



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 23, 1993



Ms. Swan Herlevi
Village Clerk
P.O. Box 517
Lake Nebagamon, Wisconsin 54849

Dear Ms. Herlevi:

This letter describes the progress on the evaluation of the water quality of Lake Nebagamon 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 Lake Nebagamon is fair to good and can be classified as a meso-eutrophic lake or one with moderate to many nutrients. The water quality of the lake is similar at all three monitoring sites.
- Algal growth appears to be dependent upon the amount of available phosphorus rather than nitrogen.
- In July and August, during summer stratification, oxygen disappears from the bottom portion of the lake which is then unable to support a fish population.
- During the summer anoxic (devoid of oxygen) period, there are minor amounts of phosphorus being released from the bottom sediments.
- The data enclosed herein are provisional until published.

Lake Nebagamon has a surface area of 914 acres (1.43 square miles) and a drainage area at the outlet of 40.9 square miles for a drainage area/lake size ratio of 28.6:1. 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.).

Three sites were sampled in Lake Nebagamon. The site in the Southeast Bay is located at the deepest spot in the lake at a depth of about 52 feet and is the site where most of the water-quality data were collected. Only surface samples were collected from sites in the Northeast Bay at a 40-foot depth, and the West Bay at a 20-foot depth.

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

Table 1. Lake-depth profiles for Lake Nebagamon, Southeast Bay, at Lake Nebagamon, Wisconsin, 1992 water year

Table 2. Lake water-quality data for Lake Nebagamon, West Bay, and Lake Nebagamon, Northeast Bay, at Lake Nebagamon, Wisconsin, 1992 water year

Table 3a. Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, Northeast Bay, at Lake Nebagamon, Wisconsin, 1992 water year

Table 3b. Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, Southeast Bay, at Lake Nebagamon, Wisconsin, 1992 water year

Table 3c. Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, West Bay, at Lake Nebagamon, Wisconsin, 1992 water year

Table 4. Lake stages for Lake Nebagamon at Lake Nebagamon, Wisconsin, 1992 water year

Figure 1. Location of sampling sites and staff gage on Lake Nebagamon at Lake Nebagamon, Wisconsin

Figure 2. Lake water-quality data for Lake Nebagamon, Southeast Bay, at Lake Nebagamon, Wisconsin, 1992 water year

Figure 3a. Trophic state indices for Lake Nebagamon, Northeast Bay, at Lake Nebagamon, Wisconsin

Figure 3b. Trophic state indices for Lake Nebagamon, Southeast Bay, at Lake Nebagamon, Wisconsin

Figure 3c. Trophic state indices for Lake Nebagamon, West Bay, at Lake Nebagamon, 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 Edward Girzi, near his residence. He should be commended for the excellent job he did. Lake-stage data are listed in table 4. Lake stages fluctuated 3.11 feet and ranged from 86.77 feet on March 3 to 89.88 feet on April 23.

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, incomplete water-column mixing was observed on all dates. The lake chemically and thermally stratifies during summer. The maximum stratification was reached on August 18 when depths greater than 27 feet were anoxic (devoid of oxygen) and were unable to support fish. The levels of pH are within acceptable limits to support aquatic life. Because of the buffering capacity of the lake water, Lake Nebagamon is not susceptible to the effects of acid rain.

SELECTED ANALYSES

Analyses of selected constituents for May 12 for samples collected at 1.5- and 51-foot depths are listed in figure 2. The lake was not completely mixed on this date. 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 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 24:1 and suggests the lake is phosphorus-limited. This means algal growth appears to be dependent on the amount of available phosphorus rather than nitrogen.

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. The water quality of the lake is similar at all three sites.

Lake Nebagamon, Southeast Bay

Total phosphorus: Total phosphorus concentrations sampled at a 1.5-foot depth range from 0.014 mg/L in August to 0.022 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 0.044 mg/L in May to 0.119 mg/L in June. These concentrations are indicative of minor phosphorus release from the bottom sediments during anoxic (absence of oxygen) periods.

Chlorophyll *a*: Chlorophyll *a* concentrations, which indicate algal biomass, ranged from 4 µg/L in June to 14 µg/L in July. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 5.6 feet in May to 6.9 feet in June and July. These data are within the regional values.

Lake Nebagamon, West Bay

Total phosphorus: Total phosphorus concentrations sampled at a 1.5-foot depth range from 0.012 mg/L in June to 0.021 mg/L in August. All values fall within the regional values previously referenced.

Chlorophyll a: Chlorophyll a concentrations, which indicate algal biomass, ranged from 4 µg/L in June to 13 µg/L in August. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 4.9 feet in August to 6.9 feet in June. These data are within the regional values.

Lake Nebagamon, Northeast Bay

Total phosphorus: Total phosphorus concentrations sampled at a 1.5-foot depth range from 0.015 mg/L in June to 0.020 mg/L in May. All values fall within the regional values previously referenced.

Chlorophyll a: Chlorophyll a concentrations, which indicate algal biomass, ranged from 6 µg/L in June to 13 µg/L in July. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 4.9 feet in August to 6.9 feet in June and July. 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 tables 2a, 2b, and 2c for all three sites on Lake Nebagamon, chlorophyll a concentrations and Secchi-disc depths indicate fair 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 Lake Nebagamon to other lakes in northwest Wisconsin are shown below:

| | <u>Parameter</u> | <u>Percentage of distribution of lakes in northwest Wisconsin within these concentrations</u> |
|-------------------------|--------------------------------|---|
| | Total phosphorus (mg/L) | |
| | <.010 | Best condition 12 |
| | .010-.020 | 35 |
| Lake Nebagamon values → | .020-.030 | 23 |
| | .030-.050 | 18 |
| | .050-.100 | 8 |
| | .100-.150 | 3 |
| | >.150 | Worst condition 1 |
| | Chlorophyll <i>a</i> (µg/L) | |
| | 0- 5 | Best condition 29 |
| | 5-10 | 36 |
| Lake Nebagamon values → | 10-15 | 14 |
| | 15-30 | 14 |
| | >30 | Worst condition 9 |
| | Secchi depth (in feet) | |
| | >19.7 | Best condition 0 |
| | 9.8-19.7 | 22 |
| | 6.6- 9.8 | 29 |
| Lake Nebagamon values → | 3.3- 6.6 | 30 |
| | <3.3 | Worst condition 19 |

Comparing other lakes in northwest Wisconsin to the 1992 data for Lake Nebagamon, the above data show, during the period 1966 to 1979, 53 percent had higher total phosphorous concentrations, 23 percent had higher chlorophyll *a* concentrations, and 19 percent had less water clarity.

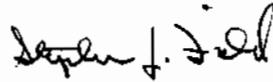
A second approach to assessing the "health" or trophic status of a lake is to use Carlson's Trophic State Index (TSI). Graphic illustrations of the Trophic State Index for Lake Nebagamon are shown on figures 3a, 3b, and 3c. The data from 1992 show Lake Nebagamon to be meso-eutrophic or one with moderate to many nutrients.

Ms. Swan Herlevi, June 23, 1993, page 6

The data that has been collected for Lake Nebagamon 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 a 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 a large initial 'S' and 'F'.

Stephen J. Field
Biologist

Enclosures

cc: Dan Ryan, DNR, Spooner

Table 1. Lake-depth profiles for Lake Nebagamon, Southeast Bay, at Lake Nebagamon, Wisconsin, 1992 water year

DISTRICT CODE 55

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY
462928091413500 - L NEBAGAMON SE BAY (CENTER) @ LAKE NEBAGAMON, W

PROCESS DATE 12-30-92

WATER-QUALITY DATA

| 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) |
|----------|---|---|--|--|--|
| MAR 1992 | | | | | |
| 03... | 1.50 | 1.0 | 116 | 6.9 | 10.7 |
| 03... | 3.00 | 1.0 | 114 | 7.0 | 10.8 |
| 03... | 6.00 | 2.0 | 114 | 7.0 | 10.4 |
| 03... | 9.00 | 3.0 | 113 | 7.1 | 10.2 |
| 03... | 12.0 | 3.0 | 113 | 7.1 | 9.4 |
| 03... | 15.0 | 3.5 | 114 | 7.1 | 8.8 |
| 03... | 18.0 | 3.5 | 114 | 7.1 | 8.0 |
| 03... | 21.0 | 4.0 | 116 | 7.0 | 6.8 |
| 03... | 24.0 | 4.5 | 118 | 7.0 | 5.6 |
| 03... | 27.0 | 4.5 | 122 | 6.9 | 5.2 |
| 03... | 30.0 | 4.5 | 123 | 6.9 | 4.6 |
| 03... | 33.0 | 4.5 | 125 | 6.9 | 4.2 |
| 03... | 36.0 | 4.5 | 128 | 6.8 | 3.6 |
| 03... | 39.0 | 4.5 | 132 | 6.8 | 2.2 |
| 03... | 42.0 | 4.5 | 138 | 6.8 | 0.6 |
| 03... | 44.0 | 5.0 | 144 | 6.8 | 0.3 |
| 03... | 45.0 | -- | -- | -- | -- |
| MAY | | | | | |
| 12... | 1.50 | 13.0 | 80 | 7.9 | 10.0 |
| 12... | 3.00 | 13.0 | 80 | 7.8 | 9.9 |
| 12... | 6.00 | 13.0 | 80 | 7.8 | 9.9 |
| 12... | 9.00 | 13.0 | 80 | 7.8 | 9.9 |
| 12... | 12.0 | 13.0 | 80 | 7.8 | 9.9 |
| 12... | 15.0 | 12.5 | 81 | 7.8 | 9.9 |
| 12... | 18.0 | 12.5 | 81 | 7.8 | 9.9 |
| 12... | 21.0 | 12.5 | 81 | 7.8 | 9.9 |
| 12... | 24.0 | 12.0 | 81 | 7.8 | 9.9 |
| 12... | 27.0 | 11.5 | 81 | 7.8 | 9.8 |
| 12... | 30.0 | 10.0 | 81 | 7.8 | 9.5 |
| 12... | 33.0 | 9.0 | 81 | 7.8 | 9.1 |
| 12... | 36.0 | 8.5 | 81 | 7.8 | 8.8 |
| 12... | 39.0 | 8.0 | 81 | 7.8 | 8.0 |
| 12... | 42.0 | 7.5 | 82 | 7.7 | 7.5 |
| 12... | 45.0 | 7.5 | 82 | 7.7 | 7.3 |
| 12... | 48.0 | 7.5 | 83 | 7.7 | 6.9 |
| 12... | 51.0 | 7.0 | 84 | 7.6 | 6.1 |
| 12... | 52.0 | -- | -- | -- | -- |
| JUN | | | | | |
| 10... | 1.50 | 21.0 | 84 | 7.5 | 8.6 |
| 10... | 3.00 | 20.5 | 84 | 7.5 | 8.6 |
| 10... | 6.00 | 20.0 | 84 | 7.5 | 8.5 |
| 10... | 9.00 | 19.0 | 84 | 7.6 | 8.1 |
| 10... | 12.0 | 18.0 | 83 | 7.6 | 7.7 |
| 10... | 15.0 | 16.0 | 83 | 7.6 | 7.2 |
| 10... | 18.0 | 15.0 | 81 | 7.6 | 7.0 |
| 10... | 21.0 | 14.5 | 82 | 7.6 | 6.6 |
| 10... | 24.0 | 13.5 | 81 | 7.6 | 6.2 |
| 10... | 27.0 | 12.0 | 81 | 7.6 | 6.2 |
| 10... | 30.0 | 11.0 | 80 | 7.6 | 6.0 |
| 10... | 33.0 | 10.5 | 80 | 7.6 | 5.5 |
| 10... | 36.0 | 9.0 | 81 | 7.6 | 4.1 |
| 10... | 39.0 | 8.5 | 82 | 7.5 | 3.5 |
| 10... | 42.0 | 8.0 | 85 | 7.5 | 2.3 |
| 10... | 45.0 | 8.0 | 88 | 7.4 | 1.8 |
| 10... | 48.0 | 7.5 | 92 | 7.4 | 1.0 |
| 10... | 51.0 | 7.5 | 95 | 7.4 | 0.4 |
| 10... | 52.0 | -- | -- | -- | -- |

Table 1. Lake-depth profiles for Lake Nebagamon, Southeast Bay, at Lake Nebagamon, Wisconsin, 1992 water year--continued

DISTRICT CODE 55

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY PROCESS DATE 12-30-92
462928091413500 - L NEBAGAMON SE BAY (CENTER) @ LAKE NEBAGAMON, W

WATER-QUALITY DATA

| 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) |
|----------|---|---|--|--|--|
| JUL 1992 | | | | | |
| 22... | 1.50 | 20.5 | 83 | 7.9 | 9.0 |
| 22... | 3.00 | 20.5 | 83 | 7.8 | 9.0 |
| 22... | 6.00 | 20.0 | 82 | 7.8 | 8.7 |
| 22... | 9.00 | 20.0 | 82 | 7.7 | 8.3 |
| 22... | 12.0 | 19.5 | 83 | 7.7 | 7.6 |
| 22... | 15.0 | 18.5 | 83 | 7.7 | 6.2 |
| 22... | 18.0 | 17.0 | 83 | 7.7 | 5.6 |
| 22... | 21.0 | 16.0 | 83 | 7.7 | 5.0 |
| 22... | 24.0 | 15.5 | 83 | 7.6 | 4.2 |
| 22... | 27.0 | 14.5 | 84 | 7.6 | 2.5 |
| 22... | 30.0 | 13.0 | 86 | 7.6 | 1.4 |
| 22... | 33.0 | 10.5 | 88 | 7.6 | 0.9 |
| 22... | 36.0 | 9.5 | 90 | 7.5 | 0.3 |
| 22... | 39.0 | 9.5 | 92 | 7.5 | 0 |
| 22... | 42.0 | 9.0 | 94 | 7.5 | 0 |
| 22... | 45.0 | 8.5 | 96 | 7.4 | 0 |
| 22... | 48.0 | 8.5 | 99 | 7.4 | 0.1 |
| 22... | 51.0 | 8.5 | 99 | 7.4 | 0.1 |
| 22... | 52.0 | -- | -- | -- | -- |
| AUG | | | | | |
| 18... | 1.50 | 20.5 | 87 | 7.0 | 8.1 |
| 18... | 3.00 | 20.5 | 87 | 7.1 | 8.1 |
| 18... | 6.00 | 20.5 | 87 | 7.1 | 8.1 |
| 18... | 9.00 | 20.5 | 87 | 7.1 | 8.0 |
| 18... | 12.0 | 20.5 | 87 | 7.2 | 8.0 |
| 18... | 15.0 | 20.5 | 88 | 7.2 | 5.7 |
| 18... | 18.0 | 19.0 | 88 | 7.2 | 1.9 |
| 18... | 21.0 | 17.5 | 88 | 7.2 | 0.9 |
| 18... | 24.0 | 15.5 | 86 | 7.2 | 1.1 |
| 18... | 27.0 | 14.0 | 88 | 7.2 | 0.1 |
| 18... | 30.0 | 13.0 | 89 | 7.2 | 0.1 |
| 18... | 33.0 | 11.5 | 92 | 7.2 | 0 |
| 18... | 36.0 | 10.0 | 96 | 7.2 | 0 |
| 18... | 39.0 | 9.5 | 97 | 7.2 | 0 |
| 18... | 42.0 | 9.0 | 106 | 7.2 | 0 |
| 18... | 45.0 | 9.0 | 110 | 7.2 | 0 |
| 18... | 48.0 | 8.5 | 117 | 7.2 | 0 |
| 18... | 51.0 | 8.5 | 121 | 7.2 | 0 |
| 18... | 52.0 | -- | -- | -- | -- |

Table 2. Lake water-quality data for Lake Nebagamon, West Bay, and Lake Nebagamon, Northeast Bay, at Lake Nebagamon, Wisconsin, 1992 water year

STREAMS TRIBUTARY TO LAKE SUPERIOR

463034091425300 LAKE NEBAGAMON, WEST BAY, AT LAKE NEBAGAMON, WI

LOCATION --Lat 46°30'34", long 91°42'53", in NE 1/4 SW 1/4 sec.35, T.46 N., R.11 W., Douglas County, Hydrologic Unit 04010301, at Lake Nebagamon.

PERIOD OF RECORD --May to August 1992.

REMARKS --Lake sampled in west bay at a depth of about 20 ft. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MAY 12 TO AUGUST 18, 1992
(Milligrams per liter unless otherwise indicated)

| | May 12 | June 10 | July 22 | Aug. 18 |
|-------------------------------------|--------|---------|---------|---------|
| Depth of sample (ft) | 1.5 | 1.5 | 1.5 | 1.5 |
| Lake stage (ft) | 88.47 | 87.59 | 88.13 | 87.47 |
| Specific conductance (µS/cm) | 80 | 86 | 84 | 88 |
| pH (units) | 7.8 | 7.5 | 7.9 | 7.0 |
| Water temperature (°C) | 13.0 | 20.5 | 20.5 | 21.0 |
| Secchi-depth (meters) | 1.7 | 2.1 | 2.0 | 1.5 |
| Dissolved oxygen | 10.1 | 8.8 | 8.7 | 8.5 |
| Phosphorus, total (as P) | <0.020 | 0.012 | 0.019 | 0.021 |
| Chlorophyll a, phytoplankton (µg/L) | 8.0 | 4.0 | 12 | 13 |

463050091412300 LAKE NEBAGAMON, NORTHEAST BAY, AT LAKE NEBAGAMON, WI

LOCATION --Lat 46°30'50", long 91°41'23", in NE 1/4 NW 1/4 sec.36, T.47 N., R.11 W., Douglas County, Hydrologic Unit 04010301, at Lake Nebagamon.

PERIOD OF RECORD --May to August 1992.

REMARKS --Lake sampled in northeast bay. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MAY 12 TO AUGUST 18, 1992
(Milligrams per liter unless otherwise indicated)

| | May 12 | June 10 | July 22 | Aug. 18 |
|-------------------------------------|--------|---------|---------|---------|
| Depth of sample (ft) | 1.5 | 1.5 | 1.5 | 1.5 |
| Lake stage (ft) | 88.47 | 87.59 | 88.13 | 87.47 |
| Specific conductance (µS/cm) | 81 | 83 | 84 | 88 |
| pH (units) | 7.8 | 7.6 | 7.9 | 7.4 |
| Water temperature (°C) | 13.5 | 23.0 | 21.0 | 21.5 |
| Secchi-depth (meters) | 1.7 | 2.1 | 2.1 | 1.5 |
| Dissolved oxygen | 10.1 | 8.4 | 8.8 | 8.8 |
| Phosphorus, total (as P) | 0.020 | 0.015 | 0.019 | 0.016 |
| Chlorophyll a, phytoplankton (µg/L) | 8.0 | 6.0 | 13 | 12 |

Table 3a.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, NE Bay, 1992 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. | |
| 5/12/92 | 1.7 | 5.6 | 52 | 1.5 | 0.020 | 20 | 51 | 8 | 51 | -- |
| 6/10/92 | 2.1 | 6.9 | 49 | 1.5 | 0.015 | 15 | 49 | 6 | 48 | -- |
| 7/22/92 | 2.1 | 6.9 | 49 | 1.5 | 0.019 | 19 | 51 | 12.7 | 54 | -- |
| 8/18/92 | 1.5 | 4.9 | 54 | 1.5 | 0.016 | 16 | 50 | 12.0 | 54 | -- |

Table 3b.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, SE Bay, 1992 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. | |
| 5/12/92 | 1.7 | 5.6 | 52 | 1.5 | 0.020 | 20 | 51 | 8 | 51 | <0.002 |
| | - | - | - | 51 | 0.044 | 44 | - | - | - | 0.014 |
| 6/10/92 | 2.1 | 6.9 | 49 | 1.5 | 0.017 | 17 | 50 | 4 | 45 | -- |
| | - | - | - | 49 | 0.119 | 119 | - | - | - | -- |
| 7/22/92 | 2.1 | 6.9 | 49 | 1.5 | 0.022 | 22 | 52 | 13.9 | 55 | -- |
| | - | - | - | 50 | 0.060 | 60 | - | - | - | -- |
| 8/18/92 | 1.8 | 5.9 | 52 | 1.5 | 0.014 | 14 | 49 | 10.2 | 52 | -- |
| | - | - | - | 50 | 0.060 | 60 | - | - | - | -- |

Table 3c.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, West Bay, 1992 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. | |
| 5/12/92 | 1.7 | 5.6 | 52 | 1.5 | 0.020 | 20 | 51 | 8 | 51 | -- |
| 6/10/92 | 2.1 | 6.9 | 49 | 1.5 | 0.012 | 12 | 47 | 4 | 45 | -- |
| 7/22/92 | 2.0 | 6.6 | 50 | 1.5 | 0.019 | 19 | 51 | 11.7 | 53 | -- |
| 8/18/92 | 1.5 | 4.9 | 54 | 1.5 | 0.021 | 21 | 52 | 12.5 | 54 | -- |

Table 4. Lake stages for Lake Nebagamon at Lake Nebagamon, Wisconsin, 1992 water year

STREAMS TRIBUTARY TO LAKE SUPERIOR

462928091413500 LAKE NEBAGAMON, SOUTHEAST BAY AT DEEP HOLE, AT LAKE NEBAGAMON, WI

LOCATION.--Lat 46°29'28", long 91°41'35", in SW 1/4 SW 1/4 sec.1, T.46 N., R.11 W., Douglas County, Hydrologic Unit 04010301, at Lake Nebagamon.

DRAINAGE AREA.--40.9 mi².

LAKE-STAGE RECORDS

PERIOD OF RECORD.--March to September 1992.

GAGE.--Non-recording staff gage. Staff gage read by Edward Girzi; gage is located near observer's residence.

EXTREMES FOR CURRENT YEAR.--Maximum gage height observed, 89.88 ft, Apr. 23; minimum observed, 86.77 ft, Mar. 3.

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 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2 | --- | --- | --- | --- | --- | --- | --- | 89.15 | --- | --- | --- | 87.49 |
| 3 | --- | --- | --- | --- | --- | 86.77 | --- | --- | --- | 88.49 | --- | --- |
| 4 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 88.70 | --- | --- |
| 5 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.59 | --- |
| 6 | --- | --- | --- | --- | --- | --- | --- | 88.72 | --- | --- | --- | --- |
| 7 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 88.85 | --- | --- |
| 8 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 88.85 | --- | --- |
| 9 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.53 |
| 10 | --- | --- | --- | --- | --- | --- | --- | 88.42 | 87.59 | --- | --- | --- |
| 11 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12 | --- | --- | --- | --- | --- | --- | --- | 88.47 | --- | --- | 87.55 | --- |
| 13 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 14 | --- | --- | --- | --- | --- | --- | --- | 88.17 | --- | --- | --- | --- |
| 15 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 88.49 | --- | --- |
| 16 | --- | --- | --- | --- | --- | --- | --- | 88.26 | --- | --- | --- | 87.59 |
| 17 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 18 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.47 | --- |
| 19 | --- | --- | --- | --- | --- | --- | --- | --- | 87.61 | --- | 87.46 | --- |
| 20 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 21 | --- | --- | --- | --- | --- | --- | 89.49 | 88.13 | --- | --- | --- | --- |
| 22 | --- | --- | --- | --- | --- | --- | 89.76 | --- | --- | 88.13 | --- | --- |
| 23 | --- | --- | --- | --- | --- | --- | 89.88 | --- | --- | 88.11 | --- | --- |
| 24 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.56 |
| 25 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 26 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.49 | --- |
| 27 | --- | --- | --- | --- | --- | --- | --- | 87.95 | 87.64 | --- | --- | --- |
| 28 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29 | --- | --- | --- | --- | --- | --- | --- | --- | 87.65 | 87.81 | --- | --- |
| 30 | --- | --- | --- | --- | --- | --- | 89.32 | --- | --- | --- | --- | 87.50 |
| 31 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| MAX | --- | --- | --- | --- | --- | 86.77 | 89.88 | 89.15 | 87.65 | 88.85 | 87.59 | 87.59 |
| MIN | --- | --- | --- | --- | --- | 86.77 | 89.32 | 87.95 | 87.59 | 87.81 | 87.46 | 87.49 |

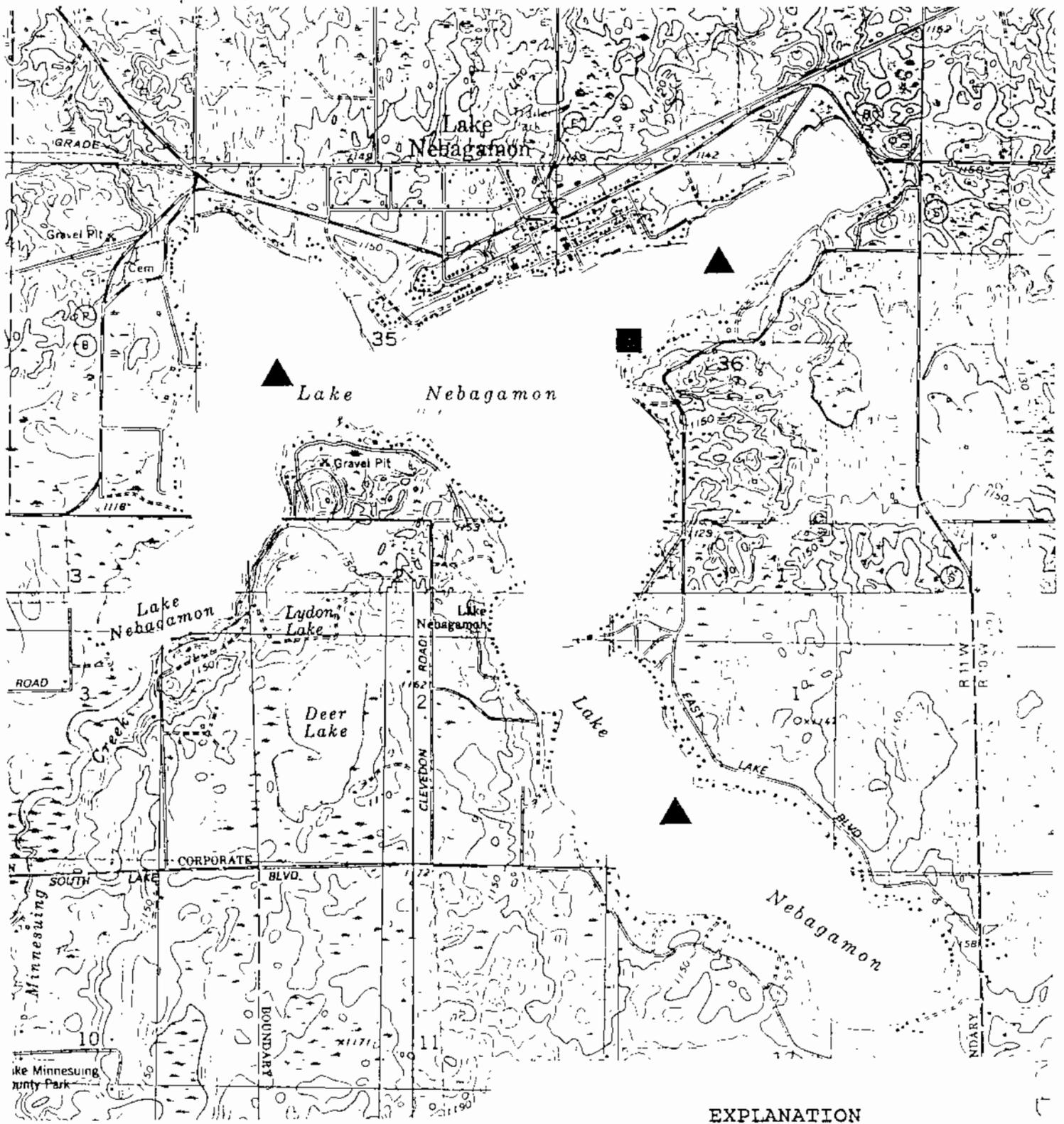


Figure 1. Location of sampling sites and staff gage on Lake Nebagamon at Lake Nebagamon, Wisconsin.

STREAMS TRIBUTARY TO LAKE SUPERIOR

462928091413500 LAKE NEBAGAMON, SOUTHEAST BAY AT DEEP HOLE, AT LAKE NEBAGAMON, WI--CONTINUED

WATER-QUALITY RECORDS

PERIOD OF RECORD.--March to August 1992.

REMARKS.--Lake sampled in southeast bay at a depth of about 52 ft. Lake ice-covered during March sampling. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MARCH 03 TO AUGUST 18, 1992
(Milligrams per liter unless otherwise indicated)

| | Mar. 03 | | May 12 | | June 10 | | July 22 | | Aug. 18 | |
|--|---------|-----|--------|-------|---------|-------|---------|-------|---------|-------|
| Depth of sample (ft) | 1.5 | 44 | 1.5 | 51 | 1.5 | 49 | 1.5 | 50 | 1.5 | 50 |
| Lake stage (ft) | 86.77 | | 88.47 | | 87.59 | | 88.13 | | 87.47 | |
| Specific conductance (µS/cm) | 116 | 144 | 80 | 84 | 84 | 95 | 83 | 99 | 87 | 121 |
| pH (units) | 6.9 | 6.8 | 7.9 | 7.6 | 7.5 | 7.4 | 7.9 | 7.4 | 7.0 | 7.1 |
| Water temperature (°C) | 1.0 | 5.0 | 13.0 | 7.0 | 21.0 | 7.5 | 20.5 | 8.5 | 20.5 | 8.5 |
| Color (Pt-Co. scale) | --- | --- | 60 | 60 | --- | --- | --- | --- | --- | --- |
| Turbidity (NTU) | --- | --- | 1.3 | 5.6 | --- | --- | --- | --- | --- | --- |
| Secchi-depth (meters) | --- | --- | --- | 1.7 | 2.1 | --- | 2.1 | --- | 1.8 | --- |
| Dissolved oxygen | 10.7 | 0.3 | 10.0 | 6.1 | 8.6 | 0.4 | 9.0 | 0.1 | 8.1 | 0.0 |
| Hardness, as CaCO ₃ | --- | --- | 38 | 39 | --- | --- | --- | --- | --- | --- |
| Calcium, dissolved (Ca) | --- | --- | 9.8 | 10 | --- | --- | --- | --- | --- | --- |
| Magnesium, dissolved (Mg) | --- | --- | 3.4 | 3.5 | --- | --- | --- | --- | --- | --- |
| Sodium, dissolved (Na) | --- | --- | 2.3 | 2.3 | --- | --- | --- | --- | --- | --- |
| Potassium, dissolved (K) | --- | --- | 0.8 | 0.8 | --- | --- | --- | --- | --- | --- |
| Alkalinity, as CaCO ₃ | --- | --- | 35 | 37 | --- | --- | --- | --- | --- | --- |
| Sulfate, dissolved (SO ₄) | --- | --- | <5.0 | <5.0 | --- | --- | --- | --- | --- | --- |
| Chloride, dissolved (Cl) | --- | --- | 2.0 | 2.0 | --- | --- | --- | --- | --- | --- |
| Fluoride, dissolved (F) | --- | --- | <0.0 | <0.0 | --- | --- | --- | --- | --- | --- |
| Silica, dissolved (SiO ₂) | --- | --- | 8.2 | 9.3 | --- | --- | --- | --- | --- | --- |
| Solids, dissolved, at 180°C | --- | --- | 74 | 72 | --- | --- | --- | --- | --- | --- |
| Nitrogen, NO ₂ + NO ₃ , diss. (as N) | --- | --- | 0.09 | 0.08 | --- | --- | --- | --- | --- | --- |
| Nitrogen, ammonia, dissolved (as N) | --- | --- | 0.02 | 0.12 | --- | --- | --- | --- | --- | --- |
| Nitrogen, amm. + org., total (as N) | --- | --- | 0.40 | 0.50 | --- | --- | --- | --- | --- | --- |
| Phosphorus, total (as P) | --- | --- | 0.020 | 0.044 | 0.017 | 0.119 | 0.022 | 0.060 | 0.014 | 0.060 |
| Phosphorus, ortho, dissolved (as P) | --- | --- | <0.002 | 0.014 | --- | --- | --- | --- | --- | --- |
| Iron, dissolved (Fe) µg/L | --- | --- | 220 | 420 | --- | --- | --- | --- | --- | --- |
| Manganese, dissolved (Mn) µg/L | --- | --- | 140 | 700 | --- | --- | --- | --- | --- | --- |
| Chlorophyll a, phytoplankton (µg/L) | --- | --- | 8.0 | --- | 4.0 | --- | 14 | --- | 10 | --- |

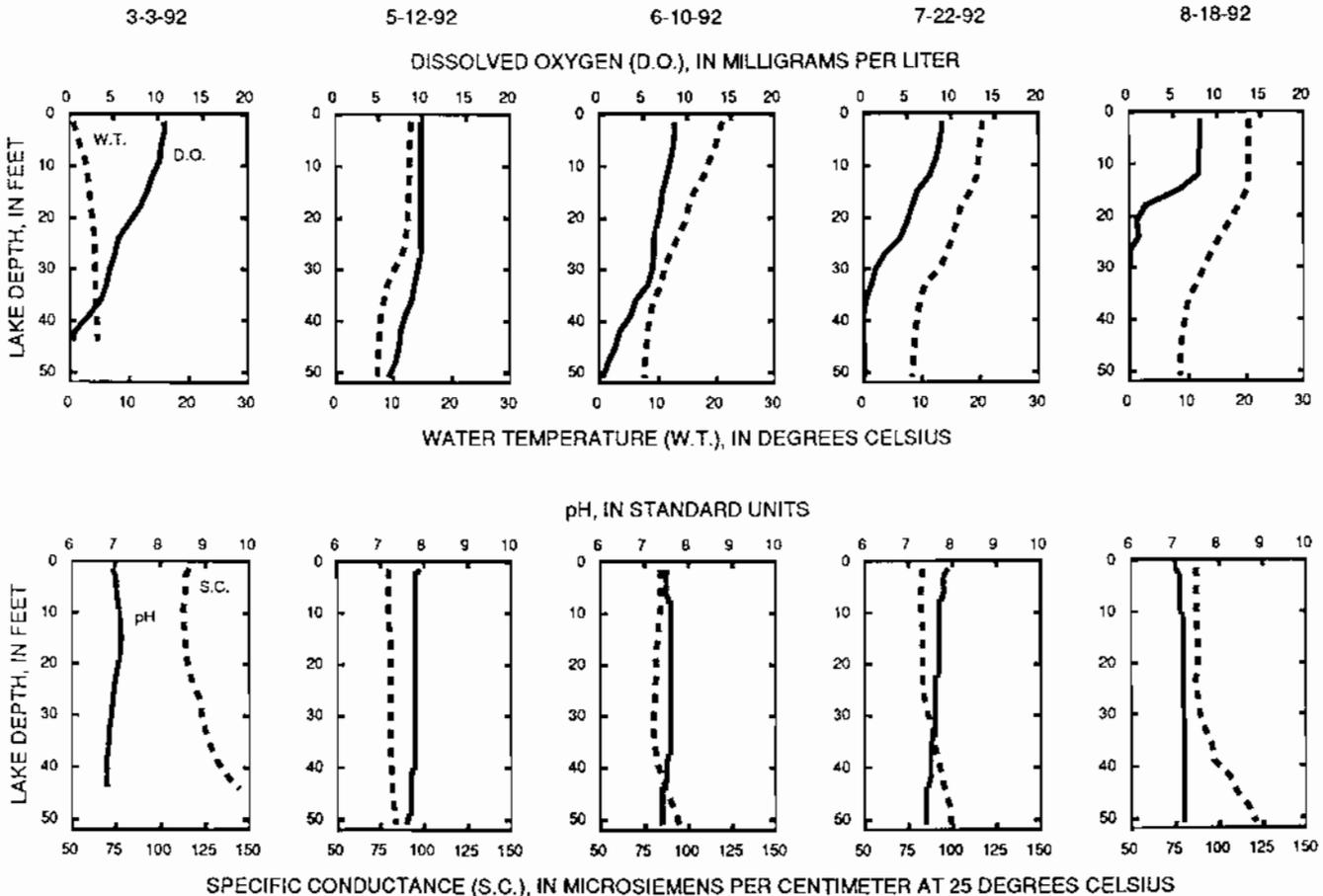


Figure 2. Lake water-quality data for Lake Nebagamon, Southeast Bay, at Lake Nebagamon, Wisconsin, 1992 water year

TROPHIC STATE INDICES
 LAKE NEBAGAMON NE BAY AT LAKE NEBAGAMON, WI.
 DOUGLAS COUNTY

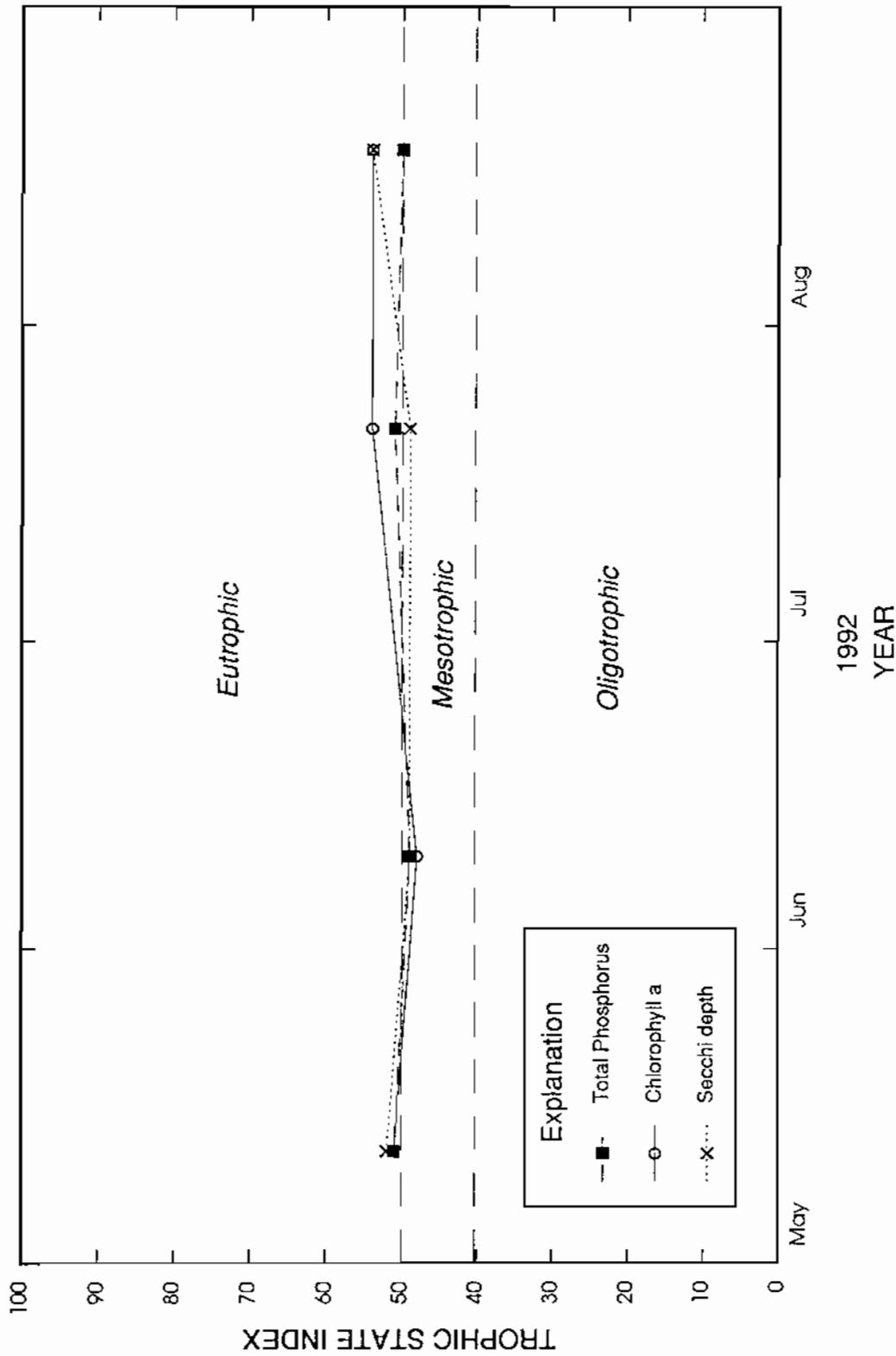


Figure 3a. Trophic State Indices for Lake Nebagamon, Northeast Bay, at Lake Nebagamon, Wisconsin

TROPHIC STATE INDICES
 LAKE NEBAGAMON, SE BAY (DEEP HOLE), AT
 LAKE NEBAGAMON, WI.
 DOUGLAS COUNTY

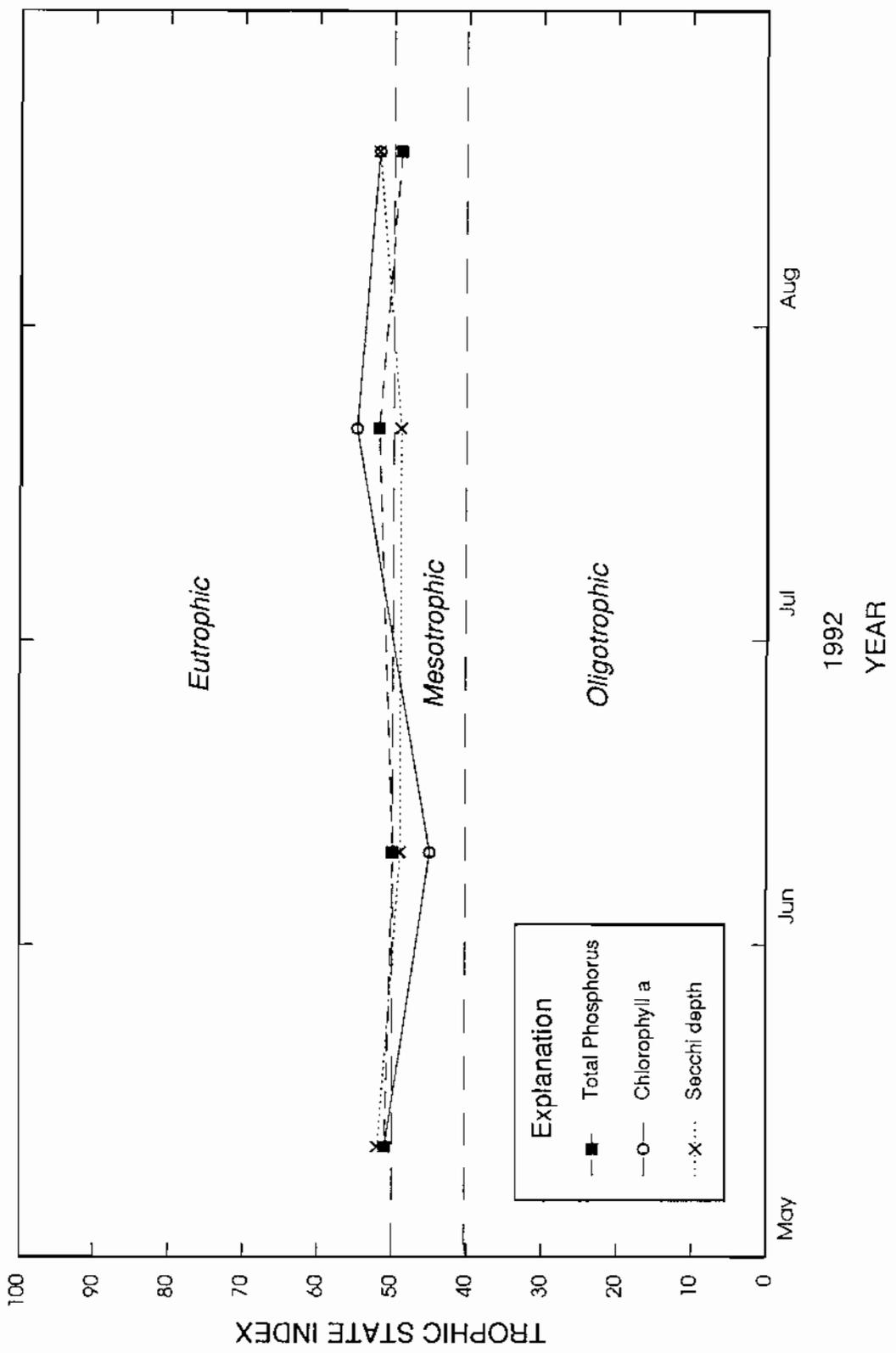


Figure 3b. Trophic State Indices for Lake Nebagamon, Southeast Bay, at Lake Nebagamon, Wisconsin

TROPHIC STATE INDICES
 LAKE NEBAGAMON, WEST BAY, AT LAKE NEBAGAMON, WI.
 DOUGLAS COUNTY

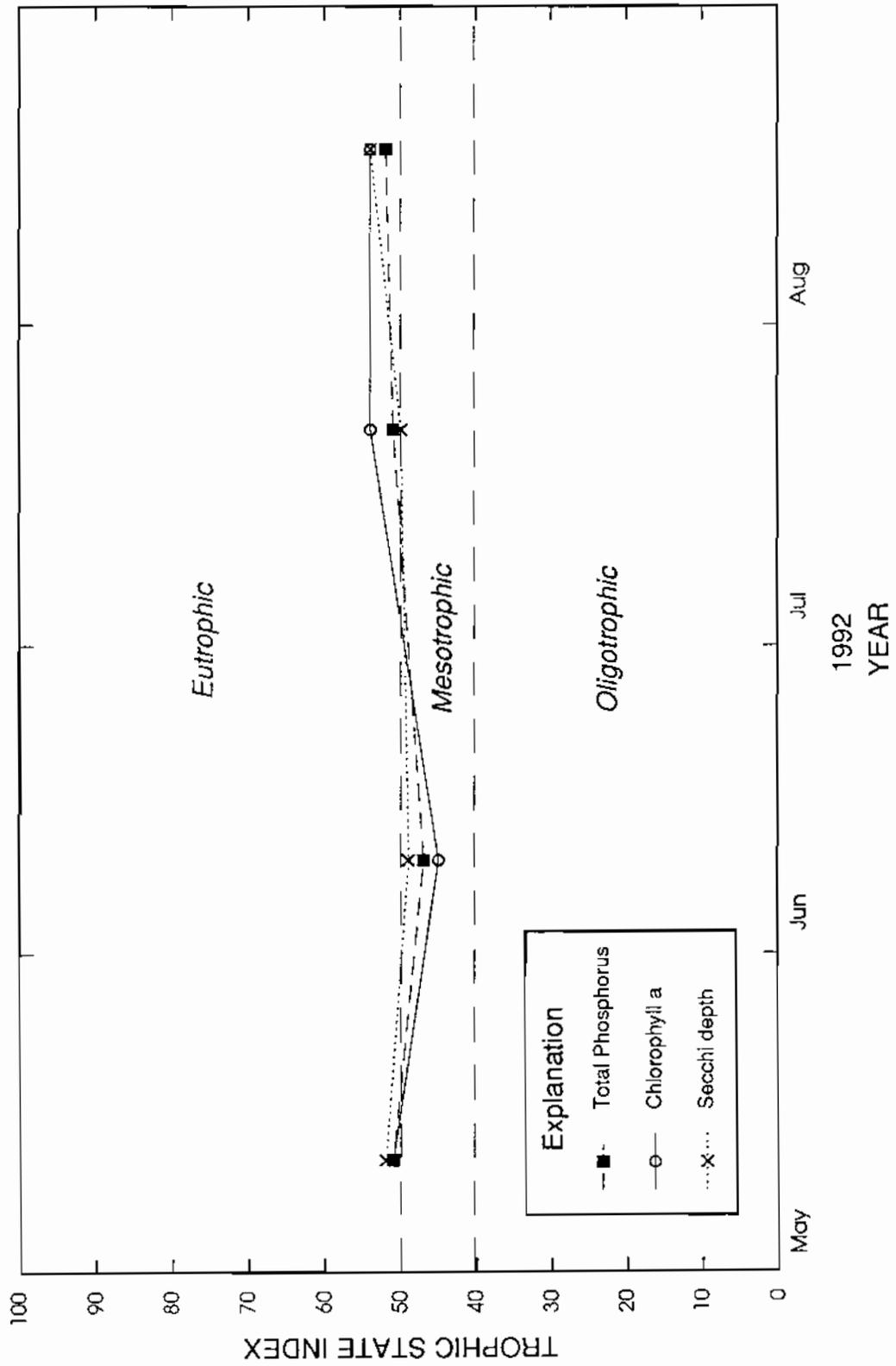


Figure 3c. Trophic State Indices for Lake Nebagamon, West Bay, at Lake Nebagamon, Wisconsin



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 28, 1994

Mr. Edward Girzi
11691 East Point Road
Lake Nebagamon, Wisconsin 54849

Dear Mr Girzi:

This letter describes the progress on the evaluation of the water quality of Lake Nebagamon according to the data collected from October 1992 to September 1993 as stated in our agreement. Please read the "U.S. Geological Survey Lake Monitoring Program in Wisconsin", sent to you last year, before proceeding with this letter.

In a brief summary, based on the 1993 data:

- The water quality of Lake Nebagamon is good to fair and can be classified as a meso-eutrophic lake or one with moderate to many nutrients. The water quality of the lake is similar at all three monitoring sites.
- Algal growth appears to be dependent upon the amount of available phosphorus rather than nitrogen.
- In July and August, during summer stratification, oxygen disappears from the bottom portion of the lake at the deep hole which is then unable to support a fish population.
- During the summer anoxic (devoid of oxygen) period, there are minor amounts of phosphorus being released from the bottom sediments.
- The data enclosed herein are provisional until published.

Lake Nebagamon has a surface area of 914 acres (1.43 square miles) and a drainage area at the outlet of 40.9 square miles for a drainage area/lake size ratio of 28.6:1. 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.).

Three sites were sampled in Lake Nebagamon. The site in the Southeast Bay is located at the deepest spot in the lake at a depth of about 51 feet and is the site where most of the water-quality data were collected. Only surface samples were collected from sites in the Northeast Bay at a 40-foot depth, and the West Bay at a 20-foot depth.

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

Table 1. Lake stages for Lake Nebagamon, 1993 water year

Table 2. Lake-depth profiles for Lake Nebagamon, Southeast Bay, 1993 water year

Table 3a. Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, Northeast Bay, 1993 water year

Table 3b. Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, Southeast Bay, 1993 water year

Table 3c. Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, West Bay, 1993 water year

Table 4. Lake water-quality data for Lake Nebagamon, West Bay, and Lake Nebagamon, Northeast Bay, 1993 water year

Figure 1. Location of sampling sites and staff gage on Lake Nebagamon

Figure 2. Lake water-quality data for Lake Nebagamon, Southeast Bay, 1993 water year

Figure 3a. Trophic state indices for Lake Nebagamon, Northeast Bay

Figure 3b. Trophic state indices for Lake Nebagamon, Southeast Bay

Figure 3c. Trophic state indices for Lake Nebagamon, West Bay

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, 1993".

LAKE-STAGE FLUCTUATIONS

Lake-stages were read by Edward Girzi, near his residence. He should be commended for the excellent job he did. Lake-stage data are listed in table 1. Lake stages fluctuated 1.36 feet and ranged from 86.52 feet on September 18 to 87.88 feet on June 2.

LAKE-DEPTH PROFILES

Profiles of water temperature, dissolved oxygen, pH, and specific conductance at the deep hole are listed in table 2 and shown in figure 2. No abnormalities in the data are apparent. The lake thermally stratifies during summer. During July and August, the bottom 20 feet became anoxic (devoid of oxygen) and were unable to support fish. The levels of pH are within acceptable limits to support aquatic life. Because of the buffering capacity of the lake water, Lake Nebagamon is not susceptible to the effects of acid rain.

SELECTED ANALYSES

Analyses of selected constituents for May 10 for samples collected at 1.5- and 48-foot depths at the deep hole are listed in figure 2. The lake was not completely mixed on this date. 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 at the deep hole 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 39:1 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.

MAY, JUNE, JULY AND AUGUST WATER QUALITY

The data for total phosphorus, chlorophyll *a*, and Secchi-depth readings, are listed in tables 3a, 3b, 3c, and 4 and on figure 2. The water quality of the lake is similar at all three sites.

Lake Nebagamon, Northeast Bay

Total phosphorus: Total phosphorus concentrations sampled at a 1.5-foot depth range from 0.012 mg/L in July to <0.020 mg/L in May. All values fall within the regional values previously referenced.

Chlorophyll *a*: Chlorophyll *a* concentrations, which indicate algal biomass, ranged from 4.21 µg/L in July to 10.8 µg/L in May. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 4.9 feet in May to 6.9 feet in July. These data are within the regional values.

Lake Nebagamon, Southeast Bay

Total phosphorus: Total phosphorus concentrations sampled at a 1.5-foot depth range from 0.013 mg/L in July to 0.014 mg/L in May, June and August. All values fall within the regional values previously referenced.

Concentration of total phosphorus 1.5 feet above the lake bottom ranged from 0.020 mg/L in July and August to 0.032 mg/L in June. These concentrations are indicative of minor phosphorus release from the bottom sediments during anoxic (absence of oxygen) periods.

Chlorophyll *a*: Chlorophyll *a* concentrations, which indicate algal biomass, ranged from 4.89 µg/L in August to 9.84 µg/L in June. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 5.6 feet in May to 5.9 feet in June, July, and August. These data are within the regional values.

Lake Nebagamon, West Bay

Total phosphorus: Total phosphorus concentrations sampled at a 1.5-foot depth range from 0.013 mg/L in June to 0.020 mg/L in July. All values fall within the regional values previously referenced.

Chlorophyll a: Chlorophyll a concentrations, which indicate algal biomass, ranged from 5.88 $\mu\text{g/L}$ in July to 8.79 $\mu\text{g/L}$ in June. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 4.9 feet in May to 5.9 feet in June, July, and 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 <u>a</u> equivalent ($\mu\text{g/L}$) | 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 |

The water quality at all three sites is similar; therefore, the discussion is continued below.

Using the above criteria to evaluate the mean summer (July-August) 1993 data shown in tables 3a, 3b, and 3c for all three sites on Lake Nebagamon, surface total phosphorus and chlorophyll a concentrations indicate good water quality, while Secchi-disc depths indicate fair water quality.

Using the data from "Limnological Characteristics of Wisconsin Lakes," 1983, by Lillie and Mason, a comparison of the 1993 mean summer data (July and August) for total phosphorus, chlorophyll a, and Secchi depths for all three sites on Lake Nebagamon to other lakes in northwest Wisconsin are shown below:

| | <u>Parameter</u> | Percentage of distribution of lakes in northwest Wisconsin within these <u>concentrations</u> |
|-------------------------|----------------------------|--|
| | Total phosphorus (mg/L) | |
| | <.010 | Best condition 12 |
| Lake Nebagamon values → | .010-.020 | 35 |
| | .020-.030 | 23 |
| | .030-.050 | 18 |
| | .050-.100 | 8 |
| | .100-.150 | 3 |
| | >.150 | Worst condition 1 |
| | Chlorophyll a (µg/L) | |
| | 0- 5 | Best condition 29 |
| Lake Nebagamon values → | 5-10 | 36 |
| | 10-15 | 14 |
| | 15-30 | 14 |
| | >30 | Worst condition 9 |
| | Secchi depth (in feet) | |
| | 9.8 | Best condition 22 |
| | 6.6- 9.8 | 29 |
| Lake Nebagamon values → | 3.3- 6.6 | 30 |
| | <3.3 | Worst condition 19 |

Comparing other lakes in northwest Wisconsin to the 1993 data for Lake Nebagamon, the above data show, during the period 1966 to 1979, 53 percent had higher total phosphorous concentrations, 37 percent had higher chlorophyll a concentrations, and 19 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). Graphic illustrations of the Trophic State Index for Lake Nebagamon are shown on figures 3a, 3b, and 3c. The data from 1993 show Lake Nebagamon to be meso-eutrophic or one with moderate to many nutrients.

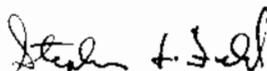
The data that has been collected for Lake Nebagamon from 1992 to 1993 is extremely important for understanding the lake's water quality and managing the lake. To continue with the monitoring as in the past will help to build on this very valuable data base.

Mr. Edward Girzi, June 28, 1994

6

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 a large initial "S".

Stephen J. Field
Biologist

Enclosures

cc: Dan Ryan, DNR, Spooner

Table 1. Lake stages for Lake Nebagamon, 1993 water year

STREAMS TRIBUTARY TO LAKE SUPERIOR

462928091413500 LAKE NEBAGAMON, SOUTHEAST BAY AT DEEP HOLE, AT LAKE NEBAGAMON, WI

LOCATION.--Lat 46°29'28", long 91°41'35", in SW 1/4 SW 1/4 sec.1, T.46 N., R.11 W., Douglas County, Hydrologic Unit 04010301, at Lake Nebagamon.

DRAINAGE AREA.--40.9 mi².

LAKE-STAGE RECORDS

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

GAGE.--Non-recording staff gage. Staff gage read by Edward Girzi; gage is located near observer's residence

EXTREMES FOR PERIOD OF RECORD.--Maximum gage height observed, 89.88 ft, Apr. 23, 1992, minimum observed, 86.52 ft, Sept. 18, 1993

EXTREMES FOR CURRENT YEAR.--Maximum gage height observed, 87.88 ft, June 2; minimum observed, 86.52 ft, Sept. 18.

GAGE HEIGHT, FEET, WATER YEAR OCTOBER 1992 TO SEPTEMBER 1993
DAILY MEAN VALUES

| DAY | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|-----|-----|-----|-----|-----|-----|-------|-----|-------|-------|-------|-------|-------|
| 1 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.38 | --- | --- |
| 2 | --- | --- | --- | --- | --- | --- | --- | --- | 87.88 | --- | --- | 86.54 |
| 3 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 4 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.88 | --- |
| 5 | --- | --- | --- | --- | --- | 86.57 | --- | --- | --- | --- | --- | --- |
| 6 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 7 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.33 | --- | --- |
| 8 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.54 |
| 9 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 10 | --- | --- | --- | --- | --- | --- | --- | 87.72 | 87.74 | --- | 86.82 | --- |
| 11 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.81 | --- |
| 12 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 14 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 15 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.54 | --- | 86.54 |
| 16 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 17 | --- | --- | --- | --- | --- | --- | --- | --- | 87.64 | --- | --- | --- |
| 18 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.69 | 86.52 |
| 19 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 20 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 21 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.31 | 86.64 | --- |
| 22 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.62 |
| 24 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.68 | --- |
| 25 | --- | --- | --- | --- | --- | --- | --- | --- | 87.74 | --- | --- | --- |
| 26 | --- | --- | --- | --- | --- | --- | --- | 87.60 | --- | --- | --- | --- |
| 27 | --- | --- | --- | --- | --- | --- | --- | --- | 87.62 | --- | --- | --- |
| 28 | --- | --- | --- | --- | --- | --- | --- | --- | 87.54 | 87.10 | --- | --- |
| 29 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.62 |
| 30 | --- | --- | --- | --- | --- | --- | --- | --- | 87.38 | --- | --- | --- |
| 31 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.00 | --- | --- |

Table 2. Lake-depth profiles for Lake Nebagamon, Southeast Bay, 1993 water year

462928091413500 - L NEBAGAMON SE BAY (CENTER) @ LAKE NEBAGAMON, W

WATER-QUALITY DATA

| 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) |
|----------|---|---|--|--|--|
| MAR 1993 | | | | | |
| 05... | 1.50 | 1.5 | 161 | 8.3 | 11.3 |
| 05... | 3.00 | 2.0 | 105 | 8.3 | 11.4 |
| 05... | 6.00 | 2.5 | 100 | 8.2 | 10.9 |
| 05... | 9.00 | 3.0 | 100 | 8.1 | 10.5 |
| 05... | 12.0 | 3.0 | 98 | 8.1 | 10.2 |
| 05... | 15.0 | 3.5 | 97 | 8.0 | 9.4 |
| 05... | 18.0 | 3.5 | 99 | 8.0 | 8.6 |
| 05... | 21.0 | 3.5 | 99 | 8.0 | 7.2 |
| 05... | 24.0 | 4.0 | 99 | 7.9 | 5.9 |
| 05... | 27.0 | 4.0 | 101 | 7.9 | 4.8 |
| 05... | 30.0 | 4.0 | 103 | 7.8 | 4.4 |
| 05... | 33.0 | 4.0 | 106 | 7.8 | 3.7 |
| 05... | 36.0 | 4.0 | 108 | 7.8 | 3.0 |
| 05... | 39.0 | 4.5 | 110 | 7.8 | 2.0 |
| 05... | 42.0 | 4.5 | 115 | 7.7 | 0.6 |
| 05... | 45.0 | 4.5 | 119 | 7.6 | 0.4 |
| 05... | 48.0 | 4.5 | 136 | 7.6 | 0.2 |
| 05... | 51.0 | 5.0 | 178 | 7.4 | 0.2 |
| 05... | 51.5 | -- | -- | -- | -- |
| MAY | | | | | |
| 10... | 1.50 | 11.5 | 89 | 7.7 | 10.0 |
| 10... | 3.00 | 11.5 | 88 | 7.7 | 10.1 |
| 10... | 6.00 | 11.5 | 88 | 7.7 | 10.1 |
| 10... | 9.00 | 11.0 | 88 | 7.7 | 10.1 |
| 10... | 12.0 | 10.5 | 90 | 7.7 | 10.2 |
| 10... | 15.0 | 10.5 | 90 | 7.7 | 10.2 |
| 10... | 18.0 | 10.0 | 90 | 7.7 | 10.1 |
| 10... | 21.0 | 10.0 | 91 | 7.7 | 10.1 |
| 10... | 24.0 | 9.5 | 91 | 7.7 | 10.1 |
| 10... | 27.0 | 9.0 | 91 | 7.7 | 9.8 |
| 10... | 30.0 | 7.5 | 91 | 7.7 | 8.8 |
| 10... | 33.0 | 7.0 | 92 | 7.7 | 8.6 |
| 10... | 36.0 | 7.0 | 92 | 7.7 | 8.5 |
| 10... | 39.0 | 7.0 | 92 | 7.6 | 8.4 |
| 10... | 42.0 | 6.5 | 92 | 7.6 | 8.2 |
| 10... | 45.0 | 6.5 | 92 | 7.6 | 8.0 |
| 10... | 48.0 | 6.5 | 92 | 7.6 | 8.0 |
| 10... | 50.0 | -- | -- | -- | -- |
| JUN | | | | | |
| 27... | 1.50 | 18.5 | 83 | 7.1 | 8.6 |
| 27... | 3.00 | 18.5 | 83 | 7.1 | 8.6 |
| 27... | 6.00 | 18.5 | 83 | 7.1 | 8.6 |
| 27... | 9.00 | 18.5 | 83 | 7.2 | 8.7 |
| 27... | 12.0 | 18.0 | 83 | 7.2 | 8.7 |
| 27... | 15.0 | 18.0 | 83 | 7.2 | 8.7 |
| 27... | 18.0 | 18.0 | 83 | 7.2 | 8.7 |
| 27... | 21.0 | 18.0 | 83 | 7.2 | 8.7 |
| 27... | 24.0 | 15.5 | 85 | 7.2 | 6.4 |
| 27... | 27.0 | 13.0 | 86 | 7.2 | 5.5 |
| 27... | 30.0 | 12.0 | 86 | 7.2 | 4.9 |
| 27... | 33.0 | 11.0 | 89 | 7.2 | 3.8 |
| 27... | 36.0 | 9.5 | 91 | 7.2 | 2.5 |
| 27... | 39.0 | 9.0 | 91 | 7.1 | 2.0 |
| 27... | 42.0 | 8.5 | 92 | 7.1 | 1.6 |
| 27... | 45.0 | 8.0 | 94 | 7.1 | 1.0 |
| 27... | 48.0 | 8.0 | 94 | 7.1 | 0.8 |
| 27... | 51.0 | -- | -- | -- | -- |

Table 2. Lake-depth profiles for Lake Nebagamon, Southeast Bay, 1993 water year--continued

462928091413500 - L NEBAGAMON SE BAY (CENTER) @ LAKE NEBAGAMON, W

WATER-QUALITY DATA

| 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) |
|----------|---|---|--|--|--|
| JUL 1993 | | | | | |
| 15... | 1.50 | 21.0 | 82 | 7.9 | 8.4 |
| 15... | 3.00 | 21.0 | 82 | 7.8 | 8.4 |
| 15... | 6.00 | 20.0 | 81 | 7.6 | 8.4 |
| 15... | 9.00 | 20.5 | 81 | 7.6 | 8.3 |
| 15... | 12.0 | 20.5 | 80 | 7.6 | 7.9 |
| 15... | 15.0 | 19.5 | 79 | 7.5 | 6.9 |
| 15... | 18.0 | 19.0 | 82 | 7.5 | 6.2 |
| 15... | 21.0 | 17.5 | 83 | 7.5 | 4.8 |
| 15... | 24.0 | 15.0 | 85 | 7.5 | 3.1 |
| 15... | 27.0 | 14.0 | 87 | 7.4 | 3.0 |
| 15... | 30.0 | 12.0 | 87 | 7.4 | 3.0 |
| 15... | 33.0 | 11.5 | 88 | 7.4 | 2.5 |
| 15... | 36.0 | 10.5 | 89 | 7.4 | 1.0 |
| 15... | 39.0 | 9.5 | 93 | 7.4 | 0.3 |
| 15... | 42.0 | 9.0 | 94 | 7.3 | 0.1 |
| 15... | 45.0 | 8.5 | 95 | 7.3 | 0.1 |
| 15... | 48.0 | 8.5 | 99 | 7.3 | 0.1 |
| 15... | 51.0 | 8.0 | 102 | 7.3 | 0.1 |
| 15... | 52.0 | -- | -- | -- | -- |
| AUG | | | | | |
| 10... | 1.50 | 22.0 | 89 | 7.9 | 7.7 |
| 10... | 3.00 | 21.5 | 88 | 7.8 | 7.7 |
| 10... | 6.00 | 21.5 | 88 | 7.8 | 7.7 |
| 10... | 9.00 | 21.5 | 88 | 7.7 | 7.5 |
| 10... | 12.0 | 21.0 | 88 | 7.7 | 7.2 |
| 10... | 15.0 | 20.5 | 87 | 7.7 | 6.8 |
| 10... | 18.0 | 20.0 | 88 | 7.6 | 6.6 |
| 10... | 21.0 | 20.0 | 89 | 7.6 | 3.9 |
| 10... | 24.0 | 17.5 | 90 | 7.6 | 0.4 |
| 10... | 27.0 | 14.0 | 91 | 7.6 | 0.4 |
| 10... | 30.0 | 12.5 | 91 | 7.5 | 0.4 |
| 10... | 33.0 | 11.5 | 94 | 7.5 | 0.2 |
| 10... | 36.0 | 10.0 | 100 | 7.5 | 0.1 |
| 10... | 39.0 | 9.0 | 104 | 7.4 | 0.1 |
| 10... | 42.0 | 9.0 | 106 | 7.4 | 0.1 |
| 10... | 45.0 | 8.5 | 110 | 7.4 | 0.1 |
| 10... | 48.0 | 8.5 | 116 | 7.4 | 0.1 |
| 10... | 51.0 | 8.5 | 123 | 7.4 | 0.1 |
| 10... | 51.5 | -- | -- | -- | -- |

Table 3a.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, Northeast Bay, 1993 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. | |
| 05/10/93 | 1.5 | 4.9 | 54 | 1.5 | <0.02 | 20 | 51 | 10.8 | 53 | -- |
| | - | - | - | -- | -- | -- | - | - | - | -- |
| 06/27/93 | 1.8 | 5.9 | 52 | 1.5 | 0.015 | 15 | 49 | 8.88 | 51 | -- |
| | - | - | - | -- | -- | -- | - | - | - | -- |
| 07/15/93 | 2.1 | 6.9 | 49 | 1.5 | 0.012 | 12 | 47 | 4.21 | 46 | -- |
| | - | - | - | -- | -- | -- | - | - | - | -- |
| 08/10/93 | 1.8 | 5.9 | 52 | 1.5 | 0.017 | 17 | 50 | 6.61 | 49 | -- |
| | - | - | - | -- | -- | -- | - | - | - | -- |

Table 3b.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, Southeast Bay, 1993 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. | | |
| 05/10/93 | 1.7 | 5.6 | 1.5 | 0.014 | 14 | 49 | 9.2 | 52 | 0.004 |
| | - | - | 48 | 0.030 | 30 | - | - | - | 0.007 |
| 06/27/93 | 1.8 | 5.9 | 1.5 | 0.014 | 14 | 49 | 9.84 | 52 | -- |
| | - | - | 49 | 0.032 | 32 | - | - | - | -- |
| 07/15/93 | 1.8 | 5.9 | 1.5 | 0.013 | 13 | 48 | 5.17 | 47 | -- |
| | - | - | 49 | 0.020 | 20 | - | - | - | -- |
| 08/10/93 | 1.8 | 5.9 | 1.5 | 0.014 | 14 | 49 | 4.89 | 47 | -- |
| | - | - | 50 | 0.020 | 20 | - | - | - | -- |

Table 3c.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, West Bay, 1993 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. | |
| 05/10/93 | 1.5 | 4.9 | 1.5 | <0.02 | 20 | 8.74 | 51 | -- |
| 06/27/93 | 1.8 | 5.9 | 1.5 | 0.013 | 13 | 8.79 | 51 | -- |
| 07/15/93 | 1.8 | 5.9 | 1.5 | 0.020 | 20 | 5.88 | 48 | -- |
| 08/10/93 | 1.8 | 5.9 | 1.5 | <0.020 | 20 | 6.06 | 48 | -- |

Table 4. Lake water-quality data for Lake Nebagamon, West Bay, and Lake Nebagamon, Northeast Bay, 1993 water year

STREAMS TRIBUTARY TO LAKE SUPERIOR

463034091425300 LAKE NEBAGAMON, WEST BAY, AT LAKE NEBAGAMON, WI

LOCATION.--Lat 46°30'34", long 91°42'53", in NE 1/4 SW 1/4 sec.35, T.46 N., R.11 W., Douglas County, Hydrologic Unit 04010301, at Lake Nebagamon.

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

REMARKS.--Lake sampled in west bay at a depth of about 20 ft. Water-quality analyses by Wisconsin State Laboratory of Hygiene

WATER-QUALITY DATA, MAY 10 TO AUGUST 10, 1993
(Milligrams per liter unless otherwise indicated)

| | May 10 | June 27 | July 15 | Aug 10 |
|-------------------------------------|--------|---------|---------|--------|
| Depth of sample (ft) | 1.5 | 1.5 | 1.5 | 1.5 |
| Lake stage (ft) | 87.72 | 87.62 | 87.62 | 86.82 |
| Specific conductance (μS/cm) | 86 | 83 | 82 | 88 |
| pH (units) | 7.7 | 7.1 | 7.5 | 7.5 |
| Water temperature (°C) | 12.5 | 18.0 | 21.0 | 22.5 |
| Secchi-depth (meters) | 1.5 | 1.8 | 1.8 | 1.8 |
| Dissolved oxygen | 10.5 | 8.5 | 8.6 | 7.9 |
| Phosphorus, total (as P) | <0.020 | 0.013 | 0.020 | <0.020 |
| Chlorophyll a, phytoplankton (μg/L) | 8.7 | 8.8 | 5.9 | 6.1 |

463050091412300 LAKE NEBAGAMON, NORTHEAST BAY, AT LAKE NEBAGAMON, WI

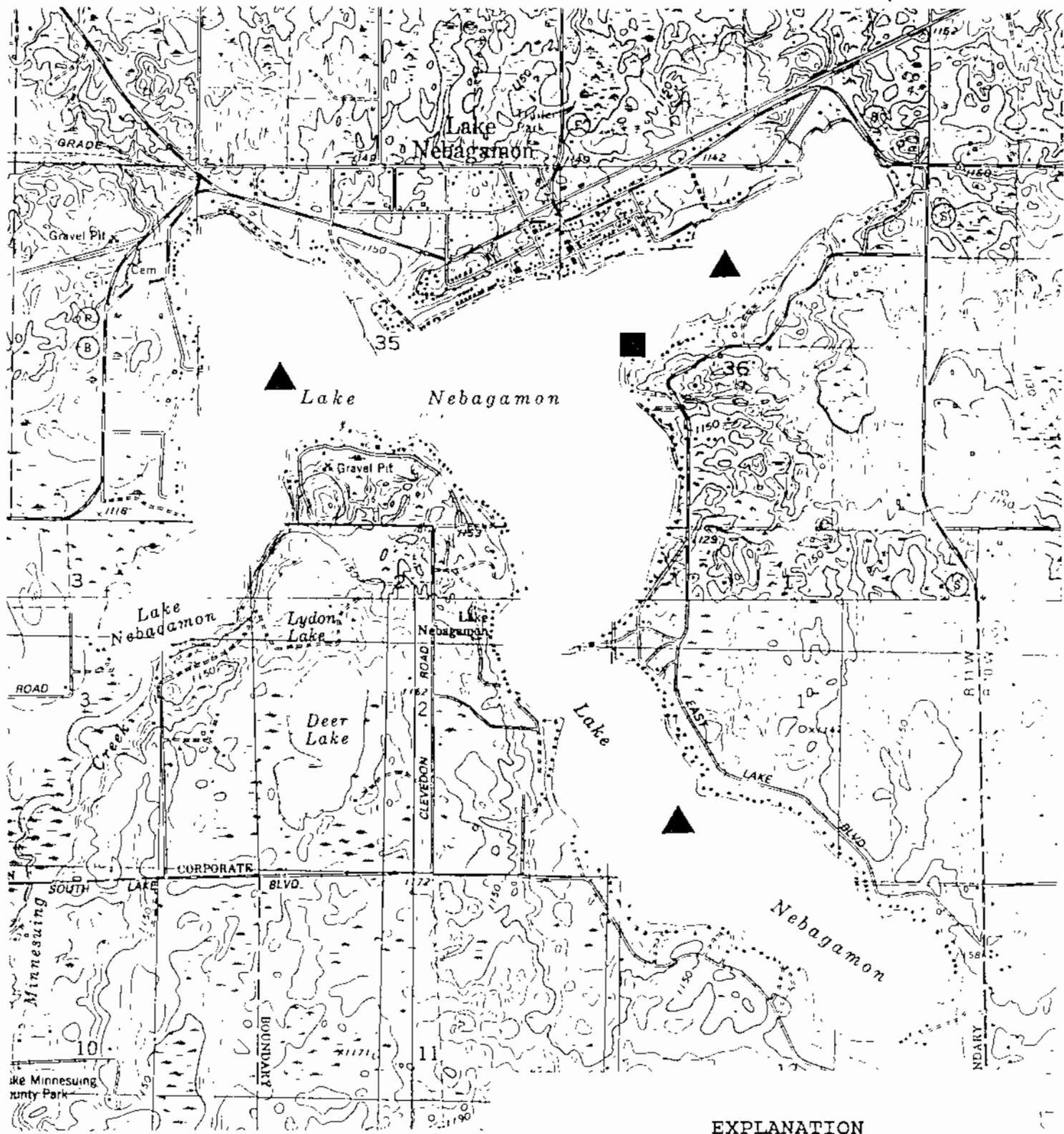
LOCATION.--Lat 46°30'50", long 91°41'23", in NE 1/4 NW 1/4 sec.36, T.47 N., R.11 W., Douglas County, Hydrologic Unit 04010301, at Lake Nebagamon.

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

REMARKS.--Lake sampled in northeast bay Water-quality analyses by Wisconsin State Laboratory of Hygiene

WATER-QUALITY DATA, MAY 10 TO AUGUST 10, 1993
(Milligrams per liter unless otherwise indicated)

| | May 10 | June 27 | July 15 | Aug. 10 |
|-------------------------------------|--------|---------|---------|---------|
| Depth of sample (ft) | 1.5 | 1.5 | 1.5 | 1.5 |
| Lake stage (ft) | 87.72 | 87.62 | 87.62 | 86.82 |
| Specific conductance (μS/cm) | 88 | 84 | 82 | 87 |
| pH (units) | 7.8 | 7.2 | 7.5 | 7.6 |
| Water temperature (°C) | 12.0 | 18.5 | 21.5 | 23.0 |
| Secchi-depth (meters) | 1.5 | 1.8 | 2.1 | 1.8 |
| Dissolved oxygen | 10.5 | 8.6 | 8.4 | 8.1 |
| Phosphorus, total (as P) | <0.020 | 0.015 | 0.012 | 0.017 |
| Chlorophyll a, phytoplankton (μg/L) | 11 | 8.9 | 4.2 | 6.6 |



EXPLANATION

- ▲ Lake water-quality sampling site
- Staff gage

Figure 1. Location of sampling sites and staff gage on Lake Nebagamon at Lake Nebagamon, Wisconsin.

STREAMS TRIBUTARY TO LAKE SUPERIOR

462928091413500 LAKE NEBAGAMON, SOUTHEAST BAY AT DEEP HOLE, AT LAKE NEBAGAMON, WI--CONTINUED

WATER-QUALITY RECORDS

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

REMARKS.--Lake sampled in southeast bay at a depth of about 52 ft. Lake ice-covered during March sampling. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MARCH 05 TO AUGUST 10, 1993
(Milligrams per liter unless otherwise indicated)

| | Mar. 05 | | May 10 | | June 27 | | July 15 | | Aug. 10 | | | |
|-------------------------------------|---------|-----|--------|-------|---------|-------|---------|-------|---------|-------|---|----|
| Depth of sample (ft) | 1 | 51 | 1.5 | 48 | 1.5 | 49 | 1 | 5 | 49 | 1 | 5 | 50 |
| Lake stage (ft) | 86.57 | | 87.72 | | 87.62 | | 87.62 | | 86.82 | | | |
| Specific conductance (µS/cm) | 161 | 178 | 89 | 92 | 83 | 94 | 82 | 102 | 89 | 123 | | |
| pH (units) | 8.3 | 7.4 | 7.7 | 7.6 | 7.1 | 7.1 | 7.9 | 7.3 | 7.9 | 7.4 | | |
| Water temperature (°C) | 1.5 | 5.0 | 11.5 | 6.5 | 18.5 | 8.0 | 21.0 | 8.0 | 22.0 | 8.5 | | |
| Color (Pt-Co. scale) | --- | --- | 50 | 50 | --- | --- | --- | --- | --- | --- | | |
| Turbidity (NTU) | --- | --- | 1.1 | 2.9 | --- | --- | --- | --- | --- | --- | | |
| Secchi-depth (meters) | --- | --- | 1.7 | | 1.8 | | 1.8 | | 1.8 | | | |
| Dissolved oxygen | 11.3 | 0.2 | 10.0 | 8.0 | 8.6 | 0.8 | 8.4 | 0.1 | 7.7 | 0.1 | | |
| Hardness, as CaCO3 | --- | --- | 43 | 46 | --- | --- | --- | --- | --- | --- | | |
| Calcium, dissolved (Ca) | --- | --- | 11 | 12 | --- | --- | --- | --- | --- | --- | | |
| Magnesium, dissolved (Mg) | --- | --- | 3.7 | 3.9 | --- | --- | --- | --- | --- | --- | | |
| Sodium, dissolved (Na) | --- | --- | 2.4 | 2.4 | --- | --- | --- | --- | --- | --- | | |
| Potassium, dissolved (K) | --- | --- | 0.7 | 0.7 | --- | --- | --- | --- | --- | --- | | |
| Alkalinity, as CaCO3 | --- | --- | 38 | 41 | --- | --- | --- | --- | --- | --- | | |
| Sulfate, dissolved (SO4) | --- | --- | 6.0 | 6.0 | --- | --- | --- | --- | --- | --- | | |
| Chloride, dissolved (Cl) | --- | --- | 2.0 | 2.0 | --- | --- | --- | --- | --- | --- | | |
| Fluoride, dissolved (F) | --- | --- | <0.0 | <0.0 | --- | --- | --- | --- | --- | --- | | |
| Silica, dissolved (SiO2) | --- | --- | 10 | 11 | --- | --- | --- | --- | --- | --- | | |
| Solids, dissolved, at 180°C | --- | --- | 72 | 74 | --- | --- | --- | --- | --- | --- | | |
| Nitrogen, nitrate, total (as N) | --- | --- | 0.05 | 0.09 | --- | --- | --- | --- | --- | --- | | |
| Nitrogen, NO2 + NO3, diss. (as N) | --- | --- | 0.05 | 0.09 | --- | --- | --- | --- | --- | --- | | |
| Nitrogen, ammonia, dissolved (as N) | --- | --- | 0.02 | 0.07 | --- | --- | --- | --- | --- | --- | | |
| Nitrogen, organic, total (as N) | --- | --- | 0.47 | 0.43 | --- | --- | --- | --- | --- | --- | | |
| Nitrogen, amm. + org., total (as N) | --- | --- | 0.50 | 0.50 | --- | --- | --- | --- | --- | --- | | |
| Nitrogen, total (as N) | --- | --- | 0.55 | 0.59 | --- | --- | --- | --- | --- | --- | | |
| Phosphorus, total (as P) | --- | --- | 0.014 | 0.030 | 0.014 | 0.032 | 0.013 | 0.020 | 0.014 | 0.020 | | |
| Phosphorus, ortho, dissolved (as P) | --- | --- | 0.004 | 0.007 | --- | --- | --- | --- | --- | --- | | |
| Iron, dissolved (Fe) µg/L | --- | --- | 140 | 180 | --- | --- | --- | --- | --- | --- | | |
| Manganese, dissolved (Mn) µg/L | --- | --- | 43 | 260 | --- | --- | --- | --- | --- | --- | | |
| Chlorophyll a, phytoplankton (µg/L) | --- | --- | 9.2 | --- | 9.8 | --- | 5.2 | --- | 4.9 | --- | | |

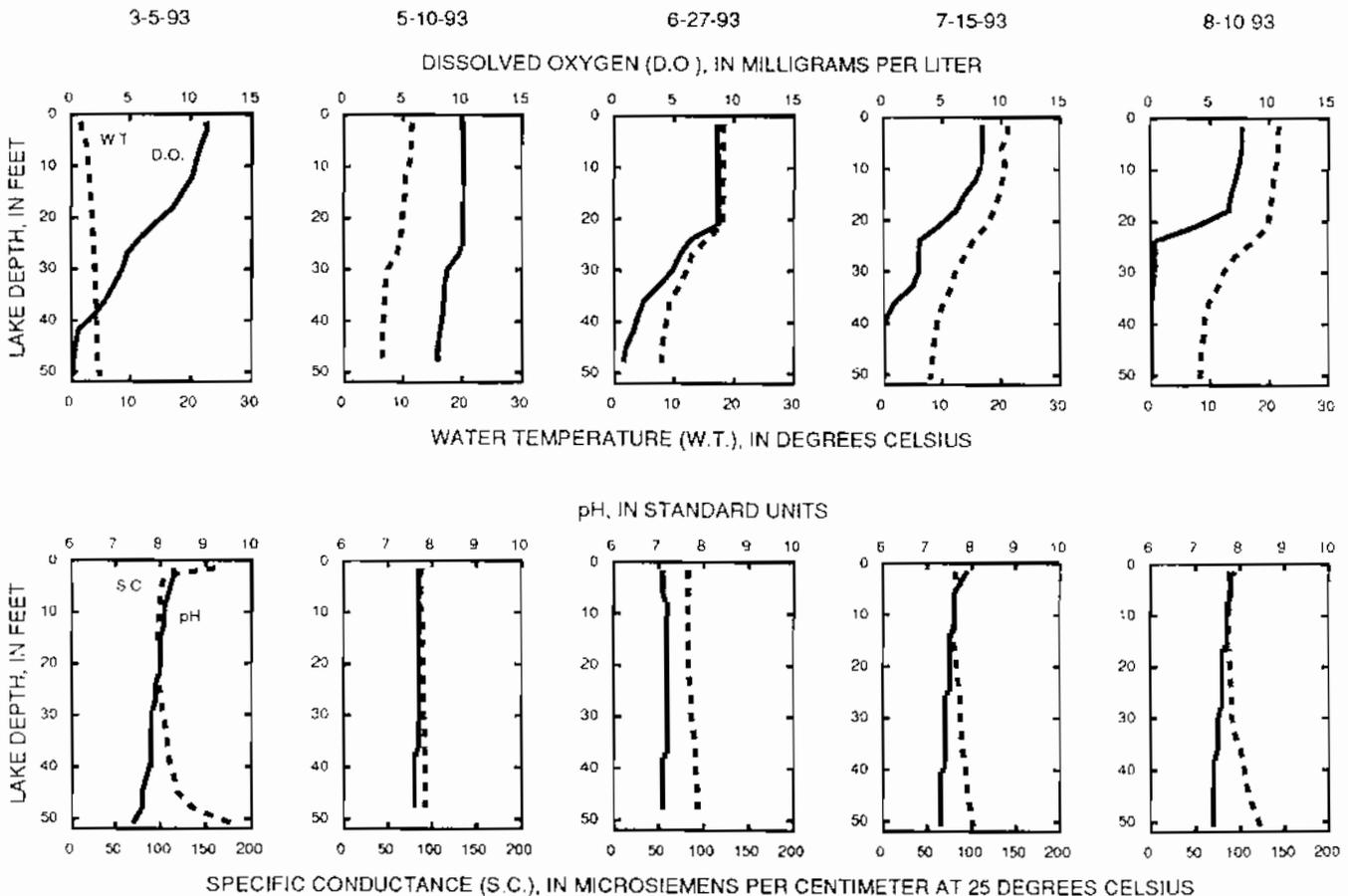


Figure 2. Lake water-quality data for Lake Nebagamon, Southeast Bay, 1993 water year

TROPHIC STATE INDICES
 LAKE NEBAGAMON NE BAY AT LAKE NEBAGAMON, WI.
 DOUGLAS COUNTY

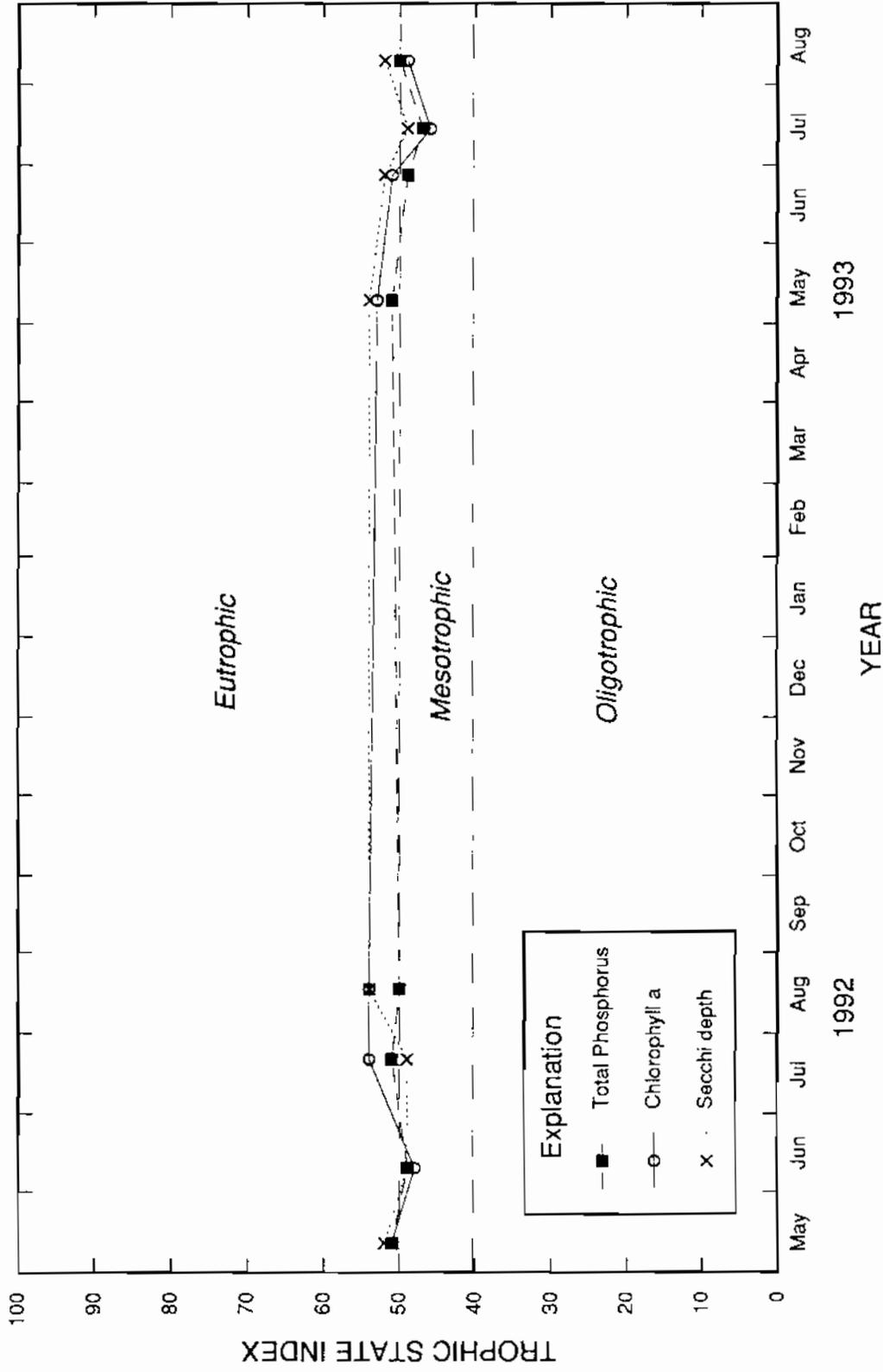


Figure 3a. Trophic state indices for Lake Nebagamon, Northeast Bay

TROPHIC STATE INDICES
 LAKE NEBAGAMON, SE BAY (DEEP HOLE), AT
 LAKE NEBAGAMON, WI.
 DOUGLAS COUNTY

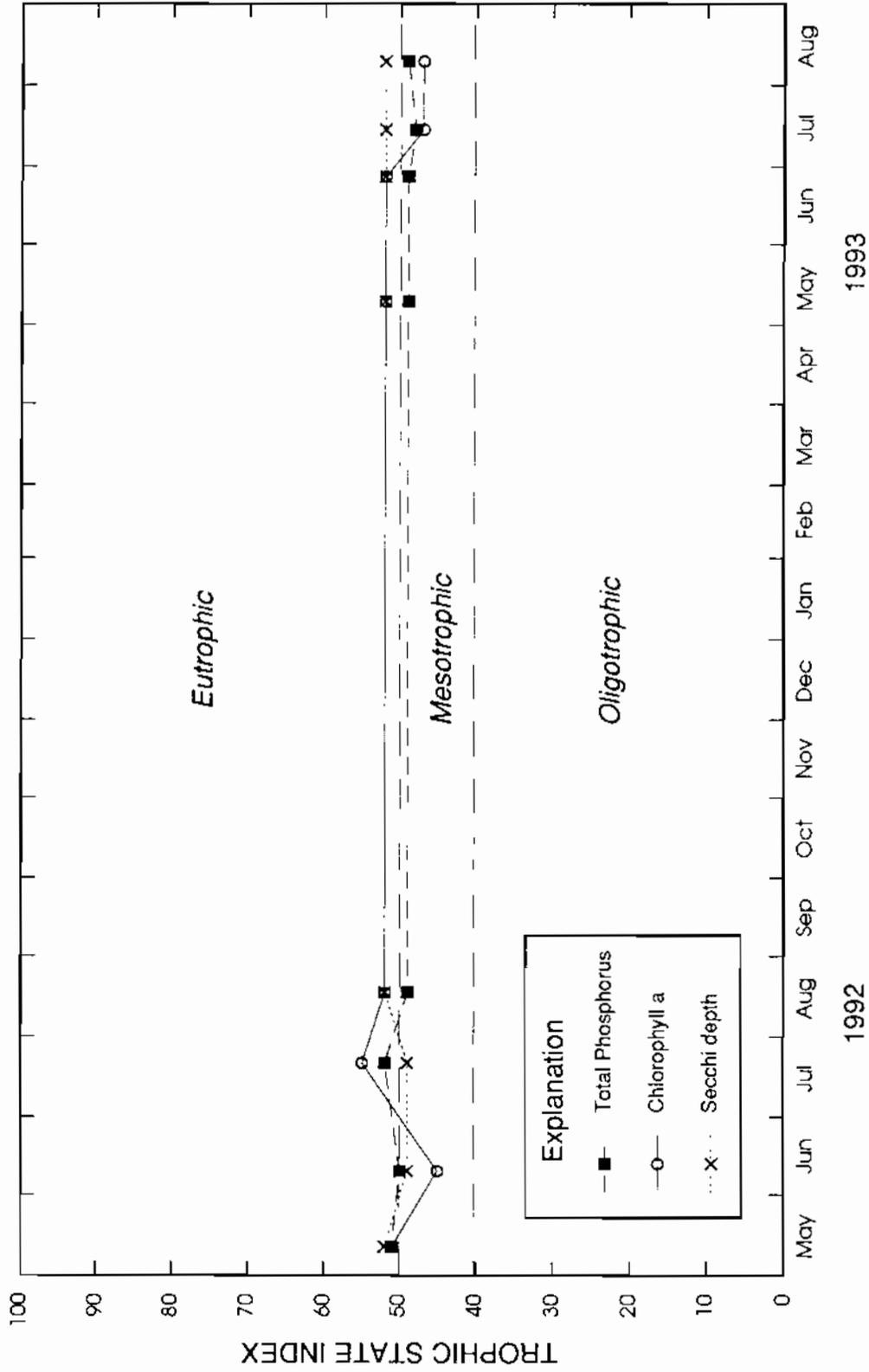


Figure 3b. Trophic state indices for Lake Nebagamon, Southeast Bay

TROPHIC STATE INDICES
 LAKE NEBAGAMON, WEST BAY, AT LAKE NEBAGAMON, WI.
 DOUGLAS COUNTY

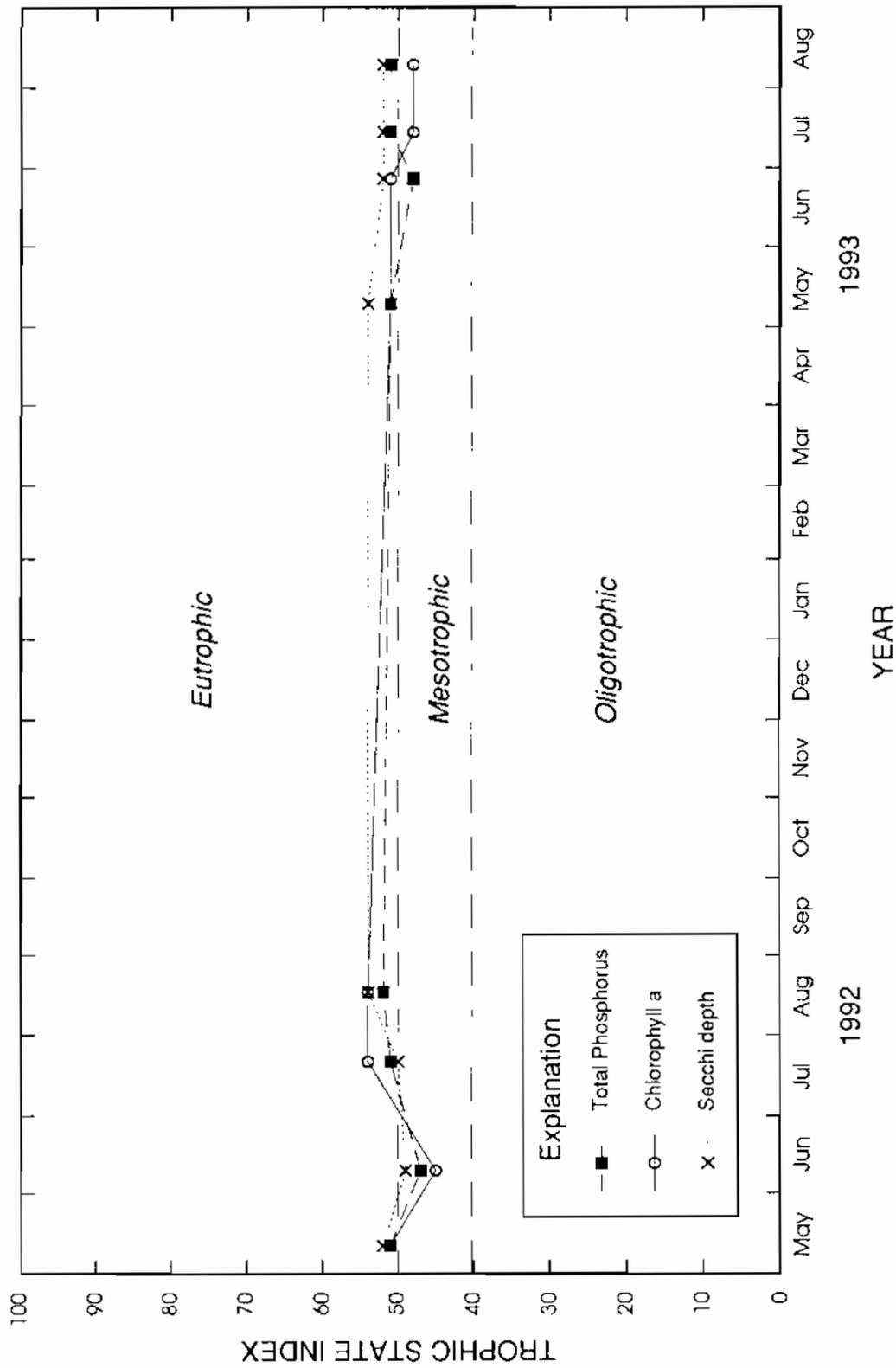


Figure 3c. Trophic state indices for Lake Nebagamon, West Bay



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

Mr. Edward Girzi
11691 East Point Road
Lake Nebagamon, Wisconsin 54849

Dear Mr. Girzi:

This letter describes the progress on the evaluation of the water quality of Lake Nebagamon 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 Lake Nebagamon is good to fair and can be classified as a meso-eutrophic lake or one with moderate to many nutrients. The water quality of the lake is similar at all three monitoring sites.
- Surface total phosphorus and chlorophyll *a* concentrations and Secchi-disc depths in 1994 show water quality similar to previous years. No trends are apparent.
- Algal growth appears to be dependent upon the amount of available phosphorus rather than nitrogen.
- In March, July and August, during summer stratification, oxygen disappears from the bottom portion of the lake at the deep hole which is then unable to support a fish population.
- During the summer anoxic (devoid of oxygen) period, there are minor amounts of phosphorus being released from the bottom sediments.
- The data enclosed herein are provisional until published.

Lake Nebagamon has a surface area of 914 acres (1.43 square miles) and a drainage area at the outlet of 40.9 square miles for a drainage area/lake size ratio of 28.6:1. 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.).

Three sites were sampled in Lake Nebagamon. The site in the Southeast Bay is located at the deepest spot in the lake at a depth of about 52 feet and is the site where most of the water-

quality data were collected. Only surface samples were collected from sites in the Northeast Bay at a 40-foot depth, and the West Bay at a 20-foot depth.

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

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

Table 2. Lake-depth profiles for Lake Nebagamon, Southeast Bay, 1994 water year

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

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

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

Table 4. Lake water-quality data for Lake Nebagamon, West Bay, and Lake Nebagamon, Northeast Bay, 1994 water year

Figure 1. Location of sampling sites and staff gage on Lake Nebagamon at Lake Nebagamon, Wisconsin

Figure 2. Lake water-quality data for Lake Nebagamon, Southeast Bay, 1994 water year

Figure 3a. Trophic state indices for Lake Nebagamon, Northeast Bay at Lake Nebagamon, Wisconsin

Figure 3b. Trophic state indices for Lake Nebagamon, Southeast Bay, at Lake Nebagamon, Wisconsin

Figure 3c. Trophic state indices for Lake Nebagamon, West Bay, at Lake Nebagamon, Wisconsin

Figure 4a. Surface total phosphorus and chlorophyll *a* concentrations and Secchi depths for Lake Nebagamon, Northeast Bay, at Lake Nebagamon, Wisconsin

Figure 4b. Surface total phosphorus and chlorophyll *a* concentrations and Secchi depths for Lake Nebagamon, Southeast Bay at deep hole, at Lake Nebagamon, Wisconsin

Figure 4c. Surface total phosphorus and chlorophyll *a* concentrations and Secchi depths for Lake Nebagamon, West Bay, at Lake Nebagamon, 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, 1994" and "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 1994".

LAKE-STAGE FLUCTUATIONS

Lake-stages were read by Edward Girzi near his residence. He should be commended for the excellent job he did. Lake-stage data are listed in table 1. Lake stages fluctuated 2.02 feet and ranged from 86.46 feet on August 21 to 88.48 feet on May 1.

LAKE-DEPTH PROFILES

Profiles of water temperature, dissolved oxygen, pH, and specific conductance at the deep hole are listed in table 2 and shown in figure 2. No abnormalities in the data are apparent. Among our sampling dates, complete water-column mixing was observed on May 5, 1994. The remainder of the profile data show incomplete mixing. The lake thermally stratifies during summer. During March, July, and August, the lake-bottom water became anoxic (devoid of oxygen) and was unable to support fish. The levels of pH are within acceptable limits to support aquatic life. Because of the buffering capacity of the lake water, Lake Nebagamon is not susceptible to the effects of acid rain.

SELECTED ANALYSES

Analyses of selected constituents for May 5 for samples collected at 1.5- and 51-foot depths at the deep hole 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 at the deep hole 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 32:1 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.

MAY, JUNE, JULY AND AUGUST WATER QUALITY

The data for total phosphorus, chlorophyll *a*, and Secchi-depth readings are listed in tables 3a, 3b, 3c, and 4 and on figure 2. The water quality of the lake is similar at all three sites.

Lake Nebagamon, Northeast Bay

Total phosphorus: Total phosphorus concentrations sampled at a 1.5-foot depth range from 0.013 mg/L in May to 0.018 mg/L in August. All values fall within the regional values previously referenced.

Chlorophyll *a*: Chlorophyll *a* concentrations, which indicate algal biomass, ranged from 6.5 µg/L in July to 9.81 µg/L in May. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 4.9 feet in May to 6.9 feet in June and July. These data are within the regional values.

Lake Nebagamon, Southeast Bay

Total phosphorus: Total phosphorus concentrations sampled at a 1.5-foot depth range from 0.011 mg/L in June to <0.020 mg/L in May. All values fall within the regional values previously referenced.

Concentration of total phosphorus 1.5 feet above the lake bottom ranged from 0.020 mg/L in May and July to 0.052 mg/L in August. These concentrations are indicative of minor phosphorus release from the bottom sediments during anoxic (absence of oxygen) periods.

Chlorophyll a: Chlorophyll a concentrations, which indicate algal biomass, ranged from 4.25 µg/L in August to 8.33 µg/L in May. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 5.9 feet in May to 6.9 feet in June, July, and August. These data are within the regional values.

Lake Nebagamon, West Bay

Total phosphorus: Total phosphorus concentrations sampled at a 1.5-foot depth range from 0.013 mg/L in May to 0.019 mg/L in August. All values fall within the regional values previously referenced.

Chlorophyll a: Chlorophyll a concentrations, which indicate algal biomass, ranged from 5.7 µg/L in June to 6.97 µg/L in August. These data are within the regional values.

Secchi disc: Secchi-disc depths, which indicate water clarity, ranged from 4.9 feet in May to 6.9 feet in July. 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 |

The water quality at all three sites is similar; therefore, the discussion below encompasses all three sites.

Using the above criteria to evaluate the mean summer (July-August) 1994 data shown in tables 3a, 3b, and 3c for all three sites on Lake Nebagamon, surface total phosphorus and chlorophyll *a* concentrations indicate good water quality, while Secchi-disc depths indicate fair 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 all three sites on Lake Nebagamon to other lakes in northwest Wisconsin are shown below:

| | <u>Parameter</u> | <u>Percentage of distribution of lakes in Northwest Wisconsin within these concentrations</u> |
|-------------------------|--|---|
| | Total phosphorus (mg/L) | |
| | <.010 | Best condition 12 |
| Lake Nebagamon values → | .010-.020 | 35 |
| | .020-.030 | 23 |
| | .030-.050 | 18 |
| | .050-.100 | 8 |
| | .100-.150 | 3 |
| | >.150 | Worst condition 1 |
| | Chlorophyll <i>a</i> (µg/L) | |
| | 0- 5 | Best condition 29 |
| Lake Nebagamon values → | 5-10 | 36 |
| | 10-15 | 14 |
| | 15-30 | 14 |
| | >30 | Worst condition 9 |
| | Secchi depth (in feet) | |
| | > 9.8 | Best condition 22 |
| | 6.6- 9.8 | 29 |
| Lake Nebagamon values → | 3.3- 6.6 | 30 |
| | <3.3 | Worst condition 19 |

Comparing other lakes in northwest Wisconsin to the 1994 data for Lake Nebagamon, the above data show, during the period 1966 to 1979, 53 percent had higher total phosphorous concentrations, 37 percent had higher chlorophyll a concentrations, and 19 percent had less water clarity.

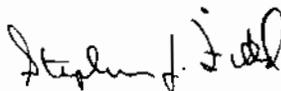
A second approach to assessing the "health" or trophic status of a lake is to use Carlson's Trophic State Index (TSI). Graphic illustrations of the Trophic State Index for the three sites on Lake Nebagamon are shown on figures 3a, 3b, and 3c. The data from 1994 show Lake Nebagamon to be meso-eutrophic or one with moderate to many nutrients.

Surface total phosphorus and chlorophyll a concentrations and Secchi-disc depths for the period of record for Lake Nebagamon are shown in figures 4a, 4b, and 4c. Based on these parameters, water quality in 1994 was similar to that of previous years. No trends are apparent.

The data that has been collected for Lake Nebagamon from 1992 to 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: Dan Ryan, DNR, Spooner

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

462928091413500 LAKE NEBAGAMON, SOUTHEAST BAY AT DEEP HOLE, AT LAKE NEBAGAMON, WI

LOCATION.--Lat 46°29'28", long 91°41'35", in SW 1/4 SW 1/4 sec.1, T.46 N., R.11 W., Douglas County, Hydrologic Unit 04010301, at Lake Nebagamon.

DRAINAGE AREA.--40.9 mi².

LAKE-STAGE RECORDS

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

GAGE.--Non-recording staff gage. Staff gage read by Edward Girzi; gage is located near observer's residence.

EXTREMES FOR PERIOD OF RECORD.--Maximum gage height observed, 89.88 ft, Apr. 23, 1992; minimum observed, 86.46 ft, Aug. 21, 1994.

EXTREMES FOR CURRENT YEAR.--Maximum gage height observed, 88.48 ft, May 1; minimum observed, 86.46 ft, Aug. 21.

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 | --- | --- | --- | --- | --- | --- | --- | 88.48 | --- | 86.72 | 86.50 | --- |
| 2 | --- | --- | --- | --- | --- | --- | --- | --- | 87.15 | --- | --- | --- |
| 3 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 4 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 5 | --- | --- | --- | --- | --- | --- | --- | 88.29 | 87.06 | --- | 86.58 | --- |
| 6 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 7 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 8 | --- | --- | --- | --- | --- | 86.63 | --- | 88.11 | 86.97 | 86.71 | --- | --- |
| 9 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.50 |
| 10 | --- | --- | --- | --- | --- | --- | 87.04 | --- | --- | --- | --- | --- |
| 11 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12 | --- | --- | --- | --- | --- | --- | --- | --- | 86.85 | --- | 86.52 | --- |
| 13 | --- | --- | --- | --- | --- | --- | --- | --- | 86.79 | 86.59 | --- | --- |
| 14 | --- | --- | --- | --- | --- | --- | --- | 87.61 | --- | 86.57 | --- | --- |
| 15 | --- | --- | --- | --- | --- | --- | --- | --- | 86.77 | --- | --- | 86.75 |
| 16 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.49 | --- |
| 17 | --- | --- | --- | --- | --- | --- | 87.52 | --- | 86.85 | --- | --- | --- |
| 18 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.47 | --- |
| 19 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.88 |
| 20 | --- | --- | --- | --- | --- | --- | --- | 87.57 | --- | --- | --- | --- |
| 21 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.59 | 86.46 | --- |
| 22 | --- | --- | --- | --- | --- | --- | --- | 87.48 | 86.89 | --- | --- | --- |
| 23 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.03 |
| 24 | --- | --- | --- | --- | --- | --- | 87.65 | --- | --- | --- | --- | --- |
| 25 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 26 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.53 | --- |
| 27 | --- | --- | --- | --- | --- | --- | --- | 87.19 | --- | --- | --- | --- |
| 28 | --- | --- | --- | --- | --- | --- | --- | 87.19 | --- | --- | --- | --- |
| 29 | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.56 | --- | --- |
| 30 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 87.02 |
| 31 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 86.58 | --- |

Table 2. Lake-depth profiles for Lake Nebagamon, Southeast Bay, 1994 water year

462928091413500 - L NEBAGAMON SE BAY (CENTER) @ LAKE NEBAGAMON, W

WATER-QUALITY DATA

| 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) |
|----------|---|---|--|--|--|
| MAR 1994 | | | | | |
| 08... | 1.50 | 1.5 | 105 | 8.8 | 11.9 |
| 08... | 3.00 | 2.5 | 100 | 8.7 | 12.0 |
| 08... | 6.00 | 2.5 | 100 | 8.7 | 11.9 |
| 08... | 9.00 | 2.5 | 100 | 8.6 | 11.9 |
| 08... | 12.0 | 2.5 | 99 | 8.6 | 11.9 |
| 08... | 15.0 | 2.5 | 98 | 8.6 | 11.9 |
| 08... | 18.0 | 3.0 | 97 | 8.5 | 10.4 |
| 08... | 21.0 | 3.0 | 98 | 8.4 | 8.7 |
| 08... | 24.0 | 3.0 | 99 | 8.4 | 8.2 |
| 08... | 27.0 | 3.5 | 102 | 8.4 | 6.3 |
| 08... | 30.0 | 3.5 | 103 | 8.3 | 6.2 |
| 08... | 33.0 | 3.5 | 105 | 8.3 | 5.4 |
| 08... | 36.0 | 3.5 | 108 | 8.2 | 3.2 |
| 08... | 39.0 | 3.5 | 108 | 8.2 | 1.2 |
| 08... | 42.0 | 4.0 | 114 | 8.1 | 0.6 |
| 08... | 45.0 | 4.0 | 119 | 8.0 | 0.4 |
| 08... | 48.0 | 4.0 | 131 | 8.0 | 0.2 |
| 08... | 51.0 | 4.5 | 170 | 7.8 | 0.1 |
| 08... | 52.0 | -- | -- | -- | -- |
| MAY | | | | | |
| 05... | 1.50 | 9.0 | 87 | 7.8 | 11.3 |
| 05... | 3.00 | 9.0 | 87 | 7.8 | 11.3 |
| 05... | 6.00 | 9.0 | 87 | 7.7 | 11.3 |
| 05... | 9.00 | 9.0 | 87 | 7.7 | 11.3 |
| 05... | 12.0 | 8.5 | 87 | 7.7 | 11.2 |
| 05... | 15.0 | 8.5 | 87 | 7.7 | 11.1 |
| 05... | 18.0 | 8.5 | 87 | 7.7 | 11.1 |
| 05... | 21.0 | 8.5 | 87 | 7.7 | 11.2 |
| 05... | 24.0 | 8.5 | 86 | 7.6 | 11.2 |
| 05... | 27.0 | 8.5 | 87 | 7.6 | 11.2 |
| 05... | 30.0 | 8.5 | 87 | 7.6 | 11.2 |
| 05... | 33.0 | 8.5 | 87 | 7.6 | 11.2 |
| 05... | 36.0 | 8.0 | 86 | 7.6 | 11.1 |
| 05... | 39.0 | 8.0 | 86 | 7.6 | 11.0 |
| 05... | 42.0 | 8.0 | 86 | 7.6 | 11.0 |
| 05... | 45.0 | 7.5 | 88 | 7.6 | 10.6 |
| 05... | 48.0 | 7.0 | 88 | 7.6 | 10.0 |
| 05... | 51.0 | 6.5 | 87 | 7.6 | 9.8 |
| 05... | 53.0 | -- | -- | -- | -- |
| JUN | | | | | |
| 15... | 1.50 | 20.0 | 91 | 7.6 | 8.4 |
| 15... | 3.00 | 19.5 | 91 | 7.6 | 8.3 |
| 15... | 6.00 | 19.5 | 91 | 7.6 | 8.2 |
| 15... | 9.00 | 19.5 | 91 | 7.5 | 8.0 |
| 15... | 12.0 | 19.0 | 91 | 7.5 | 8.0 |
| 15... | 15.0 | 19.0 | 91 | 7.5 | 7.9 |
| 15... | 18.0 | 19.0 | 91 | 7.5 | 7.9 |
| 15... | 21.0 | 15.0 | 90 | 7.5 | 6.1 |
| 15... | 24.0 | 13.0 | 90 | 7.5 | 6.8 |
| 15... | 27.0 | 12.0 | 90 | 7.5 | 7.3 |
| 15... | 30.0 | 11.0 | 89 | 7.5 | 7.5 |
| 15... | 33.0 | 11.0 | 90 | 7.5 | 6.4 |
| 15... | 36.0 | 10.0 | 91 | 7.5 | 4.2 |
| 15... | 39.0 | 10.0 | 92 | 7.4 | 3.4 |
| 15... | 42.0 | 9.5 | 93 | 7.4 | 2.5 |
| 15... | 45.0 | 9.5 | 94 | 7.4 | 2.2 |
| 15... | 48.0 | 9.5 | 94 | 7.4 | 2.0 |
| 15... | 51.0 | 9.5 | 94 | 7.4 | 2.0 |
| 15... | 53.0 | -- | -- | -- | -- |

Table 2. Lake-depth profiles for Lake Nebagamon, Southeast Bay, 1994 water year--continued

462928091413500 - L NEBAGAMON SE BAY (CENTER) @ LAKE NEBAGAMON, W

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, DIS-SOLVED (MG/L) (00300) |
|----------|-------------------------------|-----------------------------------|--------------------------------------|---|-----------------------------------|
| JUL 1994 | | | | | |
| 13... | 1.50 | 22.0 | 89 | 8.0 | 8.6 |
| 13... | 3.00 | 22.0 | 89 | 8.0 | 8.6 |
| 13... | 6.00 | 22.0 | 89 | 7.9 | 8.5 |
| 13... | 9.00 | 22.0 | 88 | 7.9 | 8.3 |
| 13... | 12.0 | 21.5 | 89 | 7.9 | 8.2 |
| 13... | 15.0 | 20.5 | 89 | 7.8 | 6.4 |
| 13... | 18.0 | 18.5 | 90 | 7.7 | 2.2 |
| 13... | 21.0 | 16.5 | 88 | 7.6 | 1.3 |
| 13... | 24.0 | 14.0 | 88 | 7.6 | 1.9 |
| 13... | 27.0 | 12.0 | 87 | 7.6 | 2.3 |
| 13... | 30.0 | 11.5 | 86 | 7.5 | 3.6 |
| 13... | 33.0 | 11.0 | 87 | 7.5 | 3.0 |
| 13... | 36.0 | 10.5 | 88 | 7.5 | 1.8 |
| 13... | 39.0 | 10.0 | 90 | 7.5 | 0.9 |
| 13... | 42.0 | 9.5 | 92 | 7.4 | 0.2 |
| 13... | 45.0 | 9.5 | 94 | 7.4 | 0.1 |
| 13... | 48.0 | 9.5 | 97 | 7.4 | 0.1 |
| 13... | 50.0 | -- | -- | -- | -- |
| AUG | | | | | |
| 16... | 1.50 | 20.5 | 99 | 8.2 | 8.2 |
| 16... | 3.00 | 20.5 | 100 | 8.0 | 8.2 |
| 16... | 6.00 | 20.0 | 99 | 7.9 | 8.2 |
| 16... | 9.00 | 20.0 | 99 | 7.9 | 8.0 |
| 16... | 12.0 | 20.0 | 98 | 7.8 | 7.8 |
| 16... | 15.0 | 20.0 | 99 | 7.8 | 7.8 |
| 16... | 18.0 | 20.0 | 98 | 7.8 | 7.8 |
| 16... | 21.0 | 19.5 | 98 | 7.7 | 7.4 |
| 16... | 24.0 | 16.5 | 98 | 7.7 | 0.3 |
| 16... | 27.0 | 13.0 | 98 | 7.6 | 0.1 |
| 16... | 30.0 | 12.5 | 97 | 7.6 | 0.1 |
| 16... | 33.0 | 11.0 | 96 | 7.6 | 0.1 |
| 16... | 36.0 | 10.5 | 102 | 7.5 | 0.1 |
| 16... | 39.0 | 10.0 | 102 | 7.5 | 0.1 |
| 16... | 42.0 | 9.5 | 111 | 7.4 | 0.1 |
| 16... | 45.0 | 9.5 | 121 | 7.4 | 0.1 |
| 16... | 48.0 | 9.5 | 123 | 7.4 | 0.1 |
| 16... | 50.0 | -- | -- | -- | -- |

Table 3a.--Water clarity and water-quality analyses and their associated Trophic State indices (TSI) for Lake Nebagamon, Northeast Bay, 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. | |
| 05/05/94 | 1.5 | 4.9 | 1.5 | 0.013 | 13 | 48 | 9.81 | 52 |
| | - | - | -- | -- | -- | - | - | - |
| 06/15/94 | 2.1 | 6.9 | 1.5 | 0.015 | 15 | 49 | 6.68 | 49 |
| | - | - | -- | -- | -- | - | - | - |
| 07/13/94 | 2.1 | 6.9 | 1.5 | 0.016 | 16 | 50 | 6.5 | 49 |
| | - | - | -- | -- | -- | - | - | - |
| 08/16/94 | 1.8 | 5.9 | 1.5 | 0.018 | 18 | 51 | 7.92 | 50 |
| | - | - | -- | -- | -- | - | - | - |

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Table 3b.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Lake Nebagamon, Southeast Bay, 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) | | Conc. (mg/L) | T.S.I. | Conc. (µg/L) | T.S.I. | |
| 05/05/94 | 1.8 | 5.9 | 1.5 | <0.020 | 51 | 8.33 | 51 | <0.002 |
| | - | - | 51 | 0.020 | - | - | - | 0.011 |
| 06/15/94 | 2.1 | 6.9 | 1.5 | 0.011 | 47 | 7.86 | 50 | - |
| | - | - | 51 | 0.048 | - | - | - | - |
| 07/13/94 | 2.1 | 6.9 | 1.5 | 0.017 | 50 | 7.55 | 50 | - |
| | - | - | 48 | 0.020 | - | - | - | - |
| 08/16/94 | 2.1 | 6.9 | 1.5 | 0.017 | 50 | 4.25 | 46 | - |
| | - | - | 48 | 0.052 | - | - | - | - |

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

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

| Date | Secchi Disk | | Sampling Depth (feet) | Total Phosphorus | | | Chlorophyll a | | Dissolved Orthophosphate Phosphorus Conc. (mg/L) |
|----------|----------------|--------------|-----------------------|------------------|--------------|--------------|---------------|--------------|--|
| | Depth (meters) | Depth (feet) | | T.S.I. | Conc. (mg/L) | Conc. (µg/L) | T.S.I. | Conc. (µg/L) | |
| 05/05/94 | 1.5 | 4.9 | 1.5 | 0.013 | 13 | 48 | 49 | 6.89 | -- |
| 06/15/94 | 2.0 | 6.6 | 1.5 | 0.014 | 14 | 49 | 48 | 5.7 | -- |
| 07/13/94 | 2.1 | 6.9 | 1.5 | 0.015 | 15 | 49 | 48 | 5.83 | -- |
| 08/16/94 | 1.8 | 5.9 | 1.5 | 0.019 | 19 | 51 | 49 | 6.97 | -- |

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Table 4. Lake water-quality data for Lake Nebagamon, West Bay, and Lake Nebagamon, Northeast Bay, 1994 water year

463034091425300 LAKE NEBAGAMON, WEST BAY, AT LAKE NEBAGAMON, WI

LOCATION.--Lat 46°30'34", long 91°42'53", in NE 1/4 SW 1/4 sec.35, T.46 N., R.11 W., Douglas County, Hydrologic Unit 04010301, at Lake Nebagamon.

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

REMARKS.--Lake sampled in west bay at a depth of about 20 ft. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MAY 05 TO AUGUST 16, 1994
(Milligrams per liter unless otherwise indicated)

| | May 05 | June 15 | July 13 | Aug. 16 |
|-------------------------------------|--------|---------|---------|---------|
| Depth of sample (ft) | 1.5 | 1.5 | 1.5 | 1.5 |
| Lake stage (ft) | 88.29 | 86.77 | 86.59 | 86.49 |
| Specific conductance (µS/cm) | 83 | 95 | 90 | 101 |
| pH (units) | 8.1 | 7.6 | 7.5 | 8.4 |
| Water temperature (°C) | 8.5 | 21.5 | 21.5 | 20.5 |
| Secchi-depth (meters) | 1.5 | 2.0 | 2.1 | 1.8 |
| Dissolved oxygen | 11.5 | 8.6 | 8.5 | 8.4 |
| Phosphorus, total (as P) | 0.013 | 0.014 | 0.015 | 0.019 |
| Chlorophyll a, phytoplankton (µg/L) | 6.9 | 5.7 | 5.8 | 7.0 |

463050091412300 LAKE NEBAGAMON, NORTHEAST BAY, AT LAKE NEBAGAMON, WI

LOCATION.--Lat 46°30'50", long 91°41'23", in NE 1/4 NW 1/4 sec.36, T.47 N., R.11 W., Douglas County, Hydrologic Unit 04010301, at Lake Nebagamon.

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

REMARKS.--Lake sampled in northeast bay. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MAY 05 TO AUGUST 16, 1994
(Milligrams per liter unless otherwise indicated)

| | May 05 | June 15 | July 13 | Aug. 16 |
|-------------------------------------|--------|---------|---------|---------|
| Depth of sample (ft) | 1.5 | 1.5 | 1.5 | 1.5 |
| Lake stage (ft) | 88.29 | 86.77 | 86.59 | 86.49 |
| Specific conductance (µS/cm) | 86 | 95 | 90 | 100 |
| pH (units) | 8.0 | 7.8 | 7.6 | 8.2 |
| Water temperature (°C) | 9.0 | 22.0 | 21.5 | 21.5 |
| Secchi-depth (meters) | 1.5 | 2.1 | 2.1 | 1.8 |
| Dissolved oxygen | 11.8 | 8.7 | 8.5 | 8.8 |
| Phosphorus, total (as P) | 0.013 | 0.015 | 0.016 | 0.018 |
| Chlorophyll a, phytoplankton (µg/L) | 9.8 | 6.7 | 6.5 | 7.9 |

WATER-QUALITY RECORDS

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

REMARKS.--Lake sampled in southeast bay at a depth of about 52 ft. Lake ice-covered during March sampling. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MARCH 08 TO AUGUST 16, 1994
(Milligrams per liter unless otherwise indicated)

| | Mar. 08 | | May 05 | | June 15 | | July 13 | | Aug. 16 | |
|-------------------------------------|---------|-----|--------|-------|---------|-------|---------|-------|---------|-------|
| Depth of sample (ft) | 1.5 | 51 | 1.5 | 51 | 1.5 | 51 | 1.5 | 48 | 1.5 | 48 |
| Lake stage (ft) | 86.63 | | 88.29 | | 86.77 | | 86.59 | | 86.49 | |
| Specific conductance (µS/cm) | 105 | 170 | 87 | 87 | 91 | 94 | 89 | 97 | 99 | 123 |
| pH (units) | 8.8 | 7.8 | 7.8 | 7.6 | 7.6 | 7.4 | 8.0 | 7.4 | 8.2 | 7.4 |
| Water temperature (°C) | 1.5 | 4.5 | 9.0 | 6.5 | 20.0 | 9.5 | 22.0 | 9.5 | 20.5 | 9.5 |
| Color (Pt-Co. scale) | --- | --- | 50 | 50 | --- | --- | --- | --- | --- | --- |
| Turbidity (NTU) | --- | --- | 1.3 | 2.6 | --- | --- | --- | --- | --- | --- |
| Secchi-depth (meters) | --- | --- | 1.8 | --- | 2.1 | --- | 2.1 | --- | 2.1 | --- |
| Dissolved oxygen | 11.9 | 0.1 | 11.3 | 9.8 | 8.4 | 2.0 | 8.6 | 0.1 | 8.2 | 0.1 |
| Hardness, as CaCO3 | --- | --- | 46 | 46 | --- | --- | --- | --- | --- | --- |
| Calcium, dissolved (Ca) | --- | --- | 12 | 12 | --- | --- | --- | --- | --- | --- |
| Magnesium, dissolved (Mg) | --- | --- | 4.0 | 4.0 | --- | --- | --- | --- | --- | --- |
| Sodium, dissolved (Na) | --- | --- | 3.0 | 3.0 | --- | --- | --- | --- | --- | --- |
| Potassium, dissolved (K) | --- | --- | 0.7 | 0.8 | --- | --- | --- | --- | --- | --- |
| Alkalinity, as CaCO3 | --- | --- | 41 | 42 | --- | --- | --- | --- | --- | --- |
| Sulfate, dissolved (SO4) | --- | --- | 6.0 | 6.0 | --- | --- | --- | --- | --- | --- |
| Chloride, dissolved (Cl) | --- | --- | 2.6 | 2.5 | --- | --- | --- | --- | --- | --- |
| Fluoride, dissolved (F) | --- | --- | <0.0 | 0.0 | --- | --- | --- | --- | --- | --- |
| Silica, dissolved (SiO2) | --- | --- | 9.6 | 10 | --- | --- | --- | --- | --- | --- |
| Solids, dissolved, at 180°C | --- | --- | 74 | 78 | --- | --- | --- | --- | --- | --- |
| Nitrogen, NO2 + NO3, diss. (as N) | --- | --- | 0.05 | 0.08 | --- | --- | --- | --- | --- | --- |
| Nitrogen, ammonia, dissolved (as N) | --- | --- | 0.01 | 0.06 | --- | --- | --- | --- | --- | --- |
| Nitrogen, amm. + org., total (as N) | --- | --- | 0.60 | 0.50 | --- | --- | --- | --- | --- | --- |
| Nitrogen, total (as N) | --- | --- | 0.64 | 0.58 | --- | --- | --- | --- | --- | --- |
| Phosphorus, total (as P) | --- | --- | <0.020 | 0.020 | 0.011 | 0.048 | 0.017 | 0.020 | 0.017 | 0.052 |
| Phosphorus, ortho, dissolved (as P) | --- | --- | <0.002 | 0.011 | --- | --- | --- | --- | --- | --- |
| Iron, dissolved (Fe) µg/L | --- | --- | 90 | 150 | --- | --- | --- | --- | --- | --- |
| Manganese, dissolved (Mn) µg/L | --- | --- | 86 | 200 | --- | --- | --- | --- | --- | --- |
| Chlorophyll a, phytoplankton(µg/L) | --- | --- | 8.3 | --- | 7.9 | --- | 7.6 | --- | 4.3 | --- |

3-8-94

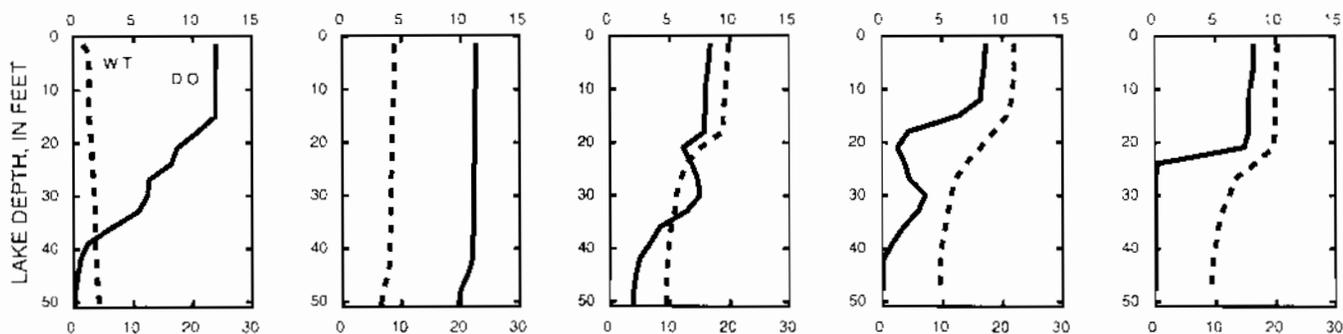
5-5-94

6-15-94

7-13-94

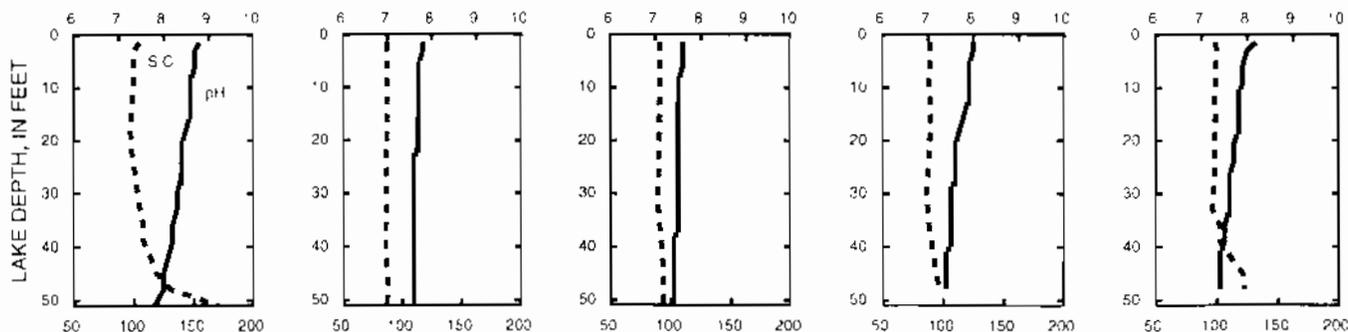
8-16-94

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



WATER TEMPERATURE (W.T.), 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 Lake Nebagamon, Southeast Bay, 1994 water year

TROPHIC STATE INDICES
 LAKE NEBAGAMON NE BAY AT LAKE NEBAGAMON, WI.
 DOUGLAS COUNTY

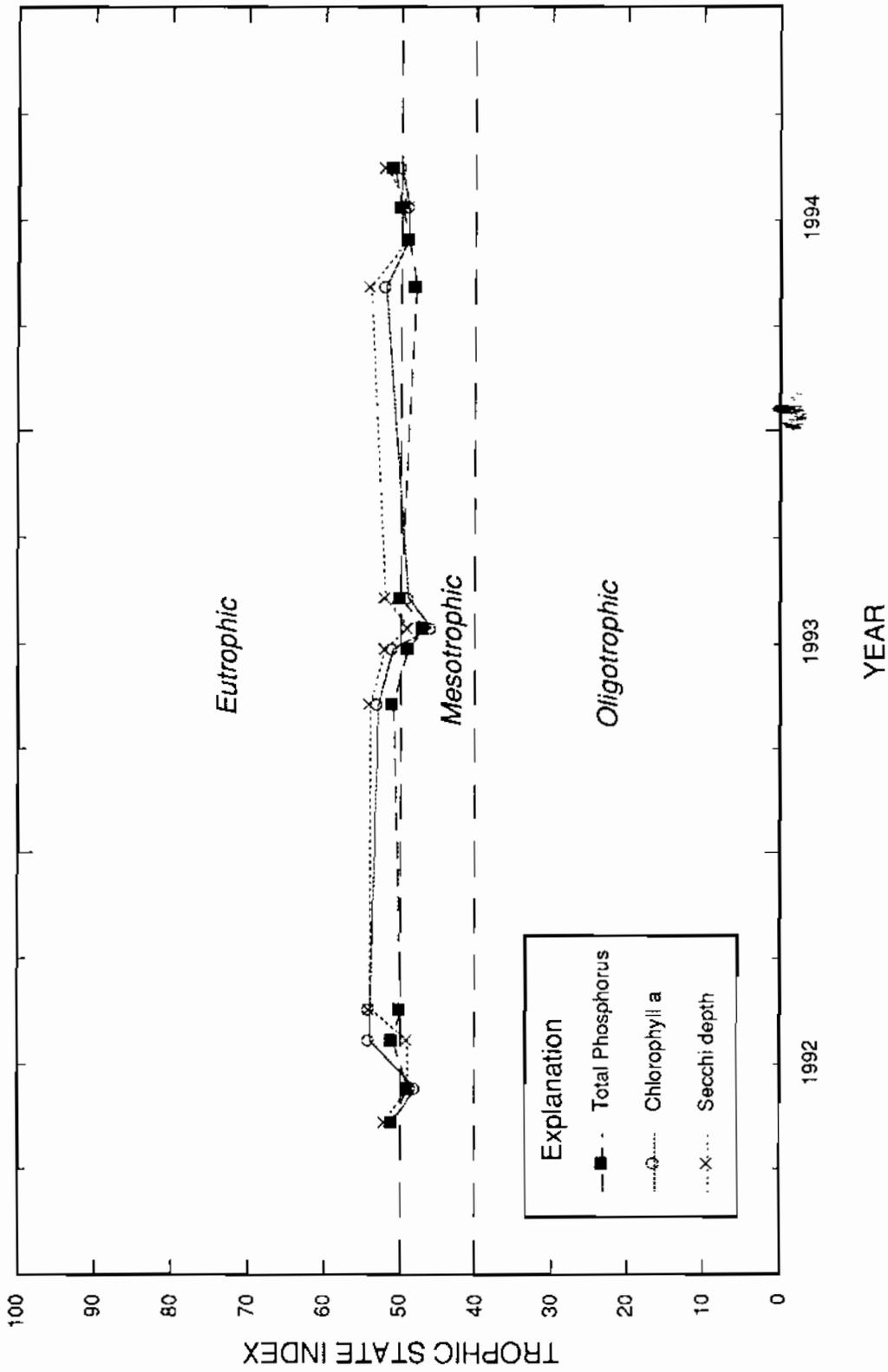


Figure 3a. Trophic state indices for Lake Nebagamon, Northeast Bay, at Lake Nebagamon, Wisconsin

TROPHIC STATE INDICES
 LAKE NEBAGAMON, WEST BAY, AT LAKE NEBAGAMON, WI.
 DOUGLAS COUNTY

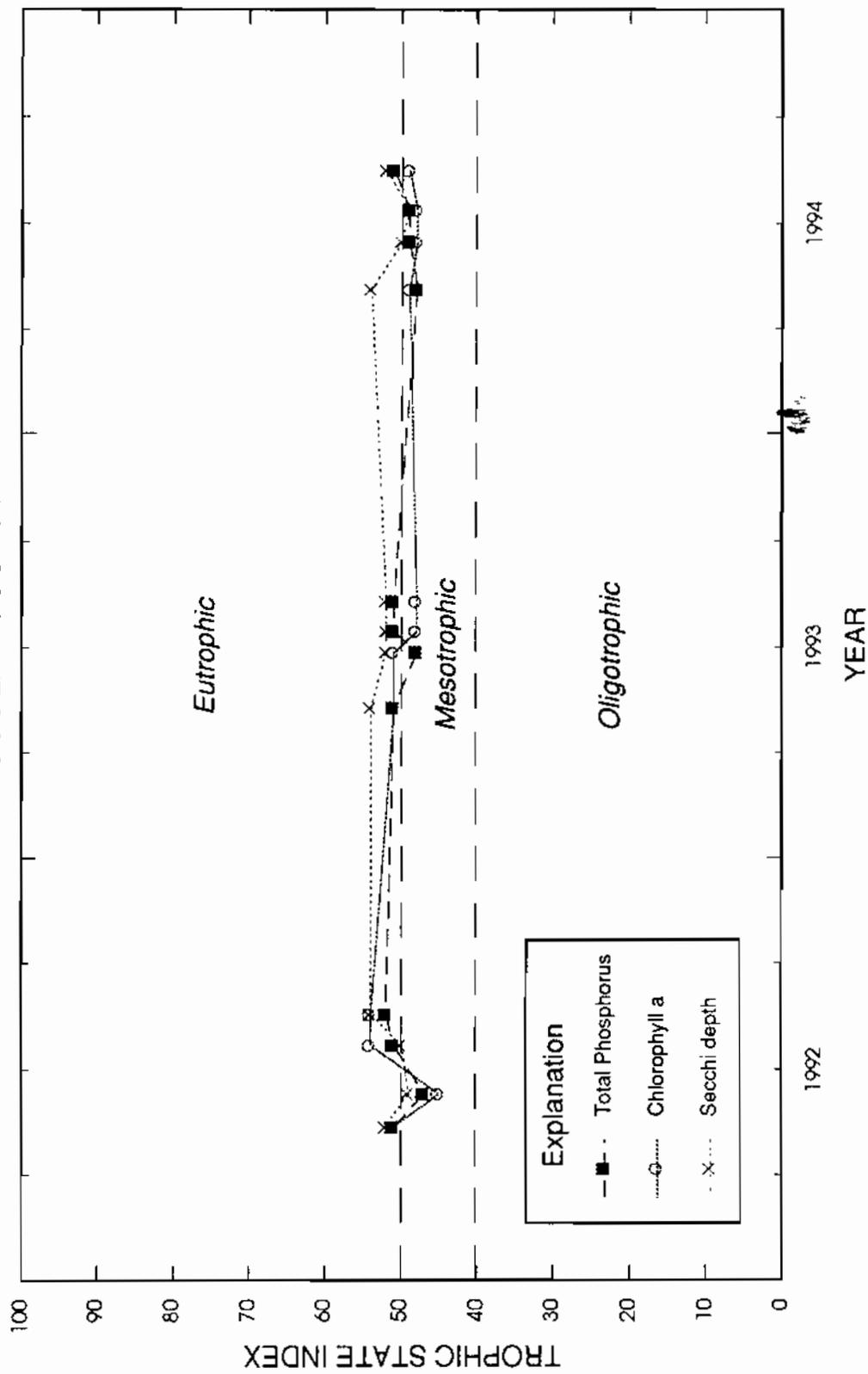


Figure 3c. Trophic state indices for Lake Nebagamon, West Bay, at Lake Nebagamon, Wisconsin

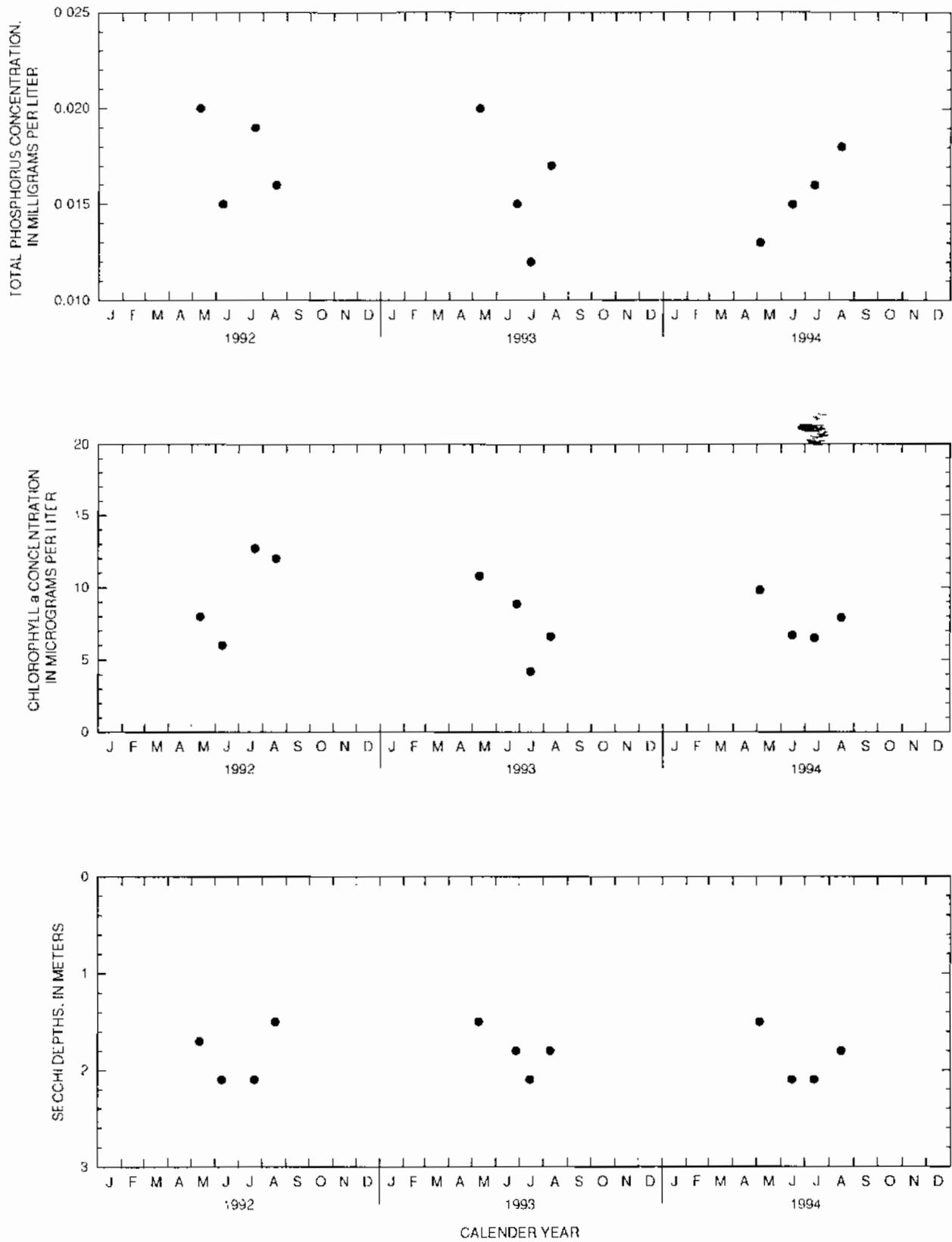


Figure 4a.-- Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Lake Nebagamon, NE Bay, at Lake Nebagamon, Wisconsin.

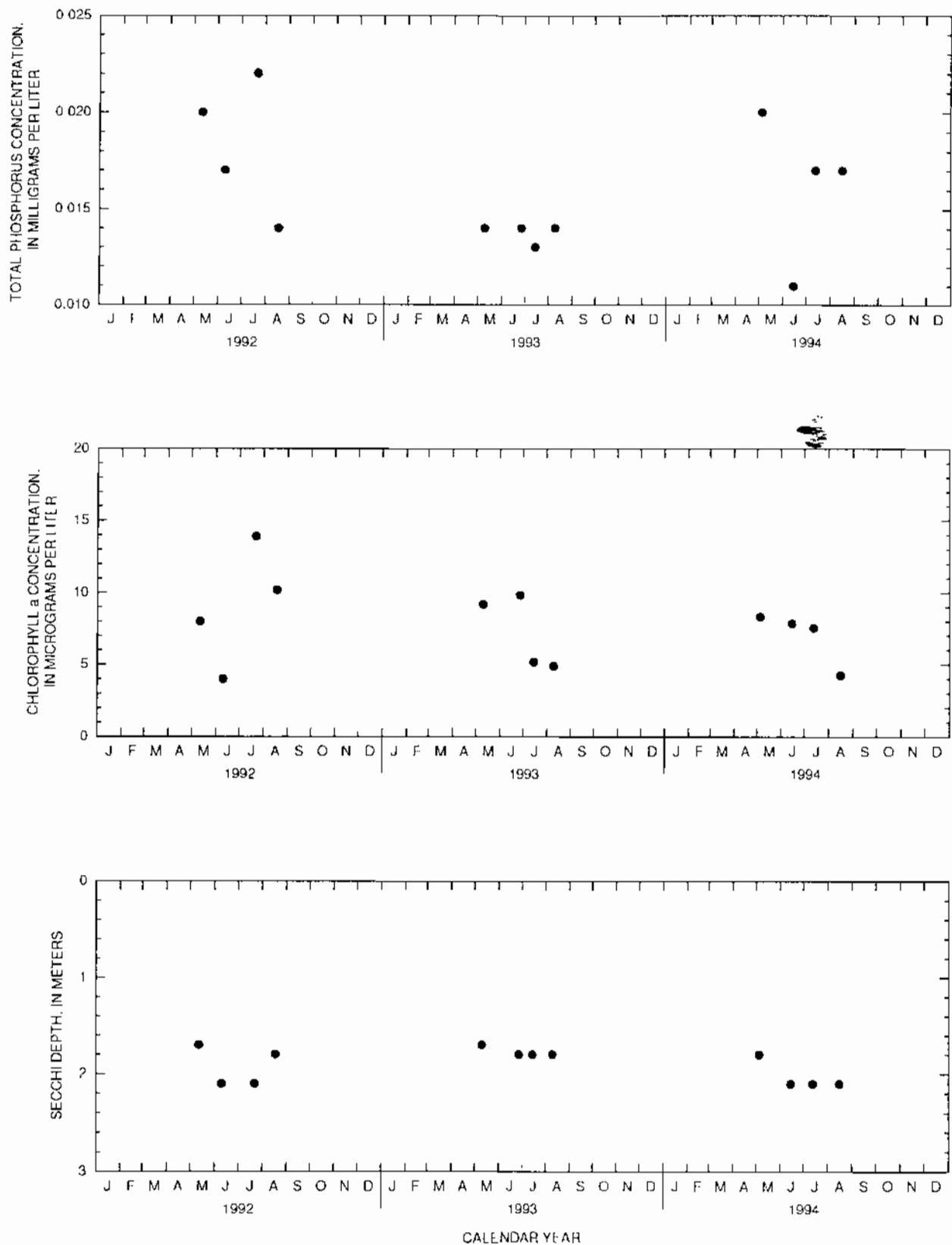


Figure 4b.-- Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Lake Nebagamon, Southeast Bay at Deep Hole, at Lake Nebagamon, Wisconsin.

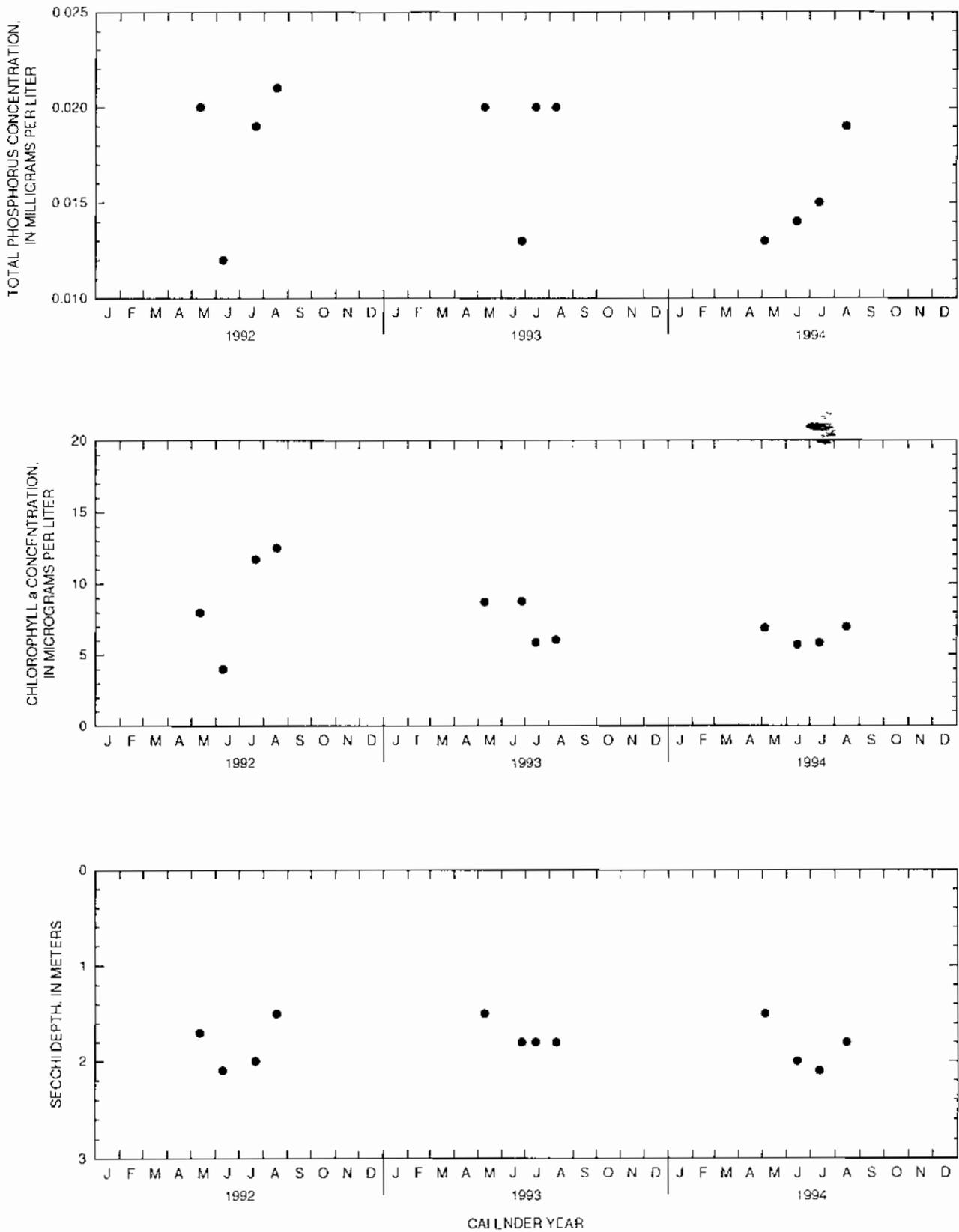


Figure 4c.-- Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Lake Nebagamon, West Bay, at Lake Nebagamon, Wisconsin.