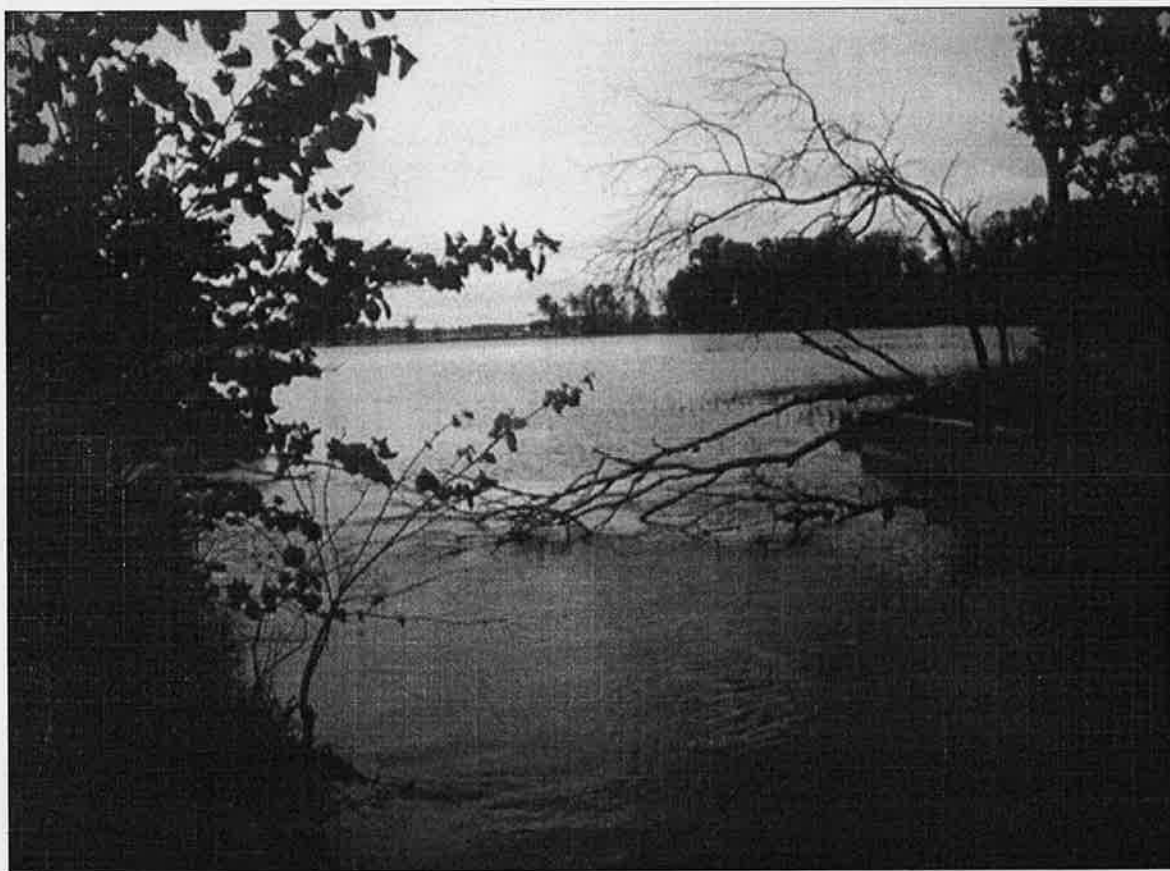


Cross Lake and Turtle Lake Water Quality Study Report



*By:
Red Lake Watershed Staff*

June 8, 2000

Table of Contents

TABLE OF CONTENTS.....	2
BACKGROUND	4
HISTORY	5
LAND USE.....	5
PROJECT OVERVIEW	5
METHODS	6
WATER QUALITY METHODS.....	6
HYDROLOGICAL METHODS.....	7
TROPIC STATUS.....	9
ECOREGION CONCEPT.....	10
RESULTS	10
WATER QUALITY RESULTS.....	10
<i>Dissolved Oxygen/Water Temperature Profiles.....</i>	<i>10</i>
<i>Trophic Status</i>	<i>11</i>
HYDROLOGICAL RESULTS	14
<i>Flow Direction</i>	<i>15</i>
QUALITY/LIMITATIONS OF DATA.....	16
RECOMMENDATIONS	18
HYDROLOGIC.....	18
WATER QUALITY.....	19
REFERENCES:	20

List of Figures

FIGURE 1. AREA OF STUDY	4
FIGURE 2. TURTLE LAKE AND CROSS LAKE IN-LAKE MONITORING LOCATIONS.....	6
FIGURE 3. CROSS LAKE AND TURTLE LAKE FLOW MONITORING SITES.....	9
FIGURE 4. TEMPERATURE AND DISSOLVED OXYGEN PROFILE.....	11
FIGURE 5. CROSS LAKE TROPIC STATUS INDEX.....	12
FIGURE 6. EAST LOBE OF CROSS LAKE TROPIC STATUS INDEX	12
FIGURE 7. TURTLE LAKE TROPIC STATUS INDEX	13
FIGURE 8. TOTAL PHOSPHORUS IN THE CROSS LAKE AND TURTLE LAKE SYSTEMS.....	14
FIGURE 9. CROSS LAKE AND TURTLE LAKE SYSTEMS FLOW DIRECTION.....	16

List of Appendices

APPENDIX A: WATER QUALITY DATA TABLES.....	A-1
--	-----

Cross Lake and Turtle Lake Report

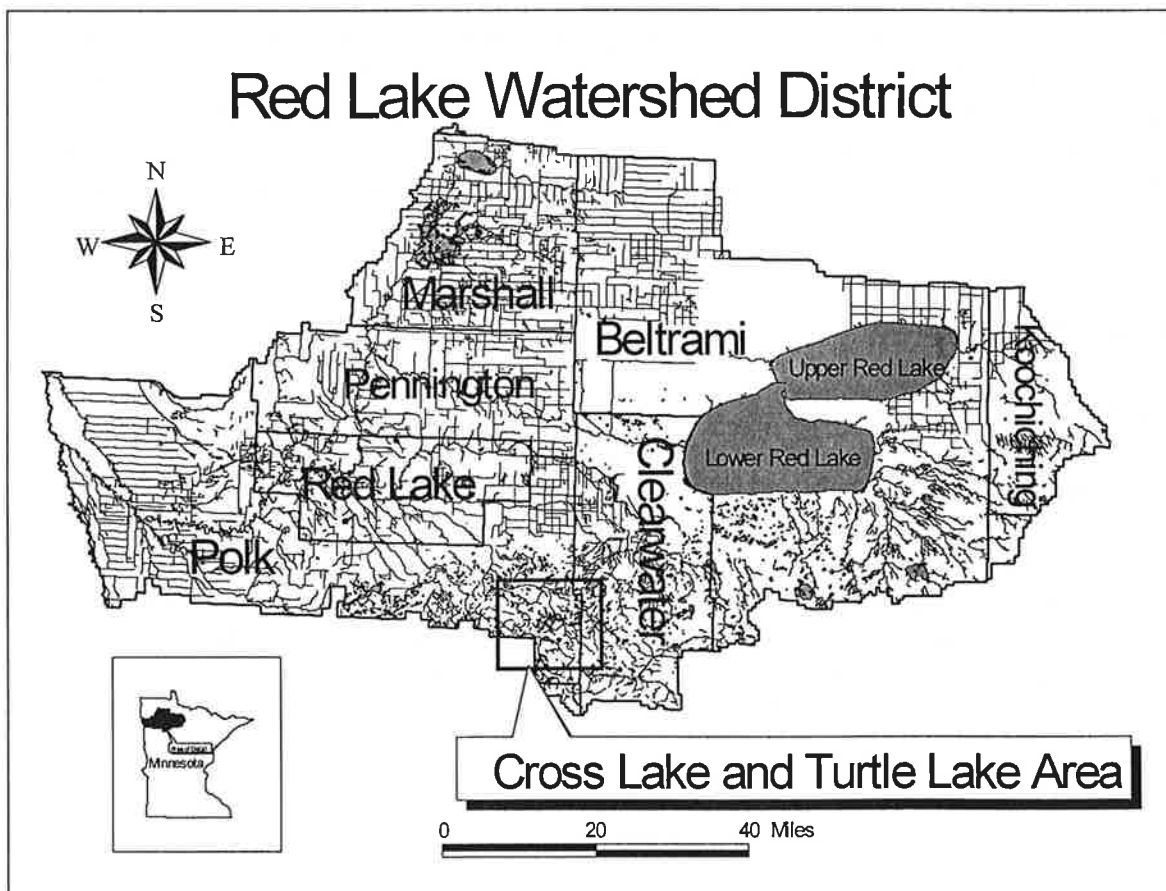
APPENDIX B: OBSERVED HISTORIES OF CROSS LAKE.....	B-1
APPENDIX C: HYDROLOGIC GRAPHS.....	C-1
APPENDIX D: REFERENCE LAKE DATA AND TROPHIC STATUS INDEX.....	D-1

Background

A long history of public concern exists over the water quality and hydrologic characteristics of the Cross Lake and Turtle Lake system. During the early 1930's, in an effort to control lake levels, the Works Progress Administration (WPA) constructed dams on South Connection Lake, Turtle Lake, and Cross Lake. Local residents often raise concern about the effects of these dams on the hydrology of the lake system. Residents believe some lakes within the system were held artificially high, thereby affecting the flow of water and the water quality of the system. Excessive algae and nutrients are the greatest concerns for Cross Lake and Turtle Lake water quality. There is also an on-going discussion about whether to manage Turtle Lake as a fishery or waterfowl lake. (Preliminary Study Design 1996)

The Cross Lake and Turtle Lake system is located in eastern Polk County, approximately 3 miles north-east of Fosston, Minnesota in the northwest part of the state. The system is near the origin of the Hill River, which is one of the main tributaries to the Clearwater River (Figure 1).

FIGURE 1. AREA OF STUDY

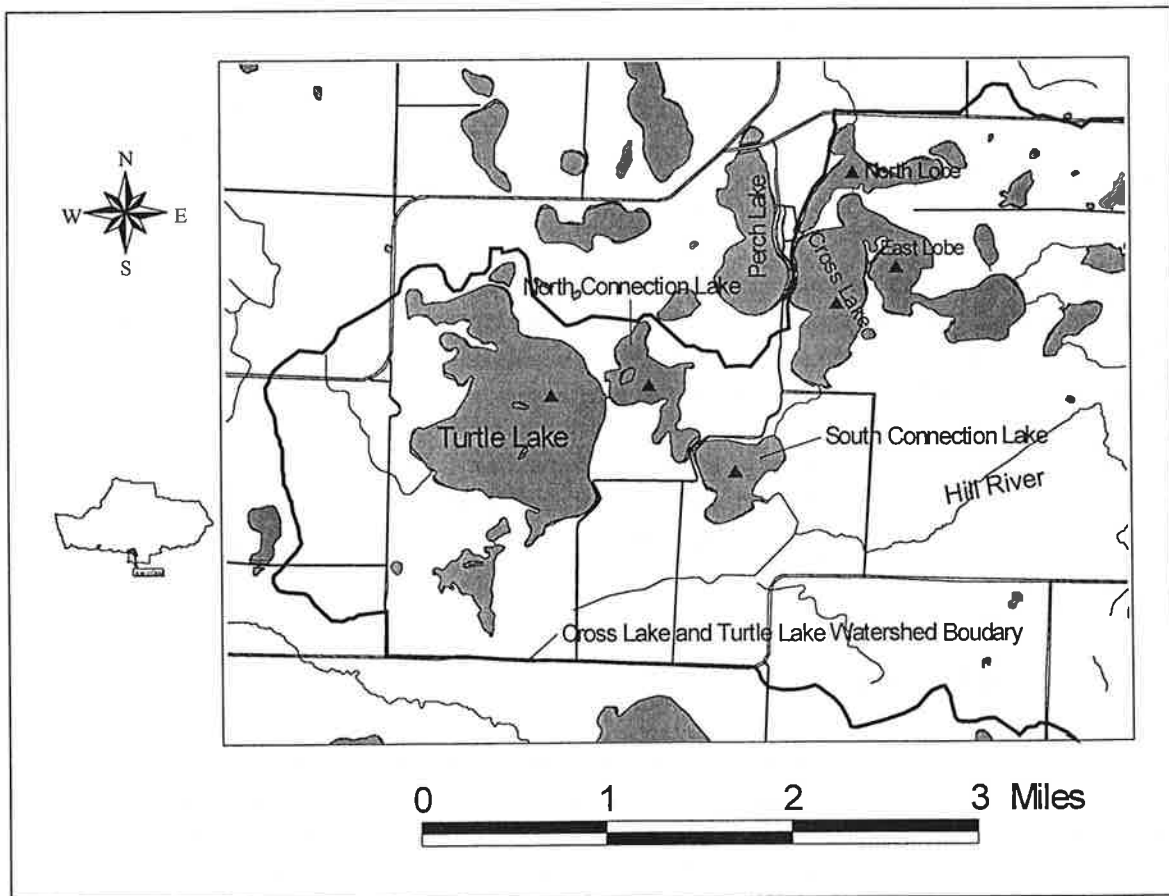


Methods

Water Quality Methods

Water quality samples were collected from six in-lake monitoring locations (Figure 2). The samples were taken from the deepest part of South Connection Lake, North Connection Lake, Turtle Lake and three basin areas on Cross Lake. Water quality parameters included chlorophyll-a and total phosphorus. Secchi disk readings were also taken. More measurements of total phosphorus and chlorophyll-a were taken than secchi disk readings. Dissolved oxygen and water temperature profiles were also taken at the monitoring sites. Each of these parameters is important in determining trophic status. Originally, the preliminary study design specified one year of water quality and flow monitoring. Due to problems in flow monitoring, the study continued and water quality information was collected for two years, 1997 and 1998.

FIGURE 2. TURTLE LAKE AND CROSS LAKE IN-LAKE MONITORING LOCATIONS



Cross Lake and Turtle Lake Report

model depth transmitters and data recorders. The instruments were installed at seven sites (Figure 3):

- 1) upstream of the box culvert on the Hill River on Polk County Road # 29 (designated point A)
- 2) near the dam or weir on the north side of Cross Lake (designated point B)
- 3) upstream of the culvert on the gravel road on the South side of Cross Lake (designated point C)
- 4) near the dam or weir on the northeast side of South Connection Lake (designated point D)
- 5) near the box culvert on the Hill River on the gravel road in the south central part of Section 28, Queen Township (designated point E)
- 6) near the dam or weir in the channel between North Connection Lake and Turtle Lake in the northwest corner of Section 29, Queen Township (designated point F)
- 7) near the culvert on the gravel road between South Connection Lake and North Connection Lake in the center of Section 29, Queen Township (designated point H)

The primary surface inflows and system discharges of Cross Lake and Turtle Lake were estimated using rating curves. Weirs serve as the primary flow control structure in Turtle Lake and Cross Lake systems. A specific weir equation was determined by varying a weir coefficient, values from 1.0 to 3.3. HEC-RAS models were utilized for the development of rating curves using the geometry and average slope of channeled stream sections. The rating curves were calibrated with measured stages and streamflows. For the ungaged sections of each watershed, as well as periods without recorded water levels stages within the primary inflow channels, runoff coefficients used in conjunction with assumed rainfall data were utilized to determine surface runoff.

Evaporation was estimated using the mean annual lake evaporation rate provided by the Soil Conservation Service Hydrology Manual. Neither of the watersheds (Cross Lake and Turtle Lake) had rain gages within; therefore, rainfall data provided by the Minnesota State Office of Climatology Volunteer Network was utilized. Because no independent measurements of lake stage were obtained, the net change in lake storage was assumed to be negligible. Groundwater inflow/outflow was assumed to be the difference between the assumed inflows and outflows of each lake. Because groundwater inflow/outflow was not actually measured, the calculated groundwater inflow/outflow also incorporates an error term. (Deutschman and Erickson 1999)

The determination of flow direction provides an understanding of how and when water moves through the Turtle Lake and Cross Lake systems. Flow direction is important for understanding mechanisms in water quality over the course of a year. Of special interest in this report is the flow direction from the Hill River into and out of the Turtle Lake system. A percentage of flow from the Hill River over time into and out of Turtle Lake needs to be determined. The stage at certain locations in the Turtle Lake system, sites E, F and H, could not be used to determine discharge (Figure 3). Problems with measurements will be discussed later in this report. The difference in height between continuous stage recordings was used to determine flow direction.

Ecoregion Concept

To define the natural amount of algal biomass or trophic status, the Environmental Protection Agency (EPA) mapped ecoregions for the United States from information on soils, landform, potential natural vegetation, and land use. The EPA defined seven ecoregions within Minnesota. Cross Lake and Turtle Lake lie within the boundaries of the North Central Hardwood Forests Ecoregion. The Minnesota Pollution Control Agency (MPCA) chose several reference lakes, lakes deemed to be representative of the ecoregion and minimally impacted by human influences, to sample from and gain an understanding of the natural trophic status and water quality (Heiskary, 1998). Since the Cross Lake and Turtle Lake systems have a history of human influences, they are compared to the reference lakes to understand changes in trophic status and water quality.

Results

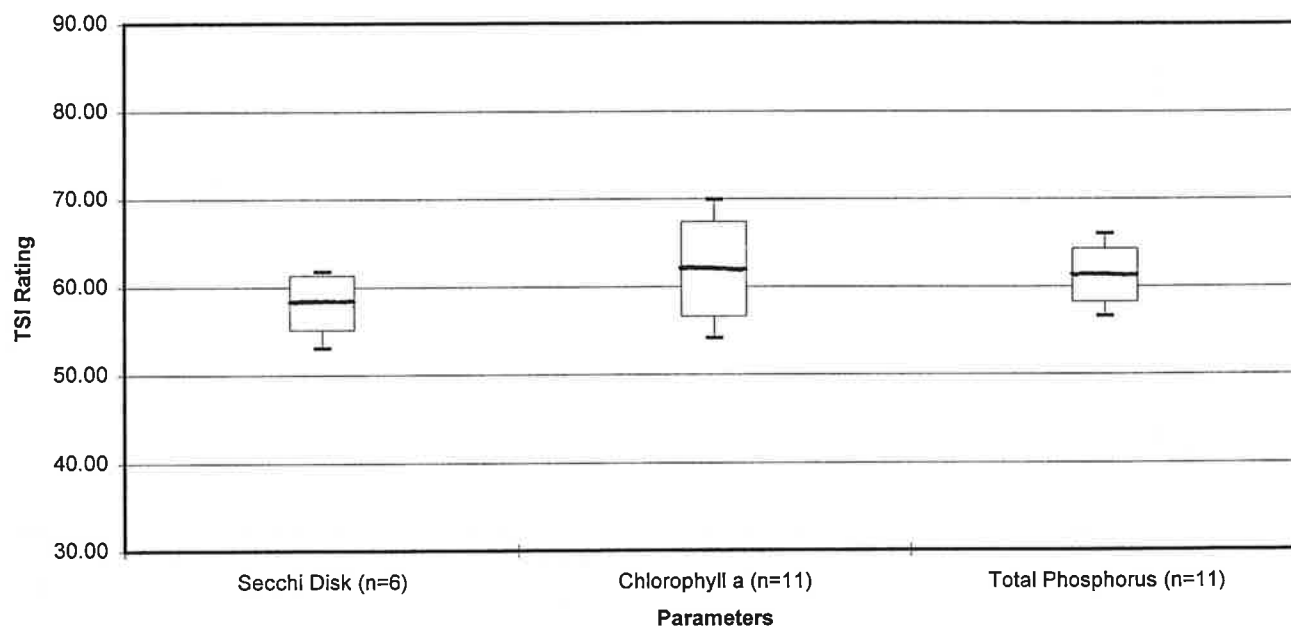
Water Quality Results

Dissolved Oxygen/Water Temperature Profiles

The dissolved oxygen and temperature profiles of Cross Lake are appropriate for lakes with depths greater than 2 meters. South Connection Lake, North Connection Lake and the north lobe of Cross Lake had depths during the sampling period of 2 meters or less. Dissolved oxygen and temperature in shallow lakes are usually evenly distributed throughout the water column. For these sites, a dissolved oxygen and water temperature at mid-level are reported on a table (Appendix A).

At the Cross Lake site, dissolved oxygen levels below 2.5 meters were less than 3 mg/L twice during the sampling period (Figure 4). Cross Lake is shallow with a maximum depth of 19 feet. Possible reasons for the periodic drop in dissolved oxygen levels include periods of mixing and non-mixing through wind and flowing water or temperature changes. The dissolved oxygen/water temperature profiles for Turtle Lake and the east lobe of Cross Lake only cover a depth of 2 meters and 2.5 meters respectively. This depth is not sufficient for identification of stratification or changes in the dissolved oxygen profile at these sites.

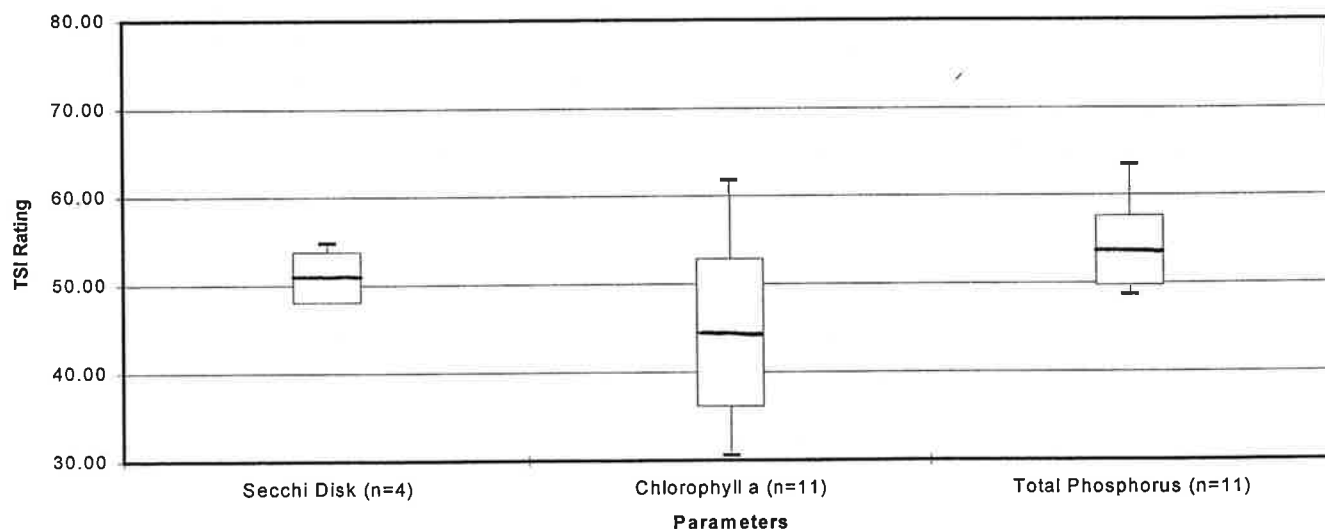
FIGURE 5. CROSS LAKE TROPHIC STATUS INDEX



The 1997 water quality data was not considered for this report due to the following reasons.

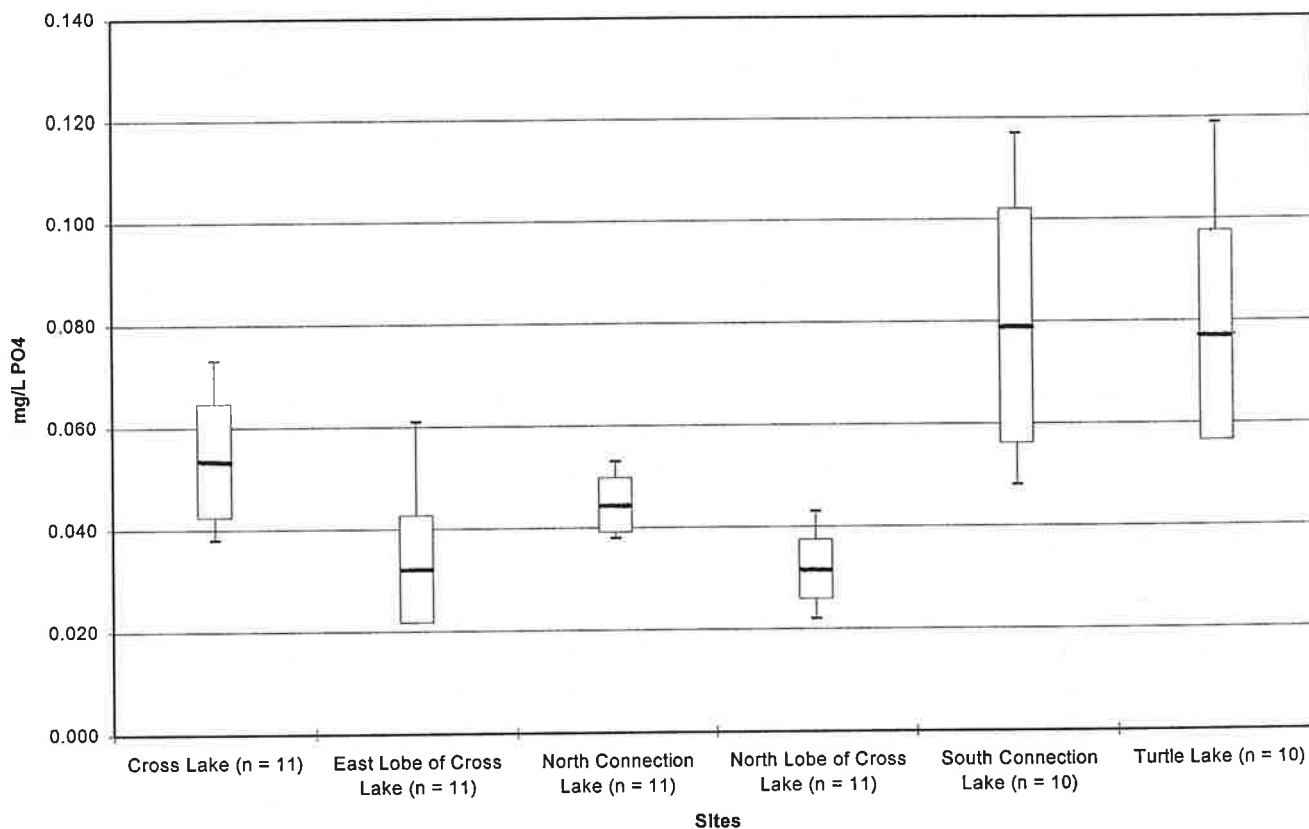
- 1) For the east lobe of Cross Lake, the largest difference was in the total phosphorus measurements. 1997 phosphorus TSI values had a high of 74.88 and a low of 45.00, whereas the 1998 data had a high of 63.43 and low of 48.72.
- 2) For Cross Lake the TSI values for both chlorophyll-a and total phosphorus .
- 3) The range of the Turtle Lake measurements was less with 1998 data.
- 4) There were very few measurements (4) actually taken in 1997.

FIGURE 6. EAST LOBE OF CROSS LAKE TROPHIC STATUS INDEX



they were not considered for this report. The mean total phosphorus value for South Connection Lake and Turtle Lake

FIGURE 8. TOTAL PHOSPHORUS IN THE CROSS LAKE AND TURTLE LAKE SYSTEMS



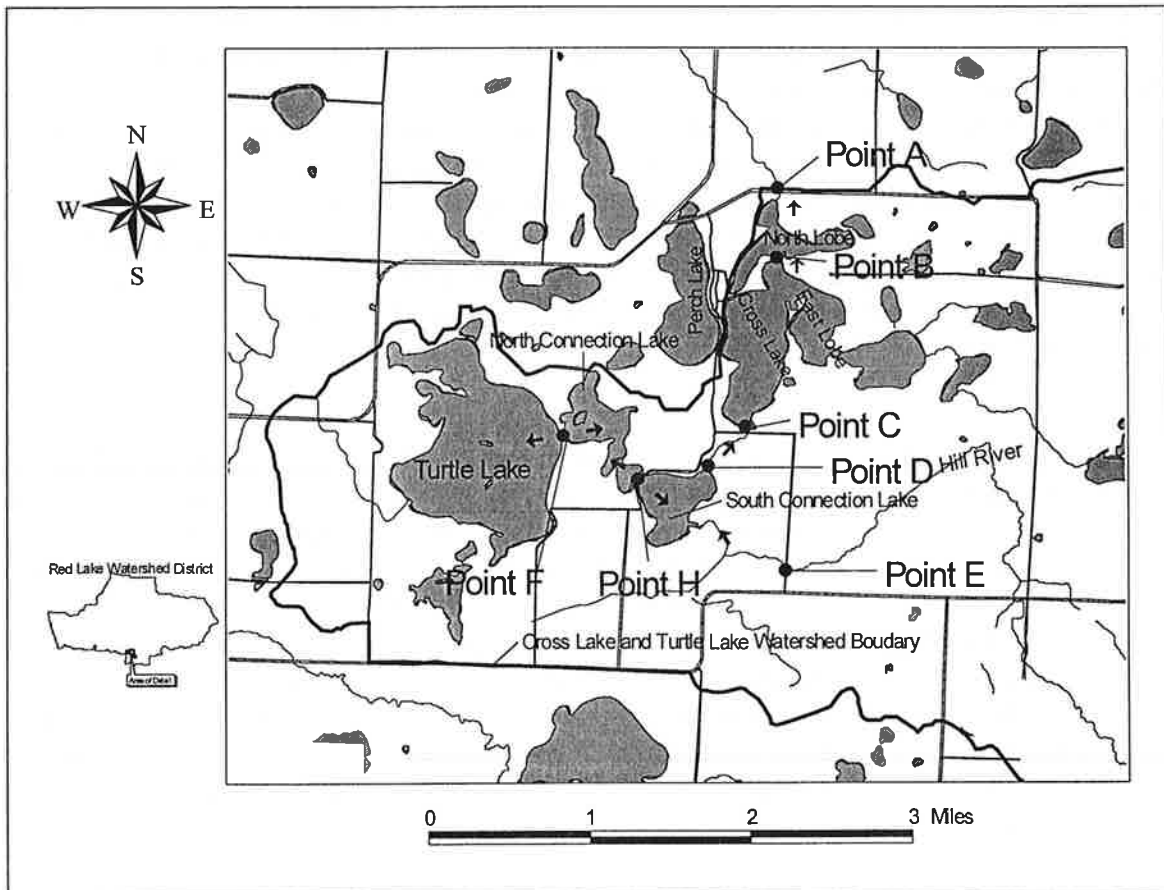
are considerably higher than the mean levels of total phosphorus for any of the Cross Lake sites. It is not known how much phosphorus and other nutrients contained in water from the Turtle Lake system is actually adding to the Cross Lake system. Future monitoring at these sites may address this situation.

Hydrological Results

The estimated magnitude of each hydrologic budget parameter is discussed in the following with regard to each lake system. Graphical representations of the hydrologic budgets in absolute terms as well as percentages of the total volume of water passing through each hydrologic system are shown (Appendix C). Also included are plots of the surface inflow and system discharge hydrographs, as well as the daily rainfall hyetographs representing each lake system (Deutschman and Erickson 1999). An illustration of the flow direction over the year is provided (Appendix D).

point A, Cross Lake system outlet (Figure 9). The flow direction, from point E (Hill River) into and out of the Turtle Lake system point D, H and F, varied throughout the year. During the first part of 1998, water was either flowing toward Turtle Lake or there was no detectable flow between South Connection Lake and Turtle Lake. The second half of the actual recorded measurements, from 8/07/98 to 8/24/98, the height difference is much greater between Turtle Lake and South Connection Lake. Water was flowing out of Turtle Lake into South Connection Lake. Each step in flow direction determination is documented (RLWD 2000).

FIGURE 9. CROSS LAKE AND TURTLE LAKE SYSTEMS FLOW DIRECTION



Quality/Limitations of Data

The quality and limitations of the data used will be discussed with respect to each lake system. Independent lake stage data, as well as groundwater inflow/outflow data was not collected and, therefore, will not be discussed.

The precipitation data used for the Turtle Lake and Cross Lake systems was obtained from Fosston, Minnesota (Polk County, Township 147, Range 40, Section 4). Fosston is located approximately 3 miles southwest of the Turtle Lake and Cross Lake, watersheds.

Another problem with these measurements is the actual difference in water surface elevations between each location in the Turtle Lake system. Each of these locations has a minimal difference in water surface elevation, often less than .1 ft. Human and environmental factors may change the actual height of the transducers over time, and they may not be reflected in the survey data. Due to the flat nature of the Turtle Lake system these problems may be unavoidable.

The third problem is the lack of data from each location. Many stations were missing most of the recorded period (RLWD 2000). Due to these factors the flow direction is also of unknown accuracy.

Recommendations

Hydrologic

The Preliminary Study Design for the Turtle Lake and Cross Lake System study identified specific technical goals. Those goals are:

- 1) Determine the hydrology of the Cross Lake and Turtle Lake system;
- 2) Develop a hydrologic budget of the Cross Lake and Turtle Lake system;
- 3) Prepare a computerized hydrologic model of the Cross Lake and Turtle Lake system and use the model to evaluate water management options;
- 4) Develop a chronological history of lakeshore development within the watershed of the Cross Lake – Turtle Lake system;
- 5) Determine the present trophic status and identify the fisheries resources within the Cross Lake – Turtle Lake system;
- 6) Obtain qualitative information about the composition of the lake bottom through sediment coring and photography;
- 7) Inventory and map current land use within specific lake drainage areas and identify potential non-point pollution sources; and
- 8) Make future lake management and/or water quality monitoring recommendations based on results obtained from the preliminary (Phase I) water quality and hydrologic study.

Cross Lake and Turtle Lake Report

- 3) Permanent buoys or GPS coordinates need to be established at the maximum depths of Cross Lake, Turtle Lake and the east lobe of Cross Lake for more accurate monitoring of depth profiles and other water chemistry.
- 4) The monitoring should follow the “Standard Operating Procedures for Field Samplers” manual from the RLWD.
- 5) Identify fisheries resources (using DNR collected information or as an actual fisheries study).

Appendix A: Water Quality Data Tables

Site	Date	Time	H2O Temp. °C	Air Temp. °C	Conductivity µS/cm	Chlorophyll-a µg/L	Secchi Disk feet	Total Phosphorus mg/L PO ₄ ³⁻
Cross Lake	07/01/97		24.8	23	453	37.38	4.5	0.058
	07/22/97	10:25	23.4	21	426	13.98	6.5	0.05
	08/05/97	13:15		21.5	416	25.63	5	0.063
	08/11/97					44.856		
	08/20/97	13:20	14.5	21		98.256	4	0.079
	10/22/97	12:38	8.2	3.8	376	48.06		0.017
	05/20/98	13:00	19.6	24		11		0.038
	06/11/98	12:15	19.4	23	452	15		0.04
	06/30/98	14:40	23.2	26.7	419	16		0.048
	07/14/98	13:20	25.3		499	12		0.043
	07/27/98	16:20	24.2	29.5	430	28	3.3	0.063
	08/11/98	11:25	25.3	26.7	389	55		0.066
	08/24/98	15:50	24.2	26.7	433	54	2.9	0.073
	09/08/98	16:25	21.5	26.7	391	27	3.2	0.051
	09/24/98	13:45	17.4	21	406	35	4	0.058
	10/07/98	12:45	11.8	9.5	407	29	4	0.058
	10/28/98	11:45	10.5	12	412	27	5.3	0.051
East Lobe of Cross Lake	07/01/97	11:45	25		329	2.67	10	0.018
	07/22/97	10:40	23.2		403	3.35	8.5	0.056
	08/05/97	1:35			350	4.27	8.5	0.135
	08/11/97					6.408		
	08/20/97	1:40	14			0	9.1	0.017
	05/20/98	14:00	20.6	24		2		0.027
	06/11/98	13:00	19.6	24	320	2		0.022
	06/30/98	14:20	24.1	26.7	308	6		0.035
	07/14/98	12:55	25.1		369	3		0.03
	07/27/98	15:30	24.5	26.7	330	24	7	0.022
	08/11/98	11:05	26	26.7	342	8		0.028
	08/24/98	11:20	24.3	24	383	5	4.7	0.033
	09/08/98	15:55	22.2	26.7	347	3	6	0.033
	09/24/98	13:15	16.3	21	378	4	clear	0.033
	10/07/98	12:15	10.4	9	373	7	7.3	0.061
	10/28/98	11:15	10.6	11.5	379	1	clear	0.03
Turtle Lake	07/01/97		24.1		385	11.27	7	0.051
	07/22/97	1:05	22		403	18.45	4.5	0.025
	08/11/97					23.496		
	08/20/97	3:20				23.496	4	0.064
	10/22/97	12:02	7.7		367	12.46		0.018
	05/20/98	16:00	20.9	26.7		15		0.073
	06/12/98	11:15	19.2	15.5	329	26		0.066
	06/30/98	16:05	22.9	25	315	32		0.073
	07/14/98	15:40	26.3		370	23		0.058

Appendix A: Water Quality Data Tables

Site	Date	Time	H2O Temp. °C	Air Temp. °C	COND. µS/cm	Chlorophyll-a µg/L	Secchi Disk feet	Total Phosphorus mg/L PO ₄ ³⁻
South Connection Lake	07/01/97		23.8	18	363	5.34		0.025
	07/22/97	13:25	26.2		381	6.15	5	0.055
	08/05/97	14:45		21	337	8.54	4	0.072
	08/11/97					6.408		
	08/20/97	14:40	15	21		0		0.023
	10/22/97	12:15	3.5	3.8	394	3.204		0.016
	05/20/98	17:00	21.8	26.7		13		0.099
	06/12/98	11:40	19.3	15.5	342	3		0.071
	06/30/98	15:30	25.6	26.7	446	29		0.094
	07/14/98	14:15	26.6		432	55		0.209
	07/27/98	12:15	23.6	24	321	28	3	0.094
	08/11/98	12:30	26.5	28	336	22		0.117
	08/24/98	14:30	25.1		346	17	clear	0.091
	09/08/98	13:15	20.3		274	2	clear	0.053
	09/24/98	15:30	16.3		330	4	clear	0.066
	10/07/98	16:15				9	clear	0.048
	10/28/98	13:00	11.2	14	388	4	clear	0.058

Cross Lake Dissolved Oxygen/Water Temperature Data

Date	Diss. Ox. Surface mg/L O ₂	Wat. Temp Surface °C	Diss. Ox. 0.5 meter mg/L O ₂	Wat. Temp 0.5 meter °C	Diss. Ox. 1 meter mg/L O ₂	Wat. Temp 1 meter °C	Diss. Ox. 1.5 meter mg/L O ₂	Wat. Temp 1.5 meter °C	Diss. Ox. 2 meter mg/L O ₂
03/03/97					1.3				1
07/01/97					11.3	21			11.4
07/22/97					7.8	20			7.7
08/05/97									
08/11/97									
08/20/97	10.6	15			9.9	14.5			9.6
10/22/97	9.4	8.2							
05/20/98	6.6	19.6	6.6	19.6	6.65	19.5	6.65	19.5	6.6
06/11/98	9	18	9.35	17	9.9	16.5	10.05	16.5	10.2
06/30/98	8.5	21.5	8.5	21.3	8.6	21.1	8.65	21	8.65
07/14/98	6.75	24.5	6.9	24.3	7.4	24.2	7.6	24.4	7.8
07/27/98	10.15	23.5	10.15	23.5	10	23.3	10	23.2	9.7
08/11/98	13.2	24.1	13.05	24	13.1	23.9	12.9	23.8	12.7
08/24/98	11.6	23.1	11.7	23	11.7	22.9	11.7	22.9	11.55
09/08/98	9.1	20.2	9.1	20.2	9	20.1	8.95	20.1	8.8
09/24/98	10.8	16.1	10.7	16.1	10.65	15.9	10.6	15.8	10.6
10/07/98	9.95	10.1	9.65	10.2	9.7	10.2	9.65	10.4	9.6
10/28/98	13.65	8.3	13.7	8.3	13.7	8.2	13.65	8.1	13.5
Date	Wat. Temp 2 meter °C	Diss. Ox. 2.5 meter mg/L O ₂	Wat. Temp 2.5 meter °C	Diss. Ox. 3 meter mg/L O ₂	Wat. Temp 3 meter °C	Diss. Ox. 3.5 meter mg/L O ₂	Water Temp 3.5 meter °C	Diss. Ox. 4 meter mg/L O ₂	Wat. Temp 4 meter °C
03/03/97	1			0.8	1			0.2	3
07/01/97	21			10.2	20			3.2	19
07/22/97									
08/05/97	20			7.2	19			0.8	17
08/11/97									
08/20/97	14			9.6	14			9	14
10/22/97									

Appendix A: Water Quality Data Tables

Date	Diss. Oxygen 1.5 meter mg/L O ₂	Water Temp. 1.5 meter °C	Diss. Oxygen 2 meter mg/L O ₂	Water Temp. 2 meter °C	Diss. Oxygen 2.5 meter mg/L O ₂	Water Temp. 2.5 meter °C
09/08/98	9.1	20.4	9	20.3	8.9	19.5
09/24/98	10.3	14.2				
10/07/98	10.55	8.8	10.6	8.7	10.6	8.5
10/28/98	12.95	8.5	12.95	8.5	13	8.4

Turtle Lake Dissolved Oxygen/Water Temperature Data

Date	Diss. Oxygen Surface mg/L O ₂	Water Temp. Surface °C	Diss. Oxygen 0.5 meter mg/L O ₂	Water Temp. 0.5 meter °C	Diss. Oxygen 1 meter mg/L O ₂
07/01/97					8
07/22/97					
08/11/97					
08/20/97					
10/22/97	10.6	7.7			
05/20/98	6	20.9	6.05	20.5	6.1
06/12/98	11.5	18	12.9	17.9	11.1
06/30/98	9.5	22	9.6	21.5	9.5
07/14/98	7.2	25	7.2	25	7.2
07/27/98	8.8	22.4	8.9	22.1	8.9
08/11/98	9.75	24	9.8	24.7	9.9
08/24/98	9.8	22.4	9.9	22.4	9.9
09/08/98	9.2	19.9	9.1	19.9	9
09/24/98	11.4	15.1	11.45	14.9	11.6
10/07/98	11	9.1	11	9	10.95
10/28/98	13.9	8.1	13.95	8	13.95

Date	Water Temp. 1 meter °C	Diss. Oxygen 1.5 meter mg/L O ₂	Water Temp. 1.5 meter °C	Diss. Oxygen 2 meter mg/L O ₂	Water Temp. 2 meter °C
07/01/97	20			7.4	20
07/22/97					
08/11/97					
08/20/97					
10/22/97					
05/20/98	20.3	6.15	20	6.15	20
06/12/98	17.1	11.1	17		
06/30/98	21.5	9.45	21.2	9.3	21
07/14/98	25	7.2	24.9	7.2	24.8
07/27/98	22.1	8.65	21.9	8.55	21.8
08/11/98	24	9.95	23.9	9.6	23.6
08/24/98	22.2	9.9	22.1	9.75	22.1
09/08/98	19.9	8.9	19.9	8.9	19.9
09/24/98	14.9	11.6	14.9	11.65	14.9
10/07/98	9	10.95	9	11	9
10/28/98	8	13.95	8		

Appendix B: Observed History of Cross Lake and Turtle Lake

I was born and raised on the north shore of Turtle Lake and I remember alot of what transpired of the past of Turtle Lake.

My first memory was when the fish died and I had walked down to the lakeshore and saw a row of fish, large and small, of all different kinds and it occurred to me I could walk on that line of fish without setting foot on any ground. This was about 1920. (I was about 10 years old.)

In 1883 the homesteaders who settled around the lakes, and who had becomes owners of their farms, some years later got the idea they could gain more land by lowering the Turtle and Connection Lakes. What they gained was mostly unproductive land. It was wonderful for sow thistle and Canadian thistle, however. So by a petition of the lakes landowners that passed, County Ditch #68 was cut to lower Turtle and Connection Lakes.

Then because of the main watershed coming into Connection Lake on the southeast side and the outlet of Connection Lake being on the northeast side, the flow had just a short way to go from inlet to outlet.

Turtle Lake did not get any water. So Turtle Lake became lower and lower until about 1920 when the fish died. Then in the drought of the 1930's the lake kept getting lower and lower until as I remember Turtle Lake. It then became Upper and Lower Turtle Lake and you could hardly find any depth of more than five feet.

My father, who was opposed to the ditching that took place, together with a neighbor, namely Roy Hoialmen, decided in the late 1920's to try to have the lakes restored.

Working with W.E. Row, Crookston Attorney, Erling Swanson, Director, Division of Game and Fish, Herman C. Wenzel, Conservation Commissioner of Minnesota, Walter S. Olson, Director, Division of Drainage and Waters of Minnesota and other interested parties, progress was made until a survey was taken from just north of Gully, Minnesota to the north shore of Turtle Lake.

A heavy iron stake was driven down. The top of the stake was then to establish the water level as it was before the ditch was dug to lower the lakes.

In the final Certificate of Condemnation, filed in the Fourteenth Judicial district of Polk County on July 18, 1932, the levels to which these lakes were to be stabilized are stated.as follows:

Cross Lake, 1303.50 Mean Sea Level Datum Fourth General Adjustment 1912
Turtle Lake, 1307.00 Mean Sea Level Datum Fourth General Adjustment 1912
Connection Lake, 1307.00 Mean Sea Level Datum Fourth General Adjustment 1912

Turtle and Connections Lakes are then 3 feet 6 inches higher than Cross Lake.

All water level easements were then paid for and the dams were constructed in 1933. Because of the drought of the 1930's there was no water for the lakes until 1941 when the rains came. By the fall of 1941 all three lakes were restored.

In 1942 heavy rains continued so that the water level would flood over the stabilized levels. Complaints then were made of the State Conservation Department.

The Department, being somewhat careful because of the controversy over the dams, decided to take out one stop log on each side of the Connection Lake dam. And that is the way it remains to this day as far as I know. (NOTE: Now Turtle and Connection Lakes have a water level of 1306.50, three feet higher than Cross Lake.)

Appendix B: Observed History of Cross Lake and Turtle Lake

TO: East Polk Soil and Water Conservation District
P.O. Box 57
McIntosh, Mn 56556

FROM: Paul Stolen *Paul Stolen*
RR3, Box 116
Fosston, Mn 56542
Owner, SE 1/4, Sec 24 T148N, R44W

DATE: April 18, 1994

RE: Survey of Cross and Turtle Lakes

The comments that follow are not made as an employee of the Department of Natural Resources. Rather, they are made as a private citizen who grew up on the shores of these lakes, and who became a biologist because of the large amount of time I spent there. I support your planning efforts. This survey was a good idea. I may be able to assist both as a resident and in my job. Thanks for the opportunity to comment. Sorry it took so long.

My comments are influenced by my childhood and adult wanderings around the lakes, and by my present avocational interest in ecology, rather than my DNR employment or by any biological data obtained from studying the lakes objectively.

I will try to provide my best recollection of the time period from the early 1950's until about 1966 because that was when I was around the lakes year-around, every year. I probably better recall the more spectacular events from my childhood, such as fish kills, large waterfowl flights, very high or very low water, and what was happening at the lake inlets and outlets. However, I am attempting to recall the more mundane events also.

HISTORICAL INFORMATION ABOUT DRAINAGE OF TURTLE AND CONNECTION

I would first like to pass on some material from Orrin Torgerson, a neighbor who died last summer whom I have known since childhood, and from family stories about my grandfather, Roy Hoialmen, who died before I was old enough to know him. Orrin truly loved Turtle Lake. His father, Louis Torgerson, and my grandfather were involved in the 1930's in getting dams placed so that Turtle and Cross lake levels could be restored when rains returned. Orrin gave me his files before he died.

This material shows conclusively that it was not the drought of the 1930's that instigated the building of the two dams at the outlets of Connection Lake. Instead, it was the building of County Ditch #68 in about 1918 that resulted in lowering the levels of Connection and Turtle lakes. It is likely that the extremely low water levels suffered during the drought swung support to those who

Appendix B: Observed History of Cross Lake and Turtle Lake

before. Other affected individuals did not receive payment. According to family stories, these tended to be individuals in favor of the restorations.

OBSERVATIONS OF TURTLE, CONNECTION, AND CROSS LAKES.

A couple of points: Your survey should include Connection Lake--you cannot separate the three lakes hydrologically or ecologically. Secondly, my opinions about ecological relationships are not based on research done on the lakes.

Water levels of Turtle, Connection, and Cross. Perhaps the most interesting item regarding lake levels is that the 1950's and 1960's were a time of low water--lower than the drought that ended three years ago. During my wanderings around the lake, I always walked out to the big island on the west side (just north of Gene and Diana Hegge's farm.) It looks like a peninsula, but it is an island under normal water levels.

Until I graduated from high school in 1962, there was a mud flat between this island and the main lakeshore. Sometimes lake levels went up, and I had to use hip boots, or lay boards across the mud. Three years ago this area was dry as well. But not as dry as in 1959 or 1960. In one of those years, there was only a little puddle of water in the whole west arm of the lake (the arm that extends close to my place.) I remember this distinctly because my dog chased a raccoon out onto the mud flat, and I had heard the stories of raccoons being able to drown a dog if they got it out into deep water. At that time I could walk on the firm mud across the northwestern bay.

I monitored the lake level three years ago during the recent drought, and Turtle Lake reached its lowest point just before freeze-up in the fall of 1991. There was an edge of exposed mud flat around the northwest bay, but nothing like the low levels when my dog chased the raccoon.

I also watched the lakes during floods. When I started my walks in the early 1950's the water control structure between Turtle and Connection had not yet washed out. I think the wash-out occurred after the mid-1960's, and likely happened more than once. I think the big wash-out occurred when the road across Connection Lake washed out about 15-20 years ago. There never were any boards in the Turtle/Connection lake structure, even before it washed out. The channel between Turtle and Connection was often dry during the 1950's and early 1960's.

The enclosed letter from Walter Olson (State of Minnesota) to Louis Torgerson points out that there was still an ongoing drought in 1940. I know from my work on the recent Poplar River/Maple Lake diversion project that the rains returned in 1941, and a much wetter period ensued until the 1950's.

Appendix B: Observed History of Cross Lake and Turtle Lake

exposing mud flats, there were many species of shorebirds using it. American mergansers seem to really like it in the spring, and not as much in the fall.

Water quality. I have been around the lakes frequently enough since the mid-1960's to notice the general trends that have occurred. Water quality in the lakes is a puzzle. In the 1950's, Turtle Lake had tremendous algae blooms, and you could smell it for long distances both in the spring with the onset of warm weather, and when the blooms were on. Water clarity was very poor. Thick green mats formed on windblown shores. No point then in putting in a fish house in the winter--a person couldn't see enough to spear a fish.

This seems to have changed dramatically in recent years. Turtle Lake has generally had good clarity both in winter and summer. It has never smelled like it used to, and algal blooms have been present but not unusual. The water is not always clear in the winter, but usually has been good or at least minimally adequate for spearing.

On the other hand, Cross Lake's water quality seems to have declined in the last 15-20 years. Even though the 1950's and early 1960's were years of generally low water levels, there were never algal blooms similar to Turtle Lake during these times. Cross Lake seems to have more algae blooms, poor tasting fish, and poor swimming. Up until the 1970's and 1980's, Cross Lake was at times a popular swimming area. And we have family pictures of the Cross Lake swimming beach with a hundred people in and along the water in the 1920's.

Lake water quality is dependent on land practices on its watershed. There have been changes--two of the most obvious are a big decrease in intensive pasturing of cattle around the lakeshores of Cross, Turtle, and Connection, and an increase in the use of fertilizers on farm fields. The first would tend to decrease the amount of nutrients going into the lakes; the second would increase the amount of nutrients.

Fish in Cross, Turtle, and Connection.

Turtle Lake has always been a lake subject to explosions of fish and crashes from winterkill. My mother talks of Louis Hanson (or his father? He lived on the farm Gene and Diane Hegge live on now on the west side of Turtle) taking "wagonloads" of netted northern pike out about the time of World War I.

Few people fished Turtle in the 1950's and early 1960's, even though there were abundant fish at times. Each spring when there was a winter kill, I would measure northern pike, and I remember getting a 38 inch fish probably about in 1958 or so. That same year there was a lot of large crappies and suckers. Fishing didn't

Appendix B: Observed History of Cross Lake and Turtle Lake

migratory birds on their way down the Mississippi flyway and to Chesapeake Bay (canvasbacks.) Ducks and other migratory waterbirds don't use just any lake--this one has had significantly different habitats.

Northern pike quickly return after a winter die-off. The lake should be recognized by the county as an important waterfowl lake and managed as such. It should also be managed so as to not impede northern pike movement into it, and management recognition given that it is a local recreational resource for northern pike fishing.

Water control structures. The water control structures in place now need to be dealt with. The structure at the outlet of Connection Lake has almost washed out previously, and will likely do so in a future flood event. This will likely result in substantial lowering of Connection and Turtle lake water levels, and likely large acreage loss of both wetlands and lake around the fringes of the current Turtle and Connection lakes. There were public funds expended in 1932 for taking these lands out of private use as farmland and putting them into public use as wetlands and lakes.

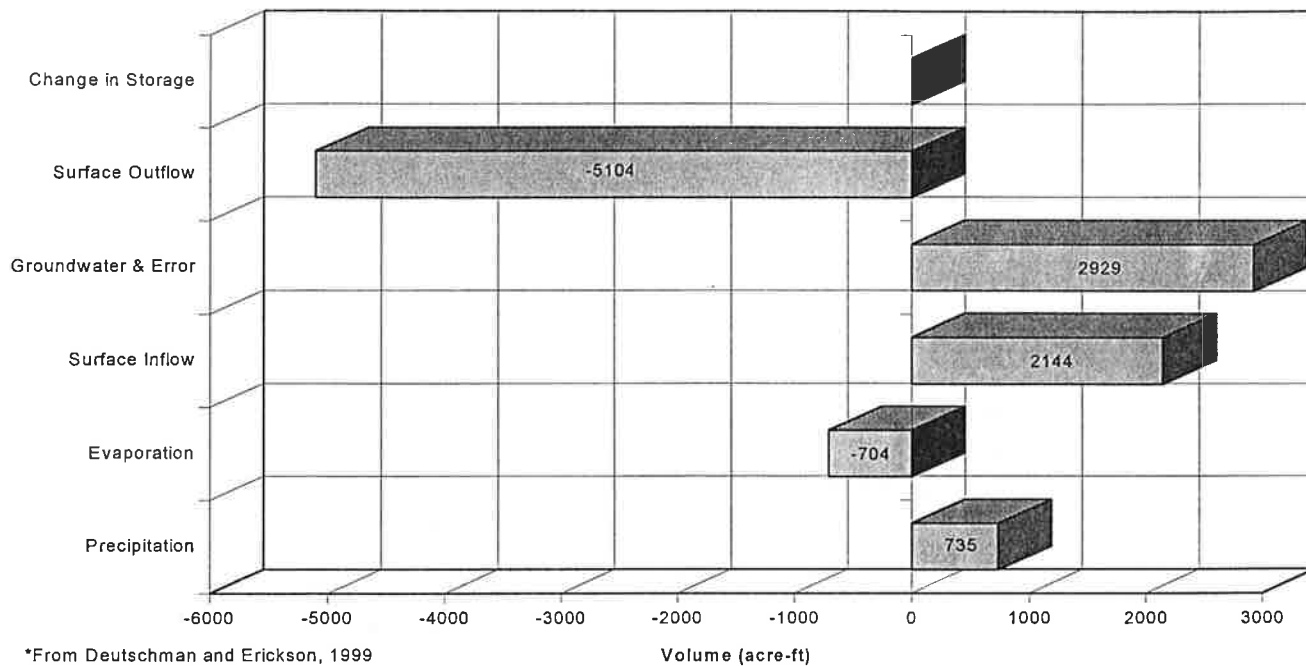
The county should look at the 1932 Court Order to find its legal status and relevance today. Because the key structure at the outlet of Connection Lake is subject to damage, consideration should be given to restoring the water control structures to their previous condition and following the Court Order. According to the Walter Olson letter, the structures were apportioned to give Cross Lake 60 percent of the Hill River flow because of Cross Lake's value for "resorts." (In modern terms that would likely read value for fishing.) Perhaps this is a reasonable apportionment, based on the historical record of kinds of uses for the lakes and on the biological attributes of all three lakes.

Other suggestions

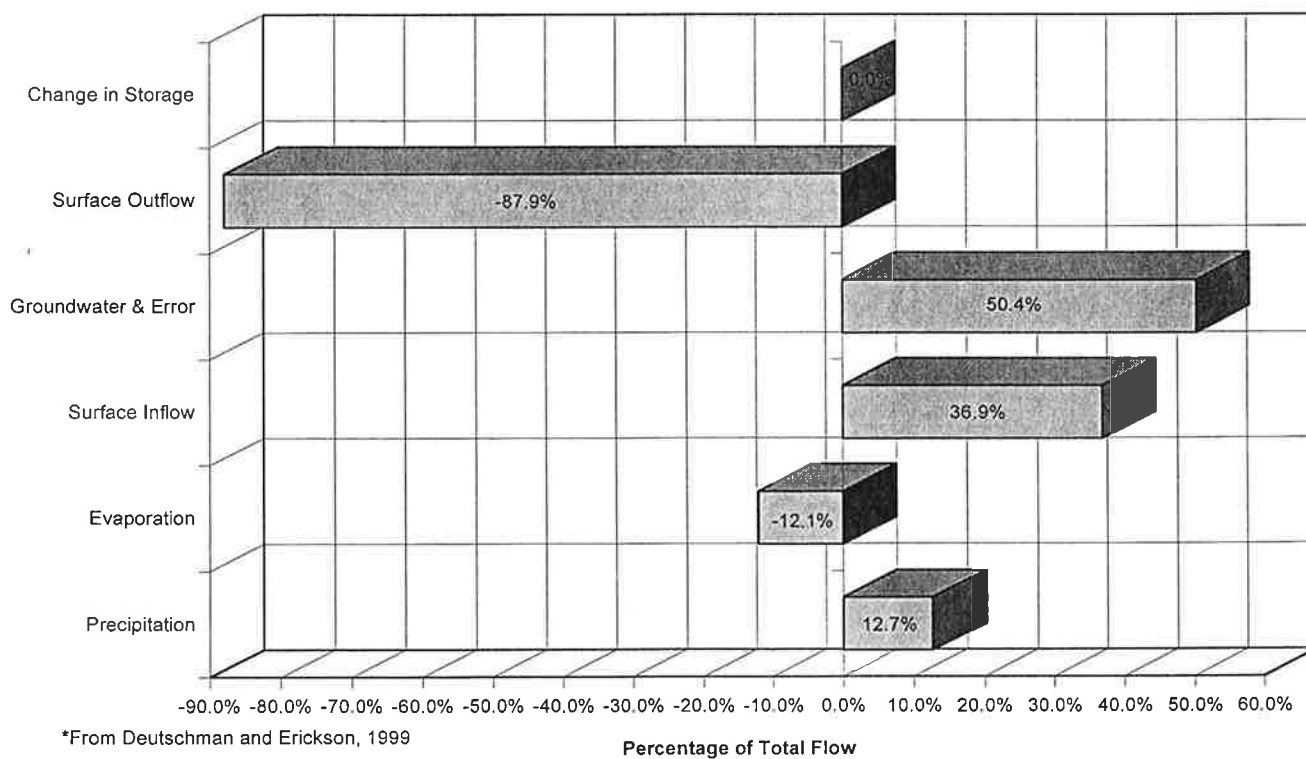
Consideration should be given to establishing a hiking, biking, and cross-country ski trail from Fosston to Tilberg Park. Over the long-term, there are often grants available for such a project. Local initiative is needed. This could increase day use and camping use of the park, and add value and use for and by Fosston residents. I might be able to give some advice on how to proceed with such an idea.

Appendix C: Hydrologic Graphs

Annual (1998) Hydrologic Budget for the Cross Lake System

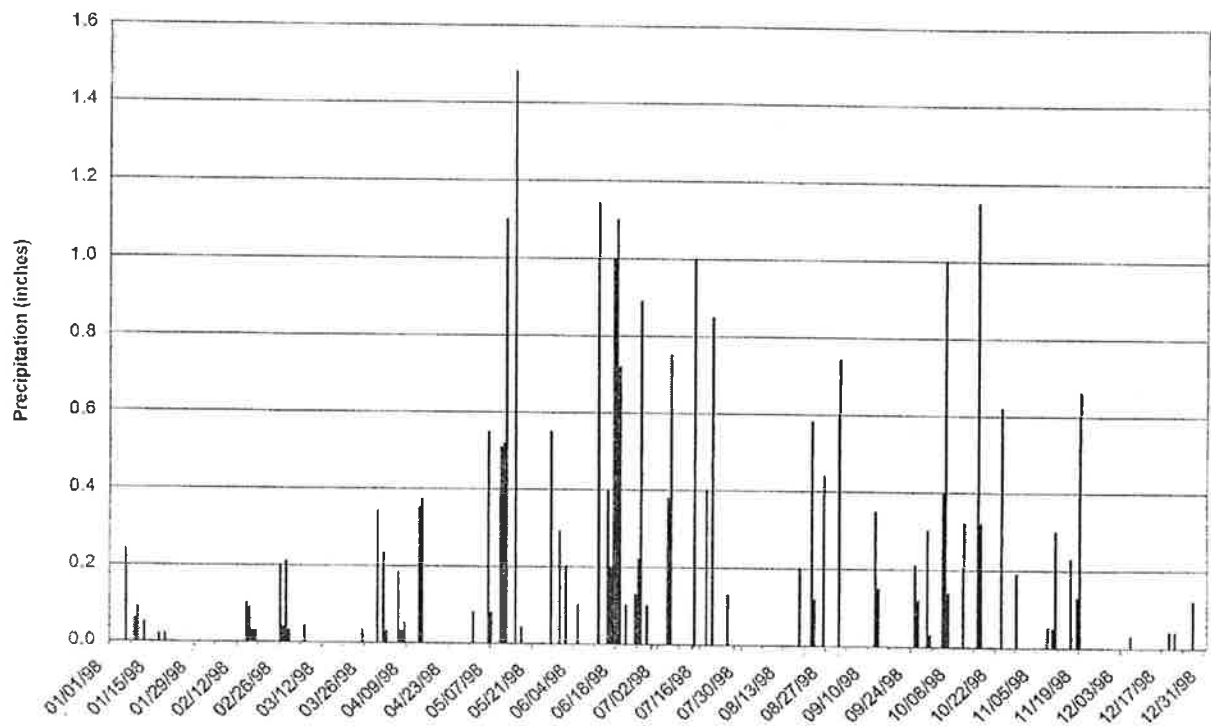


Annual (1998) Hydrologic Budget for the Cross Lake System



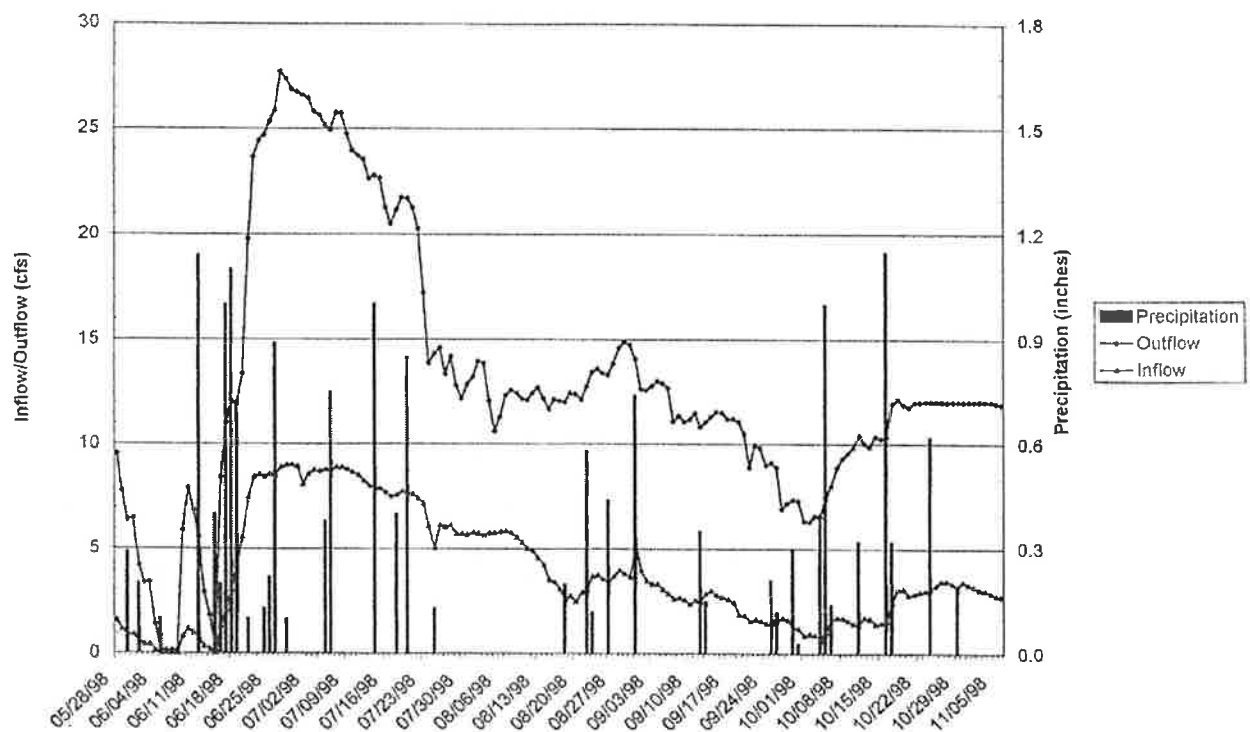
Appendix C: Hydrologic Graphs

1998 Precipitation Recorded in Polk County, Township 147, Range 40, Section 4



* From Deutschman and Erickson, 1999

Daily Inflow/Outflow Hydrograph and Precipitation Record for Cross Lake



* From Deutschman and Erickson, 1999

Appendix D

Carlson's Trophic State Index RE Carlson

- TSI < 30** Classic Oligotrophy: Clear water, oxygen throughout the year in the hypolimnion, salmonid fisheries in deep lakes.
- TSI 30 - 40** Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer.
- TSI 40 - 50** Water moderately clear, but increasing probability of anoxia in hypolimnion during summer.
- TSI 50 - 60** Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnia during the summer, macrophyte problems evident, warm-water fisheries only.
- TSI 60 - 70** Dominance of blue-green algae, algal scums probable, extensive macrophyte problems.
- TSI 70 - 80** Heavy algal blooms possible throughout the summer, dense macrophyte beds, but extent limited by light penetration. Often would be classified as hypereutrophic.
- TSI > 80** Algal scums, summer fish kills, few macrophytes, dominance of rough fish.

