



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 18, 1996

Mr. Don Beseler
1624 Highway C
St. Germain, Wisconsin 54558

Dear Mr. Beseler:

This letter describes the progress on the evaluation of the water quality of Big St. Germain 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 was 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 northcentral Wisconsin (Pamela Naber-Knox, UW-Extension, Geological and Natural History Survey, written commun., 1995). Watershed runoff in the region of Big St. Germain 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:

Big St. Germain Lake is classified as a drainage lake, with one major and one minor inlet, and one major outlet. Big St. Germain Lake has a mean depth of 21 feet, a surface area of 1463 acres (2.3 square miles), and a watershed area 73.1 square miles. The water-quality sampling site is located at the deepest point in the lake at a depth of about 32 feet. Lake stage was monitored in Fawn Lake at the

dam along the southern 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 provided by Wisconsin Valley Improvement Company (WVIC) and the USGS on lake sampling dates. The stages ranged from 8.46 on February 28 to 10.80 feet on August 14. This range of fluctuation is similar to the previous 3 years of monitoring. WVIC stage values are listed in table 1, and USGS values are shown in the table on 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 generally similar to those from the previous year; with the exception of anoxic (devoid of oxygen) conditions observed near the bottom in August 1995 and not in 1994. This may be the result of a stronger thermal stratification in 1995, which would allow depletion of oxygen to occur in the hypolimnion by decaying material. These profiles, which were measured over the deepest point in the lake, are listed in Table 2 and shown in Figure 2. During the February through August sampling period, complete water-column mixing was observed April 27. The lake became weakly thermally stratified through the summer. In July the lower 2.5 feet of water was anoxic, and by August the lower 8.5 feet was anoxic. The anoxic zone is unable to support fish. The pH, which ranged between 6.5 and 8, is normal for northeast Wisconsin lakes and poses no problems for aquatic life.

Chemical constituents:

Analyses of water samples collected on April 27 for selected chemical constituents for chemical characterization of the lake are shown in Figure 2. Samples collected at 1.5 and 29-foot depths show similar constituent concentrations, as would be expected under mixed water column conditions. The constituent values for color, chlorophyll *a*, chloride, 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.

The ratio of dissolved-nitrogen to dissolved-phosphorus was 4:1, based on the surface concentrations on

April 27. This ratio suggests the lake is nitrogen limited, which means algal growth is dependent on the amount of available nitrogen rather than phosphorus.

Three common measures of water quality used as indices are near-surface total-phosphorus and chlorophyll a concentrations, and Secchi depth. Total-phosphorus concentrations ranged from 0.008 mg/L on June 13 to 0.017 mg/L (estimated value) on April 27, chlorophyll a ranged from 0.1 µg/L on July 19 to 12 µg/L on April 27, and Secchi depths ranged from 2.3 m on April 27 to 3.5 m on June 13.¹

Surface total-phosphorus and chlorophyll a concentrations, and Secchi depths for the 1992-95 period are shown on Figure 3. No clear-cut year-to-year trends are apparent in the data for the four year period. However, the pattern of increasing total-phosphorus and chlorophyll a concentrations and decreasing Secchi depths through the summer months is generally repeated each year.

Total-phosphorus concentration 1.5 feet above the lake bottom at the center site ranged from 0.015 mg/L on April 27 to 0.257 mg/L on August 17. The highest total-phosphorus concentration, which was observed in the August sampling during anoxic conditions, is indicative of moderate phosphorus release from the bottom sediments. The slight increase in surface phosphorus concentration from June to August, along with the apparent weak thermal stratification as indicated by the temperature profiles, suggests there may be intermittent mixing of hypolimnetic and epilimnetic waters throughout the summer.

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 and chlorophyll a concentrations, and Secchi depths. According to the index, surface total-phosphorus concentrations and Secchi depths in Big St. Germain Lake indicate "good" water quality, and chlorophyll a concentrations indicate "fair" water quality.

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

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

	Parameter	Percentage distribution of lakes in northeast Wisconsin within parameter ranges	
	<u>Total phosphorus (mg/L)</u>		
	<0.010	best condition	22
Big St. Germain Lake values	0.010-0.020	↓	41
	0.020-0.030		21
	0.030-0.050	↓	12
	>0.050	worst condition	5
	<u>Chlorophyll <i>a</i> (µg/L)</u>		
	0-5	best condition	34
	5-10	↓	38
Big St. Germain Lake values	10-15		11
	15-30	↓	11
	>30	worst condition	5
	<u>Secchi depth (feet)</u>		
	>19.7	best condition	4
	9.8-19.7	↓	32
Big St. Germain Lake values	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 TSI data is listed in Table 2. Figure 4 is a graphical illustration of the variation in Trophic State Indices for Big St. Germain 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 lower eutrophic, or a lake with moderate nutrient levels.

The data that have been collected for Big St. Germain 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 Rose
Hydrologist

Enclosures

cc: Bob Young, DNR, Rhinelander

Table 1- Lake stages for Big St. Germain Lake, 1995 water year

LOCATION.--Lat 45°55'00", long 89°31'55" in NE 1/4 SE 1/4 sec.30, T.40 N., R.8 E., Vilas County, Hydrologic Unit 07070001, at dam outlet, 7.7 mi northeast of Lake Tomahawk.

DRAINAGE AREA.--73.1 mi².

PERIOD OF RECORD.--October 1991 to current year. Lake stages for previous years were recorded by Wisconsin Valley Improvement Company.

GAGE.--Nonrecording gage. Datum of gage is 1,580 ft, above sea level.

COOPERATION.--Lake stages provided by Wisconsin Valley Improvement Company.

EXTREMES FOR PERIOD OF RECORD.--Maximum gage height observed, 10.80 ft, Aug. 14, 1995; minimum observed, 8.32 ft, Mar. 1, 2, 1993.

EXTREMES FOR CURRENT YEAR.--Maximum gage height observed, 10.80 ft, Aug. 14; minimum observed, 8.46 ft, Feb. 28, and Mar. 1, 3.

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	10.50	10.50	9.58	8.96	8.60	8.46	9.76	10.54	10.52	10.52	10.54	10.50
2	10.50	10.50	9.54	---	---	---	9.78	10.54	10.50	10.50	10.52	10.50
3	10.46	10.50	---	8.92	8.58	8.46	9.86	10.54	10.48	10.50	10.52	10.50
4	10.52	10.48	---	---	---	---	9.94	10.54	10.44	10.50	10.52	10.50
5	10.58	10.48	---	---	---	---	9.92	10.54	10.48	10.52	10.52	10.52
6	10.58	10.46	9.46	8.88	---	---	9.94	10.54	10.50	10.52	10.52	10.52
7	10.60	10.50	---	---	8.56	8.50	9.94	10.52	10.50	10.54	10.60	10.54
8	10.62	10.52	---	---	---	---	9.94	10.54	10.50	10.52	10.58	10.52
9	10.64	10.54	9.40	---	---	---	9.94	10.66	10.50	10.52	10.58	10.50
10	10.68	---	---	8.80	8.54	8.48	9.94	10.64	10.50	10.50	10.58	10.48
11	10.64	10.22	---	---	---	---	9.96	10.60	10.50	10.50	10.56	10.48
12	10.62	---	---	---	---	---	10.02	10.58	10.50	10.52	10.54	10.48
13	10.62	10.22	9.30	8.74	---	---	10.02	10.60	10.52	10.58	10.66	10.50
14	10.60	---	---	---	8.52	8.58	10.02	10.64	10.52	10.56	10.80	10.50
15	10.60	10.00	---	---	---	8.64	10.02	10.64	10.52	10.60	10.70	10.50
16	10.58	---	9.22	---	8.50	8.72	10.02	10.64	10.52	10.64	10.62	10.54
17	10.64	---	---	8.68	8.50	8.80	10.02	10.64	10.52	10.60	10.56	10.54
18	10.68	9.86	---	---	---	8.90	10.02	10.58	10.52	10.66	10.58	10.56
19	10.54	---	---	---	---	8.96	10.08	10.56	10.52	10.58	10.60	10.58
20	10.54	9.86	9.20	8.66	---	9.10	10.18	10.50	10.52	10.58	10.60	10.58
21	10.52	---	---	---	8.48	9.22	10.30	10.52	10.54	10.56	10.56	10.58
22	10.50	9.72	---	---	---	9.28	10.36	10.50	10.52	10.54	10.54	10.60
23	10.52	---	9.12	---	---	9.34	10.40	10.54	10.52	10.50	10.50	10.60
24	10.50	---	---	8.64	8.48	9.40	10.44	10.54	10.52	10.50	10.46	10.56
25	10.48	9.64	---	---	---	9.44	10.48	10.54	10.52	10.48	10.54	10.52
26	10.48	---	---	---	---	9.50	10.52	10.52	10.50	10.48	10.64	10.50
27	10.48	---	9.04	8.62	---	9.56	10.54	10.52	10.52	10.50	10.58	10.50
28	10.50	---	---	---	8.46	9.60	10.54	10.60	10.52	10.54	10.56	10.50
29	10.50	9.60	---	---	---	9.64	10.54	10.56	10.60	10.52	10.56	10.50
30	10.50	---	9.00	---	---	9.70	10.54	10.54	10.54	10.52	10.54	10.64
31	10.50	---	---	8.60	---	9.72	---	10.52	---	10.52	10.54	---

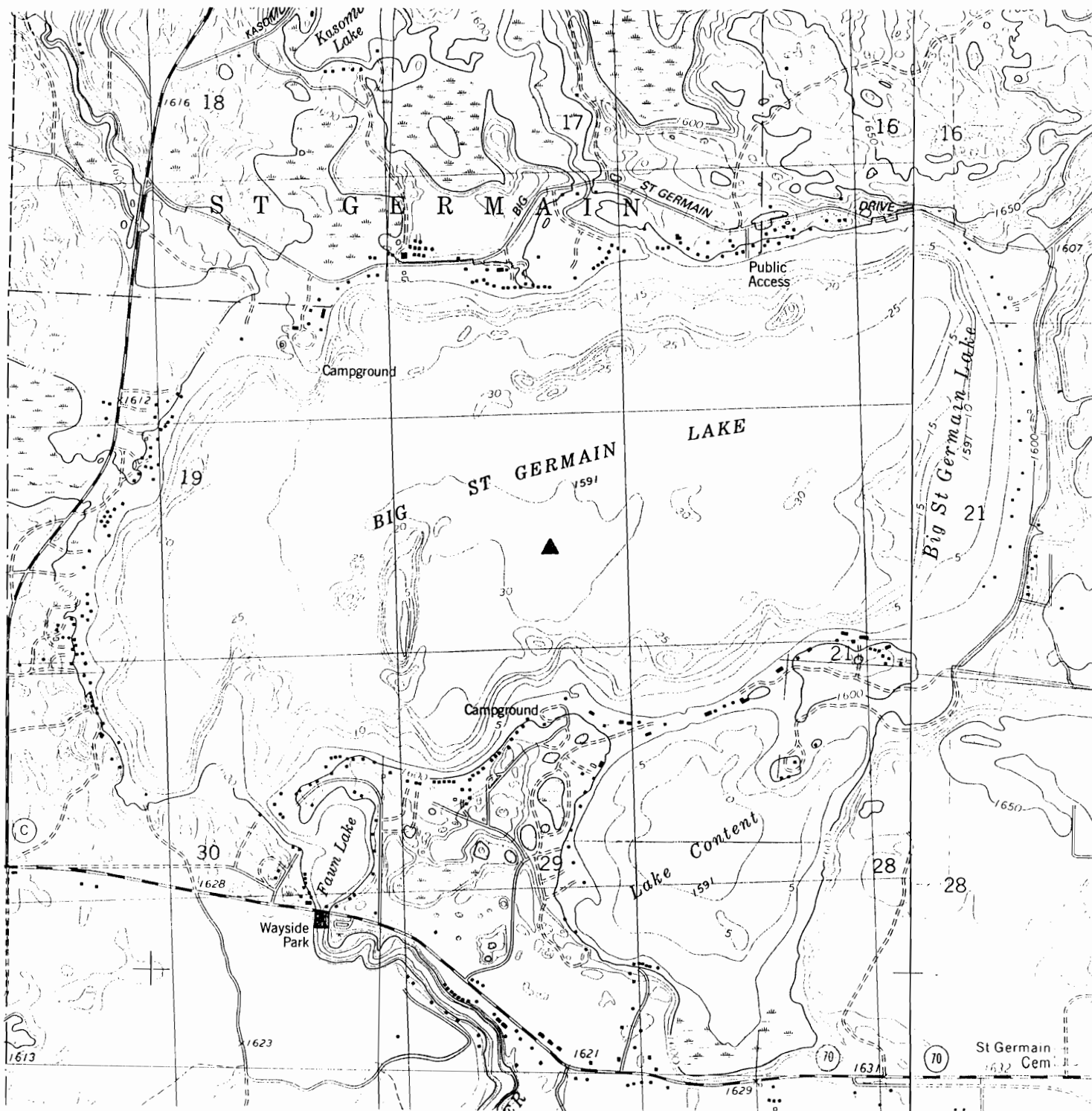
Table 2- Lake-depth profiles for Big St. Germain Lake, 1995 water year

DATE	SAM- PLING DEPTH (FEET) (00003)	TEMPER- ATURE WATER (DEG C) (00010)	SPE- CIFIC CON- DUCT- ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND- ARD UNITS) (00400)	OXYGEN, DIS- SOLVED (MG/L) (00300)
FEB 1995					
16...	3.00	1.0	101	7.9	15.3
16...	6.00	2.0	98	8.0	13.5
16...	9.00	2.5	95	7.8	12.7
16...	12.0	3.0	95	7.6	12.0
16...	15.0	3.0	90	7.5	9.0
16...	18.0	3.5	89	7.4	7.2
16...	21.0	3.5	93	7.3	6.4
16...	24.0	4.0	97	7.1	4.4
16...	27.0	4.5	100	6.9	2.9
16...	29.0	4.5	105	6.8	2.6
16...	30.0	--	--	--	--
APR					
27...	1.50	4.5	85	7.5	11.7
27...	3.00	4.5	85	7.5	11.7
27...	6.00	4.5	83	7.5	11.7
27...	9.00	4.5	83	7.5	11.6
27...	12.0	4.5	82	7.5	11.6
27...	15.0	4.5	82	7.5	11.6
27...	18.0	4.5	82	7.5	11.6
27...	21.0	4.5	82	7.5	11.6
27...	24.0	4.5	82	7.5	11.6
27...	27.0	4.5	82	7.5	11.6
27...	29.5	4.5	82	7.5	11.6
27...	31.0	--	--	--	--
JUN					
13...	1.50	18.5	82	7.4	9.4
13...	3.00	18.5	82	7.4	9.4
13...	6.00	18.5	81	7.5	9.4
13...	9.00	18.5	81	7.5	9.4
13...	12.0	18.5	80	7.6	9.4
13...	15.0	18.0	80	7.6	9.4
13...	18.0	15.5	81	7.2	8.1
13...	21.0	15.0	80	7.1	7.6
13...	24.0	14.5	81	6.9	6.5
13...	27.0	14.0	81	6.8	4.3
13...	30.0	13.5	85	6.7	2.7
13...	31.5	13.5	85	6.6	2.2
13...	33.0	--	--	--	--
JUL					
19...	1.50	22.0	76	7.4	8.2
19...	3.00	22.0	77	7.4	8.2
19...	6.00	22.0	76	7.4	8.2
19...	9.00	22.0	76	7.4	8.2
19...	12.0	22.0	76	7.4	8.2
19...	15.0	22.0	76	7.4	8.2
19...	18.0	21.5	77	7.1	6.9
19...	21.0	19.0	79	6.6	4.6
19...	24.0	18.5	80	6.5	2.7
19...	27.0	18.0	83	6.5	1.0
19...	30.0	17.0	90	6.6	0.2
19...	31.0	16.5	98	6.6	0.2
19...	32.5	--	--	--	--
AUG					
17...	1.50	23.5	79	7.6	7.7
17...	3.00	23.5	80	7.6	7.7
17...	6.00	23.5	80	7.6	7.7
17...	9.00	23.5	79	7.6	7.6
17...	12.0	23.5	77	7.5	7.5
17...	15.0	23.5	76	7.5	7.4
17...	18.0	23.5	77	7.4	7.3
17...	21.0	23.0	76	7.2	5.3
17...	24.0	21.5	78	6.5	0.3
17...	27.0	19.0	102	6.6	0.2
17...	30.0	18.0	120	6.9	0.2
17...	31.0	17.5	123	7.0	0.2
17...	32.5	--	--	--	--

Table 3.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Big St. Germain Lake, 1995 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)		Conc. (mg/L)	Conc. (µg/L)	Conc. (µg/L)	T.S.I.	
04/27/95	2.3	7.5	1.5	E0.017*	17	12	54	0.011
	-	-	29	0.015	15	-	-	0.002
06/13/95	3.5	11.5	1.5	0.008	8	2.1	40	--
	-	-	31	0.030	30	-	-	--
07/19/95	3.0	9.8	1.5	0.011	11	0.1	17	--
	-	-	31	0.024	24	-	-	--
08/17/95	2.5	8.2	1.5	0.015	15	11	53	--
	-	-	31	0.257	257	-	-	--

* E = Estimated



EXPLANATION

- ▲ Water-quality monitoring site
- Lake-stage monitoring site

Figure 1. Locations of water-quality and lake-stage monitoring sites on Big St. Germain Lake near St. Germain, Wisconsin.

LOCATION.--Lat 45°55'57", long 89°31'10", in NE 1/4 SW 1/4 sec.20, T.40 N., R.8 E., Vilas County, Hydrologic Unit 07070001, 2.5 mi north-west of St. Germain.

DRAINAGE AREA.--73.1 mi².

PERIOD OF RECORD.--February 1992 to current year.

REMARKS.--Lake sampled near center 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 16 TO AUGUST 17, 1995
(Milligrams per liter unless otherwise indicated)

	Feb. 16		Apr. 27		June 13		July 19		Aug. 17	
Depth of sample (ft)	3.0	29	1.5	29	1.5	31	1.5	31	1.5	31
Lake stage (ft)	8.50		10.55		10.52		10.58		10.62	
Specific conductance (µS/cm)	101	105	85	82	82	85	76	98	79	123
pH (units)	7.9	6.8	7.5	7.5	7.4	6.6	7.4	6.6	7.6	7.0
Water temperature (°C)	1.0	4.5	4.5	4.5	18.5	13.5	22.0	16.5	23.5	17.5
Color (Pt-Co. scale)	---	---	10	10	---	---	---	---	---	---
Turbidity (NTU)	---	---	1.3	1.4	---	---	---	---	---	---
Secchi-depth (meters)	---	---	2.3		3.5		3.0		2.5	
Dissolved oxygen	15.3	2.6	11.7	11.6	9.4	2.2	8.2	0.2	7.7	0.2
Hardness, as CaCO ₃	---	---	38	41	---	---	---	---	---	---
Calcium, dissolved (Ca)	---	---	10	11	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	3.1	3.2	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	2.7	2.3	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	0.4	0.5	---	---	---	---	---	---
Alkalinity, as CaCO ₃	---	---	35	35	---	---	---	---	---	---
Sulfate, dissolved (SO ₄)	---	---	6.0	5.0	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	3.2	2.8	---	---	---	---	---	---
Fluoride, dissolved (F)	---	---	<0.1	<0.1	---	---	---	---	---	---
Silica, dissolved (SiO ₂)	---	---	14	8.5	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	62	62	---	---	---	---	---	---
Nitrogen, NO ₂ + NO ₃ , diss. (as N)	---	---	0.01	0.02	---	---	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	<0.03	<0.03	---	---	---	---	---	---
Nitrogen, organic, total (as N)	---	---	0.40	0.20	---	---	---	---	---	---
Nitrogen, amm. + org., total (as N)	---	---	0.40	0.20	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	0.41	0.22	---	---	---	---	---	---
Phosphorus, total (as P)	---	---	0.017	0.015	0.008	0.030	0.011	0.024	0.015	0.257
Phosphorus, ortho, dissolved (as P)	---	---	0.011	0.002	---	---	---	---	---	---
Iron, dissolved (Fe) µg/L	---	---	50	40	---	---	---	---	---	---
Manganese, dissolved (Mn) µg/L	---	---	100	96	---	---	---	---	---	---
Chlorophyll a, phytoplankton (µg/L)	---	---	12	---	2.1	---	0.1	---	11	---

E Estimated 2-16-95

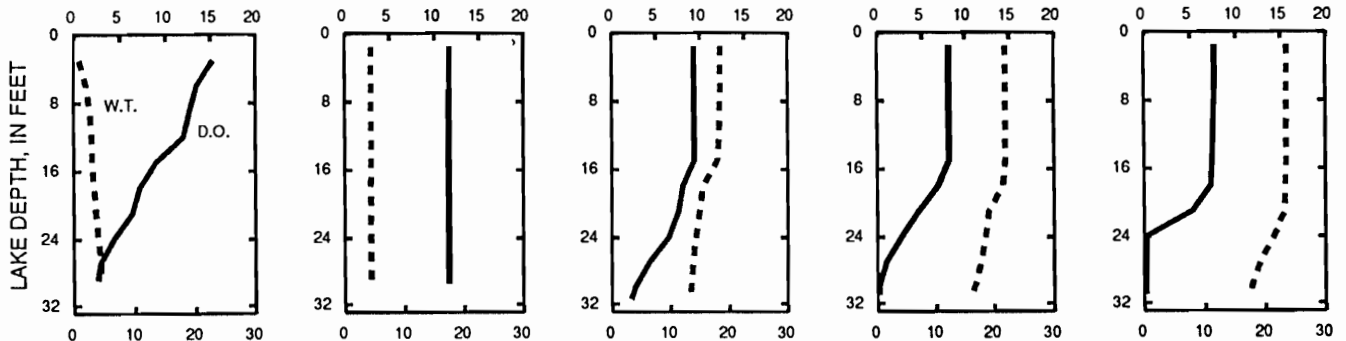
4-27-95

6-13-95

7-19-95

8-17-95

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



WATER TEMPERATURE (W.T.), IN DEGREES CELSIUS

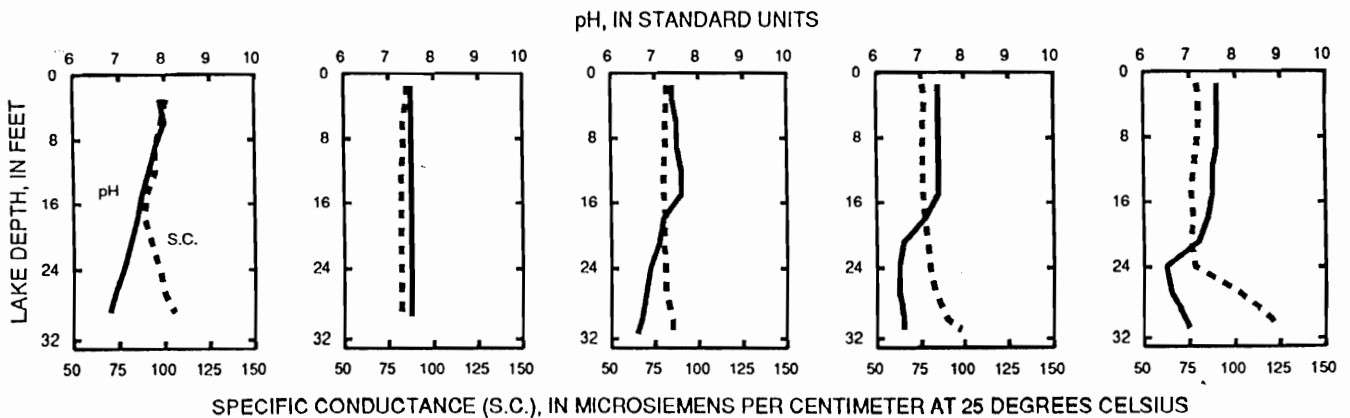


Figure 2- Water-quality data for Big St. Germain Lake, 1995 water year

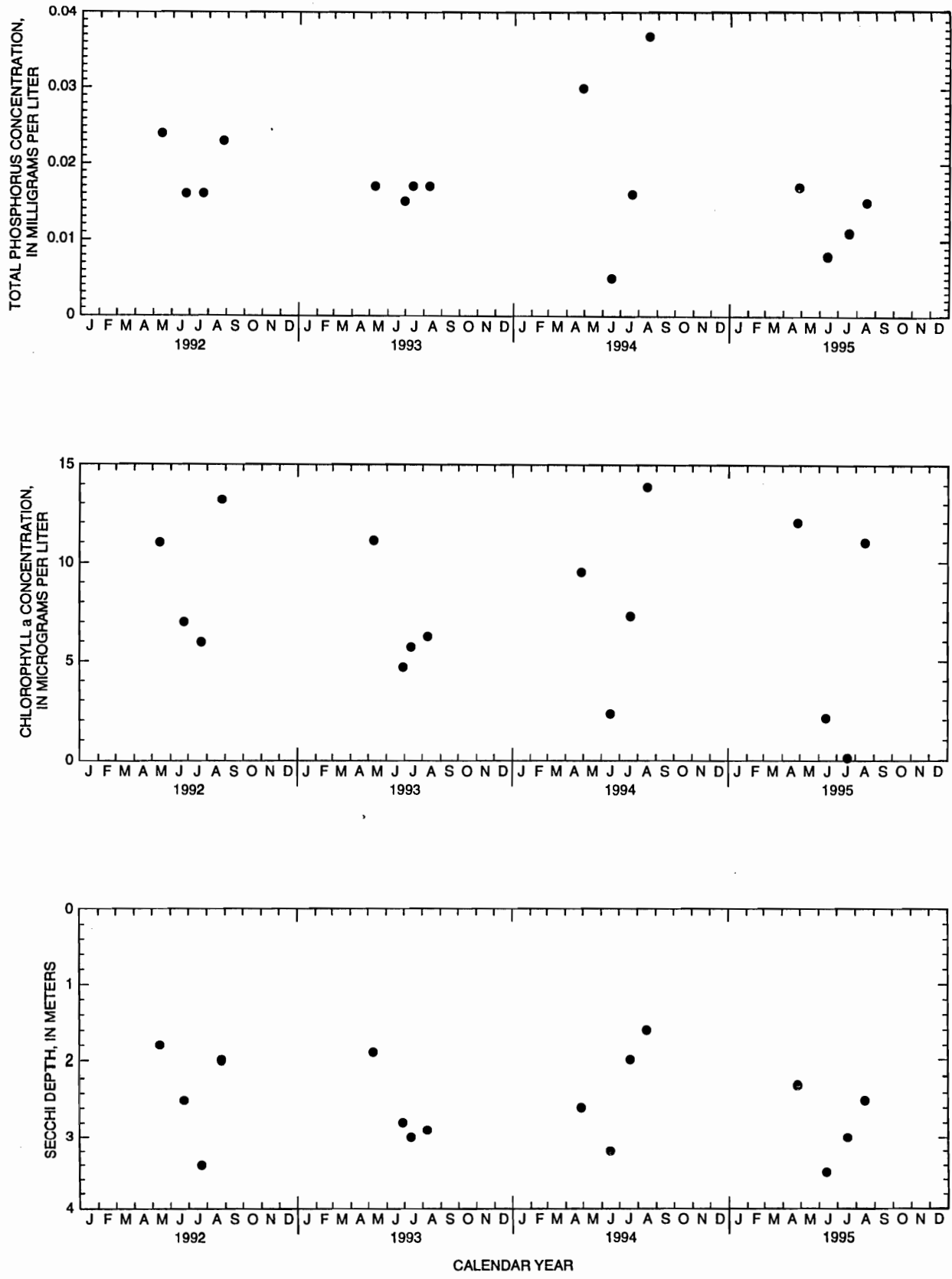


Figure 3. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Big St. Germain Lake near St. Germain, Wisconsin.

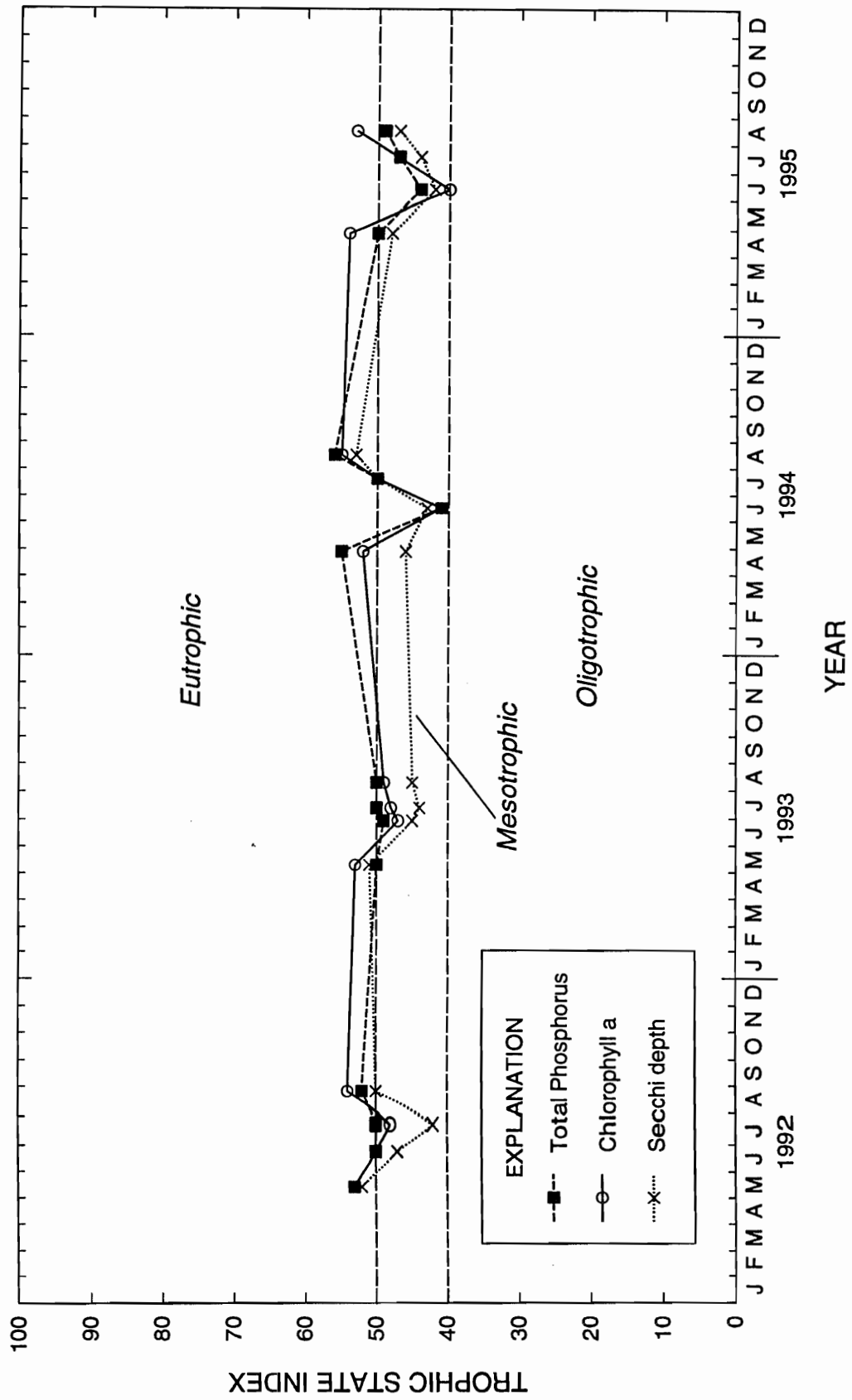


Figure 4. Trophic state indices for Big St. Germain Lake near St. Germain, Wisconsin