



# United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Water Resources Division  
6417 Normandy Lane  
Madison, Wisconsin 53719-1133  
608 274-3535 (Fax 608 276-3817)

June 15, 1995

Chairperson  
Eagle Spring Lake Management District  
P.O. Box 196  
Eagle, Wisconsin 53119

Dear Chairperson,

This letter describes the progress on the evaluation of the water quality of Eagle Spring Lake according to the data collected from October 1993 to September 1994 as stated in our agreement. Please read the "U.S. Geological Survey Lake Monitoring Program in Wisconsin", sent to you previously, before proceeding with this letter.

In a brief summary, based on the **1994** data:

- The water quality of Eagle Spring Lake is good and can be classified as a meso-eutrophic lake or one with moderate to many nutrients.

Although there is annual variability in water quality, based on surface total phosphorus and chlorophyll *a* concentrations and Secchi-disc depths, no trends are apparent.

- Algal growth appears to be dependent upon the amount of available phosphorus rather than nitrogen.
- The data enclosed herein are provisional until published.

Eagle Spring Lake has a surface area of 311 acres (0.486 square miles) and a drainage area at the outlet of 33.2 square miles, for a drainage area/lake-size ratio of 68:1. Lakes with drainage area/lake-size ratios of greater than 10:1 tend to develop water-quality problems. (Uttormark, Paul D., and Mark L. Hutchins, 1978, Input/output models as decision criteria for lake restoration. University of Wisconsin-Madison, Wisconsin, Water Resources Center technical report No. 78-03, 61 pp.).

One site was sampled in Eagle Spring Lake. It was located approximately at the deepest spot in the lake at a depth of about 8 feet and is shown in figure 1.

The data for this report are found in the following tables and figures:

Table 1. Lake-depth profiles for Eagle Spring Lake at Eagleville, Wisconsin, 1994 water year

Table 2. Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Eagle Spring Lake at Eagleville, Wisconsin, 1994 water year

Figure 1. Location of sampling site and staff gage on Eagle Spring Lake near Eagleville, Wisconsin

Figure 2. Lake water-quality data for Eagle Spring Lake at Eagleville, Wisconsin, 1994 water year

Figure 3. Trophic State Indices for Eagle Spring Lake at Eagleville, Wisconsin

Figure 4. Surface total phosphorus and chlorophyll *a* concentrations and Secchi-disc depths for Eagle Spring Lake at Eagleville, Wisconsin

All the water-quality samples collected were analyzed by the Wisconsin State Laboratory of Hygiene at Madison, Wisconsin. The water-quality data are published in our annual publications, "Water Resources Data for Wisconsin, 1994" and "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 1994."

#### LAKE-STAGE FLUCTUATIONS

**Lake** stages were read from a staff gage mounted to the left upstream headwall of the dam at the outlet. They were read by the USGS at the time of lake sampling. Lake-stage data are listed in figure 2. Lake stages fluctuated 0.20 feet and ranged from 9.36 feet on March 1 to 9.56 feet on April 7 and August 10. However, the total fluctuation may not have been observed since the lake stage was read only five times in the 1994 water year.

#### LAKE-DEPTH PROFILES

Profiles of water temperature, dissolved oxygen, pH, and specific conductance at the deep hole are listed in table 1 and shown in figure 2. No abnormalities in the data are apparent. The lake does not thermally stratify during summer. The levels of pH are within acceptable limits to support aquatic life. Because of the high buffering capacity of the lake water, Eagle Spring lake is not susceptible to the effects of acid rain.

#### SELECTED ANALYSES

Analyses of selected constituents for April 7 for samples collected at 1.5 and 4-foot depths are listed in figure 2. The water-quality values for color, chlorophyll *a*, chlorides, calcium, magnesium, pH, alkalinity, total nitrogen and total phosphorus are within regional values for this area as described by Lillie and Mason in "Limnological Characteristics of Wisconsin Lakes," 1983, Technical Bulletin No. 138, Department of Natural Resources.

To compute the nitrogen-phosphorus ratio, only the sample collected from the 1.5-foot sampling depth for April was used. This depth was used because algae grow in the upper part of the lake rather than at the bottom. The ratio of total nitrogen to phosphorus was calculated as 156:1 and suggests the lake is phosphorus-limited and is consistent with previous data. This means algal growth appears to be dependent on the amount of available phosphorus rather than nitrogen.

## APRIL, JUNE, JULY AND AUGUST WATER QUALITY

The data for total phosphorus, chlorophyll a, and Secchi-depth readings are listed in table 2 and on figure 2.

Total phosphorus: Total phosphorus concentrations sampled at a 1.5-foot depth range from 0.009 mg/L in April to 0.019 mg/L in July. All values fall within the regional values previously referenced

Chlorophyll a: Chlorophyll a concentrations, which indicate algal biomass, ranged from 4.34 µg/L in June to 10.2 µg/L in July. These data are within the regional values,

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 3.6 feet in July to 5.6 feet in April. These data are within the regional values.

## TROPHIC STATUS

Lillie and Mason (1983) classified Wisconsin lakes using a random data set (summer, July and August) according to total phosphorus and chlorophyll a concentrations, and Secchi-disc depth. This evaluation is shown below:

Water quality index	Approximate total phosphorus equivalent (mg/L)	Approximate chlorophyll <u>a</u> equivalent (µg/L)	Approximate water clarity equivalent (Secchi-disc depth in ft)
Excellent	<0.001	<1	<19.7
Very good	.001-.010	1-5	9.8-19.7
Good	.010-.030	5-10	6.6-9.8
Fair	.030-.050	10-15	4.9-6.6
Poor	.050-.150	15-30	3.3-4.9
Very poor	>.150	>30	<3.3

Using the above criteria to evaluate the mean summer (July-August) 1994 data shown in table 2 for Eagle Spring Lake, surface total phosphorus and chlorophyll a concentrations indicate good water quality, while Secchi-disc depths indicate poor water quality.

Using the data from "Limnological Characteristics of Wisconsin Lakes," 1983, by Lillie and Mason, a comparison of the 1994 mean summer data (July and August) for total phosphorus, chlorophyll a, and Secchi depths for Eagle Spring Lake to other lakes in southeast Wisconsin are shown below:

	<u>Parameter</u>	<u>Percentage of distribution of lakes in southeast Wisconsin within these concentrations</u>	
	Total phosphorus (mg/L)		
	<.010	Best condition	7
Eagle Spring Lake values →	.010-.020	↓	21
	.020-.030		15
	.030-.050		21
	.050-.100		21
	.100-.150		3
	>.150		Worst condition
	Chlorophyll <u>a</u> (µg/L)		
	0- 5	Best condition	22
Eagle Spring Lake values →	5-10	↓	31
	10-15		14
	15-30		12
	>30		Worst condition
	Secchi depth (in feet)		
	>19.7	Best condition	1
	9.8-19.7	↓	9
	6.6- 9.8		26
Eagle Spring Lake values →	3.3- 6.6		31
	<3.3		Worst condition

Comparing other lakes in southeast Wisconsin to the 1994 data for Eagle Spring Lake, the above data show, during the period 1966 to 1979, 72 percent had higher total phosphorous concentrations, 48 percent had higher chlorophyll a concentrations, and 33 percent had less water clarity.

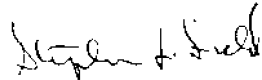
A second approach to assessing the "health" or trophic status of a lake is to use Carlson's Trophic State Index (TSI). A graphic illustration of the Trophic State Index for Eagle Spring Lake is shown on figure 3. The data from 1994 show Eagle Spring Lake to be meso-eutrophic or one with moderate to many nutrients. The TSI values for Secchi depth generally plot considerably higher than those for chlorophyll a. This suggests that turbidity caused by fish, motorboats, winds, etc., may be the reason for the higher TSI. Therefore, chlorophyll a and total phosphorus concentrations may better represent the lake's water quality than Secchi depth.

Surface total phosphorus and chlorophyll a concentrations and Secchi-disc depths for Eagle Spring Lake since 1991 are shown in figure 4. Although the data show annual variability, no trends are apparent.

The data that has been collected for Eagle Spring Lake from 1991-1994 is extremely important for understanding the lake's water quality and managing the lake. To continue with the monitoring as in the past will help to build on this very valuable data base.

If you have any questions regarding this evaluation, please contact me at 608/276-3842.

Sincerely,

A handwritten signature in black ink, appearing to read "Stephen J. Field". The signature is written in a cursive style with some loops and flourishes.

Stephen J. Field  
Biologist

Enclosures

cc: Bob Wakeman, DNR, Milwaukee

Table 1. Lake-depth profiles for Eagle Spring Lake at Eagleville, Wisconsin, 1994 water year

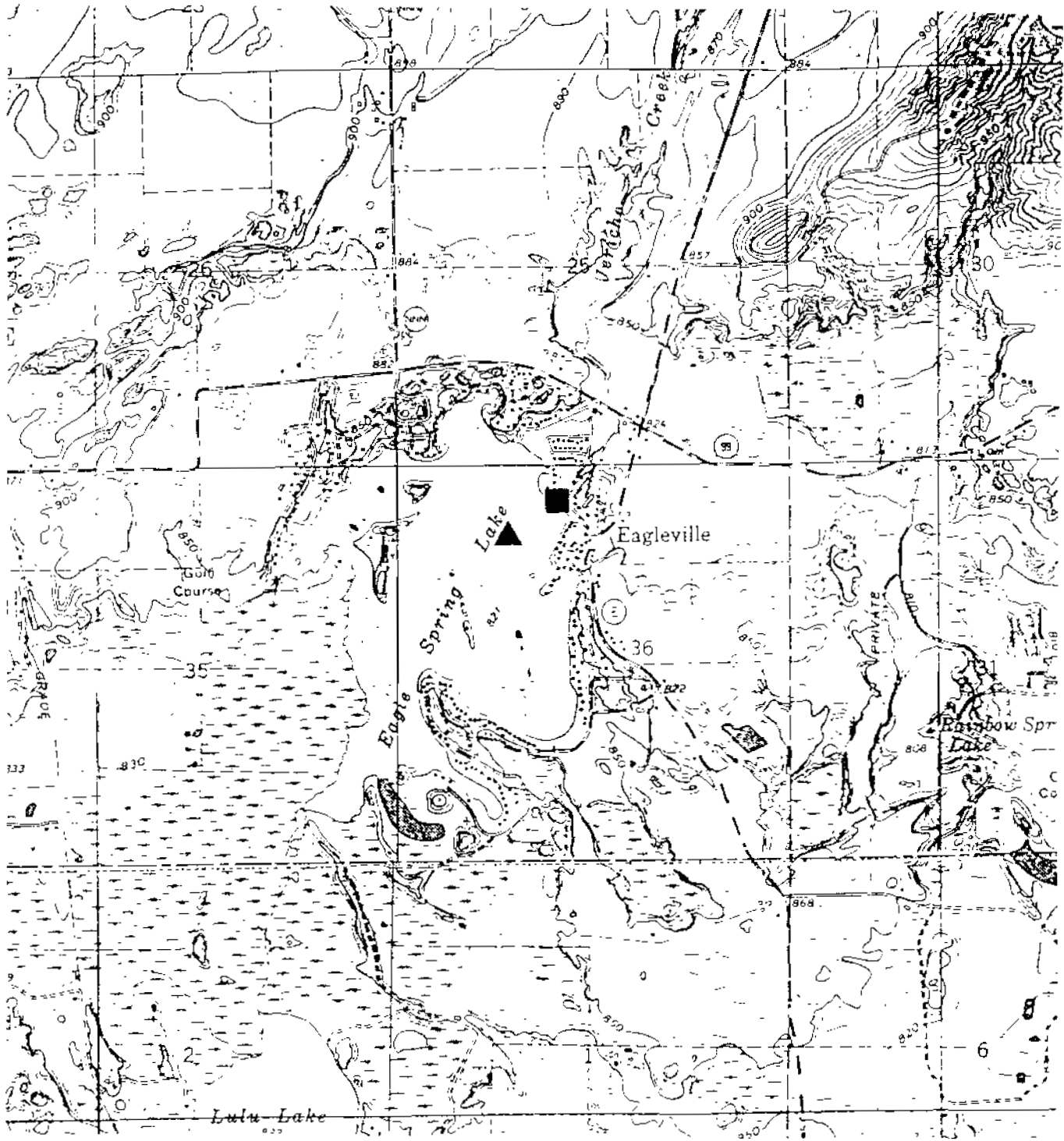
425103080261500 - EAGLE SPRING LAKE AT EAGLEVILLE, WI

WATER-QUALITY DATA

DATE	SAMPLING DEPTH (FEET) (00003)	TEMPERATURE WATER (DEG C) (00010)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH WATER FIELD (STANDARD UNITS) (00400)	OXYGEN, DISSOLVED (MG/L) (00300)
MAR 1994					
01...	1.00	1.0	565	7.6	10.6
01...	2.00	1.5	555	7.4	9.7
01...	3.00	2.5	567	7.4	9.6
01...	4.00	3.0	606	7.4	8.6
01...	5.00	3.5	623	7.6	7.7
01...	5.50	--	--	--	--
APR					
07...	1.00	8.0	442	9.0	13.5
07...	1.50	8.0	442	9.0	13.4
07...	2.00	7.5	442	9.0	13.5
07...	3.00	7.5	442	8.9	13.5
07...	4.00	7.5	442	8.9	13.6
07...	5.00	7.5	442	8.9	13.6
07...	5.50	--	--	--	--
JUN					
20...	1.00	29.5	465	7.9	7.8
20...	1.50	30.0	465	7.9	7.7
20...	2.00	29.5	459	8.0	8.4
20...	3.00	29.5	457	8.0	8.6
20...	4.00	29.5	460	8.0	9.1
20...	5.00	29.5	460	8.0	8.9
20...	6.00	29.5	462	8.0	8.7
20...	7.00	29.5	463	8.0	8.8
20...	7.50	29.5	467	8.0	8.6
20...	9.00	--	--	--	--
JUL					
18..	1.00	27.5	419	8.3	10.9
18...	1.50	27.0	417	8.3	11.3
18...	2.00	27.0	418	8.3	11.5
18...	3.00	27.0	413	8.3	11.2
18...	4.00	26.5	408	8.4	13.9
18...	5.00	26.5	409	8.4	12.2
18..	6.00	26.0	412	8.3	11.7
18..	7.00	25.5	417	8.3	10.0
18..	7.50	25.5	417	8.3	10.1
18..	9.00	--	--	--	--
AUG					
10..	1.00	22.0	428	8.4	8.7
10...	1.50	22.0	428	8.4	8.7
10...	2.00	22.0	428	8.4	8.6
10...	3.00	22.0	427	8.4	8.1
10...	4.00	22.0	427	8.3	8.1
10...	5.00	22.0	427	8.3	8.1
10...	6.00	22.0	428	8.3	8.4
10...	7.00	22.0	427	8.3	8.8
10...	7.50	22.0	427	8.3	8.6
10...	9.00	--	--	--	--

Table 2.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Eagle Spring Lake,  
 1994 water year  
 [ - **indicates** not applicable; -- indicates no data available]

Date	Secchi Disk			Sampling Depth (feet)	Total Phosphorus			Chlorophyll a		Dissolved Ortho- phosphate Phosphorus Conc. (mg/L)
	Depth (meters)	Depth (feet)	T.S.I.		Conc. (mg/L)	Conc. (µg/L)	T.S.I.	Conc. (µg/L)	T.S.I.	
04107194	1.7	<b>5.6</b>	<b>52</b>	1.5	0.009	9	45	6.37	49	<0.002
				<b>4</b>	0.009	9				<0.002
06120194	<b>1.2</b>	<b>3.9</b>	57	1.5	0.012	<b>12</b>	47	<b>4.34</b>	<b>46</b>	--
				7.5	0.030	30				--
07118/94	1.1	<b>3.6</b>	<b>59</b>	1.5	0.019	<b>19</b>	51	10.2	<b>52</b>	--
				7.5	0.021	21				--
08110/94	1.4	<b>4.6</b>	55	1.5	0.017	17	50	9.74	<b>52</b>	--
				<b>7.5</b>	0.018	18				--



**EXPLANATION**

Lake water-quality sampling site

Staff gage

Figure 1. Location of sampling site and staff gage on Eagle Spring Lake near Eagleville, Wisconsin



425103068261500 EAGLE SPRING LAKE AT EAGLEVILLE, WI

LOCATION.--Lat 42°51'03" Long 88°26'15", in SE 1/4 NW 1/4 sec.36, T.5 N., R.17 E., Waukesha County, Hydrologic Unit 07120006, at Eagleville.

DRAINAGE AREA.--33.2 mi.<sup>2</sup>

PERIOD OF RECORD.--Apr:1 1991 to current year

REMARKS.--Lake sampled near southeast end of lake at a lake depth of about 8 ft Lake ice-covered during March sampling. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MARCH 01 TO AUGUST 10, 1994  
(Milligrams per liter unless otherwise indicated)

	Mar. 01		Apr. 07		June 20		July 18		Aug. 10	
Depth of sample (ft)	1.0	5.0	1.5	4.0	1.5	7.5	1.5	7.5	1.5	7.5
Lake stage (ft)	9.36		9.56		9.52		9.53		9.56	
Specific conductance (µS/cm)	565	623	442	442	465	467	419	417	428	427
pH (units)	7.6	7.6	8.0	8.9	7.9	8.0	8.3	8.3	8.4	8.3
Water temperature (°C)	1.0	3.5	8.0	7.5	29.5	29.5	27.5	25.5	22.0	22.0
Color (Pt-Co. scale)	---	---	10	16	---	---	---	---	---	---
Turbidity (NTU)	---	---	1.3	1.2	---	---	---	---	---	---
Secchi-depth (meters)	---	---	1.7	---	1.2	---	1.1	---	1.4	---
Dissolved oxygen	10.6	7.7	13.4	13.6	7.8	8.6	10.9	10.1	8.7	8.6
Hardness, as CaCO <sub>3</sub>	---	---	230	230	---	---	---	---	---	---
Calcium, dissolved (Ca)	---	---	51	51	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	26	28	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	5.0	5.0	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	1	1	---	---	---	---	---	---
Alkalinity, as CaCO <sub>3</sub>	---	---	210	210	---	---	---	---	---	---
Sulfate, dissolved (SO <sub>4</sub> )	---	---	15	15	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	12	12	---	---	---	---	---	---
Fluoride, dissolved (F)	---	---	0.1	0.1	---	---	---	---	---	---
Silica, dissolved (SiO <sub>2</sub> )	---	---	5.0	4.9	---	---	---	---	---	---
Solids dissolved, at 180°C	---	---	248	252	---	---	---	---	---	---
Nitrogen, NO <sub>2</sub> + NO <sub>3</sub> , diss. (as N)	---	---	1.1	1.1	---	---	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	<0.00	<0.00	---	---	---	---	---	---
Nitrogen, amm + org., total (as N)	---	---	0.30	0.40	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	1.4	1.5	---	---	---	---	---	---
Phosphorus, total (as P)	---	---	0.009	0.009	0.012	0.030	0.019	0.021	0.017	0.018
Phosphorus, ortho, dissolved (as P)	---	---	<0.002	<0.002	---	---	---	---	---	---
Iron, dissolved (Fe) µg/L	---	---	<50	<50	---	---	---	---	---	---
Manganese, dissolved (Mn) µg/L	---	---	<40	<40	---	---	---	---	---	---
Chlorophyll a, phytoplankton (µg/L)	---	---	6.4	---	4.3	---	10	---	9.7	---

3-1-94

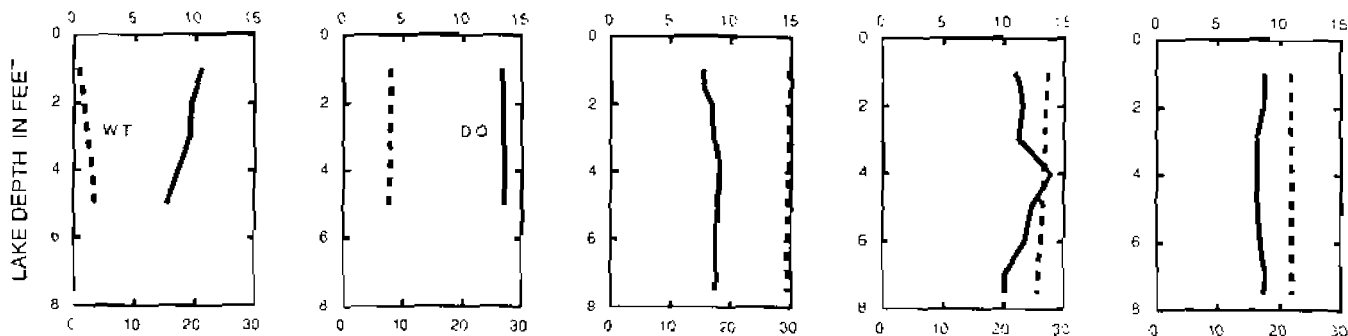
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6-20-94

7-18-94

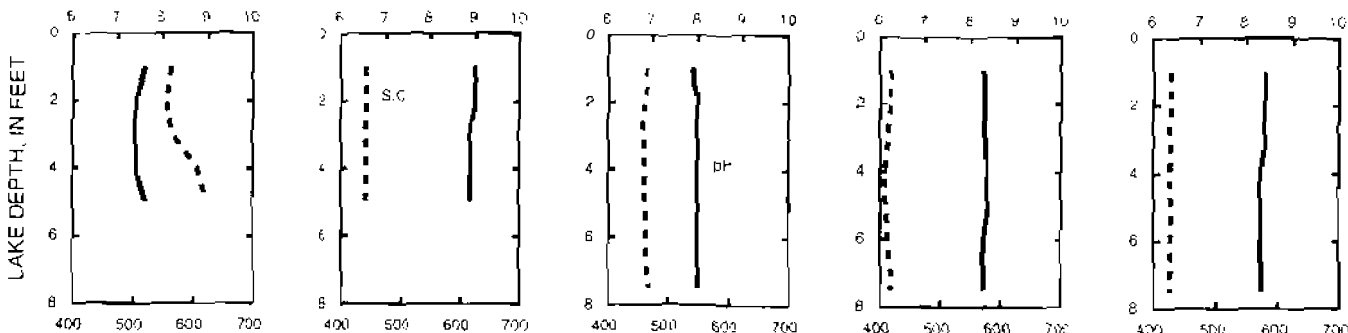
8-10-94

DISSOLVED OXYGEN (D.O.), IN MILLIGRAMS PER LITER



WATER TEMPERATURE (WT.), IN DEGREES CELSIUS

pH, IN STANDARD UNITS



SPECIFIC CONDUCTANCE (S.C.) IN MICROSIEMENS PER CENTIMETER AT 25 DEGREES CELSIUS

Figure 2. Lake water-quality data for Eagle Spring Lake at Eagleville, Wisconsin 1994 water year

TROPHIC STATE INDICES  
 EAGLE SPRING LAKE AT EAGLEVILLE, WI.  
 WAUKESHA COUNTY

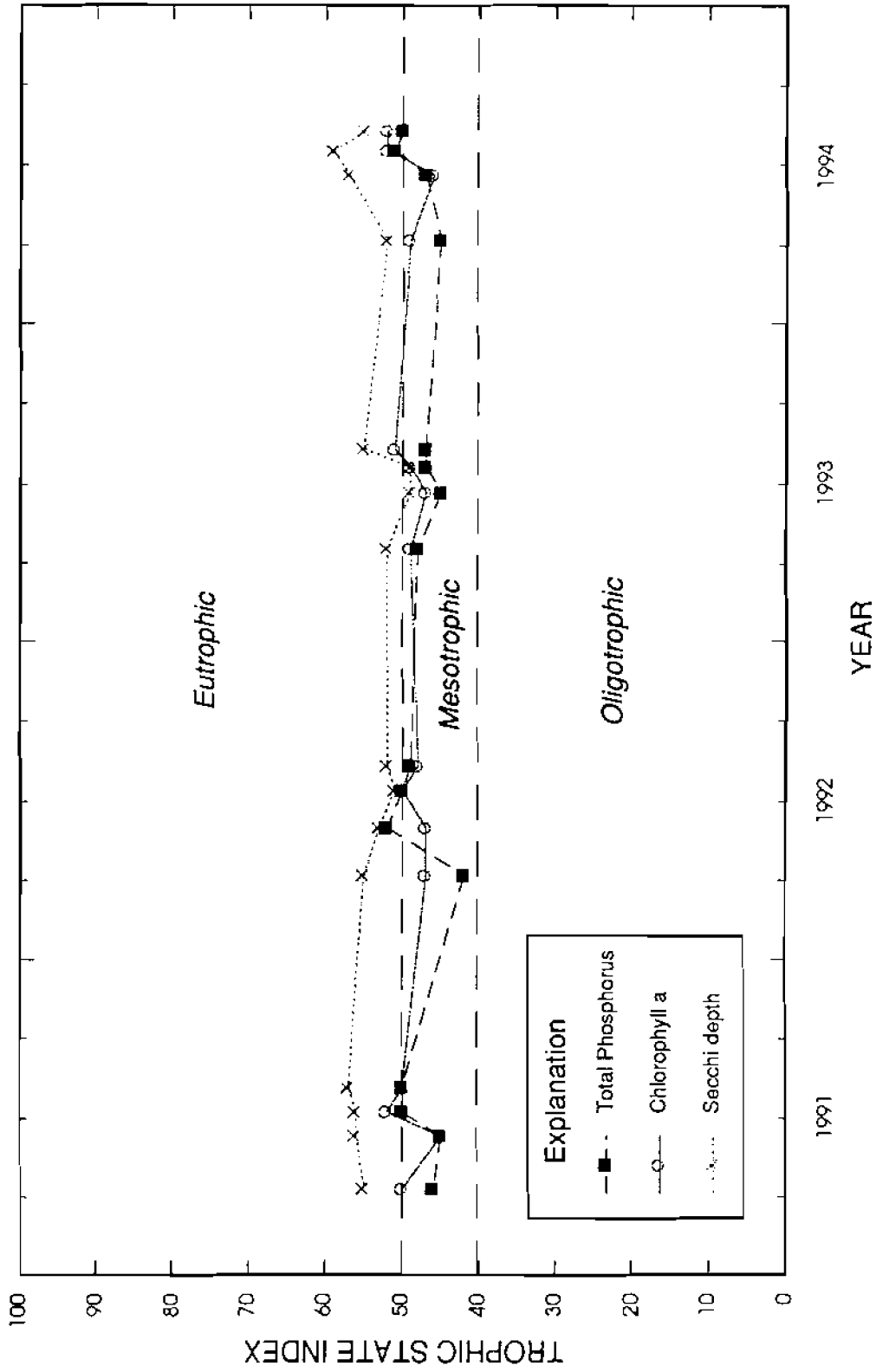


Figure 3. Trophic state indices for Eagle Spring Lake at Eagleville, Wisconsin

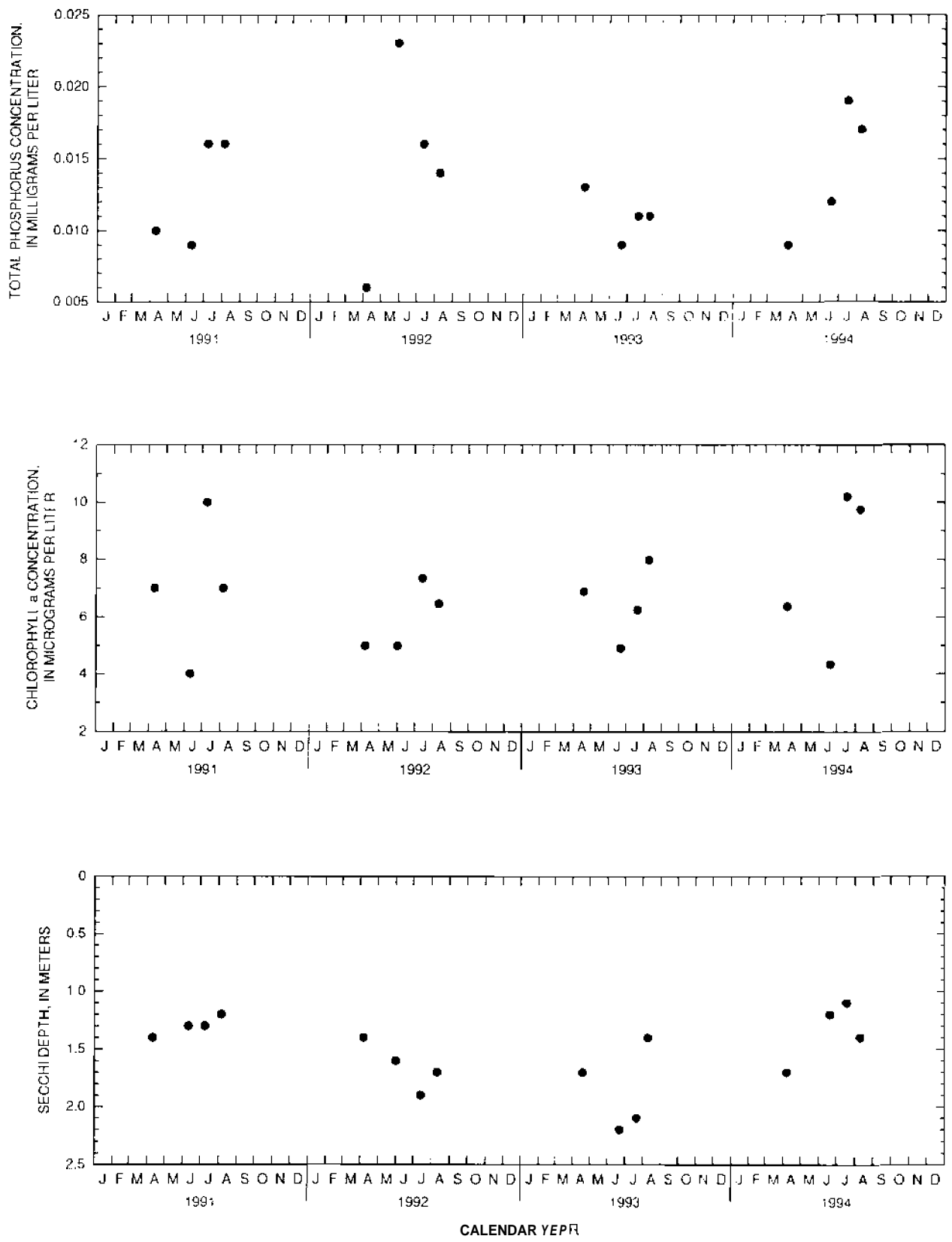


Figure 4.-- Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Eagle Spring Lake at Eagleville, Wisconsin.