LPL-030

United States Department of the Interior

GEOLOGICAL SURVEY

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

June 16, 1993

Chairperson
Alma-Moon Lake Protection and
Rehabilitation District
P.O. Box 145
St. Germain, Wisconsin 54558

Dear Chairperson:

This letter describes the progress on the evaluation of the water quality of Alma Lake according to the data collected from October 1991 to September 1992 as stated in our agreement. Please read the enclosure, "U.S. Geological Survey Lake Monitoring Program in Wisconsin", before proceeding with this letter.

In a brief summary, based on the 1992 data:

- The water quality of Alma Lake is good to very good and can be classified as a mesotrophic lake or one with moderate nutrients.
- Alma Lake is not susceptible to the effects of acid rain because of the buffering capacity of the lake water. During open water, the lake's pH is generally slightly acidic.
- Algal growth appears to be dependent upon the amount of available phosphorus rather than nitrogen.
- The lake does not thermally stratify during summer.
- The data enclosed herein are provisional until published.

Alma Lake has a surface area of 55 acres (0.086 square miles). One site was sampled in Alma Lake. It was located approximately at the deepest spot in the lake at a depth of about 18 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 Alma Lake near St. Germain, Wisconsin, 1992 water year

Table 2. Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Alma Lake near St. Germain, Wisconsin, 1992 water year

Table 3. Lake stages for Alma Lake, 1992 water year

Figure 1. Location of sampling site and staff gage for Alma Lake near St. Germain, Wisconsin

Figure 2. Lake water-quality data for Alma Lake near St. Germain, Wisconsin, 1992 water year

Figure 3. Trophic state indices for Alma Lake near St. Germain, Wisconsin

All the water-quality samples collected were analyzed by the Wisconsin State Laboratory of Hygiene at Madison, Wisconsin. The water-quality data is published in our annual publication, "Water Resources Data for Wisconsin, 1992".

LAKE-STAGE FLUCTUATIONS

Lake stages were read by John Seibel. Lake-stage data are listed in table 3. Lake stages fluctuated 0.50 feet and ranged from 10.88 feet on September 11 to 11.38 feet on May 18.

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. Among our sampling dates, complete water-column mixing was observed on June 22. The remainder of the profile data show incomplete mixing. The lake does not thermally stratify during summer. The levels of pH are within acceptable levels to support aquatic life. The lake water during non-ice periods was generally slightly acidic, with pH ranging from 5.9 to 7.0.

SELECTED ANALYSES

Analyses of selected constituents for May 12 for samples collected at 1.5 and 17-foot depths are listed in figure 2. The water-quality values for color, chlorophyll a, calcium, 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 May 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 approximately 46:1 and suggests the lake is phosphorus-limited. This means algal growth appears to be dependent on the amount of available phosphorus rather than nitrogen.

Alma Lake is not susceptible to the effects of acid rain because of the buffering capacity of the lake water. Lakes with alkalinity concentrations greater than 2 mg/L are not considered sensitive to acid deposition (Garrison and others, 1987, North American Lake Management Society, Lake and Reservoir Management, 1987, vol. III, pgs 356-364). Alma Lake's alkalinity averaged 6 mg/L as calcium carbonate on May 12, 1993.

MAY, 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 0.007 mg/L in May to 0.012 mg/L in July and August. All values fall within the regional values previously referenced.

Concentration of total phosphorus 1.5 feet above the lake bottom ranged from 0.013 mg/L in August to 0.019 mg/L in July.

Chlorophyll a: Chlorophyll a concentrations, which indicate algal biomass, ranged from 3.6 µg/L in July and June to 4.5 µg/L in August. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 8.5 feet in June to 10.5 feet in August. 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 a 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) 1992 data shown in table 2 for Alma Lake, chlorophyll a concentrations and Secchi-disc depths indicate very good water quality, while surface total phosphorus concentrations indicate good water quality.

Using the data from "Limnological Characteristics of Wisconsin Lakes," 1983, by Lillie and Mason, a comparison of the 1992 mean summer data (July and August) for total phosphorus, chlorophyll a, and Secchi depths for Alma Lake to other lakes in northeast Wisconsin are shown below:

	Parameter	Percentage of distribution of lakes in northeast Wisconsin within these concentrations	
	Total phosphorus (mg/L)		
Alma Lake values →	<.010	Best condition	22
	.010-.020		41
	.020-.030		21
	.030-.050		12
	>.050	Worst condition	5
	Chlorophyll a (µg/L)		
Alma Lake values →	0- 5	Best condition	34
	5-10		38
	10-15		11
	15-30		11
	>30	Worst condition	5
	Secchi depth (in feet)		
	>19.7	Best condition	4
Alma Lake values →	9.8-19.7		32
	6.6- 9.8		22
	3.3- 6.6		26
	<3.3	Worst condition	16

Comparing other lakes in northeast Wisconsin to the 1992 data for Alma Lake, the above data show, during the period 1966 to 1979, 38 percent had higher total phosphorous concentrations, 65 percent had higher chlorophyll a concentrations, and 64 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 Alma Lake is shown on figure 3. The data from 1992 show Alma Lake to be mesotrophic or one with moderate nutrients.

The data that has been collected for Alma Lake from 1992 is extremely important for understanding the lake's water quality and managing the lake. To continue with the monitoring 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,

Stephen J. Field
Biologist

Enclosures

cc: Bob Young, DNR, Rhinelander

Table 1. Lake-depth profiles for Alma Lake near St. Germain, Wisconsin, 1992 water year

DATE	SAMPLING DEPTH (FEET) (00003)	TEMPERATURE WATER (DEG C) (00010)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STANDARD UNITS) (00400)	OXYGEN, DISSOLVED (MG/L) (00300)
FEB 1992					
20...	3.00	1.5	31	7.1	9.3
20...	5.00	3.0	30	6.9	4.9
20...	7.00	3.5	29	6.9	4.9
20...	9.00	4.0	29	6.8	4.8
20...	11.0	4.0	29	6.8	4.8
20...	13.0	4.0	29	6.8	4.8
20...	15.0	4.0	29	6.7	4.8
20...	17.0	4.0	29	6.7	4.8
20...	18.0	--	--	--	--
MAY					
12...	2.00	16.5	22	6.6	10.4
12...	4.00	16.5	22	6.7	10.4
12...	6.00	16.5	23	6.7	10.4
12...	8.00	15.5	23	6.7	10.7
12...	10.0	13.0	24	6.9	11.6
12...	12.0	12.0	24	6.9	11.7
12...	14.0	11.5	25	6.9	11.7
12...	16.0	11.0	24	7.0	11.3
12...	18.0	10.5	24	6.9	9.7
12...	18.5	10.0	26	6.8	8.5
JUN					
22...	1.50	18.5	23	6.1	9.2
22...	3.00	18.5	24	6.2	9.2
22...	5.00	18.5	24	6.3	9.2
22...	7.00	18.5	24	6.3	9.2
22...	9.00	18.5	24	6.3	9.2
22...	11.0	18.5	24	6.3	9.1
22...	13.0	18.0	25	6.4	9.1
22...	15.0	18.0	25	6.4	9.0
22...	16.0	18.0	25	6.4	9.0
22...	17.5	18.0	26	6.5	8.9
JUL					
22...	1.50	19.5	23	6.8	8.9
22...	3.00	20.0	23	6.8	8.9
22...	5.00	20.0	23	6.9	8.9
22...	7.00	20.0	23	7.0	8.9
22...	9.00	20.0	23	7.0	8.9
22...	11.0	20.0	23	7.0	8.8
22...	13.0	19.5	24	7.0	8.4
22...	15.0	19.0	24	7.0	7.2
22...	17.0	18.5	25	6.8	4.2
22...	18.5	18.0	27	6.6	2.1
AUG					
25...	1.50	21.5	24	5.9	8.2
25...	4.00	21.5	24	6.1	8.2
25...	6.00	21.5	24	6.2	8.2
25...	8.00	21.5	25	6.2	8.2
25...	10.0	21.5	25	6.3	8.2
25...	12.0	21.5	25	6.3	8.2
25...	14.0	21.0	26	6.3	7.8
25...	16.0	21.0	26	6.2	7.0
25...	17.0	21.0	28	5.9	5.2
25...	18.5	--	--	--	--

Table 2.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI), 1992 water year for Alma Lake

[- indicates not applicable; -- indicates no data available]

Date	Secchi Disk			Sampling	Total Phosphorus			Chlorophyll a		Dissolved Ortho-phosphate Phosphorus
	Depth (meters)	Depth (feet)	T.S.I.	Depth (feet)	Conc. (mg/L)	Conc. (µg/L)	T.S.I	Conc. (µg/L)	T.S.I.	Conc. (mg/L)
5/12/92	3.0	9.8	44	1.5	0.007	7	43	4	45	<0.002
	-	-	-	17	0.015	15	-	-	-	<0.002
6/22/92	2.6	8.5	46	1.5	0.011	11	47	4	45	--
	-	-	-	16	0.014	14	-	-	-	--
7/22/92	2.8	9.2	45	1.5	0.012	12	47	3.6	44	--
	-	-	-	17	0.019	19	-	-	-	--
8/25/92	3.2	10.5	43	1.5	0.012	12	47	4.5	46	--
	-	-	-	17	0.013	13	-	-	-	--

Table 3. Lake stages for Alma Lake, 1992 water year

WISCONSIN RIVER BASIN

455426089254700 ALMA LAKE NEAR ST. GERMAIN, WI

LOCATION.--Lat 45°54'26", long 89°25'47", in NE 1/4 sec.36, T.40 N., R.8 E., Vilas County, Hydrologic Unit 07070001, 3 mi east of St. Germain.

LAKE-STAGE RECORDS

PERIOD OF RECORD.--October 1984 to September 1990, May to September 1992.

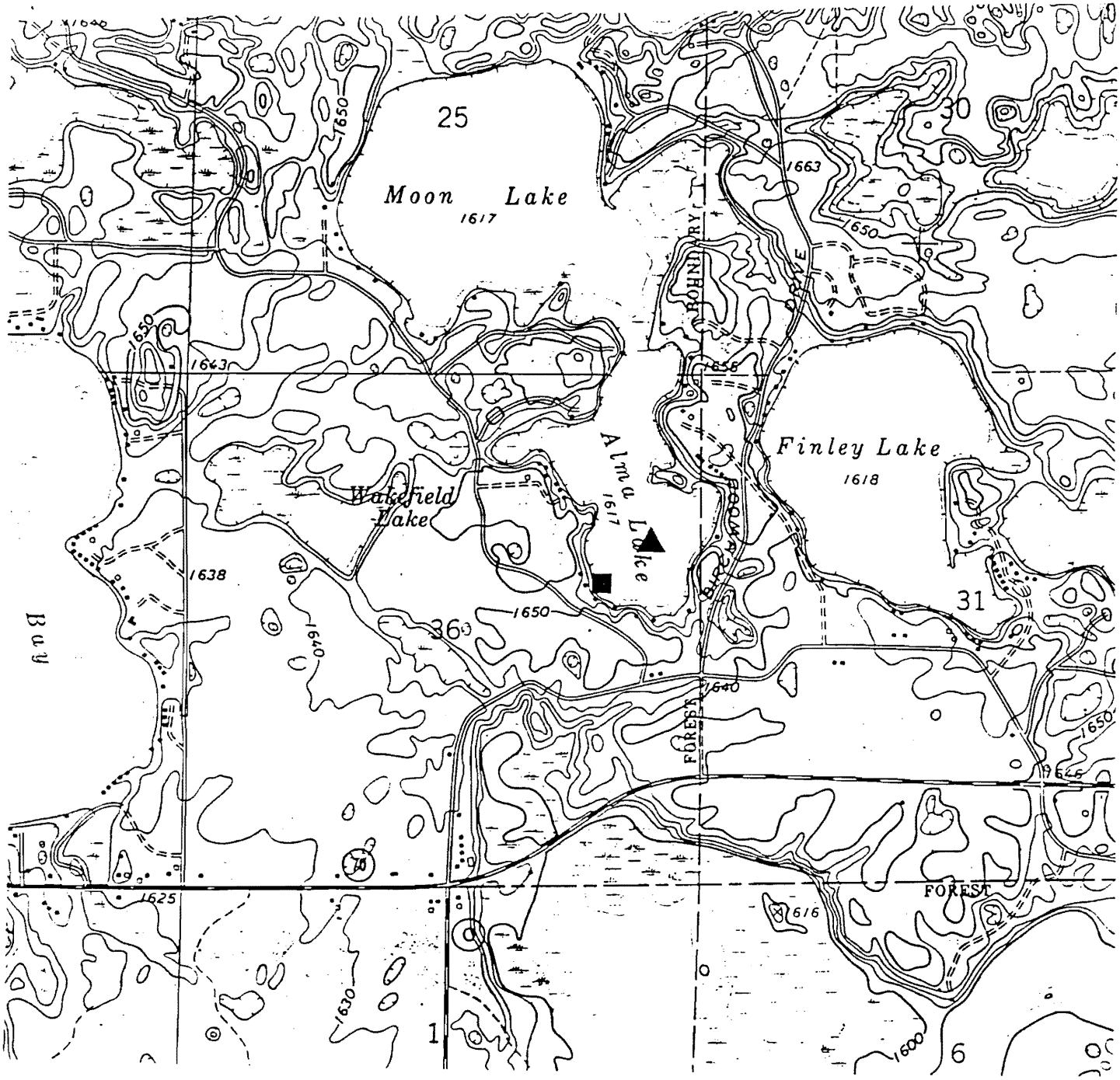
GAGE.--Staff gage read by John P. Seibel. Elevation of gage is 1,617 ft, from topographic map.

EXTREMES FOR PERIOD OF RECORD.--Maximum gage height observer, 12.35 ft, Apr. 11, 12, 1986; minimum observed, 8.98 ft, Oct. 26, 27, 1989.

EXTREMES FOR CURRENT YEAR.--Maximum gage height observed, 11.38 ft, May 18; minimum observed, 10.88 ft, Sept. 11.

GAGE HEIGHT, FEET, WATER YEAR OCTOBER 1991 TO SEPTEMBER 1992
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	---	---	---	---	---	---	---	11.28	---	---	---
2	---	---	---	---	---	---	---	---	---	---	---	---
3	---	---	---	---	---	---	---	---	---	11.22	---	---
4	---	---	---	---	---	---	---	---	---	---	---	10.90
5	---	---	---	---	---	---	---	---	---	---	11.02	---
6	---	---	---	---	---	---	---	---	---	---	---	---
7	---	---	---	---	---	---	---	---	---	---	---	---
8	---	---	---	---	---	---	---	---	---	---	---	---
9	---	---	---	---	---	---	---	---	11.22	---	---	---
10	---	---	---	---	---	---	---	---	---	---	---	---
11	---	---	---	---	---	---	---	---	---	---	---	10.88
12	---	---	---	---	---	---	---	11.18	---	---	---	---
13	---	---	---	---	---	---	---	---	---	---	10.98	---
14	---	---	---	---	---	---	---	---	---	---	---	---
15	---	---	---	---	---	---	---	---	---	11.22	---	---
16	---	---	---	---	---	---	---	---	---	---	---	---
17	---	---	---	---	---	---	---	---	11.12	---	---	11.04
18	---	---	---	---	---	---	---	11.38	---	---	---	---
19	---	---	---	---	---	---	---	---	---	---	---	---
20	---	---	---	---	---	---	---	---	---	---	---	---
21	---	---	---	---	---	---	---	---	---	11.22	---	---
22	---	---	---	---	---	---	---	---	11.11	11.22	---	---
23	---	---	---	---	---	---	---	---	---	---	---	---
24	---	---	---	---	---	---	---	---	11.19	---	---	10.96
25	---	---	---	---	---	---	---	---	---	---	10.92	---
26	---	---	---	---	---	---	---	11.36	---	---	---	---
27	---	---	---	---	---	---	---	---	---	---	---	---
28	---	---	---	---	---	---	---	---	---	---	10.89	---
29	---	---	---	---	---	---	---	---	---	---	---	---
30	---	---	---	---	---	---	---	---	11.12	---	---	10.98
31	---	---	---	---	---	---	---	---	---	---	---	---



EXPLANATION

▲ Water-quality sampling site

■ Lake-staff gage

Figure 1. Location of sampling site and staff gage for Alma Lake near St. Germain, Wisconsin

455426089254700 ALMA LAKE NEAR ST. GERMAIN, WI--CONTINUED

WATER-QUALITY RECORDS

PERIOD OF RECORD.--October 1984 to September 1990 secchi depth only; February to August 1992.

REMARKS.--Lake sampled near center of southern lobe of lake at deep hole. Lake ice-covered during February sampling. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, FEBRUARY 20 TO AUGUST 25, 1992
(Milligrams per litr unless otherwise indicated)

	Feb. 20		May 12		June 22		July 22		Aug. 25	
Depth of sample (ft)	3.0	17	1.5	17	1.5	16	1.5	17	1.5	17
Lake stage (ft)	---		11.18		11.11		11.22		10.92	
Specific conductance (µS/cm)	31	29	22	24	23	25	23	25	24	28
pH (units)	7.1	6.7	6.6	6.9	6.1	6.4	6.8	6.8	5.9	5.9
Water temperature (°C)	1.5	4.0	16.5	10.5	18.5	18.0	19.5	18.5	21.5	21.0
Color (Pt-Co. scale)	---	---	5	5	---	---	---	---	---	---
Turbidity (NTU)	---	---	0.70	1.3	---	---	---	---	---	---
Secchi-depth (meters)	---		3.0		2.6		2.8		3.2	
Dissolved oxygen	9.3	4.8	10.4	9.7	9.2	9.0	8.9	4.2	8.2	5.2
Calcium, dissolved (Ca)	---	---	1.8	1.5	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	<1.0	<1.0	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	<1.0	<1.0	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	0.4	0.4	---	---	---	---	---	---
Alkalinity, as CaCO3	---	---	6	6	---	---	---	---	---	---
Sulfate, dissolved (SO4)	---	---	<5.0	<5.0	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	<1.0	<1.0	---	---	---	---	---	---
Fluoride, dissolved (F)	---	---	<0.0	<0.0	---	---	---	---	---	---
Silica, dissolved (SiO2)	---	---	<0.2	<0.2	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	<10	60	---	---	---	---	---	---
Nitrogen, NO2 + NO3, diss. (as N)	---	---	0.02	0.02	---	---	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	<0.00	0.01	---	---	---	---	---	---
Nitrogen, amm. + org., total (as N)	---	---	0.30	0.40	---	---	---	---	---	---
Phosphorus, total (as P)	---	---	0.007	0.015	0.011	0.014	0.012	0.019	0.012	0.013
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)	---	---	4.0	---	4.0	---	3.6	---	4.5	---

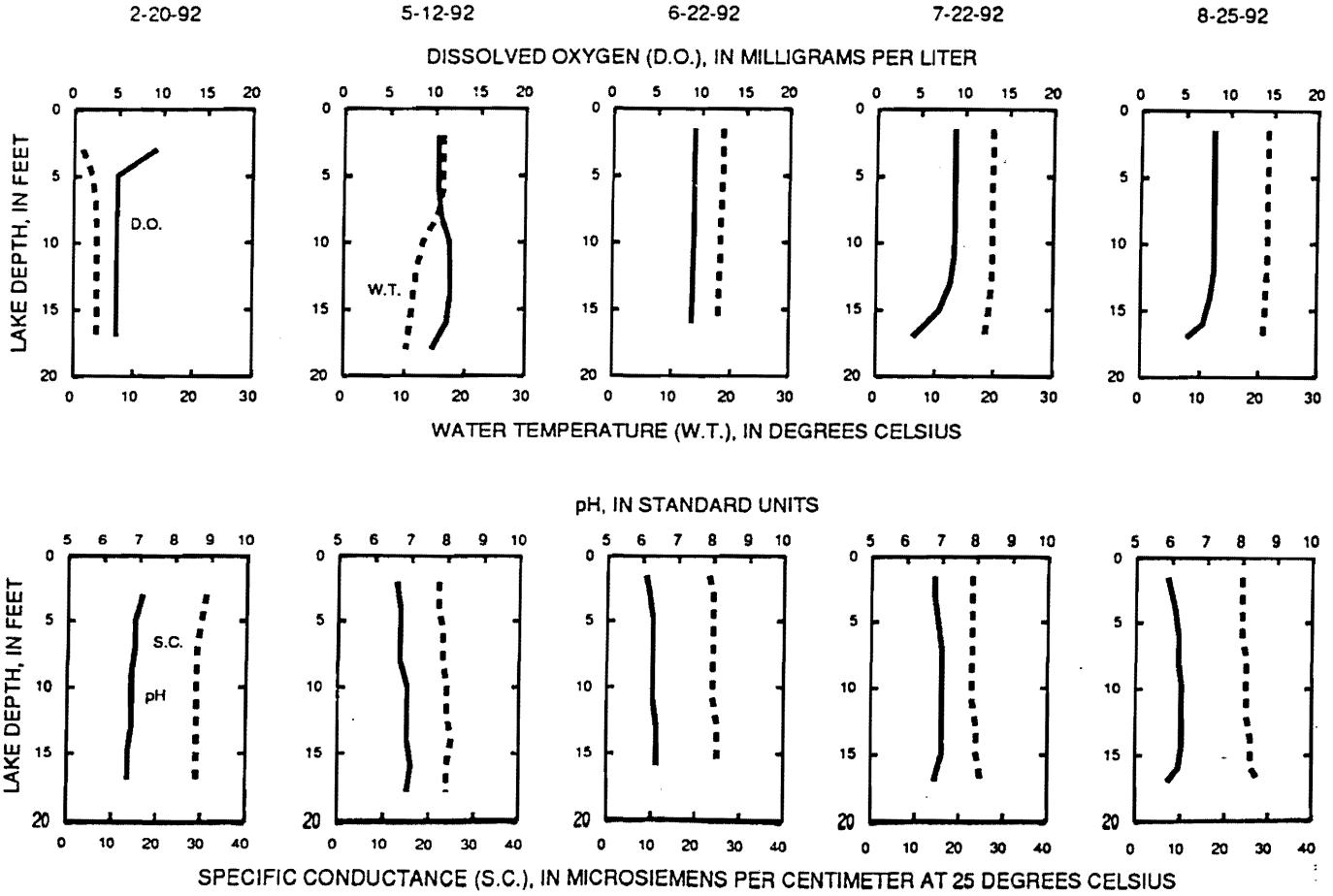


Figure 2. Lake water-quality data for Alma Lake near St. Germain, Wisconsin, 1992 water year

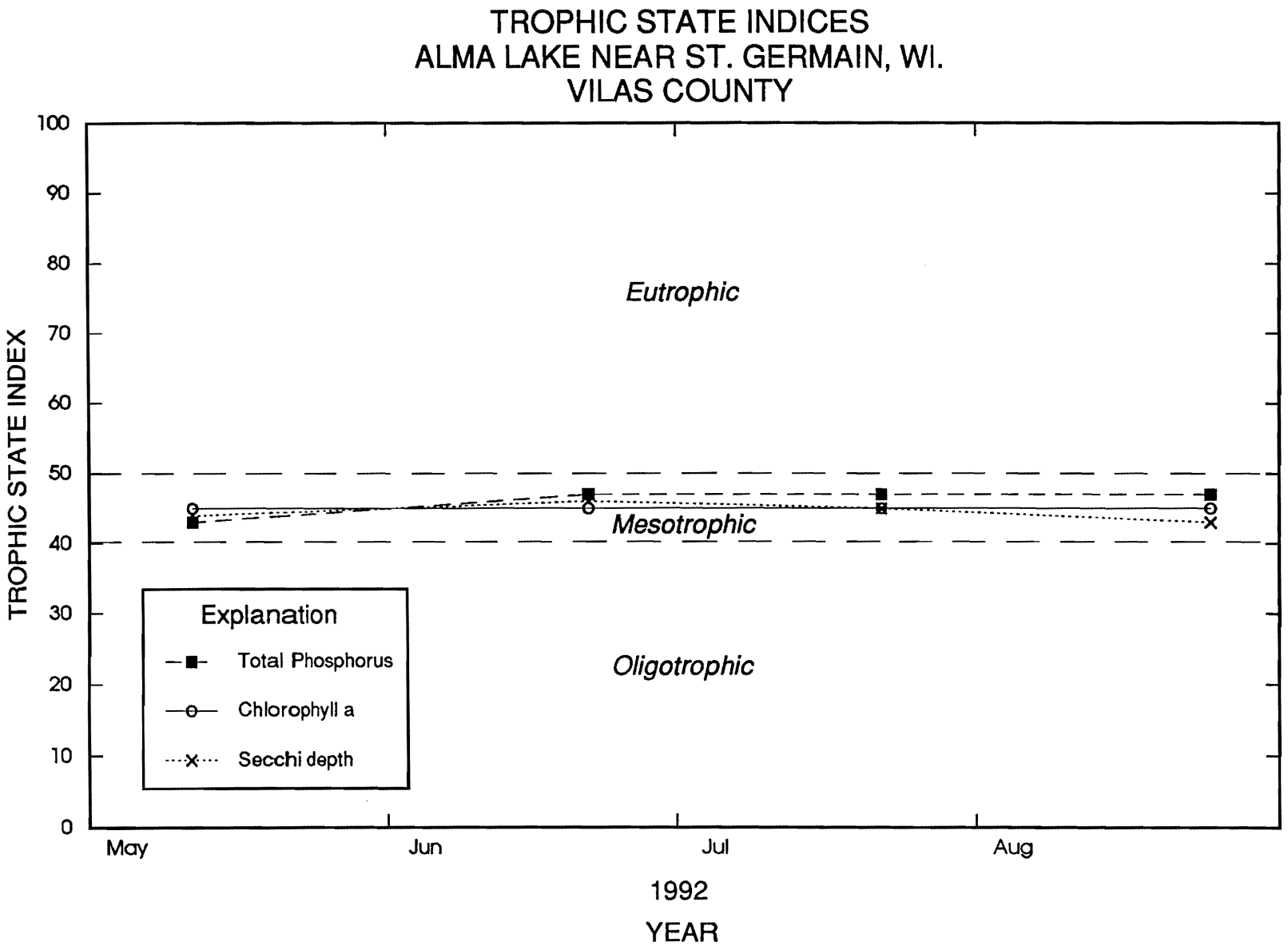


Figure 3. Trophic state indices for Alma Lake near St. Germain, Wisconsin

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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 19, 1995

Ms. Mary Platner
Alma-Moon Lake Protection and
Rehabilitation District
N61 W29911 Rybeck Road
Hartland, Wisconsin 53029

Dear Ms. Platner:

This letter describes the progress on the evaluation of the water quality of Alma 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 Alma Lake is good to very good and can be classified as a lower mesotrophic lake or one with low to moderate nutrients.
- Alma Lake is not susceptible to the effects of acid rain because of the buffering capacity of the lake water. During open water periods, the lake's pH is generally slightly acidic.
- Surface total phosphorus and chlorophyll a concentrations in 1994 are similar to values in 1992 and 1993. Water clarity has increased slightly.
- Algal growth appears to be dependent upon the amount of available phosphorus rather than nitrogen.
- The lake does not thermally stratify during summer.
- The data enclosed herein are provisional until published.

Alma Lake has a surface area of 55 acres (0.086 square miles). One site was sampled in Alma Lake. It was located approximately at the deepest spot in the lake at a depth of about 19 feet and is shown in figure 1.

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

Table 1. Lake stages for Alma Lake, 1994 water year

Table 2. Lake-depth profiles for Alma Lake near St. Germain, Wisconsin, 1994 water year

Table 3. Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Alma Lake, 1994 water year

APRIL, JUNE, JULY AND AUGUST WATER QUALITY

The data for total phosphorus, chlorophyll a, and Secchi-depth readings, are listed in table 3 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 0.013 mg/L in July. All values fall within the regional values previously referenced.

Concentration of total phosphorus 1.5 feet above the lake bottom ranged from 0.010 mg/L in June to 0.020 mg/L in July.

Chlorophyll a: Chlorophyll a concentrations, which indicate algal biomass, ranged from 1.39 µg/L in August to 3.53 µg/L in July. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 13.0 feet in June to 14.4 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 a equivalent (µg/L)	Approximate water clarity equivalent (Secchi-disc depth in ft)
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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 3 for Alma Lake, surface total phosphorus concentrations indicate good water quality, while chlorophyll a concentrations and Secchi-disc depths indicate very good 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 Alma Lake to other lakes in northeast Wisconsin are shown below:

The data that has been collected for Alma Lake from 1992-1994 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,

Stephen J. Field
Biologist

Enclosures

cc: Bob Young, DNR, Rhinelander

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455426089254700 ALMA LAKE NEAR ST. GERMAIN, WI

LOCATION.--Lat 45°54'26", long 89°25'47", in NE 1/4 sec.36, T.40 N., R.8 E., Vilas County, Hydrologic Unit 07070001, 3 mi east of St. Germain.

LAKE-STAGE RECORDS

PERIOD OF RECORD.--October 1984 to September 1990, May 1992 to current year.

GAGE.--Staff gage read by John P. Seibel. Elevation of gage is 1,617 ft above sea level, from topographic map.

EXTREMES FOR PERIOD OF RECORD.--Maximum gage height observer, 12.35 ft, Apr. 11, 12, 1986; minimum observed, 8.98 ft, Oct. 26, 27, 1989.

EXTREMES FOR CURRENT YEAR.--Maximum gage height observed, 12.21 ft, July 21; minimum observed, 10.53 ft, Sept. 10.

GAGE HEIGHT, FEET, WATER YEAR OCTOBER 1993 TO SEPTEMBER 1994
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	---	---	---	---	---	---	---	---	---	---	---
2	---	---	---	---	---	---	---	---	---	10.87	---	---
3	---	---	---	---	---	---	---	---	---	---	---	---
4	---	---	---	---	---	---	---	---	---	---	---	---
5	---	---	---	---	---	---	---	---	---	---	---	---
6	---	---	---	---	---	---	---	---	---	---	---	---
7	---	---	---	---	---	---	---	---	---	---	10.81	---
8	---	---	---	---	---	---	---	---	---	---	---	---
9	---	---	---	---	---	---	---	---	---	---	---	---
10	---	---	---	---	---	---	---	11.09	---	11.04	---	10.53
11	---	---	---	---	---	---	---	---	---	---	---	---
12	---	---	---	---	---	---	---	---	---	---	---	---
13	---	---	---	---	---	---	---	---	---	---	---	---
14	---	---	---	---	---	---	---	---	---	---	---	---
15	---	---	---	---	---	---	---	---	11.01	---	---	---
16	---	---	---	---	---	---	---	---	---	---	10.71	---
17	---	---	---	---	---	---	---	---	---	---	---	---
18	---	---	---	---	---	---	---	---	---	10.97	---	---
19	---	---	---	---	---	---	---	---	---	---	---	---
20	---	---	---	---	---	---	---	---	---	11.01	---	---
21	---	---	---	---	---	---	---	---	---	12.21	10.69	---
22	---	---	---	---	---	---	---	---	---	---	---	---
23	---	---	---	---	---	---	---	---	---	---	---	---
24	---	---	---	---	11.17	---	---	---	---	---	---	---
25	---	---	---	---	---	---	---	---	10.97	---	---	---
26	---	---	---	---	---	---	---	---	---	---	10.64	---
27	---	---	---	---	---	---	11.15	---	---	---	---	---
28	---	---	---	---	---	---	---	10.93	---	---	---	---
29	---	---	---	---	---	---	---	---	---	11.74	---	---
30	---	---	---	---	---	---	---	---	---	---	---	---
31	---	---	---	---	---	---	---	---	---	---	---	---

Table 2. Lake-depth profiles for Alma Lake near St. Germain, Wisconsin, 1994 water year

455426089254700 - ALMA LAKE NEAR ST. GERMAIN, WI

WATER-QUALITY DATA

DATE	SAMPLING DEPTH (FEET) (00003)	TEMPERATURE WATER (DEG C) (00010)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STANDARD UNITS) (00400)	OXYGEN, DISSOLVED (MG/L) (00300)
FEB 1994					
24...	3.00	3.5	19	7.4	4.7
24...	5.00	4.0	19	7.1	4.5
24...	7.00	4.0	19	7.0	4.4
24...	9.00	4.0	19	6.9	4.4
24...	11.0	4.0	19	6.8	4.3
24...	13.0	4.0	19	6.8	4.3
24...	15.0	4.0	20	6.7	4.3
24...	17.0	4.0	20	6.7	4.3
24...	18.0	--	--	--	--
APR					
27...	1.50	9.0	11	6.3	10.0
27...	3.00	9.0	11	6.3	10.0
27...	5.00	9.0	11	6.3	10.0
27...	7.00	9.0	10	6.3	10.0
27...	9.00	9.0	10	6.3	10.0
27...	11.0	9.0	10	6.3	10.0
27...	13.0	9.0	10	6.2	10.0
27...	15.0	8.5	10	6.3	9.9
27...	17.0	8.5	10	6.2	9.4
27...	18.0	8.0	10	6.2	8.5
27...	19.5	--	--	--	--
JUN					
15...	1.50	22.0	12	5.6	8.7
15...	3.00	22.0	12	5.6	8.7
15...	5.00	21.5	12	5.6	8.8
15...	7.00	21.5	11	5.6	8.7
15...	9.00	21.0	11	5.6	8.8
15...	11.0	21.0	11	5.7	8.9
15...	13.0	20.5	11	5.7	8.8
15...	15.0	20.0	10	5.6	8.8
15...	17.5	19.5	11	5.1	5.0
15...	19.0	--	--	--	--
JUL					
20...	1.50	23.0	24	6.8	8.3
20...	3.00	23.0	24	6.7	8.3
20...	5.00	23.0	24	6.7	8.4
20...	7.00	23.0	23	6.6	8.4
20...	9.00	23.0	23	6.6	8.4
20...	11.0	22.5	23	6.6	8.2
20...	13.0	22.5	24	6.6	8.4
20...	15.0	22.0	23	6.5	8.2
20...	17.0	22.0	24	6.1	6.6
20...	18.5	--	--	--	--
AUG					
16...	1.50	20.5	25	6.1	8.6
16...	3.00	20.5	24	6.0	8.5
16...	5.00	20.5	24	6.0	8.4
16...	7.00	20.0	23	6.1	8.4
16...	9.00	20.0	23	6.1	8.4
16...	11.0	20.0	23	6.1	8.4
16...	13.0	20.0	23	6.1	8.4
16...	15.0	19.5	24	6.0	8.1
16...	16.5	19.5	25	6.0	8.0
16...	18.0	--	--	--	--

Table 3.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Alma Lake, 1994 water year

[- indicates not applicable; -- indicates no data available]

Date	Secchi Disk			Sampling	Total Phosphorus			Chlorophyll a		Dissolved Ortho-phosphate Phosphorus
	Depth (meters)	Depth (feet)	T.S.I.	Depth (feet)	Conc. (mg/L)	Conc. (µg/L)	T.S.I	Conc. (µg/L)	T.S.I.	Conc. (mg/L)
04/27/94	4.4	14.4	39	1.5	0.009	9	45	2.52	42	<0.002
	-	-	-	18	0.011	11	-	-	-	<0.002
06/15/94	4.0	13.0	40	1.5	0.010	10	46	2.55	42	--
	-	-	-	17	0.010	10	-	-	-	--
07/20/94	4.1	13.5	40	1.5	0.013	13	48	3.53	44	--
	-	-	-	17	0.020	20	-	-	-	--
08/16/94	4.4	14.3	39	1.5	0.012	12	47	1.39	37	--
	-	-	-	16	0.015	15	-	-	-	--

WATER-QUALITY RECORDS

PERIOD OF RECORD.--October 1984 to September 1990 secchi depth only; February 1992 to current year.

REMARKS.--Lake sampled near center of southern lobe of lake at deep hole. Lake ice-covered during February sampling. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, FEBRUARY 27 TO AUGUST 16, 1994
(Milligrams per liter unless otherwise indicated)

	Feb. 24		Apr. 27		June 15		July 20		Aug. 16	
Depth of sample (ft)	3.0	17	1.5	18	1.5	17	1.5	17	1.5	16
Lake stage (ft)	11.17		11.15		11.01		11.01		10.71	
Specific conductance (µS/cm)	19	20	11	10	12	11	24	24	25	25
pH (units)	7.4	6.7	6.3	6.2	5.6	5.1	6.8	6.1	6.1	6.0
Water temperature (°C)	3.5	4.0	9.0	8.0	22.0	19.5	23.0	22.0	20.5	19.5
Color (Pt-Co. scale)	---	---	10	10	---	---	---	---	---	---
Turbidity (NTU)	---	---	0.60	0.60	---	---	---	---	---	---
Secchi-depth (meters)	---		4.4		4.0		4.1		4.4	
Dissolved oxygen	4.7	4.3	10.0	8.5	8.7	5.0	8.3	6.6	8.6	8.0
Calcium, dissolved (Ca)	---	---	1.8	1.7	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	< 1.0	< 1.0	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	< 1.0	< 1.0	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	0.4	0.5	---	---	---	---	---	---
Alkalinity, as CaCO3	---	---	6	6	---	---	---	---	---	---
Sulfate, dissolved (SO4)	---	---	5.0	3.0	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	0.2	0.2	---	---	---	---	---	---
Fluoride, dissolved (F)	---	---	<0.0	0.0	---	---	---	---	---	---
Silica, dissolved (SiO2)	---	---	<0.2	<0.2	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	12	12	---	---	---	---	---	---
Nitrogen, NO2 + NO3, diss. (as N)	---	---	0.05	0.05	---	---	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	0.15	0.16	---	---	---	---	---	---
Nitrogen, amm. + org., total (as N)	---	---	0.50	0.40	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	0.55	0.45	---	---	---	---	---	---
Phosphorus, total (as P)	---	---	0.009	0.011	0.010	0.010	0.013	0.020	0.012	0.015
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)	---	---	2.5	---	2.6	---	3.5	---	1.4	---

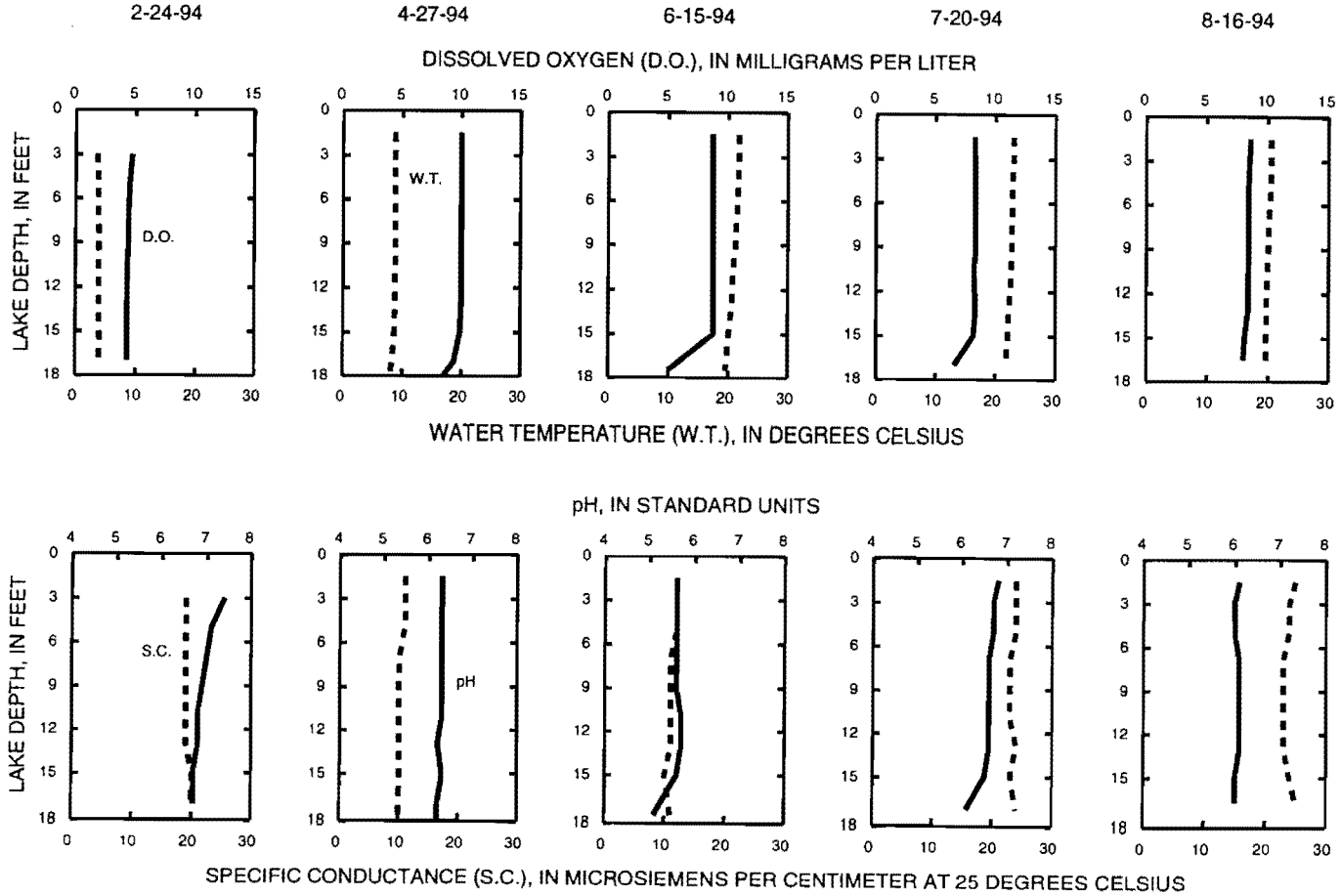

Figure 2. Lake water-quality data for Alma Lake near St. Germain, Wisconsin, 1994 water year

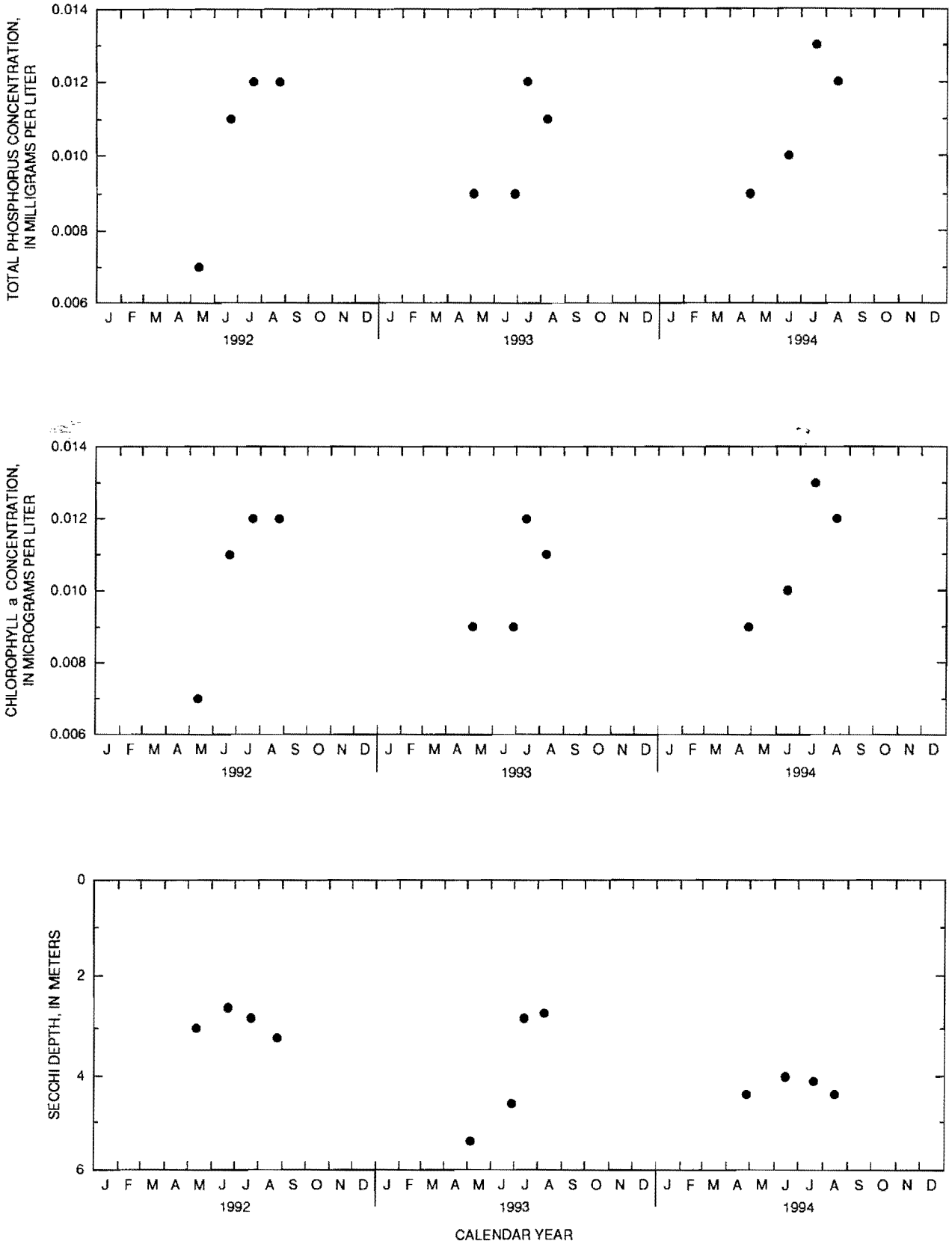

Figure 4.-- Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Alma Lake near St. Germain, Wisconsin.

LDS 2050
LPL-080

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)

July 30, 1996

Ms. Mary Platner
Alma-Moon Lake Protection and Rehabilitation District
N61 W29911 Rybeck Road
Hartland, Wisconsin 53029

Dear Ms. Platner:

This letter describes the progress on the evaluation of the water quality of Alma Lake according to the data collected from October 1994 to September 1995 as stated in our agreement. The format for this progress report is different from that of previous years, but it contains essentially the same type of information.

In reviewing the data, it may be helpful to refer to the methods and explanations of physical and chemical characteristics sections in the USGS annual lake data report "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 1995" and to Shaw and others (1994) "Understanding Lake Data."

Hydrologic conditions during water year 1995:

Annual variability in lake condition often reflects variability in climatic and hydrologic conditions. Air temperature in northcentral Wisconsin was, on the average, 3.6 °F warmer than normal for the period December 1994 through March 1995; April and May were 4.0 °F cooler than normal; and the period June through August was 3.2 °F warmer than normal (National Oceanic and Atmospheric Administration "Climatological Data--Wisconsin"). Precipitation during water year 1995 was 93 percent of normal precipitation for the northcentral division in Wisconsin (Pamela Naber-Knox, UW-Extension, Geological and Natural History Survey, written common., 1995). Watershed runoff in the region of Alma Lake was between 60 and 80 percent of long-term average runoff (Holmstrom and others, 1996, "Water Resources Data--Wisconsin").

Lake description and sampling locations:

Alma Lake is classified as a seepage lake, with no inlet or outlet. Alma Lake has a mean depth of 11 feet and a surface area of 55 acres (0.086 square miles). The water-quality monitoring site is located at the deepest point in the lake at a depth of about 17 feet. Lake stage was monitored along the southwest

shoreline. The locations of these monitoring sites are shown in Figure 1.

Lake Data for 1995:

Data collected during the year, as published in the lake data report are enclosed. The following summary presents some highlights from the tables and figures.

Lake-stage fluctuations:

Lake stages were read by Douglas Pagel intermittently and by the USGS on sampling dates. Stages ranged from 10.55 feet on September 27 to 10.91 feet on May 19 and 29. This range of fluctuation is the lowest seen in the four years of monitoring. Stage values read by Douglas Pagel are listed in Table 1, and the USGS values are listed in the table in the top half of Figure 2.

Lake-depth profiles:

Vertical profiles of water temperature, dissolved oxygen, pH, and specific conductance exhibit no abnormalities and are similar to those from the previous year; with the exception of specific conductance values. Specific conductance values were significantly higher, in percentage, in February, April and June 1995 as compared to the 1994 values, but August 1995 values were lower than August 1994 values. However, overall values are low in comparison to lakes in northcentral Wisconsin. These profiles, which were measured over the deepest point in the lake, are listed in Table 2 and shown in Figure 2. The lake did not thermally stratify through the summer. No anoxic (devoid of oxygen) region developed at any depth. The pH, which ranged from 5.7 to 6.5, indicates the lake is acidic. This range in pH poses no problems for most aquatic life.

Chemical constituents:

Analyses of water samples collected on April 26 for selected chemical constituents for chemical characterization of the lake are shown in Figure 2. Samples collected at 1.5 and 17-foot depths show similar constituent concentrations, as would be expected under mixed water column conditions. The constituent values for color, chlorophyll a, calcium, 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; while values for chloride and magnesium are below regional values.

The ratio of dissolved-nitrogen to dissolved-phosphorus was 45:1, based on the surface concentrations on April 26. This ratio suggests the lake is phosphorus limited, which means algal growth is dependent

on the amount of available phosphorus rather than nitrogen.

Three common measures of water quality used as indices are concentrations of near-surface total-phosphorus and chlorophyll a, and Secchi depth. Total phosphorus concentrations ranged from 0.011 mg/L on April 26 and August 16 to 0.016 mg/L on June 13, chlorophyll a ranged from <0.1 µg/L on July 19 to 5.4 µg/L on August 16, and Secchi depths ranged from 2.8 m on August 16 to 4.2 m on June 13 and July 19.[1]

Surface total-phosphorus and chlorophyll a concentrations, and Secchi depths for the 1992-95 period are shown in Figure 3. No general year to year or seasonal trends are apparent from the data. However, the surface total-phosphorus concentration appears to be slightly higher, on average, than the values from the previous three years.

Total-phosphorus concentrations 1.5 feet above the lake bottom ranged from 0.010 mg/L on August 16 to 0.012 mg/L on April 26 and July 19.

Lake condition:

Water-quality index:

Lillie and Mason (1983) classified all Wisconsin lakes using a random data set collected in the summer (July and August). The index, shown on page 12 of "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 1995," is based on surface total-phosphorus, chlorophyll a concentrations, and Secchi depths. According to the index, surface total-phosphorus and chlorophyll a (using only the August value) concentrations in Alma Lake indicate "good" water quality, and Secchi depths indicate "very good" water quality.

Lillie and Mason (1983) also provided a means of comparing the condition of Alma Lake with other lakes in northeast Wisconsin. The comparison on page 4 shows the percentage distribution of northeast Wisconsin lakes within each condition group and the relative position of Alma Lake.

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1. The extremely low chlorophyll a values for July 19 is believed to be erroneous and the result of a laboratory error. Abnormally low chlorophyll a values were obtained for samples from numerous other lakes samples during a two week period in July. These low values for chlorophyll a were not accompanied by corresponding decreases in total phosphorus or increases in Secchi depth as would be expected.

	Parameter		Percentage distribution of lakes in northeast Wisconsin within parameter range
	Total-phosphorus (mg/L)		
	<0.010	best condition	22
Alma Lake values	0.010-0.020		41
	0.020-0.030		21
	0.030-0.050		12
	>0.050	worst condition	5
	Chlorophyll a (µg/L)		
	0-5	best condition	34
Alma Lake values	5-10		38
	10-15		11
	15-30		11
	>30	worst condition	5
	Secchi depth (feet)		
	>19.7	best condition	4
Alma Lake values	9.8-19.7		32
	6.6-9.8		22
	3.3-6.6		26
	<3.3	worst condition	16

Trophic status:

Another means of assessing the nutrient, or trophic, status of a lake is to use Carlson's Trophic State Index (TSI). The 1995 data is listed in Table 3. Figure 4 is a graphical illustration of the variation in Trophic State Indices for Alma Lake during the 4 year study period. The chlorophyll a value for July 1995 is not included in Figure 4. The data from 1995 show the lake to be mesotrophic to upper oligotrophic, or a lake with moderate to low nutrient levels.

The data that have been collected for Alma Lake from 1992 through 1995 are useful for understanding the lake's water quality, and for managing the lake. These data define the present water quality of the lake and provide a basis for assessing trends or changes in water quality in the future. Continued monitoring will help to build on this valuable data base.

If you have questions regarding this evaluation, please contact me at (608) 276-3834.

Sincerely,

William J Rose

William Rose
Hydrologist

Enclosures

cc: Bob Young, DNR, Rhinelander

Table 1. Lake stages for Alma and Moon Lakes, near St. Germain, Wisconsin, 1995 water year

LOCATION.--Lat 45°54'26", long 89°25'47", in NE 1/4 sec.36, T.40 N., R.8 E., Vilas County, Hydrologic Unit 07070001, 3 mi east of St. Germain.

LAKE-STAGE RECORDS

PERIOD OF RECORD.--October 1984 to September 1990, May 1992 to current year.

GAGE.--Staff gage read by Douglas Pagel.

EXTREMES FOR PERIOD OF RECORD.--Maximum gage height observed, 12.35 ft, Apr. 11, 12, 1986; minimum observed, 8.98 ft, Oct. 26, 27, 1989.

EXTREMES FOR CURRENT YEAR.--Maximum gage height observed, 10.91 ft, May 19, 29; minimum observed, 10.55 ft, Sept. 27.

GAGE HEIGHT, FEET, WATER YEAR OCTOBER 1994 TO SEPTEMBER 1995

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	---	---	---	---	---	---	---	---	---	---	---
2	---	---	---	---	---	---	---	---	---	10.69	---	---
3	---	---	---	---	---	---	---	---	---	---	---	---
4	---	---	---	---	---	---	---	---	10.87	---	---	10.77
5	---	---	---	---	---	---	---	---	---	---	---	---
6	---	---	---	---	---	---	---	10.73	---	---	10.61	---
7	---	---	---	---	---	---	---	---	---	---	---	---
8	---	---	---	---	---	---	---	---	---	---	---	10.71
9	---	---	---	---	---	---	---	---	---	10.67	---	---
10	---	---	---	---	---	---	---	---	---	---	---	---
11	---	---	---	---	---	---	---	10.81	---	---	---	---
12	---	---	---	---	---	---	---	---	10.83	---	---	---
13	---	---	---	---	---	---	---	---	10.82	---	10.77	---
14	---	---	---	---	---	---	---	---	---	---	---	---
15	---	---	---	---	---	---	---	---	---	---	---	---
16	---	---	---	---	---	---	---	---	---	10.71	10.87	---
17	---	---	---	---	10.72	---	---	---	10.74	---	---	10.63
18	---	---	---	---	---	---	---	---	---	---	---	---
19	---	---	---	---	---	---	---	10.91	---	10.72	---	---
20	---	---	---	---	---	---	---	---	---	---	10.83	---
21	---	---	---	---	---	---	---	---	---	---	---	---
22	---	---	---	---	---	---	---	---	---	---	---	---
23	---	---	---	---	---	---	---	---	10.73	10.71	---	---
24	---	---	---	---	---	---	---	---	---	---	---	---
25	---	---	---	---	---	---	---	---	---	---	---	---
26	---	---	---	---	---	---	10.76	---	---	---	---	---
27	---	---	---	---	---	---	---	---	---	---	10.85	10.55
28	---	---	---	---	---	---	---	---	---	10.73	---	---
29	---	---	---	---	---	---	---	10.91	---	---	---	---
30	---	---	---	---	---	---	---	---	---	---	---	---
31	---	---	---	---	---	---	---	---	---	---	---	---

Table 2. Lake depth profiles for Alma Lake near St. Germain, Wisconsin, 1995 water year

455426089254700 - ALMA LAKE NEAR ST. GERMAIN, WI

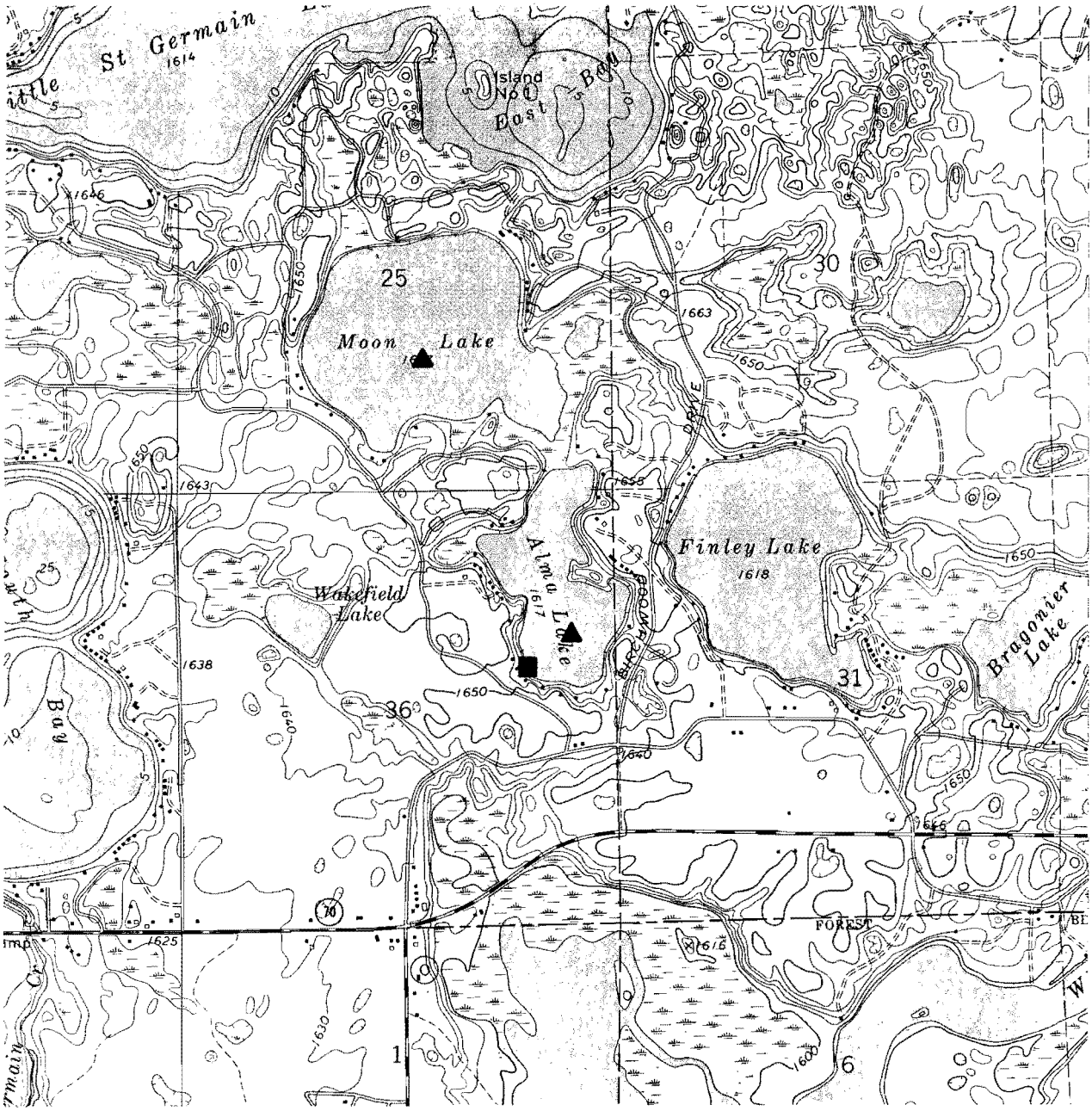
WATER-QUALITY DATA

DATE	SAMPLING DEPTH (FEET) (00003)	TEMPERATURE WATER (DEG C) (00010)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STANDARD UNITS) (00400)	OXYGEN, DISSOLVED (MG/L) (00300)
FEB 1995					
17...	3.00	2.0	31	6.0	7.2
17...	5.00	4.0	31	6.1	6.6
17...	7.00	4.0	30	5.8	6.6
17...	9.00	4.0	30	5.7	6.6
17...	11.0	4.0	28	5.7	6.6
17...	13.0	4.0	28	5.7	6.6
17...	15.0	4.0	28	5.7	6.6
17...	17.0	4.0	28	5.7	6.5
17...	18.0	--	--	--	--
APR					
26...	1.50	7.0	25	6.5	11.6
26...	3.00	7.0	25	6.4	11.6
26...	5.00	7.0	25	6.3	11.6
26...	7.00	6.5	24	6.3	11.6
26...	9.00	6.5	24	6.3	11.6
26...	11.0	6.5	24	6.3	11.6
26...	13.0	6.5	24	6.3	11.6
26...	15.0	6.5	24	6.3	11.6
26...	17.0	6.0	24	6.2	11.6
26...	18.5	--	--	--	--
JUN					
13...	1.50	20.0	24	5.9	9.0
13...	3.00	20.0	24	5.9	9.0
13...	5.00	19.5	23	5.9	9.0
13...	7.00	19.5	22	5.9	9.0
13...	9.00	19.0	22	5.9	9.1
13...	11.0	18.5	22	6.0	9.2
13...	13.0	18.5	22	5.9	9.1
13...	15.0	18.5	22	5.9	9.1
13...	17.0	18.0	22	5.9	8.3
13...	18.5	--	--	--	--
JUL					
19...	1.50	23.0	25	6.4	8.1
19...	3.00	23.0	24	6.4	8.0
19...	5.00	23.0	24	6.4	8.0
19...	7.00	23.0	23	6.4	8.0
19...	9.00	23.0	23	6.4	8.0
19...	11.0	23.0	23	6.2	8.0
19...	13.0	23.0	23	6.1	8.0
19...	15.0	23.0	24	6.0	7.8
19...	16.0	22.5	24	5.7	7.0
19...	17.5	--	--	--	--
AUG					
16...	1.50	25.0	17	6.1	8.0
16...	3.00	25.0	17	6.1	8.0
16...	5.00	25.0	16	6.1	7.9
16...	7.00	25.0	15	6.2	7.9
16...	9.00	25.0	15	6.2	7.9
16...	11.0	25.0	14	6.2	7.9
16...	13.0	25.0	15	6.1	7.7
16...	15.0	24.5	15	6.0	7.5
16...	16.5	24.5	14	5.9	7.3
16...	18.0	--	--	--	--

Table 3.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Alma Lake, 1995 water year

[- indicates not applicable; -- indicates no data available]

Date	Secchi Disk			Sampling	Total Phosphorus			Chlorophyll a		Dissolved Ortho-phosphate Phosphorus
	Depth (meters)	Depth (feet)	T.S.I.	Depth (feet)	Conc. (mg/L)	Conc. (µg/L)	T.S.I	Conc. (µg/L)	T.S.I.	Conc. (mg/L)
04/26/95	3.8	12.5	41	1.5	0.011	11	47	3.20	44	<0.002
	-	-	-	17	0.012	12	-	-	-	<0.002
06/13/95	4.2	13.8	39	1.5	0.016	16	50	1.4	37	--
	-	-	-	17	0.011	11	-	-	-	--
07/19/95	4.2	13.8	39	1.5	0.013	13	48	<0.1	17	--
	-	-	-	16	0.012	12	-	-	-	--
08/16/95	2.8	9.2	45	1.5	0.011	11	47	5.4	48	--
	-	-	-	16	0.010	10	-	-	-	--



EXPLANATION

▲ Water-quality monitoring site

■ Lake-stage monitoring site

Figure 1. Locations of water-quality and lake-stage monitoring sites on Alma and Moon Lakes near St. Germain, Wisconsin.

WATER-QUALITY RECORDS

PERIOD OF RECORD.--October 1984 to September 1990 secchi depth only; February 1992 to current year.

REMARKS.--Lake sampled near center of southern lobe of lake at the deep hole. Lake ice-covered during February measurements. Water-quality analyses done by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, FEBRUARY 17 TO AUGUST 16, 1995
(Milligrams per liter unless otherwise indicated)

	Feb. 17		Apr. 26		June 13		July 19		Aug. 16	
Depth of sample (ft)	3.0	17	1.5	17	1.5	17	1.5	16	1.5	16
Lake stage (ft)	10.72		10.76		10.82		10.72		10.87	
Specific conductance (µS/cm)	31	28	25	24	24	22	25	24	17	14
pH (units)	6.0	5.7	6.5	6.2	5.9	5.9	6.4	5.7	6.1	5.9
Water temperature (°C)	2.0	4.0	7.0	6.0	20.0	18.0	23.0	22.5	25.0	24.5
Color (Pt-Co. scale)	---	---	5	10	---	---	---	---	---	---
Turbidity (NTU)	---	---	<0.50	0.50	---	---	---	---	---	---
Secchi-depth (meters)	---		3.8		4.2		4.2		2.8	
Dissolved oxygen	7.2	6.5	11.6	11.6	9.0	8.3	8.1	7.0	8.0	7.3
Hardness, as CaCO3	---	---	9	8	---	---	---	---	---	---
Calcium, dissolved (Ca)	---	---	2.4	2.0	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	0.7	0.7	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	0.7	0.7	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	<0.3	0.3	---	---	---	---	---	---
Alkalinity, as CaCO3	---	---	6	6	---	---	---	---	---	---
Sulfate, dissolved (SO4)	---	---	4.0	5.0	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	0.2	1.0	---	---	---	---	---	---
Fluoride, dissolved (F)	---	---	<0.1	<0.1	---	---	---	---	---	---
Silica, dissolved (SiO2)	---	---	<0.0	<0.0	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	16	18	---	---	---	---	---	---
Nitrogen, NO2 + NO3, diss. (as N)	---	---	0.06	0.05	---	---	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	0.03	<0.03	---	---	---	---	---	---
Nitrogen, organic, total (as N)	---	---	0.47	0.50	---	---	---	---	---	---
Nitrogen, amm. + org., total (as N)	---	---	0.50	0.50	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	0.56	0.55	---	---	---	---	---	---
Phosphorus, total (as P)	---	---	0.011	0.012	0.016	0.011	0.013	0.012	0.011	0.010
Phosphorus, ortho, dissolved (as P)	---	---	<0.002	<0.002	---	---	---	---	---	---
Iron, dissolved (Fe) µg/L	---	---	20	10	---	---	---	---	---	---
Manganese, dissolved (Mn) µg/L	---	---	16	7	---	---	---	---	---	---
Chlorophyll a, phytoplankton (µg/L)	---	---	3.2	---	1.4	---	<0.1	---	5.4	---

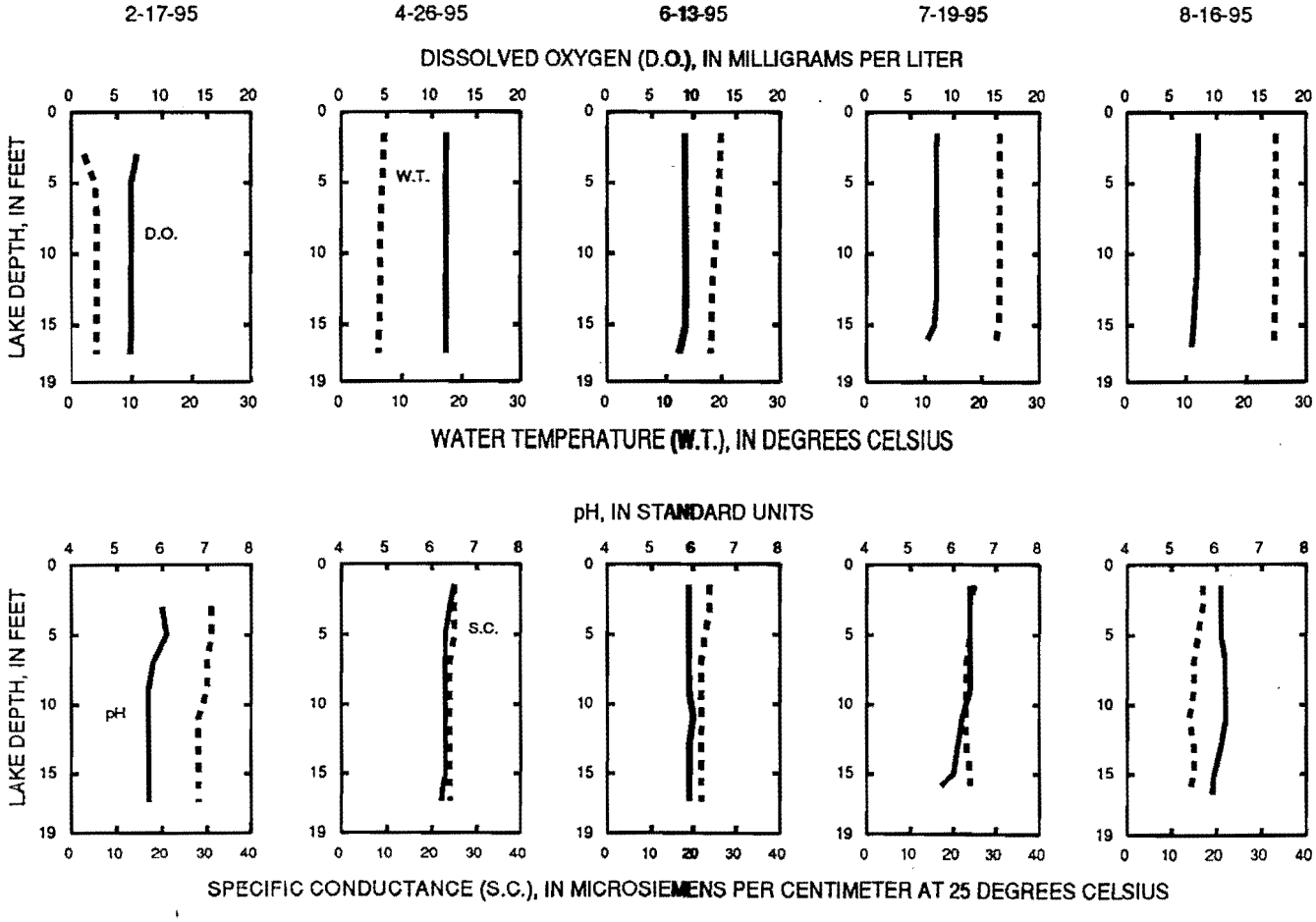
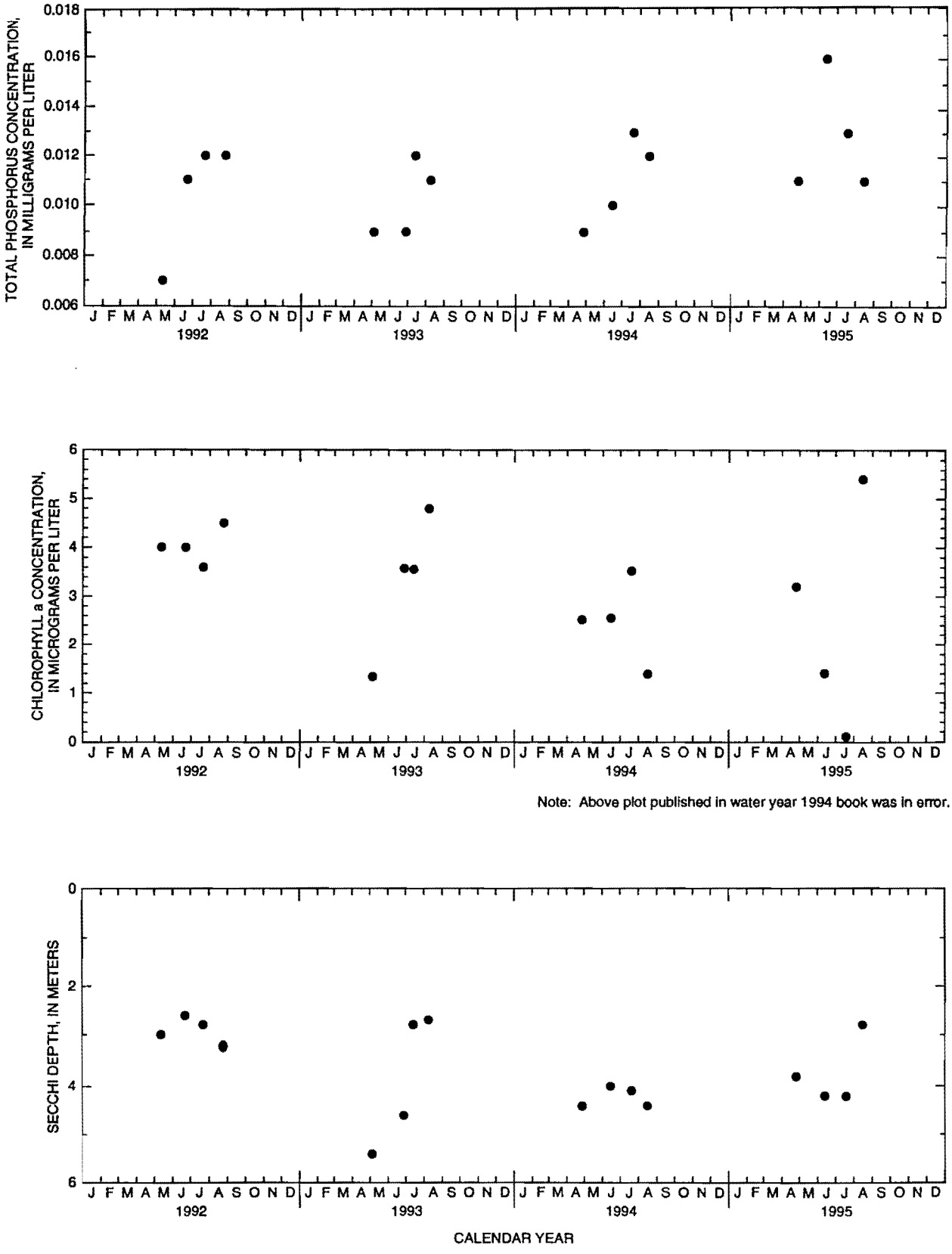


Figure 2. Lake water-quality data and depth profiles for Alma Lake, near St. Germain, Wisconsin, 1995 water year



Note: Above plot published in water year 1994 book was in error.

Figure 3. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Alma Lake near St. Germain, Wisconsin.

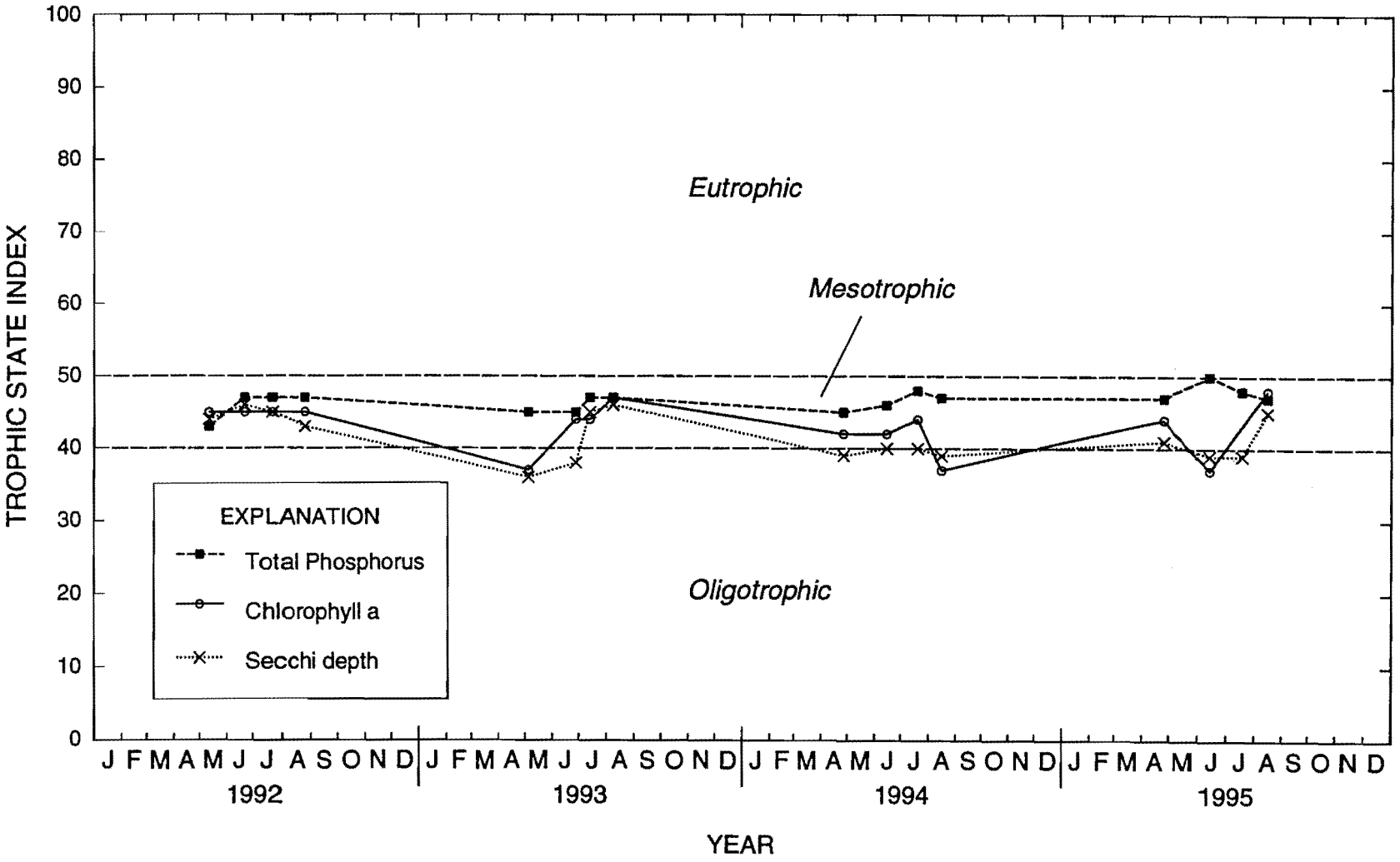


Figure 4. Trophic state indices for Alma Lake near St. Germain, Wisconsin