R.A.SMITH
& ASSOCIATES, INC.

ROCK LAKE
PLANNING GRANT STUDY

Rock Lake Improvement Association

Jefferson County, Wisconsin

Project No.: 94910-0-342-342

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LPL-224

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CHAPTER 1

INTRODUCTION

Summary

R. A. Smith and Associates has prepared this Planning Grant Study to address the current concerns of the Rock Lake Improvement Association. The purpose of this study was to assess the threats to the water quality and aquatic habitat of Rock Lake and to develop recommendations which would alleviate these threats. This study was funded by the Rock Lake Improvement Association and the Wisconsin Department of Natural Resources Lakes Management Program under the Lake Planning Grant Program.

Location and Description

Rock Lake is a 1,371-acre drainage lake lying in western Jefferson County, in the Town of Lake Mills (See Figure 1-1 and Appendix A). The lake has a maximum depth of 56 feet, with a mean depth of 16 feet. The lake consists of two basins; a larger and deeper north basin 1,161 acres in size, and a 210-acre shallower south basin known as Marsh Lake. Rock Lake has one main inflowing stream and one outlet, Rock Creek. A dam was built on the outlet in 1865. This dam has raised the water level of the lake by approximately 10 feet. The higher water level has flooded many shoreline areas, including much of Marsh Lake.

The watershed (excluding Rock and Marsh Lakes) consists of 7,672 acres--the majority lying south of the lake. The land use in the watershed includes residential land use in the City of Lake Mills, row crops, pasture, hayfields, conservation preserve land, woodlands, and wetlands. The majority (67%) of land in the watershed is used for agriculture. Wetlands comprise 22% of the watershed land cover and surround the main tributary entering Rock Lake. In addition, two shallow lakes (Mud and Marsh Lakes) and their associated marshes lie on this tributary. Bean Lake also lies within the Rock Lake watershed. Bean Lake is a 33-acre lake surrounded by Tamarack and shrub swamp and now lies within the 195-acre Bean Lake State Natural Area. Residential land use is currently 4%, with the thin strip of land on the east shore in Lake Mills being the primary residential area. Existing residential development on the north and west shores of the lake is sparse, but potential for future growth is great in this portion of the watershed.

Background

There have been several efforts to assess the water quality of Rock Lake and to make appropriate plans to protect it. In the early 1970s, there was a U.S. Environmental Protection Agency (EPA) study of the water quality of Rock Lake which estimated a phosphorus budget. In 1978, there was a University of Wisconsin Urban and Regional Planning Department (UW-URPL) student workshop which developed "The Rock Lake Plan"--a land use plan for the Rock Lake watershed. The Rock Lake Improvement Association was established in 1978. Residents established objectives and goals revolving around the natural environment, population growth trends, land use, and unique historical and archaeological sites. The Wisconsin Department of Natural Resources (WDNR) Long Term Trends Program has been collecting water quality data since 1985.

This project is a continuation of the above research and planning efforts. This project analyzes the watershed's nonpoint source pollution in a more sophisticated manner than the 1970s EPA study. This project also provides more specific recommendations for protecting the Lake's aquatic habitat than those available in the 1978 UW-URPL plan. This project was conducted as a cooperative effort between the Rock Lake Improvement Association, the WDNR, and R. A. Smith and Associates, Inc.

Scope and Objectives

This study consists of four main components including: a watershed analysis using a nonpoint source pollution computer model; a shoreline erosion potential survey; sensitive area mapping, including an aquatic plant inventory and protection strategies; and a continuing informational and educational program outline.

This study provides a central core of baseline data and recommendations which will help in guiding the future development of the Rock Lake watershed. The creation and implementation of 5-acre zoning areas, erosion control ordinances, restoration plans for gravel pits, and establishment of buffer zones are some of the recommendations for the safe growth and continued protection of the Rock Lake watershed. The objectives here are to establish an environmental program for the long-term preservation and enjoyment of the "Rock Lake" community.

CHAPTER 2

LAKE AND WATERSHED OVERVIEW

Cultural Features

CIVIL DIVISIONS

The Rock Lake watershed lies in Jefferson County and extends over an area of 12 square miles. The largest incorporated area within the watershed is a portion of the City of Lake Mills.

POPULATION SIZE AND DISTRIBUTION

The 1990 census information indicates the City of Lake Mills has a population of 4,277, most of whom reside outside of the watershed. The surrounding Township of Lake Mills has an additional 1,682 individuals.

LAND USES

Cropland covers 8 square miles or 67% of the watershed. Wetlands encompass 22% of the watershed at 2.8 square miles, the majority lying directly south of Rock Lake. Currently, urban land uses occupy approximately 0.5 square miles or 4% of the watershed. However, the potential for growth is strong. The remaining land uses consist of woodlands, open water, pasture, and gravel pits in decreasing percentages.

DAM ON LAKE OUTLET

In 1865, a dam was constructed on the outlet to Rock Lake. This dam has raised the water level of the lake by approximately 10 feet, resulting in the enlargement of the lake and the flooding of low, shoreline areas.

SANITARY SEWER SERVICE

Sanitary sewer service is found within the City of Lake Mills on the eastern shore of Rock Lake, and within the boundary of the Sanitary District on the south, west and north sides of the lake. Approximately 4,000 people receive service. The remaining population, located to the west and south of the lake, outside of the sanitary district maintain septic systems.

MUNICIPAL POINT SOURCES OF WATER POLLUTION

The municipal wastewater facility in the City of Lake Mills discharges treated wastewater downstream of Rock Lake into Rock Creek. A city fish hatchery also discharges treated wastewater into Rock Creek downstream from the lake.

The other significant source of waste material is the poultry farm located in the southeast section of the watershed. Waste from the birds is regularly spread across the farm fields and incorporated as a fertilizer. Depending on breakdown time and amount of material, this waste product may influence the nitrate content of the soil and corresponding groundwater.

WATER SUPPLY SERVICE

The source of all potable water used in the watershed is groundwater. A municipal water supply system services the city residents, while those outside of the City of Lake Mills rely on private wells.

TRANSPORTATION CORRIDORS

Interstate Highway 94 skirts the northern edge of the watershed. A former Chicago and Northwestern Railroad line runs east and west, crossing Rock Lake at the narrows which connect the main basin of the lake to Marsh Lake. This railroad corridor has been converted to the Glacial Drumlin State Bike Trail.

RECREATIONAL AMENITIES

Rock Lake has four public and three private boat ramps and provides recreational opportunities for fishing, boating, and ice-boating. The Glacial Drumlin State Bicycle Trail also crosses Rock Lake at the narrows connecting the main body of the lake to Marsh Lake. This bike trail is owned and operated by the Wisconsin State Park system and runs along the former Chicago and Northwestern railroad grade. There is a bike trail rest stop in Lake Mills in the old railroad depot.

Natural Resource Features

CLIMATE

The frequency, duration, and amount of precipitation influences surface and groundwater quality and quantity, soil moisture content, runoff characteristics, and the physical condition of waterways. The average annual precipitation in the Rock Lake Watershed is 29.8 inches with the driest months being December, January, and February, averaging 1.58, 1.32, and 0.97 inches respectively (USDA, Soil Conservation Service, Soil Survey of Jefferson County, Wisconsin). These are also the months of greatest snowfall. The wettest months are June, July, and August with 3.87, 3.90, and 3.37 inches of precipitation, respectively. The majority of runoff occurs in March and April when the land surface is still frozen and soil moisture is the highest.

TOPOGRAPHY

The limestone bedrock of Jefferson County is topped with unconsolidated end and ground moraines left during the last glacier recession. Restricted flow through one terminal moraine, due to glacial drift, resulted in Lake Koshkonong (which lies 14 miles south of Rock Lake), Rock Lake, and the associated wetlands in between. Overall landforms are generally glacial drift features, with the northern portion of the watershed lying in a large drumlin field with low concave depressions lying between the drumlins. The area from Lake Mills south to the end of the watershed reflects the characteristics of a melt-water terrace. Surface elevations range from 800 to 1,000 feet in this area.

SOILS

The soil types in the watershed include Houghton Muck (35%), Kidder Loam (20%), Fox Loam (10%), and Palms Muck (5%). The soils and their corresponding hydrology are described in more detail below (USDA, 1979) (See Figure 2-1).

Houghton Series

"The Houghton series (Ht) consists of very poorly drained soils on outwash plains and moraines. These soils formed in more than 51 inches of organic material. Permeability is moderately slow to moderately rapid. Slope is 0 to 1 percent." Depth to the water table typically ranges from one foot deep to a foot above the ground surface. The period for high water tables occurs through the months of September to June.

Kidder Loam

"The Kidder series (Kf) consists of deep, well drained and moderately well drained, moderately permeable soils, formed in loamy deposits and in underlying loamy glacial till. These soils are on till plains and drumlins. Slopes range from 2 to 20 percent." Depth to the water table may range from 2.5 to 6 feet depending on the soil slope.

Fox Loam

"The Fox series (Fo) consists of deep, well drained soils that are moderately permeable in the upper part and rapidly or very rapidly permeable in the substratum. These soils are on outwash plains and terraces. They formed in silty and loamy deposits over sand and gravel. Slopes range from 0 to 12 percent." The depth to the water table may vary from 3 to 6 feet for members of this series.

Palms Muck

"The Palms series consists of deep, very poorly drained, moderately permeable soils that formed in 16 to 51 inches of organic material accumulated mainly from sedges and that are underlain by loamy deposits. These soils are in depressions in old lake basins. Slopes range from 0 to 2 percent." The seasonal high water table varies from surface to a depth of 1 foot.

GROUNDWATER RESOURCES

Sand and Gravel Aquifer (USGS, 1975): Water-bearing sand and gravel is located in approximately half of Jefferson County and is concentrated in low areas. The saturated thickness of unconsolidated deposits range from 0 to 150 feet in the Rock Lake watershed, the saturated thickness of the sand and gravel aquifer ranges from 0 to 100 feet. Groundwater in these deposits moves among the sand and gravel grains. The potential for contamination may be high due to the shallow depth to groundwater and the permeability of the bedrock.

Sandstone Aquifer (USGS, 1975): The sandstone aquifer underlies Southeastern Wisconsin and is also an important source of water within this watershed. This aquifer is completely saturated, and thicknesses may reach 1,100 feet. Well yields in the Rock Lake watershed may reach as high as 1,000 gallons per minute from this source.

FISHERIES AND WATERFOWL

The fishery of Rock Lake consists mostly of Walleye, Yellow Perch, Largemouth and Smallmouth Bass, panfish, Northern Pike and carp. Walleye and Northern Pike were stocked by the Wisconsin Department of Natural Resources in 1994. Marsh Lake is a stopover sight for migrating Coots, Mallards, and Canada Geese. Other waterfowl spotted on Rock Lake are Bufflehead, Canvasback, Ring-Necked Ducks, and Tundra Swan. In addition, Trumpeter Swans were sighted on the lake in 1993 and 1994, and a Bald Eagle was sighted on the west shore in November 1994.

WETLANDS

A wetland complex of approximately 1,700 acres exists in the southern watershed of Rock Lake. The complex consists of such diverse communities such as tamarack swamp, shrub carr, sedge meadow, and shallow marsh. Much of the wetland complex is publicly owned. A 195-acre State Natural area was designated around Bean Lake due to its high ecological value.

CHAPTER 3

WATER QUALITY CONDITIONS AND NONPOINT SOURCE LOADING TO ROCK LAKE

Existing In-Lake Water Quality

Analyzing lake water chemistry is an important way to determine the health of a lake. One of the main problems experienced by lakes is excess nutrients which encourage nuisance algae and aquatic macrophyte growth. The trophic state of a lake relates to the level of nutrients and water clarity of a lake. There are three trophic states: oligotrophic, mesotrophic, and eutrophic. **Oligotrophic** lakes are generally clear, cold, and free of weeds or large blooms of algae, although they have low fish populations. **Eutrophic** lakes are high in nutrients and, therefore, support a large biomass. They are likely to be weedy or have algae blooms. They often support large fish populations. **Mesotrophic** lakes are intermediate between oligotrophic and eutrophic lakes. The trophic status is determined by the water chemistry parameters--Total Phosphorus, Chlorophyll-*a*, and Secchi depth. Phosphorus, in excess quantities, is the nutrient primarily responsible for nuisance algae and aquatic macrophyte growth. Chlorophyll-*a* measures the quantity of algae in the water. Secchi depth measures water clarity which, in turn, is related to the quantity of algae in the water column.

The water chemistry of Rock Lake has been analyzed periodically since 1973. Rock Lake is part of the Wisconsin Department of Natural Resources (WDNR) Long Term Trends (LTT) monitoring program. This is a program which is collecting comprehensive, long-term data on 50 inland lakes throughout the state to document changes which may be occurring. This program began collecting water quality data from Rock Lake in 1985. Generally, LTT lakes are sampled at spring turnover and in June, July, and August--although there are a few gaps in sampling. Supplementing this data are the water quality data collected by volunteers for the Wisconsin Self Help Monitoring Program administered by the WDNR. In addition, there are two years of water quality data collected from May 1973 through February 1975 by the WDNR. A summary of this data is in Table 3-1.

The water quality data for Rock Lake was plotted on a scale which indicates trophic status (Figure 3-1). According to this plot, Rock Lake is considered to be **mesotrophic.**

Table 3-1

Water Quality Data for Rock Lake (WDNR)

Date		Secchi depth	Surface D.O.	Phosphorus Concentration	Chlorophyll a Concentration
Year	Month	(meters)	(mg/l)	(ug/l)	(ug/l)
1973	**MAY**	**3.0**	**9.5**	**20**	
1973	July	1.7	8.1	60	
1973	Nov.	2.2	10.5	20	
1974	Feb.	1.8	10.6	40	
1974	July	2.3	11.3	30	
1974	August	1.6	8.4	10	
1974	Nov.	1.8	10.3	60	
1975	Feb.	4.4	12.3	20	
1985	August	2.0	8.8	20	13
1986	April	1.5	11.6	20	18
1986	July	1.6	7.4	17	7
1986	Sep.	1.8	9.2	20	10
1987	March		12.0	10	
1987	June	2.2	8.1	20	5
1987	July	1.6	8.0	33	7
1987	August	2.0	7.1	9	8
1988	March			8	2
1988	**APRIL**		**10.8**	**12**	**5**
1988	June			10	3
1988	July	2.0	7.9	30	5
1988	August		7.1	9	5
1989	March		17.0	20	18
1989	**APRIL**		**13.0**	**12**	**5**
1990	July*	4.7		>20	
1990	Sep.*	3.0		14	
1990	Oct. *	3.2		16	
1991	July*	4.4		9	4
1991	August*	3.0		26	5
1991	Sep.*	2.5		10	11
1991	Oct.*	3.4		25	8
1992	July*			8	3
1992	August*			9	2
1992	Oct.*			12	3
1994	Feb.			32	**0**
1994	**APRIL**	**1.8**		**20**	**19**
1994	July 5			10	3
1994	July			6	7
1994	August			17	4

BOLD = spring turnover conditions

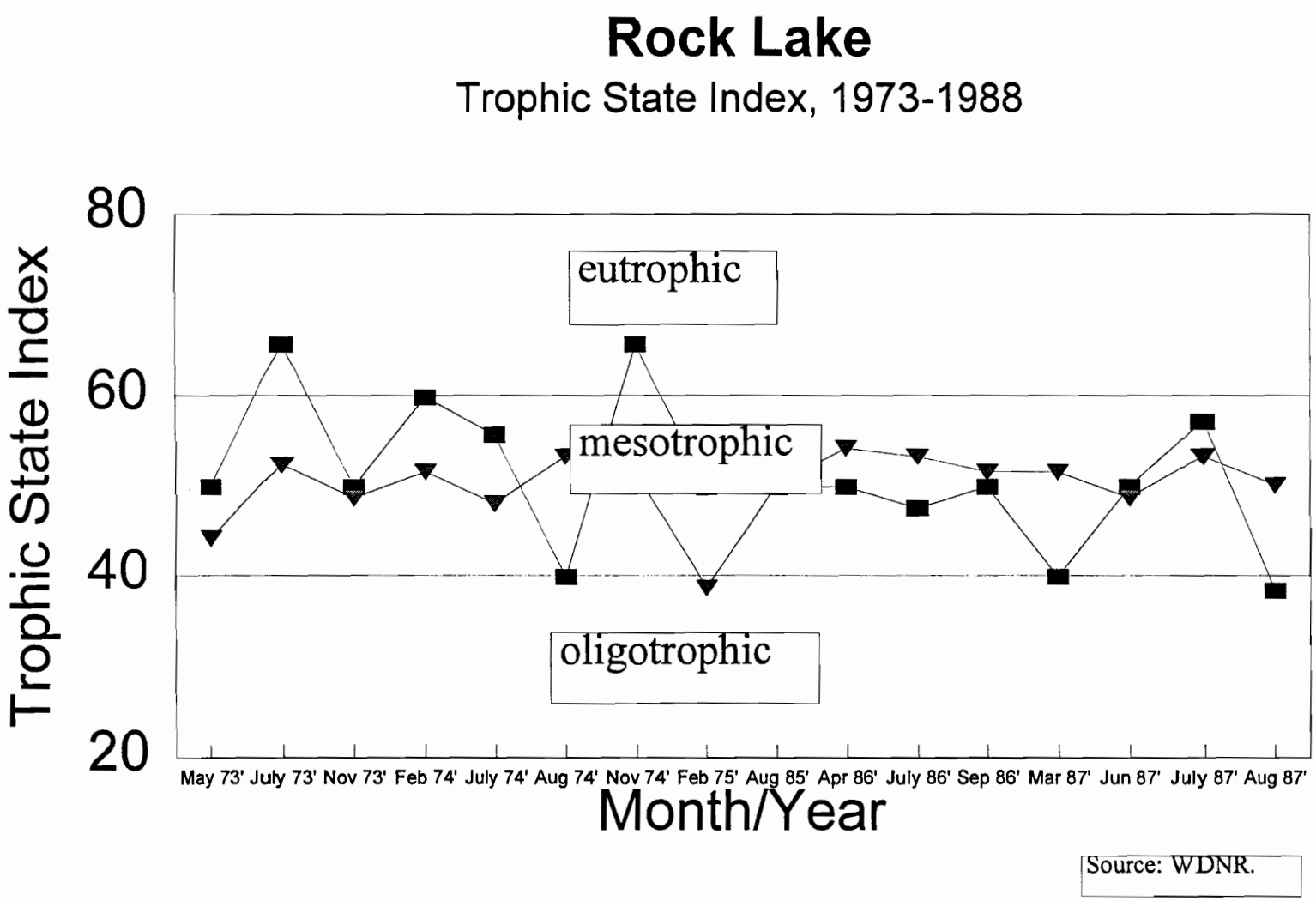
* Data collected by Self Help Lake Monitoring volunteer.

D.O. = Dissolved Oxygen

Blank = No Data

Source: WDNR, 1995

Figure 3-1


Rock Lake
Trophic State Index, 1973-1988
Trophic State Index
80
60
40
20
eutrophic
mesotrophic
oligotrophic
May 73' July 73' Nov 73' Feb 74' July 74' Aug 74' Nov 74' Feb 75' Aug 85' Apr 86' July 86' Sep 86' Mar 87' Jun 87' July 87' Aug 87'
Month/Year
Source: WDNR.
Total Phos.
Secchi Disk

Nonpoint Source Pollution from the Watershed

LAND COVER

The land cover in the watershed includes residential land use in the City of Lake Mills, row crops, pasture, hayfields, conservation reserve land, woods, and wetlands. The major land use in the watershed is agriculture, comprising 67% of the land cover. Wetlands are a large part of the watershed, comprising 22% of the land cover. Wetlands surround the main tributary going into Rock Lake. In addition, two shallow lakes (Mud Lake and Marsh Lake) which are surrounded by shallow marsh are on this tributary. Residential land use (4% of the land cover) is a small but growing part of the watershed. The portion of the watershed lying in the City of Lake Mills is a thin strip of land on the east shore of the lake and is primarily a residential area. There is low density residential development on the north and west shores of the lake with potential for much more development on that side of the watershed.

TABLE 3-2

Rock Lake Land Cover

Land Cover	Area (acres)	Percent of Watershed
Crops	5121	67%
Wetland	1716	22%
Woods	365	5%
Residential	286	4%
Water (excluding Rock Lake)	136	1.7%
Pasture	28	.05%
Gravel Pit	10	.01%
Christmas Trees	10	.01%
Total	**7672**	**100%**

Source: R. A. Smith & Associates, Inc.

ESTIMATING NONPOINT SOURCE POLLUTION.

Nonpoint source pollution inputs to Rock Lake were separated into three categories: rural, urban, and shoreline erosion. The pollutant of primary concern for Rock Lake is phosphorus. The quantities of phosphorus which enter Rock Lake were estimated. The rural component was calculated using a computer model which approximates the erosion and transport of sediment throughout the entire watershed. The urban component was estimated using a unit area load calculation. The shoreline erosion component was calculated by multiplying the estimated erosion rate by an estimated phosphorus concentration of the eroded soil.

The three estimated phosphorus loading quantities were then analyzed in comparison with the actual in-lake phosphorus concentrations discussed in the section above. The phosphorus loading estimates give relative rates of loading and must be calibrated using actual water quality data. A lake water quality model was used to calibrate the estimated nonpoint source phosphorus loadings. The lake water quality model calculates the in-lake phosphorus concentration, given a phosphorus loading rate. This modelled phosphorus concentration is then compared to the measured in-lake concentration and the estimated phosphorus loading is adjusted accordingly.

Rural Nonpoint Source Pollution

Rural nonpoint source pollution is a significant source of pollution to Rock Lake due to the large percentage of agricultural land in the Rock Lake watershed. Rural nonpoint source pollution loading was estimated with a computer model.

WINHUSLE Model

The model used for this project was WINHUSLE, a water quality model for agricultural lands developed by the WDNR utilizing the universal soil loss equation (USLE). The USLE calculates the amount of sediment eroded from a field given the rainfall energy, soil type, slope, flow path length, cropping practices, and erosion control practices (Novotny and Chesters, 1981). WINHUSLE is a computer model which expands the scope of the USLE from a field basis to a watershed basis. In addition to calculating sediment eroded, WINHUSLE calculates the amount of phosphorus eroded as well. WINHUSLE is very data intensive, but is integrated with the field inventory computer data bases being developed by every County Land Conservation Department in the State of Wisconsin.

To run WINHUSLE, the Rock Lake watershed was first delineated. The watershed was divided into 60 separate drainage areas called Hydrologic Units, with the last one being the main basin of Rock Lake itself. Marsh Lake and Mud Lake were modelled as part of the inflowing stream. These Hydrologic Units are shown in Figure 3-2. Within each Hydrologic Unit, samples of farm fields were inventoried. This farm field information was obtained from the U.S. Soil Conservation Service (SCS) conservation plans. For the model to run accurately, 20% of the land area in the watershed picked randomly need to be described. The model extrapolates information from the inventoried fields to the uninventoried areas. For the Rock Lake WINHUSLE model, 57 % of the land area was inventoried.

WINHUSLE performs these functions in sequence:

1. Estimates runoff of sediment, phosphorus, and water from each field and extrapolates this to runoff for the entire Hydrologic Unit.

2. Routes runoff through the stream system of the watershed.

3. Estimates deposition of sediment and phosphorus in the streams.

4. Estimates the final loading of sediment and phosphorus to the outlet, which for this application was Rock Lake.

It is possible for the model to calculate sediment loading from individual farms. However, the model is not capable of calculating phosphorus loading on a farm-by-farm basis since phosphorus loading is sensitive to particular land uses, such as barnyards and manure spreading, which cannot be accounted for in the model. The Rock Lake model was not run on a farm-by-farm basis but on a watershed basis, which calculates the loading by Hydrologic Units.

WINHUSLE estimates in-stream deposition of sediment and phosphorus. This takes into account the settling of sediment in stream sections with low flow velocities. WINHUSLE does not take into account any sediment and phosphorus deposition or absorption in flows through extensive wetlands. This is significant because the tributary system of Rock Lake goes through wetlands which may be absorbing sediment and phosphorus and thus reducing the loadings to Rock Lake.

Results

Tree diagrams of the loadings of sediment and phosphorus coming from the watershed going to Rock Lake are in Figures 3-3 and 3-4. These diagrams track the loading coming from the Hydrologic Units and also the deposition occurring in the stream system. **The WINHUSLE model estimated that 339 tons of sediment and 2,066 pounds of phosphorus flow into Rock Lake annually from the rural lands in the watershed.** This does not include contributions of pollution from the urban land in the City of Lake Mills or from shoreline erosion. The model also estimated that 1,073 tons of sediment was delivered from the fields to the streams within the watershed annually, with 734 tons of this sediment being deposited within the streams. A full computer printout is in Appendix B.

It should be noted that the Hydrologic Units which directly drain into Rock Lake (units 48-58) contribute a disproportionate share of the pollutant loadings. These six Hydrologic Units contribute 66% of the phosphorus loading calculated by WINHUSLE, yet comprise only 17% of the rural land cover in the watershed. The reason for this is that these units drain directly to the lake so there is no deposition occurring in the stream system.

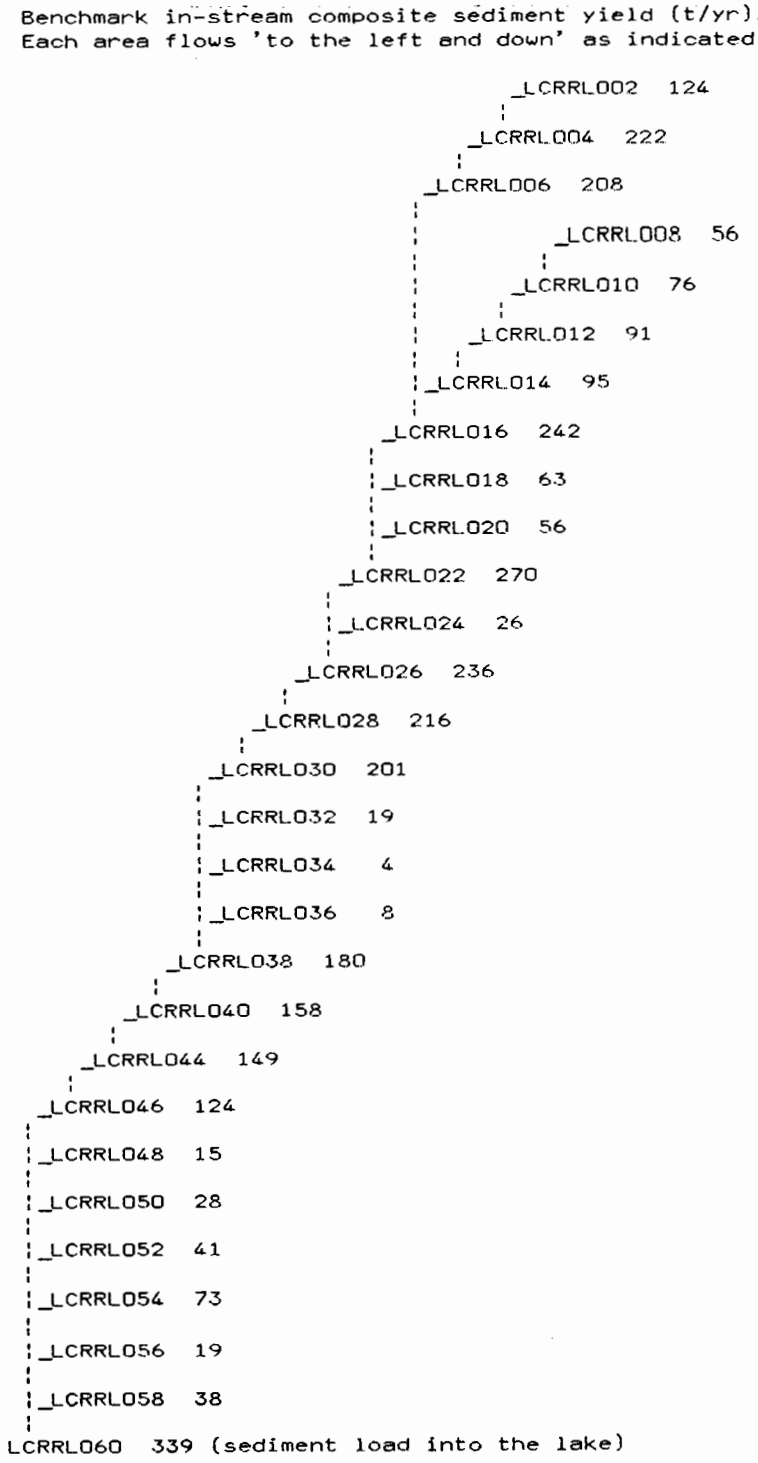


Figure 3-1	Source: Rock Lake WINHUSLE output.
Sediment Loading Tree Diagram	R.A.SMITH & ASSOCIATES, INC. *Engineering driven by vision* 414-786-1777 FAX 786-0826 16745 W. Bluemound Rd, Suite 301 Brookfield, WI 53005-5938
Instream composite sediment yield (tons/year)	

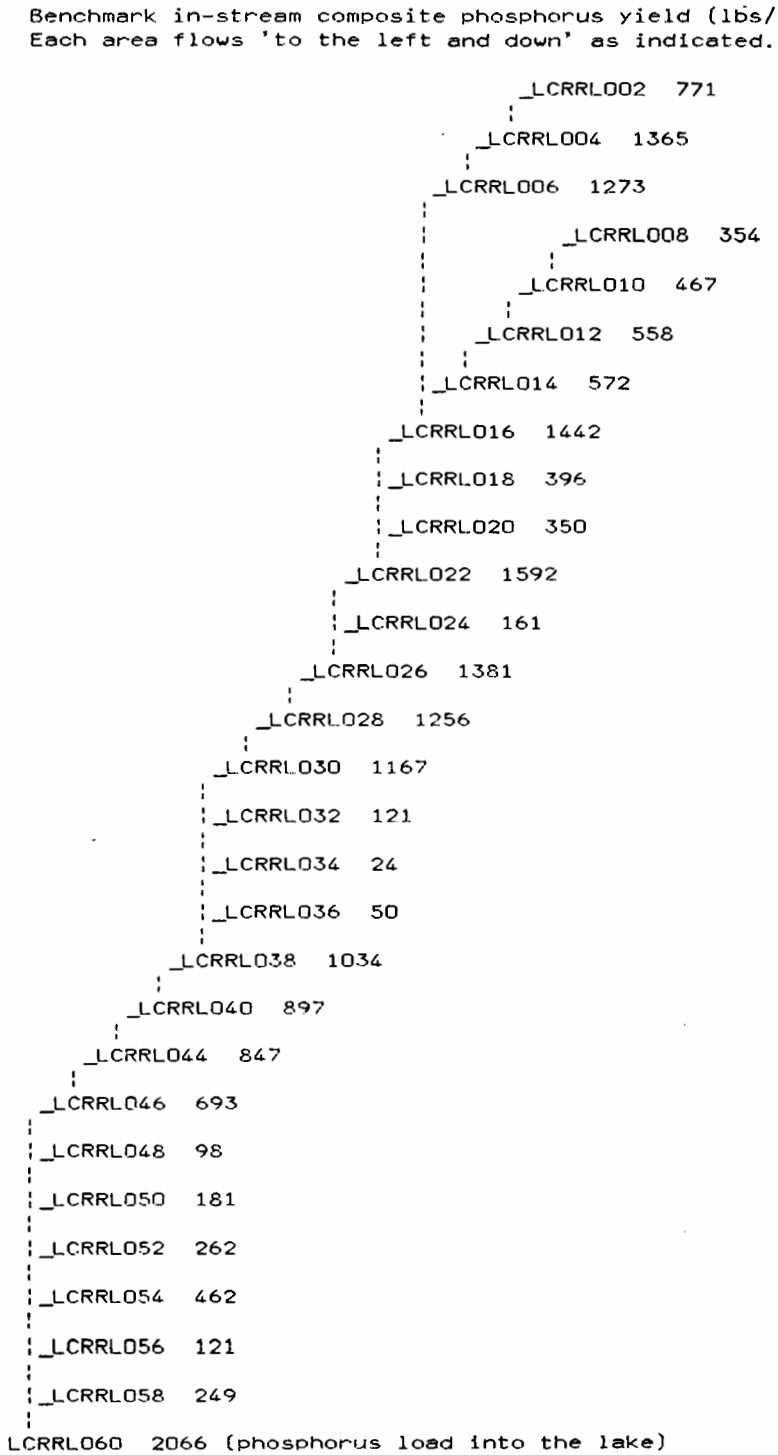


Figure 3-4	Source: Rock Lake WINHUSLE output
Phosphorus Loading Tree Diagram	
Instream composite phosphorus yield (pound/year)	

R.A.SMITH & ASSOCIATES, INC.
Engineering driven by vision
414-786-1777 FAX 786-0826
16745 W. Bluemound Rd, Suite 301
Brookfield, WI 53005-5938

While most of the sediment and phosphorus running off from the southern watershed is deposited in the stream system before reaching the main basin of Rock Lake, it is still useful to look at the amount of sediment which is generated by each hydrologic unit before deposition occurs. Even though most of the sediment and phosphorus loading from the southern watershed may not be reaching the main body of Rock Lake, deposition of this sediment and phosphorus in the intervening wetlands and in Mud and Marsh Lakes may be causing problems. Table 3-3 presents the sediment loading from each hydrologic unit.

The hydrologic units are ranked by the per-acre sediment load. The per-acre load indicates hydrologic units which may be eroding at a higher rate. The per-acre sediment loading rates are low in comparison with typical maximum recommended sediment loading rates from cropped lands of three to five tons per acre. The low rates may be due to the averaging of rates across the hydrologic unit. WINHUSLE assumes that the land use composition ratio of each hydrologic unit is the same as the total watershed. This means that land uses other than cropland, such as wetlands and woods, are a part of each hydrologic unit, which would lower the average per-acre sediment loading rate. In some instances, if there is enough field inventory information, the watershed land use composition ratio is overridden to reflect the land use ratio represented by the field inventories. The higher ranked hydrologic units in Table 3-3 are areas which are mostly farmed and have some slope. The lower ranked hydrologic units tend to be areas which are mostly wetlands and are flat.

TABLE 3-3

Ranked Sediment Loading per Acre Without Deposition.

Hydrologic Unit I.D. No.	Sediment load per acre (tons/ac/yr)	Sediment total load (tons/yr)	Hydrologic Unit I.D. No.	Sediment load per acre (tons/ac/yr)	Sediment total load (tons/yr)
18	0.31	63	10	0.17	43
2	0.30	124	36	0.16	8
20	0.29	56	6	0.16	28
16	0.26	39	58	0.15	38
34	0.25	4	24	0.15	26
14	0.24	25	32	0.15	19
4	0.24	123	28	0.12	24
12	0.21	39	30	0.12	26
48	0.21	15	38	0.11	34
56	0.20	19	22	0.08	35
8	0.19	56	40	0.08	30
50	0.19	28	46	0.06	60
52	0.18	41	26	0.04	8
54	0.17	73	44	0.02	2

Source: R. A. Smith and Associates, Inc.

URBAN NONPOINT SOURCE POLLUTION

The City of Lake Mills on the east shore of Rock Lake is the major urban area in the watershed. Only a thin strip of Lake Mills along the shore is in the watershed. This area is 262 acres of primarily single-family, residential land use.

The pollutant loading from the urban area in the watershed was calculated with unit loading rates determined with field data (Schueler, 1987). The unit loading rates are a compilation of rates measured in homogeneous urban watersheds of different land uses and densities. The two types of land use classifications present in the urban watershed are low density and medium density residential. Low density residential is defined as having a dwelling density of 1 to 1.5 units/acre. Medium density residential is defined as having 2 to 10 units/acre. The east shore area was divided into two regions, the north end (north of the lake outlet) which consists of older buildings, and the south end (south of the lake outlet) which consists of newer buildings. A summary of the pollutant loadings for this area is presented in Table 3-4.

TABLE 3-4

Urban Nonpoint Source Loading to Rock Lake

Urban Region	North Area	South Area	Total
Density	medium	low	
Area (acres)	105	157	262
Unit Phos. Load (lbs./acre/yr.)	0.68	0.49	
Phosphorus Load (lbs.)	71	77	148
Unit Sediment Load (lbs./acre/yr.)	192.5	192.5	
Sediment Load (tons)	9	13.5	22.5

Source: R. A. Smith & Associates, Inc.

The total estimated urban phosphorus loading to Rock Lake is 148 pounds per year. This is only 7% of the rural phosphorus loading from the watershed estimated by WINHUSLE.

SHORELINE EROSION

In addition to causing problems for lake property owners, shoreline erosion can also be a source of excess sediment and nutrients for Rock Lake. Shoreline erosion on Rock Lake is exacerbated by the higher lake water levels created by the dam on the lake's outlet. The dam was built in 1865 and has raised the water level approximately 10 feet.

Currently the water level is lowered during the winter to minimize shoreline ice damage. By WDNR Order No. 3-SD-82-804, the maximum November 1 to spring ice breakup water level should be 827.8 feet above sea level. This usually requires a drawdown of around six inches. However, the winter drawdown is not always implemented as specified and the lower water level is not attained.

Shoreline erosion potential was investigated on Rock Lake. The shoreline was rated as having low, medium, and high erosion potential (Figure 3-5). The length of shoreline and height of bank was measured for each category. Volume of bank erosion was estimated using recession rates estimated by the WDNR for streambank erosion. The calculations are presented in Table 3-5. A total of 538 tons of sediment per year is estimated to erode from the shoreline into Rock Lake. This compares with an estimated 339 tons of sediment delivered to the lake from the rural watershed as estimated by WINHUSLE.

Phosphorus loading to Rock Lake from shoreline erosion was also estimated. This was determined by multiplying the volume of eroded soil which would contain phosphorus by the concentration of phosphorus found in such soils. The volume of soil which would contain the majority of phosphorus would be found in the top layer, or "A" horizon of the soil. The "A" horizon depths for the soils found around the lake came from the Soil Survey of Jefferson County (USDA, 1979). An average "A" horizon depth of 10.5 inches was calculated from these soil types. The concentration of phosphorus used in the calculation was an average of concentration data found in silt loam soils from the Menomonee River watershed in Southeastern Wisconsin (Novotny and Chesters, 1981). This value was 1.56 pounds of phosphorus per ton of soil. The phosphorus loading calculations are in Table 3-6. **The possible phosphorus contribution to Rock Lake from shoreline erosion was calculated to be 326 pounds per year.**

TOTAL NONPOINT SOURCE POLLUTION

The total load of phosphorus and sediment going into Rock Lake is a sum of the loads originating from the rural land, urban land and shoreline erosion. The estimated phosphorus loading are given below. Rural land use accounts for 81% of the total estimated phosphorus loading into Rock Lake.

Table 3-5
Rock Lake - Shoreline Erosion Potential Summary

Erosion Potential	Linear Feet ft.	Number of Properties	Average Length per Property ft.	Average Bank Height ft.	Average Estimated Recession Rate ft./yr	Tons per year t/yr	Percent	Average Tons per Property t/prop./yr	Tons Linear Foot t/ft./yr/
Low	15,270	92	166	1.0	0.04	31	5.8%	0.3	0.002
Medium	13,660	177	77	2.0	0.20	273	52.2%	1.5	0.020
High	1,950	11	177	3.0	0.75	219	41.9%	19.9	0.113
Totals	30,880 5.85 mi.	280	110			523	100.0%		

Source: R. A. Smith & Associates, Inc.

Table 3-6
Rock Lake - Possible phosphorus contribution from shoreline erosion.

Erosion Potential	Linear Feet ft.	Number of Properties	Average A horizon Depth ft.	Average Estimated Recession Rate ft./yr	Phosphorus per year lbs./yr	Average Lbs. per Property lbs/prop./yr	Average Lbs. per LinearFoot lbs/ft/yr
Low	15,270	92	0.87	0.04	41	0.5	0.003
Medium	13,660	177	0.87	0.20	185	1.0	0.014
High	1,950	11	0.87	0.75	99	9.0	0.051
Totals	30,880	280			326		

Source: R. A. Smith & Associates, Inc.

TABLE 3-7

Estimated Rock Lake Phosphorus and Sediment Loading Summary

Nonpoint Source	Phosphorus Loading		Sediment Loading	
	(lbs./yr)	Percent	(tons/yr)	Percent
Rural Land Use	2,066	81.4%	339	38.3%
Urban Land Use	148	5.8%	23	2.6%
Shoreline Erosion	326	12.8%	523	59.1%
Total	2,540	100%	885	100%

Source: R. A. Smith & Associates, Inc.

Lake Modelling and Phosphorus Loading Calibration

A lake water quality model was used to calibrate the estimated phosphorus loading rates calculated above. The model used was Trophic, a model developed by the WDNR. The model utilizes equations derived empirically which calculate the in-lake phosphorus concentrations given several parameters. This model has the capability to use several different equations. The equation used here was developed by Dillon and Rigler (Dillon and Rigler, 1974). The parameters necessary to run the model include: lake volume, lake area, outlet flow rate, phosphorus loading rate, and phosphorus retention coefficient. Rock Lake was modelled as only the main basin, excluding Marsh Lake. The phosphorus retention coefficient varies with the other parameters and was assigned by the model. The outlet flow rate was calculated to be the sum of the surface runoff from the watershed as calculated by WINHUSLE (707.9 acre-ft.) and the net precipitation (precipitation - evaporation = 2.8 inches) on the three surface water bodies--Mud Lake, Marsh Lake, and Rock Lake. Trophic estimates the in-lake phosphorus concentration while the lake is well mixed, generally assumed to be during spring turnover. Trophic also estimates the Chlorophyll-*a* concentration and Secchi depth observed during the summer months.

Calibration of the estimated phosphorus loading rates involved adjusting the loading rate in Trophic until the modelled in-lake phosphorus concentration matched the measured in-lake phosphorus concentration during spring turnover. The most recent measured spring turnover concentration in Table 3-1 was 20 ug/l, which was observed in April of 1994. Initially the model was run with the estimated total phosphorus loading rate of 2,540 pounds per year (Table 3-6). Then, the model was run to back calculate a calibrated phosphorus loading rate given the in-lake phosphorus concentration of 20 ug/l (Table 3-1). The results of these calculations are given in Table 3-8. The full printout is in Appendix B.

TABLE 3-8

Rock Lake Modelling Results

Model Parameters	Model Results with Estimated Phosphorus Loading	Model Results with Calibrated Phosphorus Loading
Phos. loading rate (lbs./yr.)	2540	1796
Outflow rate (cfs)	1.92	1.92
Phos. coefficient	0.958	0.958
Chlorophyll-*a* concentration (ug/l)	9.22	5.58
Secchi depth (meters)	1.83	2.32

Source: R. A. Smith & Associates, Inc.

The calibration procedure indicates that the initial phosphorus loadings were overestimated. It is likely that most of the over-estimation occurred in the WINHUSLE model. The WINHUSLE estimation of 2,066 pounds of phosphorus alone is greater that the calibrated phosphorus loading of 1,796 pounds. Also, there are several deficiencies in the WINHUSLE model which would lead to over-estimation. WINHUSLE does not take into account the sediment and phosphorus removal capabilities of wetland areas which, for Rock Lake, constitute 22% of the watershed area. WINHUSLE also does not model closed depressions very well, of which there are several in the watershed. It is suggested that the rural phosphorus loading estimated by WINHUSLE be reduced so that the total phosphorus loading matches the calibrated phosphorus loading calculated in Trophic. The calibrated phosphorus and sediment loading rates by the three different sources are given in Table 3-9. The reduction of rural phosphorus loading from 2,066 pounds to 1,322 pounds is a reduction of 36%. The rural sediment loading was also reduced by 36%.

TABLE 3-9

Calibrated Rock Lake Phosphorus and Sediment Loading Summary

Nonpoint Source	Phosphorus Loading		Sediment Loading	
	(lbs./yr.)	Percent	(tons/yr.)	Percent
Rural Land Use	1322	74%	251	31%
Urban Land Use	148	8%	23	3%
Shoreline Erosion	326	18%	523	66%
Total	1796	100%	797	100%

Source: R. A. Smith & Associates, Inc.

CHAPTER 4

AQUATIC AND WETLAND HABITAT ASSESSMENT AND PROTECTION

In-Lake Sensitive Areas

INTRODUCTION

As part of the Rock Lake Planning Grant Study, ecologically sensitive areas were identified. This section describes what a sensitive area designation is, how parts of Rock Lake qualify for this designation, and specific recommendations for protecting these areas.

SENSITIVE AREA DESIGNATION

"Sensitive area" designation is described in Chapter NR 107 of the Wisconsin Administrative Code governing aquatic plant management. In Section 107.05(3(i)) it is stated that "Sensitive areas are areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water." The "department" refers to the Wisconsin Department of Natural Resources (WDNR). According to this section, the WDNR may deny a permit to chemically treat a lake area to control aquatic plants if it is true that, "The proposed chemical application is in locations identified by the department as sensitive areas, except when the applicant demonstrates to the satisfaction of the department that treatments can be conducted in a manner that will not alter the ecological character or reduce the ecological value of the area." In practice, identification as a sensitive area by the WDNR prohibits the use of broad spectrum herbicides which indiscriminately kill aquatic plants. Designation as a "sensitive area" also has an influence on the placement of piers, marina approvals, dredging, sand bed placement, or any other activity on the lake bed which requires WDNR approval. The sensitive area designation can extend beyond just areas with aquatic plants. It can also include areas which are of high importance from an ecological standpoint.

In addition to the sensitive area designation, NR 107 also has a provision to protect certain high value aquatic plant species from herbicide applications. It is stated in Section 107.08(4) that "Treatment of areas containing high value species of aquatic plants shall be done in a manner which will not result in adverse long-term or permanent changes to a plant community in a specific aquatic ecosystem. High value species are individual species of aquatic plants known to offer important values in specific aquatic ecosystems...." This section specifies 12 species which are classified as high value species of which five have been found in Rock Lake.

ROCK LAKE LITTORAL ZONE DESCRIPTION

Rock Lake is a 1,371-acre drainage lake with one main tributary feeding into it and one outlet, Rock Creek. The littoral zone, or near shore region, has a sand and marl bottom. Water clarity is good, and aquatic macrophyte densities are relatively low. The fishery is diverse with panfish, large mouth bass, and northern pike present.

The lake is considered to have two distinct basins. There is the main basin which is all of the lake north of the railroad tracks (Figure 4-1) and there is the south basin south of the railroad tracks which is often referred to as Marsh Lake. Marsh Lake was a wetland before the water level was raised by the dam at the outlet of Rock Lake.

The City of Lake Mills in on the east shore. The majority of the shoreline is developed with homes and cottages. Development is concentrated on the north, east, northwest and south sides of the lake with the only significant undeveloped area along the southwest shore.

R. A. Smith and Associates, Inc. conducted an aquatic macrophyte survey of Rock Lake during the summer of 1994. The WDNR conducted a survey of Rock Lake in 1990. Summaries of these surveys are presented on Figure 4-1 and in Table 4-1. "High value species" as defined in the preceding section are noted in the table. Assessments for habitat value were found in the Guide to Wisconsin Aquatic Plants published by the WDNR in 1988.

The most common near-shore bottom substrate is sand and marl, except in Marsh Lake which has mostly a muck bottom. The most common aquatic macrophyte is *chara vulgaris*, or muskgrass, which is found along most of the shoreline in varying densities. There are two major areas of the lake that have both dense stands of aquatic macrophytes and an undeveloped shoreline. These are Korth Bay on the west shore and Marsh Lake in the south basin.

The sand, marl, and muck bottom of Korth Bay provides a diverse substrate for both fish and aquatic plants. The most common aquatic macrophyte is *chara vulgaris*, or muskgrass, which is found along most of the shoreline in varying densities. The "high value" aquatic macrophytes found in Korth Bay include bulrush, clasping leaf pondweed, Illinois pondweed, Sago pondweed, and Wild celery. The southwestern shore of Korth Bay is relatively undisturbed by development. Stands of Yellow and White Water Lily remain along this shore. There are dense stands of bulrushes along the outer edge of Korth Bay. Bulrushes provide important spawning areas for northern pike and cover for other fish. It also provides food for ducks and geese. The sand and gravel substrate here is relatively undisturbed.

Marsh Lake is a shallow basin surrounded mostly by a shallow marsh characterized by dense cattail growth. There is some development on the east shore where channels have been dredged in the shallow marsh to provide boat access to these developments. Marsh Lake has a muck and marl bottom. The "high value" aquatic macrophytes in Marsh Lake include bulrush, Illinois pondweed, and Sago pondweed.

The emergent and submergent aquatic plants in Korth Bay and Marsh Lake create a favorable spawning and refuge area for fish, northern pike in particular. The plants also provide habitat for aquatic insects and zooplankton which are important forage for panfish. Some of the aquatic plants such as Wild Celery also provide important forage for waterfowl. It was also noted that there were areas of the lake bottom in this bay which were heavily disturbed by the churning action of power boats.

There is another important littoral zone area of the lake. On the northwestern shoreline of the lake, there is a sand and gravel bar which juts out into the lake. While this bar does not sustain dense aquatic macrophytes growth, it has been observed to be a spawning area for bluegills and sunfish. The "high value" aquatic macrophytes found in this bay include Clasping leaf pondweed, Wild Celery, and Sago pondweed.

IMPACTS OF BOAT WAKES ON AQUATIC MACROPHYTES AND NESTING BEDS

There are certain aquatic macrophytes which are susceptible to damage caused by wakes from power watercraft. According to Sandy Engel, Aquatic Biologist for the WDNR, these plants tend to have brittle stems, weak or buoyant root systems, or broad underwater leaves.

Several plant species in Rock Lake could be damaged significantly by power boating. Bulrushes often disappear under heavy boating pressure since their brittle stems tend to break from the shear stress from boat waves. Broad-leaved pondweeds such as Illinois pondweed and Clasping leaf pondweed could also be stressed since their leaves provide high hydrodynamic resistance and the plants get ripped out by waves. Wild Celery is flexible and able to withstand waves but cannot withstand the direct churning action from a power boat. These four plant species are considered high value plant species. Five plant species in Rock Lake--Coontail, Elodea, Eurasian water milfoil, Northern water milfoil, and Cattail--are resistant to power boating pressure, but these plants are not considered to be as desirable from a fishery and wildlife standpoint as the more susceptible plants. Under heavy boating pressure, aquatic plant species diversity will decrease and species composition will shift to the boating resistant plants.

Panfish nesting beds in shallow sand and gravel bars--as found on the northwest shore of Rock Lake--can be damaged by the churning action of power boats passing overhead.

TABLE 4-1

Aquatic Macrophyte Species List for Proposed Sensitive Areas in Rock Lake.

Common Name	Scientific Name	Location	Frequency	Fish Habitat	Waterfowl Habitat	Aq. Insect Habitat
Arrowhead, Broad-leafed	Sagitaria latifolia	Marsh Lake	O	spawning and cover	forage and cover	
Bladderwort	Utricularia vulgaris	Marsh Lake	O			
Bulrush*	Scirpus spp.	Marsh Lake & Korth Bay	O/R	spawning and cover	forage	
Cattail, Broad-leafed	Typhus latifolia	Marsh Lake & Korth Bay	O	spawning	cover	
Cattail, Narrow-leafed	Typhus augustifolia	Marsh Lake	O			
Coontail	Ceratophyllum demersum	Marsh Lake & Korth Bay	C	cover	forage	yes
Elodea	Elodea canadensis	Marsh Lake, Korth Bay & NW Bay	C	cover		yes
Milfoil, Northern Water	Myriophyllum sibericum	Marsh Lake & Korth Bay	C	cover	occasional forage	yes
Milfoil, Eurasian Water	Myriophyllum spicatum	Korth Bay and NW Bay	C	cover		yes
Muskgrass	Chara vulgaris	Lakewide	A	cover	forage	
Naiad, Slender	Najas flexilis	Korth Bay	A	cover	forage	
Naiad, Spiney	Najas marina	Korth Bay	O	cover	forage	
Nitella	Nitella flexilis	Korth Bay	O	cover	forage	yes
Pondweed, Clasping leaf*	Potamogeton richardsonii	Korth Bay & NW Bay	R	cover		yes
Pondweed, Floating-leafed	Potamogeton natans	Marsh Lake	O	cover		yes
Pondweed, Illinois*	Potamogeton illinoensis	Marsh Lake & Korth Bay	C	nesting and cover		yes
Pondweed, Sago*	Potamogeton pectinatus	Marsh Lake, Korth Bay & NW Bay	R	cover	forage	yes
Pondweed, Small	Potamogeton pucillus	Korth Bay & NW Bay	O	cover	forage	yes
Water Buttercup, White	Ranunculus aquatilis	Marsh Lake	O			
Water Buttercup, Yellow	Ranunculus flabellaris	Marsh Lake	O			
Water Lily, White	Nymphaea odorata	Marsh Lake & Korth Bay	O			
Water Lily, Yellow	Nuphar variegata	Marsh Lake, Korth Bay & NW Bay	O			
Wild Celery*	Vallinsneria americana	Korth Bay	O	cover	forage	

Source: R. A. Smith & Associates, Inc. and WDNR

* - High Value Species
Frequency Codes: A-abundant; C-common; O-occasional; R-rare.

RECOMMENDATIONS

Designation of "Sensitive Areas"

The Rock Lake Improvement Association could consider requesting that the areas described above and shown in Figure 4-2 be designated "sensitive areas" as defined by Chapter NR 107 of the Wisconsin Administrative Code. Since there are so few aquatic macrophyte beds in the lake, Korth Bay; Marsh Lake; and the northwest shoreline provide crucial spawning and feeding grounds for the lake's fishery. The sand and gravel bar in the northwest bay also provides an important panfish nesting area. It is very important that these areas be protected. They are unique and valuable areas in terms of the aquatic ecology of Rock Lake. The WDNR has the authority to designate an area a "sensitive area." The local WDNR lakes manager would have to be approached with this proposal in order to start the process.

Sensitive area designation provides protection from aquatic herbicide application. In addition, it could influence the placement of piers; marinas; sand beds; dredging; and any other activity on the lake bed which would require WDNR approval. While herbicide use is not much of a factor on Rock Lake, "sensitive area" status could have a major impact on how the remaining undeveloped areas on the west shore are developed, if that occurs.

Boating Regulations

In addition to protecting the proposed "sensitive areas" from herbicide use and the lake bed disturbances listed above, it is also important to protect them from the churning action and waves caused by power watercraft. Currently, the proposed "sensitive areas" are protected somewhat from the impact of power watercraft. By the Town of Lake Mills' Ordinance 93-1, the proposed "sensitive areas" are already designated "slow-no-wake" zones. In addition, state law prohibits power watercraft from operating in excess of slow-no-wake within 150 feet of the shoreline or within 100 feet of any pier, raft, or buoyed restricted area.

It is recommended that voluntary navigational channels be outlined by buoys in Marsh Lake and Korth Bay to encourage boaters to stay within a smaller area and thereby reducing the negative impacts to the aquatic macrophyte community. It is also recommended that additional "slow-no-wake" buoys be placed to better define the perimeter of the "slow-no-wake" areas.

Recommendations by Area

A. Marsh Lake - Designate a navigational channel marked by buoys connecting the boat docks on the east shore of Marsh Lake with the entrance into the main body of Rock Lake. The navigational channel would have no force of law, but would encourage boaters to use one area in order to minimize the area of impact.

B. Korth Bay - Place "slow-no-wake" buoys on the perimeter of the area approximately every 250 feet. Also, a 50 foot wide navigational channel would be marked with buoys through the bay. The navigational channel would have no force of law but would encourage boaters to use one area.

C. Northwest Bay - Place "slow-no-wake" buoys on the perimeter of the area approximately every 250 feet.

According to state law, the creation of no wake zones can be created to protect public health, safety or welfare. This is slowly being expanded to include creating no wake zones for ecological reasons. There is precedent in the state for the creation of no wake zones to protect important aquatic plant beds which have been demonstrated to be adversely affected by fast moving power boats. It is suggested that the above proposed "sensitive areas" in Rock Lake constitute important and unique ecological areas in Rock Lake and that the high value aquatic plant species and panfish nesting beds are being adversely affected by fast moving power watercraft. For this reason, it is suggested that the effectiveness of the no wake zones in Rock Lake be enhanced by the placement of additional "Slow-No-Wake" buoys and the creation of navigational channels in the proposed sensitive areas. In order to place the above suggested buoys along the "sensitive areas" and navigational channels as shown in Figure 4-2, the lake improvement association would need to acquire permits for them.

Wetlands

Wetlands, the interface between uplands and deep water aquatic systems, cover 22% of the Rock Lake watershed. The area lying south of Rock Lake, running between Bean Lake and Mud Lake, is the largest continuous section of wetland acreage with smaller parcels further south and east (See Figure 4-3).

Although wetlands vary significantly from location to location, they are typically defined using three common components including: the presence of water, either at the surface or within the root zone; soils with unique hydrophilic qualities; and vegetation adapted to permanent or semi-permanent wet conditions. This very unique combination of water, soil, and vegetation produces a valuable resource capable of cleansing polluted waters, preventing floods, protecting shorelines, and recharging groundwater aquifers. Wetlands include swamps, bogs, marshes, mires, and fens, along with other wet ecosystems. Along with playing a key role in the hydrologic cycle, they support an extensive variety of vegetation and wildlife.

Because of the location of the Rock Lake watershed's wetlands, they act as the cleansing system for the tributaries entering the lake. Any alteration or reduction of these wetlands may influence the general water quality of Rock Lake itself and, therefore, any management considerations must consider the watershed as a whole.

The Rock Lake watershed wetlands can be subdivided into several specific areas of concern for management planning. The first is the Bean Lake State Natural Area consisting of 120 acres bordering Bean Lake. This parcel of wetland consists of a tamarack and shrub swamp with a maximum depth of 6 feet. Surrounding vegetation consists of dogwood, cattails, sedges, and certain varieties of endangered orchids. The wetland also harbors a variety of wildlife including herons, wood ducks, and great horned owls. Mud Lake is described as a fen, or open wetland that usually receives some drainage from surrounding mineral soils and is covered by grasses, sedges, or reeds. The key characteristic of a fen is the underlying peat soil which may take thousands of years to develop.

Other areas of interest are those specifically identified on the Wisconsin Wetlands Inventory Map (WDNR, Rev. 1989). These sections of land, a large percentage owned by the WDNR, vary from emergent wet meadows with cattails, to deciduous forests of Tamarack. They are identified on the inventory map with a combination of letters and numbers characterized as follows: "E1K" describes an area of class "E" as emergent/wet meadow; a subclass "1" as persistent; and the hydrologic modifier "K" as a wet, Palustrine soil.

Those areas not owned by the WDNR are scattered throughout the watershed, including parcels adjacent to the tributary to Rock Lake and areas bordering plowed agricultural fields. Many identified wetland areas have been tiled or ditched and actively drained for farming. Although this drained soil provides productive agricultural land, the draining of the wetland has a negative impact on the natural vegetation and wildlife.

CHAPTER 5

RECOMMENDATIONS AND PROGRAM OF IMPLEMENTATION

Introduction

The purpose of this chapter is to describe the recommendations of the Rock Lake Planning Grant Study. The rural and urban nonpoint source loadings were presented in Chapter 3, "Water Quality Conditions and Nonpoint Source Loadings to Rock Lake." This chapter provides recommendations for the Rock Lake Improvement Association (RLIA), the local government, and the supporting county and state agencies which would improve and preserve the environmental quality of Rock Lake.

Specifically, this chapter includes information and guidelines concerning:

- Watershed Management Recommendations
- Shoreline Erosion Recommendations
- Sensitive Area Protection

Recommendations

WATERSHED MANAGEMENT RECOMMENDATIONS

The following recommendations are given to reduce nonpoint source pollution in the watershed.

Priority Lake Status

The RLIA should help to obtain Priority Lake status for Rock Lake. This program would provide full time staff at the county level to implement a water quality program and the necessary implementation funds to assure best management practices were installed where needed. Primary contacts would be with the WDNR and County. One member of the RLIA should be designated as the agency liaison who would be in frequent contact with the appropriate state and county staff. This individual could rally political support for Rock Lake when projects are being selected at district or state level.

A Priority Lake Project administered by the Nonpoint Source Program of the WDNR would be the single most beneficial program for improving and protecting the water quality of Rock Lake.

Lake Management District

The RLIA should pursue and implement a Lake Management District for Rock Lake. Second only to a Priority Lake Project, a Lake Management District would give Rock Lake a unified voice along with the political and financial strength needed to ensure the implementation of many environmental programs. Unlike the Priority Lake Project, the RLIA can be the lead organization in the efforts to obtain a Lake Management District for the lake.

Conservation Plans

Encourage all agribusinesses in the watershed to be actively applying a soil and water conservation plan on the land. This is especially important for those lands within 1,000 feet of Rock Lake, since they have a more direct impact on the Lake's water quality. Conservation plans may be voluntary or required management plans that reduce soil erosion to "tolerable" levels on all farm fields. A conservation plan may be required for certain USDA or state programs. The water quality analysis provided in Chapter 3 of this report shows that the land which drains directly to Rock Lake contributes a disproportionately higher percentage of sediment and phosphorous compared to other areas of the watershed. An annual review of conservation plans should be conducted with the Jefferson County Land Conservation Department to ensure compliance. Voluntary conservation practices should be encouraged when operators are not in federal programs. Conservation plans for cropland outside of the watershed that can impact Rock Lake should be reviewed. The muck farms to the southwest of the Lake should be evaluated for wind erosion by county land conservation staff. Appropriate recommendations should be followed up with implementation to reduce wind born sediment from entering the lake.

The RLIA should work with the County, University of Wisconsin - Extension (UW-EX), and the WDNR to ensure that proper ditch maintenance, manure spreading, and feedlot management guidelines are followed.

Development Plans

Encourage landowners with undeveloped, riparian property to develop long-term plans for their property if they intend to ultimately develop the parcel. Presently, the pattern of spot zoning or sporadic development provides no opportunity for a planned urban development. When planned as a whole, a property can provide for sediment detention basins and stormwater runoff controls.

Current minimum lot sizes for R-1 Zoning within 1,000 feet of Rock Lake or 300 feet of a stream is 10,000 square feet. It is recommended that low densities (1-1.5 units per acre) be used if existing agricultural land is proposed to be developed.

In addition to low density development, other recommended practices including conservancy areas, buffer strips, and stringent erosion control measures should be employed to protect Rock Lake.

Regulatory Permits

The RLIA should request copies of proposed development plans and then review and comment on them. An example is the proposed Shorewood Hills Road reconstruction plan. This project should be reviewed for proper erosion control. Unless absolutely necessary, storm sewering to Rock Lake should be discouraged. If drainage is necessary, then it should be conveyed by grass swales and not storm sewers. Follow-up during construction should be an important component of this process.

Major agribusinesses with WDNR or other permits should be reviewed annually with an RLIA member and the appropriate WDNR staff to ensure compliance. This task should not require a great deal of technical knowledge but a minimum understanding of what requirements might be within a permit, such as groundwater monitoring. The local county or WDNR staff could provide technical assistance with the file review. If required monitoring or reporting is not being done, the RLIA should follow up with the WDNR to ensure that all permit requirements are adhered to.

Water Quality Monitoring

Rock Lake itself is already monitored through the WDNR Long Term Trends Lake Monitoring Program; however, the RLIA should sample and monitor water quality at key locations within the watershed. These locations could be at the old railroad bridge, Marsh Lake, CTH A, and Mud Lake. This monitoring would act as an advance warning mechanism for Rock Lake and provide a better understanding of the filtering effects of Marsh and Mud Lakes. This work could be done through RLIA with another planning grant or a request could be made to WDNR to include it with their current sampling program.

Town of Lake Mills

The RLIA should request the Town of Lake Mills to require restoration plans for any new conditional use permits or gravel pit expansion plans. Gravel pits are major earth disturbances in the watershed, and their proximity to important wetland habitat areas and their end use should be planned for and implemented by the current owners. Secondary to water quality and aesthetic impacts, gravel pits can become sites for illegal dumping which can lead to potential groundwater pollution. It is really in everyone's best interest, including the Town of Lake Mills, to require the timely and orderly restoration of these sites.

City of Lake Mills

The RLIA should request in writing that the City of Lake Mills consider the following:

- Utilize grass swales instead of storm sewers when feasible.
- Install grit chambers or catch basins at all inlets.
- Provide outlet protection for all storm sewers.
- Utilize infiltration basins or trenches before storm sewering to lake.
- Utilize a potassium chloride road salt for ice removal.

The WDNR nonpoint source program can be a significant resource in working with the RLIA and the City to determine the feasibility of the practices listed above. While space is limited for some of these practices within the City, these practices should still be evaluated.

Information and Education

The RLIA should conduct an information and education program for City residents in the Rock Lake watershed on the following topics or issues:

- Redirect downspouts and driveways onto lawns to encourage infiltration.
- Reduce or eliminate herbicide and fertilizer use on lawns.
- Encourage natural shoreline landscaping.
- Mark inlets with "Dump No Waste-Drains to Lake."

The UW-EX already has developed many brochures for the list of practices above. Like the recommendations for the City, some practices may be impractical to implement. Even without complete implementation of urban practices by residents, the effort will produce a greater awareness of Rock Lake with the local residents.

SHORELINE EROSION RECOMMENDATIONS

Lake Levels

The RLIA should continue to work with the City of Lake Mills and the WDNR Water Regulation and Zoning group to manage winter lake levels. At a minimum, the City of Lake Mills should maintain or further reduce winter lake levels to reduce shoreline damage by ice. Lake levels have been shown to fluctuate with precipitation and, therefore, it may be necessary to further reduce lake levels during cycles of higher than normal precipitation.

Boating Regulations

Several state and local boating ordinances or laws are already in place on Rock Lake. These boating rules are primarily for safety but can also have water quality benefits. The Township should continue to enforce slow-no-wake boating regulations within 150 feet of shoreline to reduce wave damage.

Bioengineering

Landowners within the "high" and "medium" erosion potential zones (shown on Map 3-5) should be contacted in writing. These contacts would be intended to encourage them to investigate an environmentally sound shoreline protection project. Along with this letter, bioengineering should be discussed as a possible solution for sites with high and medium erosion potential.

Information and Education

The RLIA should, through its newsletter and other direct contacts, remind riparian landowners of the need for permits to construct shoreline protection practices.

SENSITIVE AREA PROTECTION RECOMMENDATIONS

Designation of "Sensitive Areas"

The RLIA could consider requesting that the areas described in Chapter 4 and shown in Figure 4-2 be designated "sensitive areas" as defined by Chapter NR 107 of the Wisconsin Administrative Code. Since there are so few aquatic macrophyte beds in the lake, Korth Bay; Marsh Lake; and the northwest shoreline provide crucial spawning and feeding grounds for the lake's fishery. The sand and gravel bar in the northwest bay also provides an important panfish nesting area. It is very important that these areas be protected. They are unique and valuable areas in terms of the aquatic ecology of Rock Lake. The WDNR has the authority to designate an area a "sensitive area." The local WDNR lakes manager would have to be approached with this proposal in order to start the process.

"Sensitive area" designation provides protection from aquatic herbicide application. In addition, it could influence the placement of piers, marinas, sand beds, dredging, and any other activity on the lake bed which would require WDNR approval. While herbicide use is not much of a factor on Rock Lake, "sensitive area" status could have a major impact on how the remaining undeveloped areas on the west shore are developed, if that occurs.

Boating Regulations

In addition to protecting the proposed "sensitive areas" from herbicide use and the lake bed disturbances listed in Chapter 4, it is also important to protect them from the churning action and waves caused by power watercraft. Currently, the proposed "sensitive areas" are protected somewhat from the impact of power watercraft. By the Town of Lake Mills' Ordinance 93-1, the proposed "sensitive areas" are already designated "slow-no-wake" zones. In addition, state law prohibits power watercraft from operating in excess of "slow-no-wake" speeds within 150 feet of the shoreline or within 100 feet of any pier, raft, or buoyed restricted area.

It is recommended that voluntary navigational channels be outlined by buoys in Marsh Lake and Korth Bay to encourage boaters to stay within a smaller area, thereby reducing the negative impacts to the aquatic macrophyte community. It is also recommended that additional "Slow-No-Wake" buoys be placed to better define the perimeter of the no wake areas.

According to state law, no wake zones can be created to protect public health, safety, or welfare. This is slowly being expanded to include creating no wake zones for ecological reasons. There is precedent in the state for the creation of no wake zones to protect important aquatic plant beds which have been demonstrated to be adversely affected by fast moving power boats. It is suggested that the above proposed "sensitive areas" in Rock Lake constitute important and unique ecological areas in Rock Lake and that the high value aquatic plant species and panfish nesting beds are being adversely affected by fast moving power watercraft. For this reason it is suggested that the effectiveness of the no wake zones in Rock Lake be enhanced by the placement of additional "slow-no-wake" buoys and the creation of navigational channels in the proposed sensitive areas. In order to place the above suggested buoys along the "sensitive areas" and navigational channels as shown in Figure 4-2, the lake improvement association would need to acquire permits for them.

The following is a summary of the recommended boating regulations by area.

Marsh Lake: Designate a navigational channel marked by buoys connecting the boat docks on the east shore of Marsh Lake with the entrance into the main body of Rock Lake. The navigational channel would have no force of law, but would encourage boaters to use one area in order to minimize the area of impact.

Korth Bay: Place "slow-no-wake" buoys on the perimeter of the area approximately every 250 feet. Also, a 50 foot wide navigational channel would be marked with buoys through the bay. The navigational channel would have no force of law but would encourage boaters to use one area.

Northwest Bay: Place "slow-no-wake" buoys on the perimeter of the area approximately every 250 feet.

CHAPTER 6

INFORMATION AND EDUCATION PROGRAM

Rock Lake Improvement Association Newsletter

"Making Waves" is a well written and comprehensive newsletter produced by the Rock Lake Improvement Association (RLIA) and it should be continued. If the financial capabilities exist, the newsletter might consider adding two additional printings annually and have one edition produced specifically for a community mailing. This annual community mailing, although at an increased cost, would access many individuals who are unaware of lake district functions and increase the general level of education, along with RLIA membership.

The "Lake Mills Leader"

The "Lake Mills Leader" is another access point to the entire Rock Lake community. There are several ways the community newspaper and the RLIA can work together in promoting greater involvement and understanding of Rock Lake, including:

1. Printing quarterly excerpts from the RLIA newsletter to keep the community informed on wetlands, waterfowl and recreation.

2. Having a RLIA member write specific articles for the newspaper on a regular basis.

3. Having a newspaper reporter attend RLIA meetings or events and keep the community informed with pertinent articles.

Interpretive Lake and Watershed Tours

A more interactive approach in education involves establishing educational corridors or areas created within the watershed to allow exploration of the wetlands, wildlife, and geologic features using tour guides or posted information and educational pamphlets. The Rock Lake watershed encompasses a myriad of historical, as well as natural features that can be used as educational formats, inviting individuals to explore and better appreciate the environment as opposed to forbidding entrance due to the sensitivity of an area. Boardwalks through wetlands surrounding Bean, Mud, and Marsh Lakes can be used for school children or scout groups as educational opportunities. The local fish hatchery can establish a "where do they go from here" brochure and use it for informational tours for visitors or residents. The self-guided tour pamphlets can be located in a variety of accessible areas, including the old railroad depot, and can provide an opportunity for exploration by bike riders.

Demonstrations, Projects, and Workshops

Educational corridors will stretch beyond the local community in addressing the significance of the Rock Lake watershed, but local projects and workshops will keep the Lake Mills area actively and productively involved in the care and maintenance of Rock Lake. Demonstrations such as erosion control practices like grass swales, or farm practices such as fall plowing and conservation tillage can be established using volunteers, and tours can be given during summer community events.

Workshops for teachers or RLIA members or volunteers can also be conducted throughout the year. The University of Wisconsin - Extension, or local WDNR officials can be invited to discuss such topics as water quality, natural vegetation, and geology to teach the volunteers how to further educate the public. Workshops or projects for school classes or scout groups might include: the Adopt-A-Lake program, painting lake drains with "Dump No Waste - Drains To Lake" signs, or constructing the nature trail signs to be used in the self-guided tours.

Rock Lake Improvement Association/Community Activities

The RLIA goal is to create a well-informed and active community that takes pride in the quality of the surrounding environment. Active participation, however, develops from a variety of forms, most importantly the family. Through joint cooperation between the City and Town of Lake Mills and the RLIA, several events might be established to create family involvement in the Rock Lake environment. Many Northern Wisconsin lakes sponsor one or two fishing days during the year, some specifically for children and parents. RLIA may want to establish a trial ice fishing or summer panfish fry. Another option may be a summer festival running during a weekend and involving picnics, fishing, educational family boat tours, or similar activities. Winterfests involving snow sculpting, ice skating, or ice boating provide an additional opportunity to express the importance and pleasure associated with Rock Lake.

Numerous other opportunities exist to further the conscientious and environmentally sound development of the Rock Lake watershed, including production of an educational video, labeling of boat ramps with relation to sensitive areas, and water quality sampling sites.

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