics of sediment transport. Hence, only the estimated loads of phosphorus and lead--and the water load--were increased in order to account for groundwater loading.

TABLE 7: FORECAST WATER QUALITY BASED ON ADDITIONAL NUTRIENT AND METAL INPUTS FROM GROUNDWATER SOURCES.

SCENARIO/ Pollutant	Units	Predicted Magnitude
1. POLLUTANT LOAD AND WATER LOAD FROM TABLE 4		
L_p	pounds per acre per year	0.28
L_{pb}	pounds per acre per year	0.16
qs	meters per year	1.05
Phosphorus	mg/l	0.011
Lead	mg/l	0.007
2. 50% INCREASE IN POLLUTANT LOAD, NO INCREASE IN WATER LOAD		
L_p	pounds per acre per year	0.42
L_{pb}	pounds per acre per year	0.24
qs	meters per year	1.05
Phosphorus	mg/l	0.017
Lead	mg/l	0.011
3. 100% INCREASE IN POLLUTANT LOAD, NO INCREASE IN WATER LOAD		
L_p	pounds per acre per year	0.55
L_{pb}	pounds per acre per year	0.32
qs	meters per year	1.05
Phosphorus	mg/l	0.020
Lead	mg/l	0.015
4. 100% INCREASE IN POLLUTANT LOAD, 50% INCREASE IN WATER LOAD		
L_p	pounds per acre per year	0.55
L_{pb}	pounds per acre per year	0.32
qs	meters per year	1.58
Phosphorus	mg/l	0.016
Lead	mg/l	0.011
5. 100% INCREASE IN POLLUTANT LOAD, 100% INCREASE IN WATER LOAD		
L_p	pounds per acre per year	0.55
L_{pb}	pounds per acre per year	0.32
qs	meters per year	2.10
Phosphorus	mg/l	0.009
Lead	mg/l	0.009

Source: International Environmental Management Services Ltd

sampling program be conducted in this watershed. No comparative data were available for lead or metals and (suspended) sediments in the lake.

If these concentrations are accepted as being reasonable representations of the observed pollutant concentrations in Kirby Lake, the water quality of the lake should stabilize within present limits for the foreseeable future. Particular note should be taken of the apparent sensitivity of the model to groundwater-related variables. The substantial contributions to contaminant loadings arising from this source, combined with inter-annual fluctuations in rainfall volumes, can have significant implications for the water quality in Kirby Lake. These are discussed further below.

Forecast In-lake Responses: The net result of nutrient loadings to Kirby Lake is the response of the lake biota, usually assessed in terms of algal growth determined as chlorophyll-a. The algal cells, in turn, reduce the transparency or clarity of the water and decrease the observed Secchi disc transparency measurements (although such reductions in Secchi disc transparency can also be related to the presence of inorganic turbidity [silt] and/or water color [humic coloration]). Based on the relationship between the chlorophyll-a response to nutrient input, the in-lake chlorophyll-a concentrations and Secchi disc transparencies were predicted using the OECD models from the forecast phosphorus concentrations presented in Tables 5 and 7. The results are set forth in Table 6.

The models generally over-predicted Secchi disc transparencies in the lake, even when estimated from a phosphorus concentration similar to that observed in Kirby Lake--generated under scenario 3 in Table 7. This over-estimation is likely to be due, in part, to the same causative factors discussed above--particularly, the under-estimation of contaminant (phosphorus) loads from groundwater sources--but, principally, to the presence of humic substances in the water column. These substances are not accounted for in the OECD models. Notwithstanding such shortcomings of the models themselves, and with the same caveats as were applied to the contaminant concentrations forecast for this lake, it may be suggested that these water quality indicators should also stabilize within present limits for the foreseeable future.

Aquatic Plants, Fisheries, Wildlife and Waterfowl

As noted, the quality and chemical composition of the influent water entering a waterbody, in combination with the morphology of the lake basin, determines the nature and extent of the biological response observed. In parts of Kirby Lake, abundant growths of emergent, floating leaved and submerged aquatic plants occur. An aquatic plant survey has not been completed on this lake, but a brief distribution survey was undertaken during the course of the inspection of shoreline protection structures conducted by IEMS Ltd staff in May 1994.

TABLE 8: AQUATIC PLANT SPECIES PRESENT IN KIRBY LAKE

Aquatic Plant

Emergent Vegetation
Polygonum amphibium var. stipulaceum (water smartweed)
Typha latifolia (broad-leaved cat-tail)

Submergent Vegetation
Ceratophyllum demersum (coontail)
Chara sp.
Eleocharis acicularis (needle spike rush)
Myriophyllum verticulatum (water milfoil)
Potamogeton americanus (pondweed)
P. amplifolius (large leaf pondweed)
Utricularia vulgaris (bladderwort)

Floating-leaved Vegetation
Nymphaea tuberosa (white water lily)

Source: International Environmental Management Services Ltd

The principle plant species observed at that time are set forth in Table 8. The aquatic flora of Kirby Lake was poor at the time of the survey, with most plants just beginning their spring growth. The bladderwort, Utricularia vulgaris, was widespread in the lake and could be considered the dominant species. Other species observed included three species of pond weed, the white waterlily, coontail, water smartweed and a native water milfoil. This distribution of plants represents a well-balanced native plant flora, well-suited to a sound fishery and stable shoreline. Given this situation, the preparation of an aquatic plant management plan for Kirby Lake is recommended. Such a plan would include the mapping of the plant distribution and suggested actions needed to maintain and preserve the aquatic plant community of this lake.

Kirby Lake is well-known for its sport and panfish fishing. The DNR Publication No. FM-800-91, Wisconsin Lakes, 1991, indicates that northern pike and large-mouth bass are common. Panfish also are rated as being common. Numerous areas along the less steeply-sloping eastern, western and northern shores of the lake present suitable habitats for the spawning of bass and northern pike. Spawning takes place in spring, between the time of the spring thaw and mid-June. Although about 92,000 northern pike fingerlings and fry were stocked in the lake to augment natural reproduction, the majority of the fishes in the lake are the result of natural reproduction.

Given the rural nature of much of the lake's shorelands, numerous small animals, such as squirrel, raccoon and cotton-tailed rabbit, and limited numbers of larger mammals, such as deer and bear, inhabit these areas and can be considered common. A variety of waterfowl make use of the wetland areas adjacent to the Lake.

Trophic State Assessment

Assuming that the inflow volumes predicted using the rainfall-runoff coefficient of 25 percent are correct, the forecast chlorophyll-a concentration, and measured phosphorus concentration and Secchi disc transparency, was used to evaluate the trophic state of Kirby Lake using the open-ended OECD trophic state models.[11] Based on these three indicators, Kirby Lake has the greatest probability of being mesotrophic. This is consistent with a water quality rating of fair to good based on relationships developed by Lillie and Mason for natural lakes in the State of Wisconsin,[12] and supported by the Wisconsin Trophic State Index

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[11] Ryding and Rast, op. cit.; OECD, op. cit.

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

value of about 49, indicative of a mesotrophic state.[13] However, the annual average phosphorus concentration marginally exceeds the guideline of 0.02 mg/l recommended by SEWRPC for the prevention of excessive aquatic plant growth and the maintenance of a warmwater fishery and full recreational use. In short, while few water quality problems are foreseen for Kirby Lake, the lake will probably remain a productive resource requiring a low-level of continued vigilance to ensure that the resource does not degrade in the future.

Controllable Pollutant Loads

Given the rather unique location of Kirby Lake on the surface and ground watersheds of the St. Croix and Chippewa river basins, and provided the existing level of development is not significantly increased or modified, the major controllable pollutant sources in the watershed are the limited number of residences and accesses situated around the lakeshore. Table 9 presents an assessment of the relative contributions of the various contaminant sources to Kirby Lake. It is clear from this Table that the majority of contaminants enter Kirby Lake from the watershed--between 86 and 94 percent of the contaminant load enters Kirby Lake from natural sources. This load can be considered to be non-controllable from the point of view of actions taken within the Kirby Lake direct drainage area; such actions will not affect the magnitude of the load entering the lake from the watershed. Therefore, the controllable contaminant loads are those that are most closely situated to Kirby Lake and which occur within the direct drainage area of that lake.

Of the controllable pollutant sources, the most significant source under existing land use conditions is the transportation and utility corridor around the Lake, which contributes between 5 and 11 percent of the load of all three modelled contaminants. In addition, while no further development of the Kirby Lake watershed is identified in Tables 1 and 9, the immediacy of the impact resulting from construction activities--as established through previous experience in Wisconsin--should not be overlooked.[14]

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[13] The Wisconsin Trophic State Index was developed by the Wisconsin Department of Natural Resources as a refinement of the more common Carlson Trophic State Index; the formulation of the index is described by R.A. Lillie, S. Graham and P. Rasmussen in Research Management Findings No. 35, Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes, May 1993. See also Wisconsin Department of Natural Resources, Wisconsin's Lakes: A Trophic Assessment, January 1983.

[14] Wisconsin Department of Natural Resources Publication No. WR-222-92, Wisconsin Construction Site Best Management Practice Handbook, 1992.

TABLE 9: CONTAMINANT LOADS RESULTING FROM LAND USE ACTIVITIES IN THE KIRBY LAKE DIRECT DRAINAGE AREA, 1990.

Land Use Category	Direct Drainage Area						
	acres	sediment load		phosphorus load		lead load	
		pounds	%	pounds	%	pounds	%
URBAN							
Residential	13	104	0.5%	0.4	1.6%	0.08	0.6
Transportation/ Utilities	5	1,070	5.5	2.9	11.3	1.15	7.9
Recreational	2	6	0.0	0.1	0.4	0.01	0.1
Subtotal	20	1,180	6.0	3.4	13.3	1.24	8.6
RURAL							
Woodland} Wetland }	337	1,011	5.2%	10.1	39.6%	1.35	9.2
Water	92	17,296	88.8	12.0	47.1	12.0	82.2
Subtotal	429	18,307	94.0	22.1	86.7	13.35	91.4
TOTAL	449	19,487	100.0	25.5	100.0	14.59	100.0

Source: International Environmental Management Services Ltd

Controlling runoff from even a small amount of construction activity can result in large reductions in pollutant loadings to surface waters. When such activities are combined with the development and/or maintenance of transportation corridors, as may be the situation around Kirby Lake, the potential benefits to be achieved is likely to be substantial. Hence, construction site erosion control and stormwater management are highlighted below as not only issues of concern to the Kirby Lake community but also as areas where nonpoint source pollution controls are particularly desirable and feasible.

LAND USE PROBLEMS AND CONCERNS

Although Kirby Lake is in good condition and is capable of supporting a wide variety of water uses, there are a number of existing and potential future problems that warrant concern. These problems or issues of concern include the protection of ecologically valuable areas, construction site erosion control and stormwater pollution control, boating demands and public access, wastewater pollution control--including potential contamination from historic landfill operations in close proximity to the watershed, and continued protection of the shoreline.

Inspection of the shorelands and the banks of the influent streams by IEMS Ltd staff during May 1994 did not reveal any areas of active erosion.

Ecologically Valuable Areas

The ecologically valuable areas of Kirby Lake and its watershed--the wetlands and woodlands--are shown on Map 4. These areas were confirmed by the field inventory conducted during May 1994 by IEMS Ltd staff. Almost all of the best remaining woodlands, wetlands and wildlife habitat are contained within these areas. In addition to providing habitat, these areas also provide the scenic vistas which characterize the ambience of the Kirby Lake watershed and serve beneficial environmental purposes as a buffer between the urbanizing lands south of the watershed and the Lake. For these reasons, the protection of these resources from additional intrusion by incompatible land uses which degrade and destroy the environmental values of these sites, and the preservation of these areas in an essentially open and natural state, is essential to the maintenance of a high level of environmental quality, the protection of natural beauty, and the provision of recreational and quality residential opportunities in the watershed.

It is recommended that all ecologically valuable lands in the Kirby Lake watershed be preserved in essentially-natural open-space uses, primarily through public land use controls. Such preservation should be promoted through the placement of such resources in appropriate conservancy zoning districts, and through the enforcement of existing regulations intended to protect such

natural resources. It is also conceivable that future management actions may be necessary to ensure the habitat quality of the lands included in these areas--actions such as the control of invasive plants which might degrade the habitat quality of the wetlands and shorelands. For these reasons, appropriate public agencies may wish to consider the acquisition of ecologically valuable lands as such lands become available. Furthermore, should urban development not proposed or envisioned under this plan threaten to destroy or degrade natural resources located within these areas, appropriate public agencies should actively consider acquisition of such lands for resource and open space preservation purposes. Consideration should also be given to the linking of these areas into environmental corridors in order to provide migration routes and similar linkages for wildlife within Barron County and the Northwest Wisconsin Region. These corridors in turn help to maintain the ambience of the region and provide additional opportunity for outdoor recreation.

The purchase of specific critical properties 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 Program or the Chapter NR 191 Lake Protection Grant Program. Lands that might be considered as being ecologically valuable and having potential water quality benefit for Kirby Lake have been shown on Map 4 as wetlands and woodlands. Outright purchase, or the purchase of conservation easements, are both possible options. Lands proposed for purchase must be appraised using standard governmental land acquisition procedures as established by the DNR, and must be subject to a land management plan setting forth the process and procedures for their long term maintenance and development. Both grant programs provide state cost share funding for the purchase up to a maximum state share of $100,000.

Construction Site Erosion Control

Although not anticipated under this plan, erosion from new urban construction in the direct drainage area of Kirby Lake could represent a significant threat to the Lake's water quality. This would include erosion from road surfaces or from road improvement activities which are anticipated under this plan. Already there is extensive urban development activity taking place in the City of Cumberland which could stimulate potential demand for recreational access and property development at Kirby Lake. In terms of the Barron County erosion control ordinance, nonpoint source and construction erosion control plans for developments within the Kirby Lake watershed are to be developed and reviewed by all parties.

Further, recent amendments to the Federal Clean Water Act of 1982 and regulations issued pursuant thereto, require the DNR to issue permits under the Wisconsin Pollutant Discharge Elimination System

(WPDES) for the discharge of runoff from construction sites of 5 acres in area or larger, industrial sites, and municipal areas. These regulations provide for the preparation and maintenance of a construction erosion control and stormwater management plan by the permit applicants and the regular inspection of these facilities. The plans must contain (i) a site description; (ii) a description of the appropriate controls and measures that will be performed at the site to prevent the loss of pollutants from the site to the waters of the State; (iii) a description of the interim and permanent stabilization practices and structural practices to limit, store or divert stormwater flows; (iv) a description of such temporary measures as may be needed during the construction process to control pollutant loss and runoff; (v) a statement of the maintenance and management practices to ensure the continued utility of these practices and devices; (vi) a statement concerning the minimization of the loss of solid materials both on and off the site; and (vii) the identification of the contractors and sub-contractors responsible for the installation and maintenance of the stormwater management measures contained within the plan.[15]

As a consequence of these planning and permitting requirements, applicable to the Kirby Lake watershed, construction site best management practices will now be required for all construction sites greater than 5 acres in areal extent. Guidance on the nature of these practices is available from the DNR or U.S. Environmental Protection Agency and appears in various publications including s. NR 120.08 of the Wisconsin Administrative Code.

Stormwater Pollution Control

Stormwater management is generally linked with the control of erosion, and many of the common elements of stormwater and construction erosion control have been dealt with above. Nevertheless, as suggested in Table 9, the transportation corridors within the Kirby Lake watershed are cause for additional concern. Typically, stormwater management practices include both structural--constructed practices such as wet or dry detention basins, grassed waterways, flow barriers and sedimentation ponds--and non-structural--institutional practices like improved housekeeping, and development of stormwater management ordinances--measures which may be applied individually or in combination. In the case of Kirby Lake, development of an appropriate ordinance as provided for under s. NR 120.16 of the Wisconsin Administrative Code would be an initial step toward the control of both erosion and stormwater

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[15] Wisconsin Department of Natural Resources Briefing Memo for WPDES Permit No. WI-0067821-1, Construction Site Erosion Control and Storm Water Management, November 1992; and Wisconsin Department of Natural Resources Briefing Memo for WPDES Permit No. WI-0067849-1, Draft General Permit to Discharge Storm Water Associated with Industrial Activity, November 1992.

runoff.

However, additional steps are likely to be needed to protect the lake from the deleterious effects of runoff from these corridors. At present, runoff from the access roads passes directly into the Lake and surrounding wetlands. Construction of grassed verges between the roadways and waterbodies where possible could prove beneficial in intercepting particulates and pollutants from the road surfaces and should be investigated. In addition, the water quality benefits--together with any liabilities--to be achieved from paving some or all of the road surfaces should be evaluated.[16] The reconstruction or re-grading of any of these roadways could provide an opportunity to implement these or similar structural measures to minimize these stormwater impacts on Kirby Lake.

Wastewater Pollution Control and Groundwater Protection

At present, the residential areas of the Kirby Lake watershed are served by private on-site sewage disposal systems, virtually all of which are sited on soils unsuited to on-site sewage disposal.[17] Ultimately, the provision of sanitary sewer services to protect and maintain the high quality water resource that is Kirby Lake may be necessary. In the interim, adequate maintenance of the on-site sewage disposal systems should adequately manage the input of groundwater-borne nutrients to Kirby Lake.[18] As noted previously, however, the conduct of a groundwater monitoring program is highly recommended. Such a program should include the measurement of wastewater-related parameters in order to better assess the potential consequences of on-site sewage treatment systems for Kirby Lake.

Given the import of groundwater to Kirby Lake, the Kirby Lake District Commission expressed their concern over the potential contamination of the lake by leachates from abandoned landfill operations in the vicinity of the lake. These concerns do not appear to be warranted, given the directions of groundwater flow determined by the Wisconsin Geological and Natural History Survey

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[16] Environmental benefits likely to be achieved through the paving of roadways around Kirby Lake include less soil loss and pollutant transport to the lake as well as reduced dust levels, while liabilities include increased runoff from the impervious surface (relative to the limited infiltration achieved with the unpaved surface), potentially higher maintenance costs, and higher vehicle speeds. The capital cost of this project is also likely to be a signficant disincentive.

[17] Wisconsin Geological and Natural History Survey, op. cit.

[18] See Wisconsin Department of Natural Resources Publication No. PUBL-WR-165-87REV, Maintaining Your Septic System, July 1987.

(WGNHS) in this portion of Barron County[19] and the magnitude of the estimated pollutant loads presented in Table 7. If leachate from landfill operations had been present, the estimated pollutant loads should have been significantly higher than those indicated in the Table.[20] Nevertheless, this conclusion should be verified by the inclusion of suitable analytes in the already recommended groundwater monitoring study.

Boating Demands and Public Access

Overcrowding and excessive recreational boating use have plagued many lakes in Wisconsin, especially those offering high quality recreational opportunities within a one to two hour drive of major population centers such as the Minneapolis-St Paul metroplex. Given the situation and good water quality of Kirby Lake, recreational and boating uses of the lake can be expected to increase substantially in the near future.

Potential ecosystem impacts arising from heavy boating and recreational use include depletion of the sportfish resource due to angling pressures (leading to the development of stunted populations of panfish and an increase in rough fish abundance through lack of predation); intensification of the risk of boating accidents associated with the high speed operation of power boats; interruption of sportfish spawning patterns due to increased turbidities arising from resuspension of the lake bottom, increased shoreline erosion, and modification of plant community structure due to use-related damages; and, contamination of the lake waters by motor fuels and lubricants, exhaust fumes and other substances released from or exposed on the lake bottom due to the erosional effects of high speed boat traffic, and depleted oxygen levels caused by contaminant-related and other mortality amongst benthic organisms, fish and aquatic plants.

Should recreational boating pressure increase sufficiently in future, the promulgation of more stringent controls on the use of powered water craft along the shallow shorelines of Kirby Lake

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[19] Wisconsin Geological and Natural History Survey, op. cit.

[20] van der Leeden, F., Troise, F.L., Todd, D.K., The Water Encyclopedia, Second Edition, Lewis Publishers, Boca Raton, 1990; their Table 7-104 would suggest that a greater than 10 times increase in forecast contaminant loads could be expected if leachate was present. While this impact would be moderated in proportion to the relative contribution of the leachate to the total groundwater contaminant load, the approximately two-fold increase in forecast load--suggested in Table 7--is within the expected range of variation of UAL coefficients and not sufficiently extreme to suggest any major external contaminant source.

could restrict high speed boat traffic in the areas where severe ecological damage would be most likely to occur (such as the southern reaches of the lake adjacent to the County parkland which have a deep water marsh-like character unsuited to high speed boating). These controls have the advantage of being inexpensive to promulgate. Control of boat traffic could be effected either within a specified distance of the shoreline--for example, the "shore zone", within 200 feet of the shoreline, as defined in the DNR boating ordinance guidelines[21]--or in specific areas of the lake--for example, "boat excluded areas" or a "motorboat prohibition"--or by limiting the speed at which high speed boat traffic travels in specific areas of the lake--such as, "slow-no-wake" or some other "speed restriction". Boat excluded areas must be designated by approved regulatory markers. These areas are preferable to motorboat prohibition areas as the latter can lead to legal challenges based on the right of free use of navigable waters; similarly, slow-no-wake restrictions are preferable to speed limits designated in miles per hour terms.[22] Placement of regulatory markers must conform to Section NR 5.09 of the Wisconsin Administrative Code, and all restrictions placed on the use of the waters of the State must be predicated upon the protection of public health, safety or welfare. Where a boating ordinance is enacted in conformity with State law, it must be clearly posted at public landings in accordance with Section 30.77(4) of the Wisconsin Statutes.

Buoyage can be expensive to obtain, install and maintain, but has the advantage of being visible to recreational boaters. It also clearly demarcates the affected areas. Two options exist; the establishment of regulated areas--the slow-no-wake or exclusionary areas--or the enhancement of public awareness. The establishment of slow-no-wake areas within Kirby Lake requires promulgation of a boating ordinance, the authorization of the local municipality having jurisdiction over the waters involved, and a DNR permit. Only regulatory markers are enforceable. The buoys used to demarcate regulated areas must be cylindrical in shape, seven or more inches in diameter, and extend 36 or more inches above the waterline. The buoys will be white, with instructions provided in black lettering; prohibition buoys will display an orange diamond with an orange cross inside, while control buoys will display an orange circle. Alternatively, Chapter 30, Wis. Stats., allows local authorities having jurisdiction over the waters involved to place danger buoys or informational buoys without an ordinance, although a DNR permit is still required. Informational buoys should be similar in construction to the prohibition and control buoys, but will contain an orange square on the white background.

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[21] Wisconsin Department of Natural Resources, Guidelines: Ordinance Writing and Buoy Placement for Wisconsin Waters, s.d.

[22] Ibid.

Informational buoys are not enforceable.

It is recommended that provision be made at the access site on the Lake for the posting of such boating regulations as may be adopted and other notices as necessary. The facilities at these access points should also be up-graded to conform to the guidance on accessibility contained in Wisconsin Department of Natural Resources Publication No. CA-003-88, Handbook for Accessibility ... A Reference Manual to Help Develop Outdoor Recreation Areas to Include People with Disabilities, Spring 1989.

Shoreline Protection

Shoreland erosion is not a major problem on Kirby Lake, although water level fluctuations can adversely affect shoreland plant communities and established shoreland vegetated buffer strips. Thus, sensitive areas of shoreline, susceptible to recession, should be protected. Those structures that have been built were generally well maintained when inspected during May 1994 by IEMS Ltd staff. However, shoreline erosion could be expected to increase as lake usage increases, and erosion-related problems could worsen in future. While construction of visually-intrusive shoreland protection structures may be considered, other options may be preferred by lake residents seeking to conserve the ambience of Kirby Lake.

Shoreline protection can be enhanced by providing lakeshore residents with information on the methods of proper construction and maintenance of shoreland protection structures, on the problems commonly associated with such structures, and alternatives and their costs to traditional shoreland protection structures--such as, the use of vegetated buffer strips, rip-rap, etc. versus retaining walls and bulkheads. Such information is commonly available from the DNR, UWEX and U.S. Army Corps of Engineers.[23] In addition, the proposed promulgation of a boating ordinance should provide a further degree of protection to the shallow areas of the Lake and to the shorelands by limiting boat usage in these areas.

PAST AND PRESENT LAKE MANAGEMENT PRACTICES

Background

The residents of Kirby Lake, in conjunction with the Town of Maple Plain, have long recognized the importance of informed and timely action in the protection of the water quality of Kirby Lake. Their

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[23] See, for example, the relevant discussions in University of Wisconsin Extension, Life on the Edge ... Owning Waterfront Property, March 1994.

initial concern resulted in the formation of the Kirby Lake District which provides the forum for many of the lake management activities of the Lake's residents. To date, the District undertakes regular water quality measurements under the auspices of the DNR Self-help Monitoring Program. These citizen-based measurements are presently augmented by periodic DNR water quality investigations. The District holds a Phase I Lake Management Planning Grant to cost-share a watershed inventory and scoping study of Kirby Lake and its drainage basin. This study forms the basis of this report and will eventually become part of a comprehensive lake management plan for Kirby Lake. It is recommended that the District continue with its program of planning studies leading to this end, and make application to the Wisconsin Department of Natural Resources for a Phase II Lake Management Planning Grant to support additional water quality monitoring--especially of the groundwater--and, at a minimum, an aquatic plant survey of the lake.

Public Information

It is the policy of the Kirby Lake District and the Town of Maple Plain to maintain an active dialogue with the community. This dialogue is carried out through the medium of the public press and in public fora through various Town Committees, public meetings and other scheduled hearings, and regular public meetings of the District Commissioners and electors. Informational issues identified above should be dealt with at District meetings, and regular reports on the results of the citizen-monitoring effort should be a feature of these meetings. The District is encouraged to include a public information segment on their annual meeting agenda, possibly inviting guest speakers from various state and local agencies such as the DNR and UWEX.

It is recommended that the Kirby Lake District, in conjunction with the Town of Plain conduct a public education and information program providing riparian residents with information on alternative forms of lawn and garden care, household chemical usage, shoreland protection structures, and other relevant information as may be obtained from the US EPA, US Army Corps of Engineers, DNR and UWEX in order to reduce and minimize the adverse impacts of residential development in the Lake's watershed.[24] It is suggested that the aforementioned organizations seek the collaboration of the Cumberland Chamber of Commerce and sister lake organizations, such as the Big Sand Lake Association and Beaver Dam Lake Improvement Association, in distributing similar information to businesses within the Cumberland-Kirby Lake area.

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[24] Suitable materials were provided by IEMS Ltd and Aron & Associates at the 1994 annual meeting of the Kirby Lake District and should be viewed as supplemental to this report.

Public information and involvement remains an important component of this plan.

SUMMARY

This report, which documents the findings of a study requested by the Kirby Lake District, examines existing and anticipated land uses and land use problems encountered in the Kirby Lake watershed and their effect on lake water quality. This report is complementary to DNR Self-help water quality monitoring investigations being carried out by the District on Kirby Lake, and is designed to highlight those areas where further study is desirable in order to achieve the lake protection goals of the District.

Kirby Lake is a mesotrophic, deep water lake of relatively good quality located in close proximity to the Minneapolis-St Paul metropolitan area and adjacent to a rapidly urbanizing part of Barron County in which the study area was wholly located. Surveys conducted under the auspices of this planning project indicated that the watershed contains some areas of ecological value. To protect these areas from human encroachment and reduce human impacts on the ecologically valuable areas within the watershed, specific actions should be considered, including adoption or amendment of Town ordinances relating to boating on Kirby Lake, stormwater and construction site erosion management in the watershed, and monitoring of on-site wastewater disposal systems. Ordinance development should be linked with an on-going program of public information and education providing riparian residents and lake users with, for example, additional options to household chemical usage, lawn and garden care, shoreland protection, and recreational usage of the Lake.

Further, consideration should be given to the public acquisition of, or acquisition of conservation easements over, lands within the environmental corridors to ensure the protection and preservation of these ecologically valuable areas. In this way, the recommended plan seeks to balance the demand for high quality residential and recreational opportunities at Kirby Lake with the requirements of the environment that creates this sought-after high quality experience.

Costs associated with the implementation of the recommendations given in this inventory were not estimated. With the exception of the provision of buoyage to demarcate ecologically valuable areas within the Lake, such costs are primarily administrative costs, to be borne by the local units of government, including the lake management district. The cost of buoyage could potentially be off-set through the use of grants-in-aid provided under the Recreational Boating Facility Program, a cost-share program operated by the Wisconsin Waterways Commission and DNR. Cost-

benefit analyses should be conducted during later phases of this planning program.

This plan is consistent with existing planning guidelines produced for the Town of Maple Plain and Barron County. Continuation of these planning studies through the conduct of additional in-lake investigations relating to the aquatic biota, groundwater monitoring studies and the formulation of a comprehensive lake management plan for Kirby Lake, is recommended.