WHITE POTATO LAKE
FINAL REPORT

NES

Ecological Services Division of Robert E. Lee & Associates, Inc.

TABLE OF CONTENTS

LPL-608

1.0 INTRODUCTION

The White Potato Lake Sportsman's Club (Sportsman's Club) was formed in 1989 and, since its inception, has supported the protection, improvement, and recreational development of White Potato Lake for the benefit of the general public. White Potato Lake is a shallow 978-acre seepage lake located in Oconto County, Wisconsin (Figure 1-1). In April of 1999, the Sportsman's Club received a Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant to develop a lake management plan for White Potato Lake. The objectives of the White Potato Lake Planning Grant study include the following:

1. Description of the physical and chemical characteristics of the lake.
2. Development of a baseline understanding of existing water quality, fishery, and aquatic vegetation characteristics.
3. Definition of the lake's tributary watershed and potential impacts to the lake from the surrounding watershed.
4. Mapping of historic sediment accumulation in the lake, characterization of lake substrate, estimation of depositional rates, and definition of potential sources of sediment.
5. Development of comprehensive lake management goals and objectives including alternative lake management strategies.

A description of the study methodologies is provided in Section 2.0, followed by presentation and discussion of the results in Section 3.0. Section 4.0 provides the study conclusions including a summary of the findings and a discussion of future lake management options.

2.0 METHODOLOGY

2.1 Public Education and Involvement Program

Prior to project start-up (i.e., April 27, 1999), NES attended a Sportsman's Club meeting to present goals and objectives of the lake planning project and obtain input from the club members regarding existing concerns. The primary concerns of Sportsman's Club members included sediment accumulation rates in the lake and the health of the fishery.

On January 5, 2000, NES attended a second Sportsman's Club meeting to disseminate information regarding the status of the project and work completed to that point. An update was provided for each of the lake study tasks.

2.2 Watershed Definition and Existing Land Coverages

The United States Geologic Survey (USGS), White Potato Lake Quadrangle topographic map was used to define the watershed boundary for the lake. Land coverages within the delineated watershed boundary were determined using data from the Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND) and review of 1997 black-and-white aerial photography. WISCLAND is a consortium of government and private organizations formed in 1993 to acquire funding and resources to develop land cover data for the state using 1991 through 1993 Landsat Thematic Mapper satellite imagery.

The WISCLAND land cover data for Oconto County were acquired from the Wisconsin Department of Natural Resources (WDNR) and incorporated into a Geographic Information System (GIS) database containing the USGS topographic map and delineated watershed boundary. Acreage estimates for each land cover category found within the White Potato Lake Watershed were derived from the land cover data. The 1997 aerial photography was utilized to verify the WISCLAND data and modify land coverage information when appropriate.

GIS software was also used to produce a Digital Elevation Model (DEM) of the lake's watershed. The source DEM used to generate contour lines for the White Potato Lake Watershed was a USGS product that corresponds to the USGS topographic quadrangle series map. Each DEM is based on a 30x30 meter spacing of sampling points for elevation values based on the Universal Transverse Mercator projection. The source DEM was used to generate ten-foot contour intervals for the White Potato Lake Watershed.

The final component of the watershed definition process involved identification of Environmentally Sensitive Areas (ESA's) within the White Potato Lake Watershed. The ESA's represent those areas that were considered unsuitable for development due to environmental constraints. For the purposes of this study, ESA's included shoreland areas and 100-foot buffers, wetlands, areas of steep slope (i.e., greater than 12 percent), and soils undesirable for development (i.e., highly erodible soils). Soils information was obtained from the *Soil Survey of Oconto County, Wisconsin* (Roberts et al. 1988). Wetland areas were identified based upon 1994 WDNR Wisconsin Wetland Inventory digital data. The wetland areas were not field verified due to the contentious legal issues that surround wetland boundary determinations. It is important to note, therefore, that the wetland coverage contained in this report does **not** represent an official or jurisdictional wetland boundary.

2.3 Nonpoint Source Phosphorus and Sediment Loading Analysis

Acreages for each land cover type were input into the phosphorus loading module of Version 2.00 of the Wisconsin Lake Model Spreadsheet (WILMS). WILMS is a lake water quality planning tool developed by the WDNR (Panuska et al. 1994). The output from the WILMS model was used to partition the total phosphorus load for White Potato Lake into the various land cover categories.

To assist in quantifying the rate of sediment accumulation in White Potato Lake, sediment-loading estimates for each land cover type were also calculated and used to determine an annual sediment load resulting from the tributary watershed. Loading coefficients were adapted from loading estimates based upon watershed monitoring conducted in northern Virginia and contained in the *Guidebook for Screening Nonpoint Pollution Management Strategies* prepared by the Northern Virginia Planning District Commission (1979).

2.4 Point Source and Sanitary System Review

An analysis of potential point source discharges within the White Potato Lake Watershed was conducted through watershed field reviews, communication with lake residents and users, and a review of the *Upper Green Bay Basin Water Quality Management Plan* (Watermolen 1993). Information regarding the White Potato Lake sanitary sewer system was obtained from Aldie Depner, Town Chairman, Town of Brazeau.

2.5 Water Quality Monitoring

2.5.1 Water Quality Data

White Potato Lake water samples were collected by NES on May 27, 1999, June 12, 1999, August 4, 1999, January 26, 2000 and April 18, 2000. All water samples were collected three feet below the surface and three feet above bottom at the deepest point in the lake (Figure 2-1). Water quality parameters analyzed included total phosphorus, dissolved phosphorus, chlorophyll *a*, total Kjehldahl nitrogen, nitrate/nitrite, ammonia nitrogen, total alkalinity, laboratory pH, suspended solids, and calcium. The specific parameters analyzed for each water sample were based upon the WDNR Long Term Trends Lake Monitoring Methods. Field parameters and Secchi disk depth were also recorded during each water sample. Field parameters were measured using a Hydrolab Datasonde 4 Multiprobe and included pH, specific conductivity, and dissolved oxygen/temperature profiles.

2.5.2 *Trophic State Index*

Lakes are often characterized according to their trophic status. Trophic status is an indicator of the productivity of a waterbody, and is usually characterized as high productivity (eutrophic), medium productivity (mesotrophic), or low productivity (oligotrophic). All lakes experience an aging process that progresses towards eutrophication; however, anthropogenic impacts such as excessive nutrient loading can accelerate the process and produce problems like excessive algal growth and poor water quality.

Carlson (1977) developed a Trophic State Index (TSI), wherein the trophic status of a lake can be estimated based on in-lake near surface measurements of chlorophyll *a* (which is an indicator of algal concentration), total phosphorus, or Secchi disk depth. Carlson TSI values were calculated for White Potato Lake using the water quality monitoring data. In addition, the TSI values were compared to a qualitative water quality index developed by Lillie and Mason (1983) for Wisconsin lakes. Lillie and Mason defined ranges of chlorophyll a, total phosphorus, and Secchi disk depth that would correspond to the following water quality descriptors: excellent, very good, good, fair, poor, and very poor.

2.5.3 Phosphorus Sensitivity

Phosphorus sensitivity describes the susceptibility of a waterbody to increased phosphorus loading and considers factors such as lake morphology and existing trophic state. One method of evaluating phosphorus sensitivity is to determine whether phosphorus is the limiting nutrient in the system. The limiting nutrient is defined as the nutrient responsible for limiting primary production (e.g., algal growth). In general, when nitrogen-to-phosphorus ratios are greater than 15:1, phosphorus is considered the limiting nutrient in the lake system (Krenkel and Novotny 1980). When nitrogen-to-phosphorus ratios are less than 15:1, nitrogen is often the limiting nutrient. Lakes in which primary productivity is limited by phosphorus availability are more sensitive to increased phosphorus loading.

A second method of evaluating phosphorus sensitivity has been developed by the WDNR. The WDNR methodology incorporates the lake's morphology, hydrologic characteristics, and TSI values to produce a relative classification of the lake's susceptibility to additional phosphorus inputs. The WDNR analysis first separates the lakes into two major classes. Class I lakes are more sensitive to phosphorus inputs than Class II lakes. Lakes in each general classification are then further subdivided into management groups. The management groups are outlined in Table 2-1.

Table 2-1. WDNR Phosphorus Sensitivity Classifications

Primary Classification	Secondary Classification	Parameters
Class I		Stratified Lake and Flushing Rate <6
	A	Existing Water Quality Fair to Excellent (TSI≤54)
	B	Existing Water Quality Poor to Very Poor (TSI>54)
	Ins	Data Insufficient to Assess Trophic Condition
	D	Stained, Dystrophic, or Aquatic Plant-Dominated Lake
Class II		Mixed Lake or Flushing Rate >6
	A	Existing Water Quality Fair to Excellent (TSI≤54)
	B	Existing Water Quality Poor to Very Poor (TSI>54)
	Ins	Data Insufficient to Assess Trophic Condition
	D	Stained, Dystrophic, or Aquatic Plant-Dominated Lake

2.6 Aquatic Vegetation Analysis

A comprehensive aquatic vegetation survey of White Potato Lake was conducted on August 4, 1999. The lake was sampled primarily through boating and wading, and a species list of all aquatic vegetation encountered was developed. During the species inventory work, any "sensitive areas" of particular importance were mapped. In addition, isolated exotic plant populations were mapped to assist in defining possible future management options.

A Florist Quality Assessment (FQA) was applied to the aquatic vegetation species list generated for White Potato Lake using the methodology of Nichols (1999). FQA is a rapid assessment metric used to assist in assessing the floristic and natural significance of a given area. The assessment system is not intended to be a stand-alone tool, but is valuable as a complementary and corroborative method of evaluating the natural quality of a site.

The primary concept in FQA is species conservatism. Each aquatic vegetation species for White Potato Lake was assigned a coefficient of conservatism (*C*) ranging from 0 to 10. The coefficient of conservatism estimates the probability that a plant is likely to occur in a landscape relatively unaltered from what is believed to be pre-settlement condition. A *C* of 0 indicates little fidelity to a natural community, and a *C* of 10 is indicative of restriction to high quality natural areas. The FQA was applied by calculating a mean coefficient of conservatism for all species observed in White Potato Lake. The mean *C* was then multiplied by the square root of the total number of plants to yield a floristic quality index. Examination of the floristic quality index within the context of statewide and regional trends was used to provide an overall evaluation of the floristic quality of White Potato Lake.

2.7 Fishery Review

Information regarding the White Potato Lake fishery was obtained from the WDNR. Fish data gathered during WDNR electrofishing and fyke netting efforts in 1995 were reviewed and summarized to provide an overview of the existing fishery. In addition, data was obtained from the WDNR regarding historic winter fish kills on White Potato Lake.

2.8 Lake Morphology and Bottom Sediments

A 1967 bathymetric map of White Potato Lake was obtained from the WDNR. The 1967 lake survey map was generated using recording sonar and was considered the best available representation of historic water depths.

On July 12, 1999, Global Positioning System (GPS) technology was used to collect water depth data from White Potato Lake. The data was collected using Trimble 4000SSE GPS receivers and was located using Real-Time Kinematic GPS calibrated using the benchmark from the 1967 lake survey. The GPS data collected on July 12th was used to generate a bathymetric map of the lake using contour intervals similar to those generated during the 1967 lake survey. The 1967 contours were digitized and overlayed onto the 1999 contours to provide an indication of the degree of sediment accumulation that has occurred over the past 32 years (Figure 2-1).

The White Potato Lake bottom substrate was characterized during a January 26, 2000 site visit. A gas-powered ice auger was used to drill seven holes in the ice at random sample locations around the lake perimeter (Figure 2-1). At each sample location, a slotted soil recovery probe with a five-foot extension (9.5 feet total length) was used to examine the lake substrate. The substrate profile was sampled for texture, structure, and thickness.

3.0 RESULTS AND DISCUSSION

3.1 Watershed Definition

The White Potato Lake Watershed is shown in Figure 3-1. A summary of the morphometric (i.e., lake shape) and hydrologic characteristics of White Potato Lake are shown in Table 3-1, and drainage patterns within the White Potato Lake Watershed are graphically displayed in Figure 3-2. A poorly defined outlet exists along the northeast shoreline, and water elevations in White Potato Lake are controlled during periods of high water by a low-head dam (0.62 feet) located on the outlet (Figure 2-1).

While the White Potato Lake Watershed may seem large, it is often informative to consider the size of the watershed relative to the lake's surface area. The drainage basin to lake surface area ratio (DB:LA) for White Potato Lake is 2.04. For comparison purposes, the mean DB:LA ratio for mixed seepage lakes in Wisconsin is 7.0 (Lillie and Mason 1983). White Potato Lake, therefore, has a small drainage basin relative to its surface area. Lakes with small DB:LA ratios typically have long hydraulic retention times. A lake's retention time is the length of time required for the lake to undergo a complete exchange of water. The White Potato Lake retention time is estimated at 2.22 years. According to Lillie and Mason (1983), the mean retention time for mixed seepage lakes in Wisconsin is 1.24 years. White Potato Lake, therefore, has a longer than average retention time.

Table 3-1. Morphometric and hydrologic characteristics of White Potato Lake

Parameter	Value
Lake Surface Area	978.0 acres
Lake Volume	4890 acre-feet
Tributary Drainage Area	1998.0 acres
Annual Watershed Runoff Volume	1831.5 acre-feet
Annual Direct Precipitation Volume	366.8 acre-feet
Hydraulic Loading	2198.3 acre-feet/year
Areal Water Load	2.25 feet/year
Drainage Basin to Lake Surface Area Ratio	2.04
Hydraulic Retention Time	2.22 years

3.2 Existing Land Coverage and Nonpoint Source Loading Analysis

Upland forest and wetlands cover the greatest acreage (i.e., ~61% of the total acreage) in the White Potato Lake Watershed (Figure 3-3). The dominance of these two land coverages is an indication of the relatively undisturbed condition of the watershed. Row crop agriculture and mixed agriculture constitute the third and fourth largest land coverages and are the principal sources of phosphorus and sediment, comprising 59.8% and 94.4% of the total loads, respectively (Table 3-2). Interpretation of the results shown in Table 3-2, however, should be done with caution for two primary reasons. First, loading coefficients for a given land coverage can vary within different geographic regions due to factors such as soil types, topography, etc. The loading coefficients used in this study are generalized estimates and locally derived loading coefficients obtained by methods such as watershed monitoring data would yield more accurate results. Second, the phosphorus and sediment loading coefficients do not represent the nutrient or sediment load delivered to the receiving water, rather they represent the "raw" load from the associated land use type. For example, a phosphorus loading coefficient for agricultural land is based upon estimates of nutrient export directly from this land use type, and does not account for any mitigative processes (e.g., distance from receiving body, natural vegetative buffers, installed best management practices, etc.) that may occur within the watershed.

Table 3-2. Land coverages and associated phosphorus and sediment loading within the White Potato Lake Watershed

Land Coverage	Acreage	Annual P Load (pounds/year)	% of Total P Load	Annual Sed. Load (pounds/year)	% of Total Sed. Load
Upland Forest	735	59.3	4.9%	14,467	1.7%
Wetlands	491	43.6	3.6%	10,212	1.2%
Row Crop Agriculture	324	434.4	35.9%	512,302	60.2%
Mixed Agriculture	323	289.2	23.9%	291,042	34.2%
High Density Residential (3.0 dwelling units/acre)	97	112.5	9.3%	22,977	2.7%
Pasture/Grass	28	7.0	0.6%	851	0.1%
TOTAL	1998	946.0	78.4%	851,851	100%

As shown in Table 3-2, the nonpoint source phosphorus load from watershed surface runoff is estimated as 78.4% of the total phosphorus load to the lake. The remaining external phosphorus load to White Potato Lake results from direct precipitation; therefore, direct precipitation comprises approximately 21.6% of the total external load, which is more than any of the watershed nonpoint sources other than agriculture. The relatively large phosphorus load from direct precipitation is related to the large surface area of the lake, the relatively small watershed area, and the undisturbed condition of the watershed.

3.3 Environmentally Sensitive Areas

The ESA's within the White Potato Lake Watershed are shown in Figure 3-4. The total ESA coverage is approximately 665 acres, which constitutes approximately 33% of the total watershed area. The ESA's consist of wetlands (488 acres), steep slopes (99 acres), and shoreland buffer areas

(78 acres). A comparison of Figures 3-3 and 3-4 reveals that much of the shoreland buffer area has already been developed.

3.4 Point Source and Sanitary System Review

Watershed field reviews, communication with lake residents and users, and review of the *Upper Green Bay Basin Water Quality Management Plan* (Watermolen 1993) revealed no documented point source discharges to White Potato Lake. In 1976, the Town of Brazeau began construction of a sanitary sewer system around White Potato Lake. The system was completed in approximately 1978, and discharges to an evaporation pond located approximately one-quarter mile from the lake. The evaporation pond overflows to two seepage ponds and eliminates the potential for direct sewerage discharge to White Potato Lake (Depner 2000).

3.5 Water Quality Monitoring

3.5.1 Water Quality Data

A summary of the water quality monitoring data canbe found in Appendix A. Table 3-3 summarizes the White Potato Lake water quality data relative to regional lake water quality data. Total phosphorus and chlorophyll *a* concentrations in White Potato Lake were lower than regional averages. Chlorophyll *a* values can be used as an indicator of algal concentrations in a waterbody. High values of chlorophyll *a* indicate high concentrations of algae and, typically, poor water clarity. Conversely, low chlorophyll a values often coincide with relatively high Secchi disk depths. White Potato Lake, however, had lower than average phosphorus and chlorophyll *a*, and lower than average Secchi disk depths. The explanation for the poor water clarity in White Potato Lake is probably related to factors other than algae that can influence water clarity. White Potato Lake is 394% larger than the average lake, but 67% shallower than the average lake (Table 3-3). The morphology of the lake creates a long fetch (i.e, the distance along open water over which the wind blows) and generates mixing of the water column and resuspension of bottom sediments. The resuspension of sediments is probably a primary contributing factor to poor water clarity in White Potato Lake.

Table 3-3. Comparison of White Potato Lake to regional water quality parameters

	White Potato Lake	Regional Average[a]	Percent Greater or Less than Regional Average
Area (acres)	978	198	+394%
Mean Depth (ft)	5	15.4	-67%
Secchi Disk (ft)	5.4	8.9	-39%
Chlorophyll *a* (ug/l)	6.3	9.3	-32%
Total Alkalinity (mg/l)	67	37	+81%
pH	7.9	6.9	+14%
Total Nitrogen (mg/l)	1.70	0.66	+158%
Total Phosphorus (mg/l)	.015	.019	-21%

a. From Lillie and Mason, 1983

3.5.2 Trophic State Index

Table 3-4 summarizes the Carlson (1979) TSI and Lillie and Mason (1983) Water Quality Index (WQI) values for White Potato Lake. In general, lakes with a TSI less than or equal to 39 are considered oligotrophic, those from 40 to 49 are considered mesotrophic, and those with a TSI greater than or equal to 50 are considered eutrophic. White Potato Lake exhibited conditions ranging from mesotrophic to eutrophic throughout the sample period. All of the Secchi disk TSI values were higher than the chlorophyll *a* and total phosphorus TSI values. As described in Section 3.5.1, low Secchi disk depths in White Potato Lake are probably attributable to abiotic factors impacting water clarity. When abiotic factors decrease water clarity, the decrease is not associated with nutrient inputs or other biological factors that affect trophic state; therefore, poor water clarity caused by abiotic factors can produce TSI values that are "inflated" and not representative of actual trophic state. For White Potato Lake, the total phosphorus and chlorophyll *a* values are likely the best indicators of trophic state.

The WQI values indicate that White Potato Lake experiences good water quality from a nutrient loading perspective but suffers from fair to poor water clarity.

Table 3-4. Summary of White Potato Lake trophic state and water quality indices for each sample date

	May 27, 1999		July 12, 1999		August 4, 1999		January 26, 2000		April 18, 2000	
	TSI	WQI	TSI	WQI	TSI	WQI	TSI	WQI	TSI	WQI
Chlorophyll a (ug/l)	45	Very Good	50	Good	50	Good	-----	-----	-----	-----
Total Phosphorus (mg/l)	49	Good	50	Good	52	Good	47	Good	48	Good
Secchi Disk (ft)	54	Fair	57	Poor	53	Fair	50	Good	53	Fair

3.5.3 Phosphorus Sensitivity

For the White Potato Lake surface water, the nitrogen-to-phosphorus ratio was 135.7:1. In general, when nitrogen-to-phosphorus ratios are greater than 15:1, phosphorus is likely the limiting nutrient in the lake system (Krenkel and Novotny 1980). The nitrogen-to-phosphorus ratio for White Potato Lake is very high, indicating that the probable nutrient of concern relative to water quality is phosphorus.

The WDNR classification methodology for phosphorus sensitivity classifies White Potato Lake as a Class IIA lake. In general, Class II lakes are less sensitive to phosphorus inputs than Class I lakes; nevertheless, within the Class II management group White Potato Lake has the maximum phosphorus sensitivity ranking.

3.5.4 Dissolved Oxygen/Temperature Profiles

Temperature and dissolved oxygen data is used to help determine the zone of biological activity for a lake. Lakes in this region of the country typically stratify, which means that a clear separation develops whereby warm, oxygen-rich surface water rests upon a layer of colder, oxygen-poor water called the *hypolimnion*. In winter, lakes typically have low levels of dissolved oxygen and cold temperatures throughout their depths, but can still stratify. After the ice melts, warmer air temperatures heat the upper layer, and wind begins to mix oxygen from the atmosphere into the upper layer, creating the oxygen-rich, warm water layer called the *epilimnion*.

The dissolved oxygen/temperature profiles for White Potato Lake demonstrate that the lake is a mixed lake, with no clear stratification (Figures 3-5 through 3-8). Water column mixing in White Potato Lake is a result of shallow water depths and a long fetch.

Examination of the winter profile (Figure 3-7) indicates that during the time of sampling (i.e., January 26, 2000) winter dissolved oxygen levels in the lake were high and did not indicate any reason for concern. Information from the WDNR (Appendix B) stated "White Potato Lake has had a history of a number of limited winter fish kills up to 1956 when a major winter fish kill occurred". Since 1956, no winter fish kills have been recorded, but the lake has experienced some periods of low dissolved oxygen levels during the winter months. The installation of the sanitary sewer system around the lake in the 1970's may have helped to alleviate the risk of winter fish kills.

3.6 Aquatic Vegetation Analysis

A total of thirty species of aquatic vegetation were observed in White Potato Lake. The median species number for lakes in this region is 14 (Nichols 1999); therefore, White Potato Lake has more species than typical for lakes within the same ecoregion. The large number of plant species in the lake could be, in part, due to its relatively large size (i.e., 978 acres). The average lake size for lakes in this region is estimated at 198 acres (Lillie and Mason 1983); therefore, White Potato Lake is approximately four times larger than the average lake.

The aquatic vegetation observed in White Potato Lake is listed in Table 3-5. The species that appeared to be most common in the lake are shown in bold. For comparison purposes, the relative abundance of each species in Wisconsin (Nichols and Vennie 1991) is also shown in Table 3-5. Twenty-eight of the species observed (i.e., 93.3%) were native to Wisconsin. Of those twenty-eight species, 26% are classified as infrequent statewide, 37% are classified as common statewide, and 37% are classified as abundant statewide. None of the species observed in White Potato Lake are classified as rare statewide, and no threatened or endangered state or federal species were found.

Table 3-5. Aquatic Vegetation Observed In White Potato Lake

Common Name	Scientific Name	Nativity	Relative Abundance in Wisconsin
Emergent Vegetation			
Three-way sedge	*Dulichium arundinaceum*	Native	Common
Spike-rush	*Eleocharis smallii*	Native	Common
Wild blue flag	*Iris versicolor*	Native	------------
Canadian rush	*Juncus canadensis*	Native	------------
Purple loosestrife	*Lythrum salicaria*	Exotic	------------
Pickerel weed[1]	***Pontedaria cordata***	Native	Common
Grass-leaved arrowhead	*Sagittaria graminea*	Native	Common
Common arrowhead	*Sagittaria latifolia*	Native	Abundant
Hard-stemmed bulrush	**Scirpus acutus**	Native	Common
Three-square bulrush	*Scirpus americanus*	Native	Infrequent
Common bur-reed	*Sparganium eurycarpum*	Native	Infrequent
Broad-leaved cattail	Typha latifolia	Native	Common
Wild-rice	*Zizania aquatica*	Native	Infrequent
Floating-leaved Vegetation			
Water shield	Brasenia schreberi	Native	Common
Yellow pond lily	**Nuphar variegatum**	Native	Abundant
White water lily	**Nymphaea tuberosa**	Native	Abundant
Floating-leaved bur-reed	Sparganium fluctuans	Native	Infrequent
Floating Vegetation			
Small duckweed	Lemna minor	Native	Infrequent
Submergent Vegetation			
Common waterweed	*Elodea canadensis*	Native	Abundant
Pipewort	*Eriocaulon septangulare*	Native	Common
Eurasian water milfoil	*Myriophyllum spicatum*	Exotic	Infrequent
Slender naiad	***Najas flexilis***	Native	Abundant
Large-leaved pondweed	***Potamogeton amplifolius***	Native	Abundant
Berchtold's pondweed	*Potamogeton berchtoldii*	Native	Infrequent
Grass-leaved pondweed	*Potamogeton gramineus*	Native	Common
Common pondweed	***Potamogeton natans***	Native	Abundant
Sago pondweed	*Potamogeton pectinatus*	Native	Abundant
White-stemmed pondweed	***Potamogeton praelongus***	Native	Common
Flat-stemmed pondweed	***Potamogeton zosteriformis***	Native	Abundant
Wild Celery	*Vallisneria americana*	Native	Abundant

1. **Bold indicates those species that are most common.**

Two of the species observed in White Potato Lake, Eurasian water milfoil and purple loosestrife, are non-native species that sometimes become a nuisance in Wisconsin. Eurasian water milfoil was introduced from Europe and Asia and is a fast growing plant than can form extensive canopies that obstruct recreation and navigation. The morphology and rapid growth characteristics of Eurasian water milfoil allow it to out-compete native vegetation through crowding and shading. Purple loosestrife was also introduced from Europe and Asia, and aggressively displaces native emergent vegetation such as cattails, bulrushes, and bur-reeds (Borman et al. 1997). Two areas of purple loosestrife were identified along the north/northwest shoreline (Figure 3-9). Given the current extent of colonization, a focused management effort may be able to reduce the population and control the spread of loosestrife at these locations.

The FQA completed for the White Potato Lake aquatic vegetation indicated a mean native species coefficient of conservatism of 6.14 (Table 3-6). Nichols (1999) found that the median *C* for lakes in the region is 5.6. White Potato Lake, therefore, appears to have a relatively high mean coefficient of conservatism.

The native floristic quality index for White Potato Lake is 32.50, and incorporating the non-native species into the index only reduces the value to 31.4. The median floristic quality index value for lakes in this region is 20.8 (Nichols 1999), indicating that White Potato Lake is well above the regional average. Overall, the floristic quality assessment suggests that the aquatic vegetation of White Potato Lake is indicative of a diverse assemblage of vegetation with relatively high floristic quality.

One "sensitive area" associated with a wild rice bed was identified during the aquatic vegetation fieldwork. A small area of wild rice was identified along the northwest shoreline of the lake (Figure 3-9). Wild rice is an annual grass that is a valuable food source for wildlife, and humans often harvest the grain for use or sale. Wild rice has a higher protein content than most cereal grains, and its carbohydrate content is greater than oats, winter wheat, or corn (Fannucchi et al. 1986). The grain of wild rice is especially important to birds during their preparation for fall migration. Wild rice is not a state or federal threatened or endangered plant, but it is recognized as a valuable wildlife plant that is afforded extra protection under regulations such as Chapters NR 19 and NR 103 of the Wisconsin Administrative Code. The White Potato Lake Sportsman's Club could examine the feasibility of managing and/or expanding the existing wild rice population to enhance the wildlife value of the lake.

Table 3-6. Coefficients of conservatism for White Potato Lake aquatic vegetation

Common Name	Scientific Name	Coefficient of Conservatism
Water shield	*Brasenia schreberi*	7
Three-way sedge	*Dulichium arundinaceum*	9
Spike-rush	*Eleocharis smallii*	6
Common waterweed	*Elodea Canadensis*	3
Pipewort	*Eriocaulon septangulare*	9
Wild blue flag	*Iris versicolor*	5
Canadian rush	*Juncus Canadensis*	6
Small duckweed	Lemna minor	5
Purple loosestrife	*Lythrum salicaria*	Non-native species
Eurasian water milfoil	*Myriophyllum spicatum*	Non-native species
Slender naiad[1]	***Najas flexilis***	**6**
Yellow pond lily	**Nuphar variegatum**	**6**
White water lily	**Nymphaea tuberosa**	**6**
Pickerel weed	**Pontedaria cordata**	**9**
Large-leaved pondweed	***Potamogeton amplifolius***	**7**
Berchtold's pondweed	*Potamogeton berchtoldii*	7
Grass-leaved pondweed	*Potamogeton gramineus*	7
Common pondweed	**Potamogeton natans**	**5**
Sago pondweed	*Potamogeton pectinatus*	3
White-stemmed pondweed	***Potamogeton praelongus***	**8**
Flat-stemmed pondweed	***Potamogeton zosteriformis***	**6**
Grass-leaved arrowhead	*Sagittaria graminea*	9
Common arrowhead	*Sagittaria latifolia*	3
Hard-stemmed bulrush	**Scirpus acutus**	**5**
Three-square bulrush	*Scirpus americanus*	5
Common bur-reed	*Sparganium eurycarpum*	5
Floating-leaved bur-reed	*Sparganium fluctuans*	10
Broad-leaved cattail	*Typha latifolia*	1
Wild Celery	*Vallisneria americana*	6
Wild-rice	*Zizania aquatica*	8
Mean *C*		6.14

1. **Bold indicates those species that are most common.**

3.7 Fishery Review

Fish stocking information and 1995 fishery survey data for White Potato Lake were obtained from the WDNR (Appendix B). Electrofishing and fyke net survey data from 1995 identified walleye, northern pike, largemouth bass, muskellunge, bluegill, pumpkinseed, black crappie, rock bass, and yellow perch in White Potato Lake. Fish stocking data indicated that walleye have been stocked in White Potato Lake most years between 1940-1958 and 1982-1995. In 1982 and 1985, for example, 2,000,000 walleye fry were stocked. In addition to walleye, largemouth bass were stocked in 1956, muskellunge in 1964 and 1965, and bluegill in 1995. Stocking has primarily been done by the WDNR; however, there has been some private stocking recorded.

The WDNR has concluded that the White Potato Lake fishery is of good quality. NES fisheries biologists reviewed the available WDNR data and concurred with the opinion that the fishery appears to be healthy. Field observations by NES fisheries biologists, however, have raised some questions regarding the availability of walleye spawning habitat in White Potato Lake. If insufficient walleye spawning habitat exists, stocking efforts would be the only source of walleye recruitment. The Sportsman's Club should evaluate existing spawning habitat conditions and consider habitat improvement projects that could promote natural recruitment and limit the financial and environmental costs associated with continuous stocking.

3.8 Lake Morphology and Bottom Sediments

Based upon a comparison of 1967 and 1999 lake bathymetric surveys, approximately 27% of White Potato Lake is shallower now than in 1967, and 1.6% is deeper than in 1967. The reduction in depth in those areas that are shallower is approximately six to 12 inches. Using these estimates, the maximum rate of substrate accumulation over the last 32 years was 0.375 inches per year. In evaluating the significance of a six to 12 inch change, the accuracy of the water depth data must be considered. For example, the 1967 lake survey was conducted using recording sonar and the accuracy of the equipment is unknown. At least part of the difference between 1967 and 1999 water depth data could be due to error in the depth measurements.

To further evaluate sediment accumulation rates in White Potato Lake, an analysis of annual watershed sediment load to the lake was conducted. Using the sediment loading data from Section 3.2, it was determined that 851,851 pounds of sediment are potentially delivered to White Potato Lake each year. As mentioned earlier, the sediment load represents the "raw" load to the waterbody and does not account for any mitigative processes that may actually reduce the load. Using an estimate of 100 pounds per cubic foot of sediment, the annual volume of sediment delivered to the lake is 8518 cubic feet. Assuming the bottom of the lake is flat, spreading this volume ofsediment evenly across the bottom of the 978-acre lake would create an annual decrease in depth of approximately 0.002 inches per year. Over a 32-year period, the maximum estimated areal sediment deposition in White Potato Lake originating from the watershed is only 0.08 inches. If the bathymetric survey data from 1967 and 1999 are accurate and the total deposition has been 0.375 inches over the 32-year period, approximately 21% of the deposition is due to watershed sediment loading and the remainder is due to external organic loading (e.g., tree leaves, terrestrial vegetation, etc.) and internal organic loading (e.g., dying aquatic vegetation, dying aquatic organisms, etc.).

The White Potato Lake substrate analysis revealed that there are 6± feet of fibrous organic matter covering a large portion of the lake bottom (Figure 2-1 and Table 3-8). In two of the seven sample locations, however, the bottom had no organic matter build-up and was composed of coarse sand. Observations during the site visits suggest that the coarse sand substrate is possibly associated with those areas of the lake with the greatest exposure to wind and wave energy. The disturbance due to these naturally erosive forces could be responsible for the lack of organic matter in some locations.

Table 3-8. Summary of substrate characteristics at the sample locations

Sample Location	Water Depth	Substrate Texture	
1	7'	0-2+'	Soft organic matter
2	6'	0-4.5+'	Soft organic matter
3	2.5'	0-6.5'	Soft organic matter
		6.5-7+'	Coarse sand
4	3.5'	0-6+'	Soft organic matter
5	3.5"	0-2.5+'	Coarse sand
6	2.5'	0-2.5+'	Coarse sand
7	3.5'	0-6+'	Soft organic matter

Large concentrations of partially decomposed organic matter can increase biological oxygen demand in a waterbody. During summer months, aquatic plants are photosynthesizing and producing oxygen during the day. The oxygen produced by photosynthesis assists in offsetting the oxygen lost through respiration by plants and animals and microbial decomposition of organic matter. In the winter, ice and snow cover and lowered plant metabolic rates reduce photosynthesis and, therefore, oxygen production. Microbial decomposition of organic matter during winter can deplete available oxygen and contribute to reduction in dissolved oxygen concentrations to levels unsuitable for fish. For this reason, large quantities of fibrous organic matter in a lake can have deleterious effects on the fish community.

4.0 CONCLUSIONS

4.1 Summary of Findings

The results of this Lake Planning Grant study are summarized below and provide a brief overview of the issues associated with White Potato Lake.

- White Potato Lake is a mixed seepage lake that is 394% larger and 67% shallower than the average lake in the region.
- White Potato Lake is a mesotrophic to eutrophic, phosphorus-limited lake.
- Water Quality Index values show that the lake exhibits good water quality, but fair to poor water clarity. The poor water clarity is probably related to wind-driven resuspension of particulate matter.
- The three largest land coverages in the watershed by acreage are upland forest, agriculture, and wetlands.
- The land uses responsible for the highest potential per acre phosphorus and sediment loads are row crop agriculture and mixed agriculture, comprising approximately 60% and 94% of the total loads, respectively.
- Approximately 665 acres, or 33% of the total White Potato Lake Watershed area, were designated as ESA's.
- A sanitary sewer system was installed around the lake in approximately 1978, and no documented point source discharges to the lake were identified.
- The floristic quality assessment suggests that the aquatic vegetation of White Potato Lake is relatively diverse and indicative of high floristic quality.
- One "sensitive area" associated with a wild rice bed was identified during the aquatic vegetation fieldwork.
- Two of the plant species observed in White Potato Lake, Eurasian water milfoil and purple loosestrife, are non-native species that sometimes become a nuisance in Wisconsin.
- The maximum estimated substrate accumulation rate for White Potato Lake is 0.375 inches per year. Of that amount, approximately 21% is estimated to be the result of watershed sediment loading and the remainder is likely due to external and internal organic loading.
- The White Potato Lake substrate analysis revealed that there are 6± feet of fibrous organic matter covering a large portion of the lake bottom.
- Dissolved oxygen data did not suggest any risk of winter fish kills in 2000. Historic WDNR data indicated that the last recorded winter fish kill on White Potato Lake was in 1956.
- WDNR fisheries data from 1995 suggests that the lake fishery is relatively healthy.

4.2 Management Options

4.2.1 Dredging

The Sportsman's Club has expressed an interest in pursuing a dredging program for White Potato Lake. Dredging in navigable lakes is regulated by Wisconsin Statutes, Chapter 30.20. To undertake a dredging project in a navigable lake, the project proponent must obtain a contract from the State of Wisconsin. The contract functions like a permit, but provides the state with an opportunity to charge the permittee for extracted materials because the state owns the lakebed (Kent 1994).

On February 22, 2000, Robert Rosenberger, WDNR Water Management Specialist, and Russ Heiser, WDNR Fisheries Biologist, were contacted to obtain information regarding the WDNR's position on dredging in White Potato Lake. Mr. Rosenberger and Mr. Heiser stated that a project with demonstrated benefit may be permittable, but several conditions would be required as a component of the permit. Permit conditions would likely include, but not necessarily be limited to, the following:

- The dredging project would have to be included as a component of a formal lake management plan that demonstrates the overall benefit of the project.
- A complete dredging plan must be prepared and submitted to the WDNR for review and approval. Details including equipment to be used and exact method of material extraction must be provided.
- The dredging equipment must not represent a threat regarding transport of exotic species into the waterbody. In other words, it must be ensured that all equipment is "clean" and free of attached exotic species (e.g., zebra mussels).
- The dredging project must include methods for controlling dredging-induced turbidity. Water quality monitoring for total suspended solids levels within the vicinity of the project may be required and subject to WDNR imposed limits. Additionally, a turbidity barrier could be required to limit impacts.
- The spoils from the dredging project must be barged or pumped to an approved upland depository area.
- A Wisconsin Pollutant Discharges Elimination System permit may be required for wastewater discharged as a by-product of the dredging process.
- The dredging project should be scheduled for completion within a reasonable time frame to minimize disturbance to the lake.

The first condition listed above requires that the dredging project must be identified as a component of a formal lake management plan that demonstrates the overall benefit of the project. Information and data gathered during this lake management planning study found that approximately 27% of White Potato Lake may be six to 12 inches shallower now than in 1967. Using these estimates, the maximum rate of substrate accumulation over the past 32 years was 0.375 inches per year. Over the 32-year period, the maximum estimated areal sediment deposition originating from the watershed is only 0.08 inches; therefore, approximately 21% of the total estimated deposition would be due to watershed sediment loading and the remainder would be due to external and internal organic loading. The results of the White Potato Lake substrate analysis support the preceding conclusion and show that there are 6± feet of fibrous organic matter covering a large portion of the lake bottom. The prevalence of a thick layer of fibrous organic matter over much of the lake bottom could increase biological oxygen demand in the lake and increase the likelihood of winter fish kills.

The data gathered through this study regarding lake in-filling must be interpreted with caution. The 0.375-inch per year estimate is a maximum rate, and the accuracy of the 1967 recording sonar equipment is unknown. Further, only 27% of the lake was shown to be shallower, and 1.6% was shown to be deeper. The actual rate of annual substrate accumulation across the entire lake is probably substantially less than 0.375 inches per year. With regard to the deleterious effects of the thick organic substrate on dissolved oxygen levels and fish health, the results of this lake management plan have found that no fish winter kills have occurred since 1956, the fishery is currently healthy, and the 2000 winter dissolved oxygen levels were good. When reviewing all of the available data, it does not appear that there is currently sufficient evidence that a dredging project would provide substantial ecological benefit for White Potato Lake. Localized dredging to improve boat landing access or recreational opportunities may be warranted, but would best be handled on an individual, case-by-case basis.

4.2.2 Aeration

As described in Section 3.5.4, there has not been evidence of a winter fish kill on White Potato Lake since 1956. For this reason, it appears that installation of an aeration system would primarily be a precautionary measure, and, therefore, may not warrant the installation, operation, and maintenance costs that an aeration system would require.

4.2.3 Fisheries Management

WDNR and NES fisheries biologists determined that the White Potato Lake fishery appears to be healthy. Field observations by NES fisheries biologists, however, have raised some questions regarding the availability of walleye spawning habitat in White Potato Lake. According to conversations with Greg Kornely, WDNR Natural Resources Technician, the WDNR has already completed some walleye spawning habitat enhancement projects on the lake, but creation of additional spawning habitat would be beneficial. The Sportsman's Club should evaluate existing spawning habitat conditions and consider habitat improvement projects that could promote natural walleye recruitment.

4.2.4 Preservation of Environmentally Sensitive Areas

The ESA's identified in this study represent those areas that were considered unsuitable for development due to environmental constraints. Much of the ESA area, as defined in this study, is already regulated to some extent by state, federal, and local governments (e.g., state and federal wetland laws, shoreland zoning laws, etc.); however, in some cases more stringent regulation may be warranted. The Sportsman's Club would need to work with Town of Brazeau representatives to address the ESA areas. For example, the Town of Brazeau could consider amending their zoning regulations to limit/prohibit future development within the designated ESA's and define those uses that would be allowable in the ESA's.

4.2.5 Exotic Species Management

Two exotic species, Eurasian water milfoil and purple loosestrife, were observed in White Potato Lake. Eurasian water milfoil was present, but was not observed at nuisance levels. The best method of controlling Eurasian water milfoil is prevention; once established, control can be very difficult. The WDNR is currently evaluating the effectiveness of an herbivorous weevil (*Eurhychiopsis lecontei*) and a fungus (*Mycoleptidiscus terrestris*) in controlling Eurasian water milfoil (Hoffmann and Kearns 1997). Given that the milfoil is not currently exhibiting signs of severely disrupting native vegetation in White Potato Lake, no management actions are recommended at this time. However, the Sportsman's Club should monitor the milfoil population in the future and track the results of the WDNR biological control research to determine whether biological control may be a feasible option for White Potato Lake in the future.

Two areas of purple loosestrife were identified along the north/northwest shoreline of White Potato Lake. Purple loosestrife is an aggressive plant that without control would likely continue to spread along the lake shoreline. Given the current extent of colonization, a focused management effort may be able to reduce the population and control the spread of loosestrife. Options for management could include manual removal, herbicide application, or a combination of the two. The Sportsman's Club should consider the development of a lakewide purple loosestrife management plan. If initiated soon, the potential exists to prevent further colonization or possibly reduce the extent of existing colonization.

4.2.6 Wild Rice Management

A small area of wild rice was observed along the northwest shoreline of White Potato Lake. While not a threatened or endangered plant, wild rice is a valuable food source for wildlife; therefore, increasing the extent of wild rice in the lake could increase the wildlife habitat available. Wild rice grows best in six inches to three feet of water, and prefers at least 18 inches of soft, mucky sediment (Fannuchhi et al. 1986). Additionally, wild rice prefers hard waters with some movement or wave action and little water level fluctuation (Sorenson 1972). White Potato Lake appears to meet many of the growth requirements for wild rice. To enhance the wildlife value of the lake, the Sportsman's Club could examine the feasibility of managing and/or expanding the existing wild rice population through seeding programs.

REFERENCES

Borman, S., R. Korth, and J. Temte. 1997. *Through the Looking Glass: A Field Guide to Aquatic Plants*. Wisconsin Department of Natural Resources, Publication #FH-207-97.

Carlson, R.E. 1979. *A trophic state index for lakes.* Limnol. Oceanogr. 22(2):361-9.

Depner, A. 2000. *Personal communication*, January 20, 2000. Town Chairman, Town of Brazeau.

Fannucchi, G.T., W.A. Fannucchi, and S. Craven. 1986. *Wild rice in Wisconsin: its ecology and cultivation*. University of Wisconsin-Extension, Agricultural Bulletin G3372. Department of Agricultural Journalism, University of Wisconsin-Madison.

Hoffmann, R. and K. Kearns. 1997. *Wisconsin Manual of Control Recommendations for Ecologically Invasive Plants*. Bureau of Endangered Resources, Wisconsin Department of Natural Resources, Publication PUBL ER-090 97.

Kent, P.G. 1994. *Wisconsin Water Law: A Guide to Water Rights and Regulations*. University of Wisconsin-Extension, Cooperative Extension, University of Wisconsin-Stevens Point.

Krenkel, P.A. and V. Novotny. 1980. *Water Quality Management*. Academic Press, New York, NY.

Lillie, R.A. and J.W. Mason. 1983. *Limnological Characteristics of Wisconsin*. Wisconsin Department of Natural Resources Technical Bulletin No. 138.

Nichols, S.A. 1999. *Floristic quality assessment of Wisconsin lake plant communities with example applications*. Journal of Lake and Reservoir Management. 15(2):133-141.

Nichols, S.A. and J.G. Vennie. 1991. *Attributes of Wisconsin Lake Plants*. Wisconsin Geologic and Natural History Survey, Information Circular 73. Madison, WI.

Northern Virginia Planning District Commission. 1979. *Guidebook for Screening Urban Nonpoint Pollution Management Strategies*. Unpublished technical report prepared for Metropolitan Washington Council of Governments.

Panuska, J.C., N.B. Booth, and A.D. Wilson. 1994. *Wisconsin Lake Model Spreadsheet, Version 2.00, User's Manua*l. Wisconsin Department of Natural Resources Publication PUBL-WR-363-96 REV.

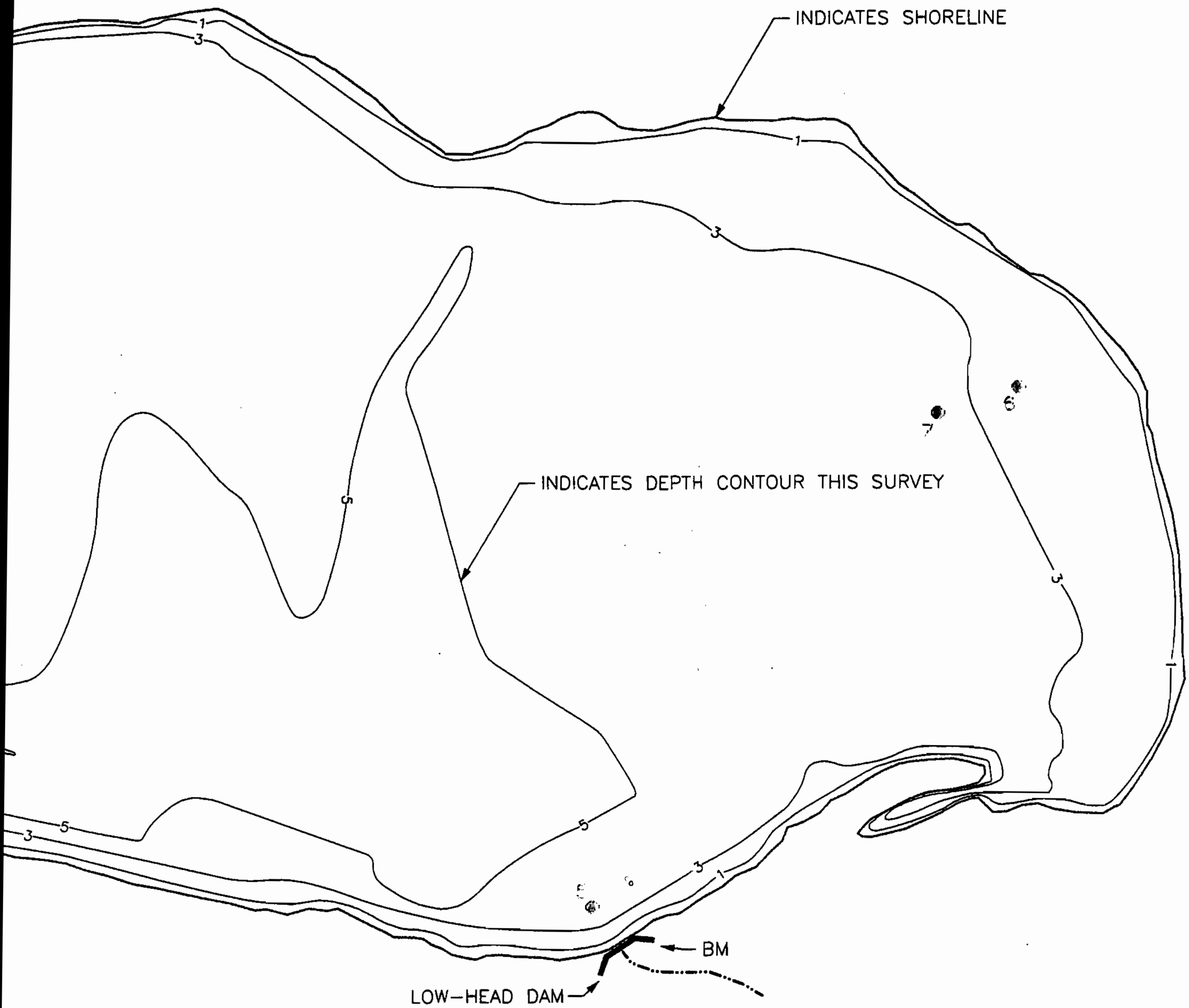
Roberts, D.C., J.E. Campbell, and T.L. Kroll. 1988. *Soil Survey of Oconto County, Wisconsin*. United States Department of Agriculture, Soil Conservation Service and Forest Service.

Sorenson, D.D. 1972. *Wild rice processing in the Upper Great Lakes Region*. University of Wisconsin-Extension, Madison, WI.

Watermolen, D.J. 1993. *Upper Green Bay Basin Water Quality Management Plan*. Wisconsin Department of Natural Resources Publication PUBL-WR-316-93.

NO.	DATE	APPROV.	REVISION	NO.	DATE	APPROV.	REVISION	DRAWN J. WESTERMAN
1	12/99	RS	ADDED 1967 SURVEY INFO					CHECKED R. STEG
1	2/2000	PR	ADDED SAMPLING LOCATIONS					DESIGNED

OC(



DEPARTMENT OF NATURAL RESOURCES B.M. 1086-C
CHISELED SQUARE IN THE CENTER OF THE UPSTREAM
CONCRETE WALL OF THE DAM. ELEVATION = 96.12

WATER LEVEL = 94.12

SURVEY DATE: JULY 12, 1999

400 0 400 800 1200

GRAPHIC SCALE IN FEET

● WATER QUALITY SAMPLING LOCATION

● SUBSTRATE SAMPLING LOCATIONS

TE POTATO LAKE COUNTY, WISCONSIN	FIGURE 2-1 WATER QUALITY AND SUBSTRATE SAMPLING LOCATIONS	DATE 11/12/99 FILE DEPTH JOB NO. 3531006	Robert E. Lee & Associates, Inc. ENGINEERING, SURVEYING, LABORATORY SERVICES 2825 SOUTH WEBSTER AVE., P. O. BOX 2100 GREEN BAY, WI. 54306-2100 PHONE:(920) 336-6338 FAX:(920) 336-9141 INTERNET: www.releeinc.com	SHEET NO. 1

Figure 3-1

White Potato Lake

Brazeau Township, Oconto County

Lake Watershed Boundary

MAP AREA SHOWN IN RED

Map Legend

County Boundary

Watershed Boundary

Data Sources:
Imagery: Georeferenced WDNR 1997 Aerial Photography
Watershed Boundaries: NES

Robert E. Lee & Associates, Inc.
Engineering, Surveying, Laboratory Services


Indian Trail
Sand Hill
18th
18th
Indian Trail
White Potato Lake
Pike
Patz
Lake
White Potato Lake
Parkway
16th
Mud Lake
Parkway
OCONTO COUNTY
MARINETTE COUNTY
Holcomb
White Potato Lake
Parkway
Kostreva
1000 0 1000 2000 3000 4000 Feet

FIGURE 3-1

Figure 3-2

White Potato Lake

Brazeau Township, Oconto County

Topography and Digital Elevation Model

MAP AREA SHOWN IN RED

Map Legend

- Watershed Boundary
- County Boundary
- 10 Foot Contour

Approximate Elevations (Feet)

- 809 - 819
- 819 - 829
- 829 - 839
- 839 - 849
- 849 - 859
- 859 - 869
- 869 - 879
- 879 - 889
- 889 - 899
- 899 - 909

Data Sources:
Watershed Boundaries: NES
Contour and Digital Elevation Model (DEM): USGS 30 Meter Mosaiked DEMs. Contour Lines Generated from DEMs

Robert E. Lee & Associates, Inc.
Engineering, Surveying, Laboratory Services

Indian Trail
White Potato Lake
Sand Hill
Pike
18th
18th
Parkway
16th
860
850
Lake
White Potato Lake
White Potato Lake
Mud Lake
850
860
860
Parkway
850
860
850
850
MARINETTE COUNTY
OCONTO COUNTY
840
Holcomb
White Potato Lake
850
850
Parkway
Kostreva
1000
0
1000
2000
3000
4000
Feet

FIGURE 3-2

Figure 3-3

White Potato Lake

Brazeau Township, Oconto County

Land Use and Land Cover

Map Legend

- Watershed Boundary
- County Boundary

Land Use/Land Cover

- High Density Residential
- Row Crop/Mixed Agriculture
- Pasture/Grass
- Upland Forest
- Open Water
- Wetland

Data Sources:
Watershed Boundaries: NES
Land Use/Land Cover: WISCLAND
High Density Residential: WDNR 1997 Aerial Photography
WDOT: Transportation

Robert E. Lee & Associates, Inc.
Engineering, Surveying, Laboratory Services

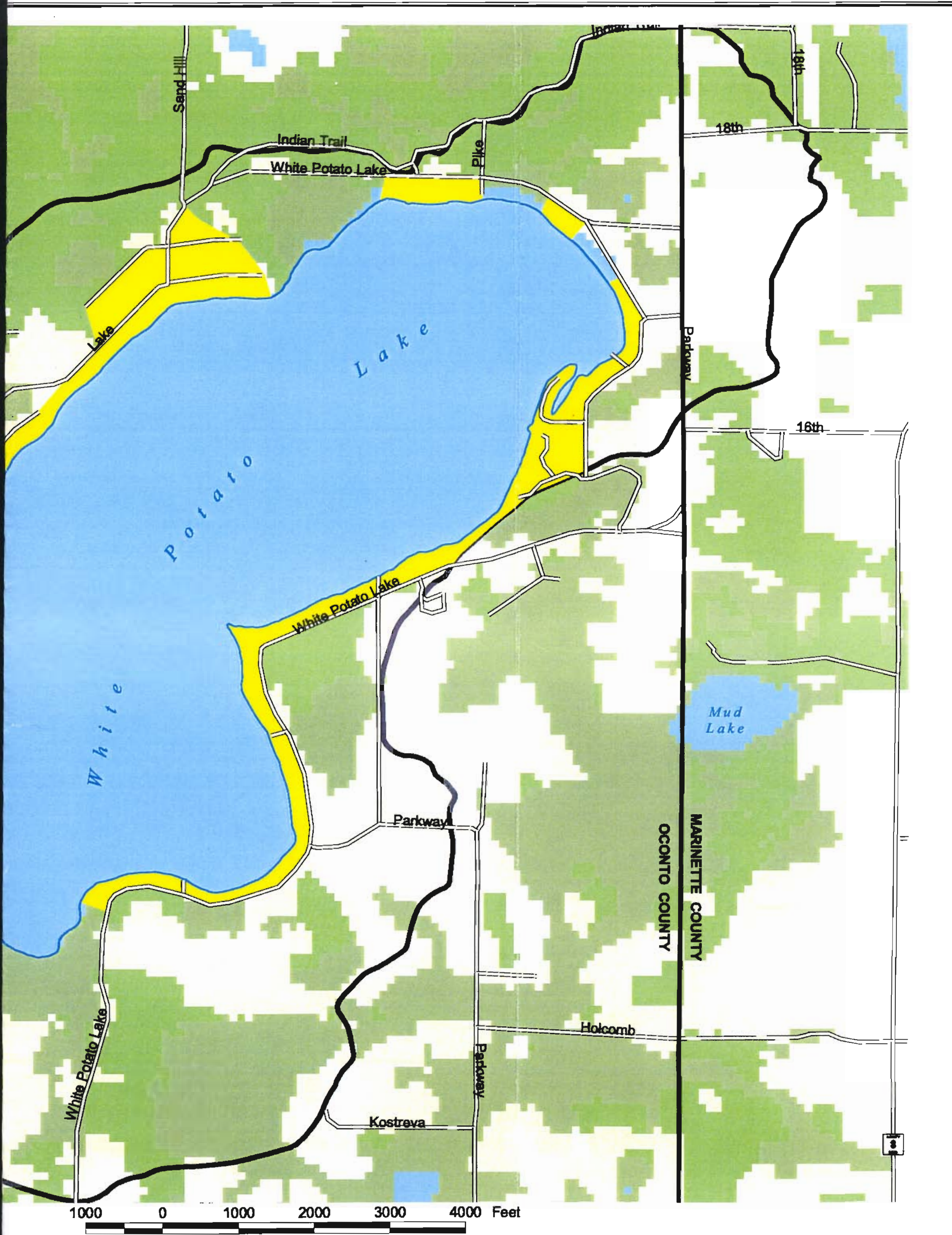

Sand Hill
Indian Trail
White Potato Lake
Pike
18th
18th
Lake
Lake
Potato
White
Parkway
16th
White Potato Lake
Mud Lake
Parkway
OCONTO COUNTY
MARINETTE COUNTY
Holcomb
Parkway
White Potato Lake
Kostreva
1000 0 1000 2000 3000 4000 Feet

FIGURE 3-3

Figure 3-4

White Potato Lake

Brazeau Township, Oconto County

Environmentally Sensitive Areas

Map Legend

- Wetlands < 2 Acres
- County Boundary
- Watershed Boundary
- 100 Foot Shoreland Buffer
- Steep Slope Soils
- Wetlands

Data Sources:
Imagery: Georeferenced WDNR 1997 Aerial Photography
Watershed Boundaries and ESAs: NES
Wetlands: WDNR WWI Wetlands (1994)
Soils Digitized from Oconto and Marinette County Soil Surveys

Robert E. Lee & Associates, Inc.
Engineering, Surveying, Laboratory Services

whitepotato-lakeshed.apr $13744001/maps/fig3-4.* 2/10/00

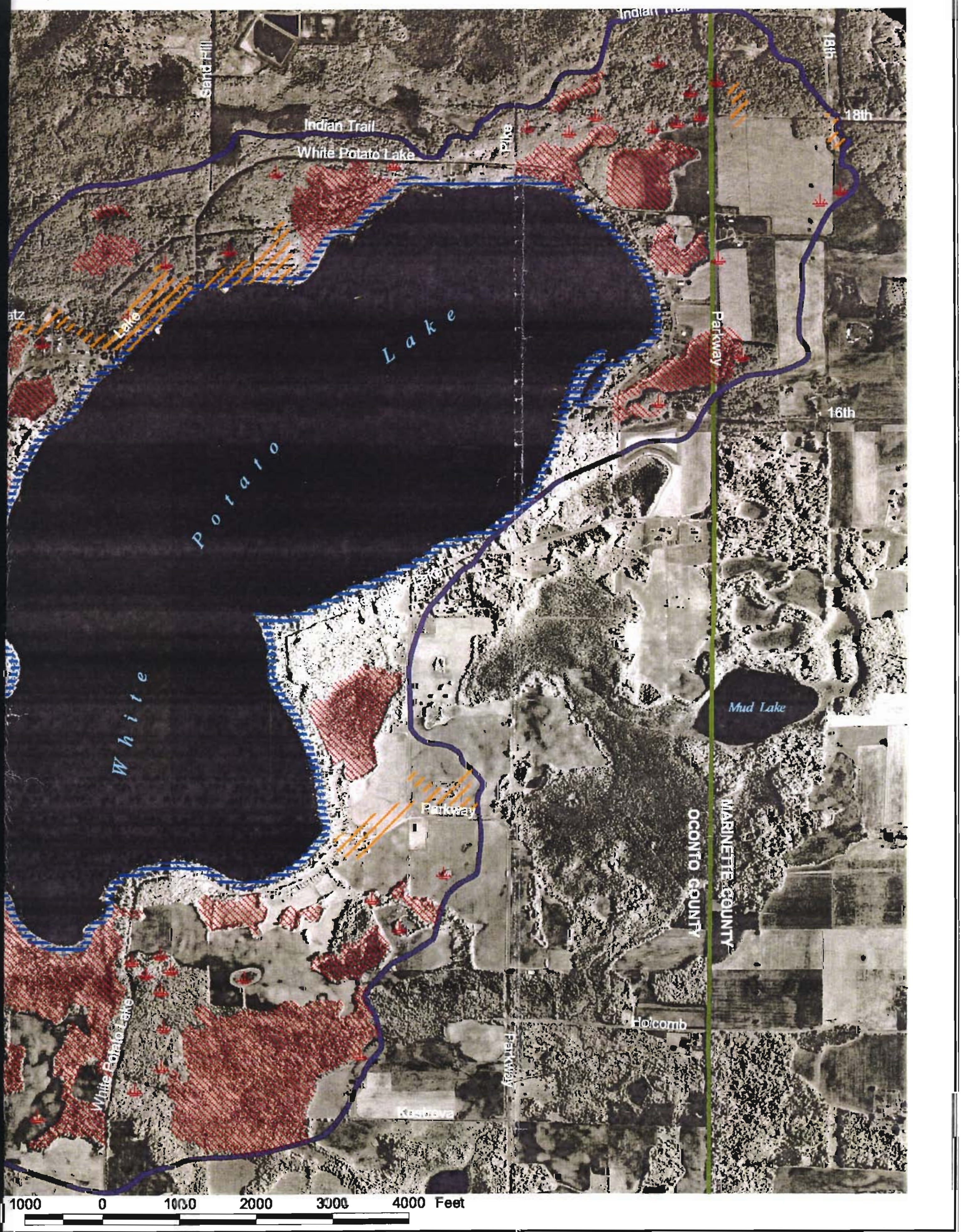

Indian Trail
Sand Hill
Indian Trail
White Potato Lake
Pike
18th
18th
Lake
White Potato Lake
Parkway
16th
Mud Lake
Parkway
OCONTO COUNTY
MARINETTE COUNTY
Holcomb
Parkway
White Potato Lake
1000 0 1000 2000 3000 4000 Feet

FIGURE 3-4

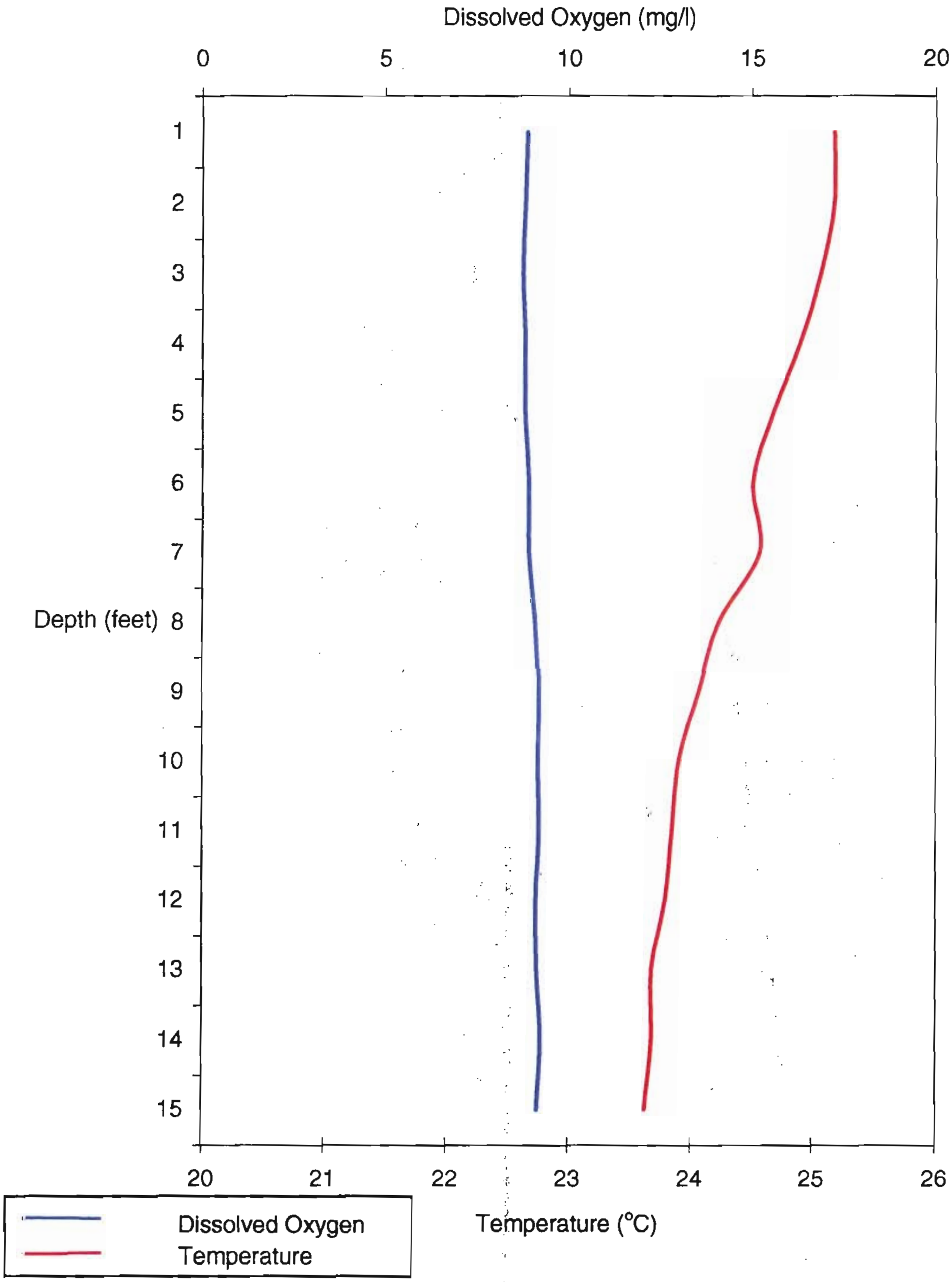


Figure 3-5. Dissolved Oxygen/Temperature Profiles for July 12, 1999

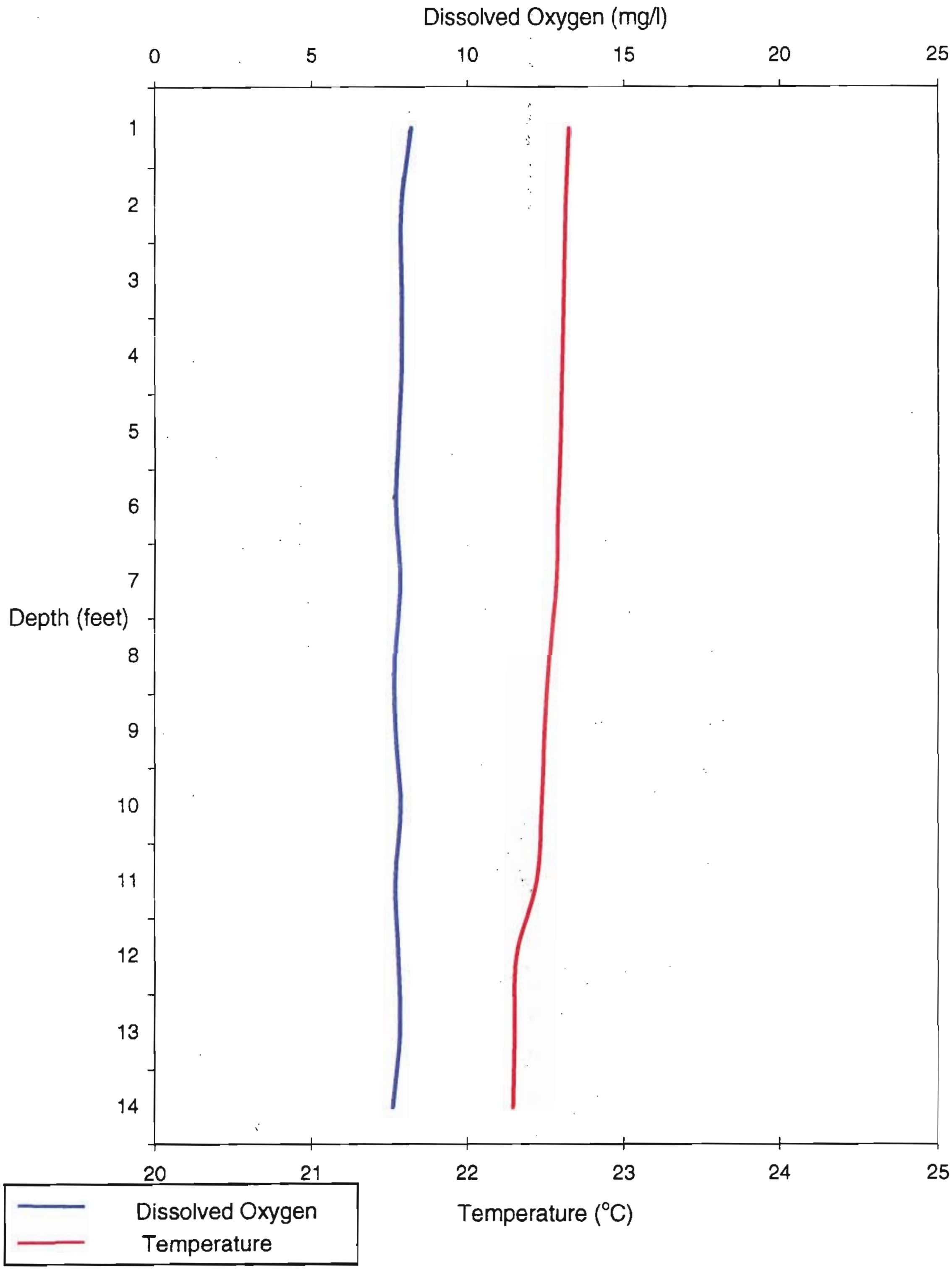


Figure 3-6. Dissolved Oxygen/Temperature Profiles for August 4, 1999

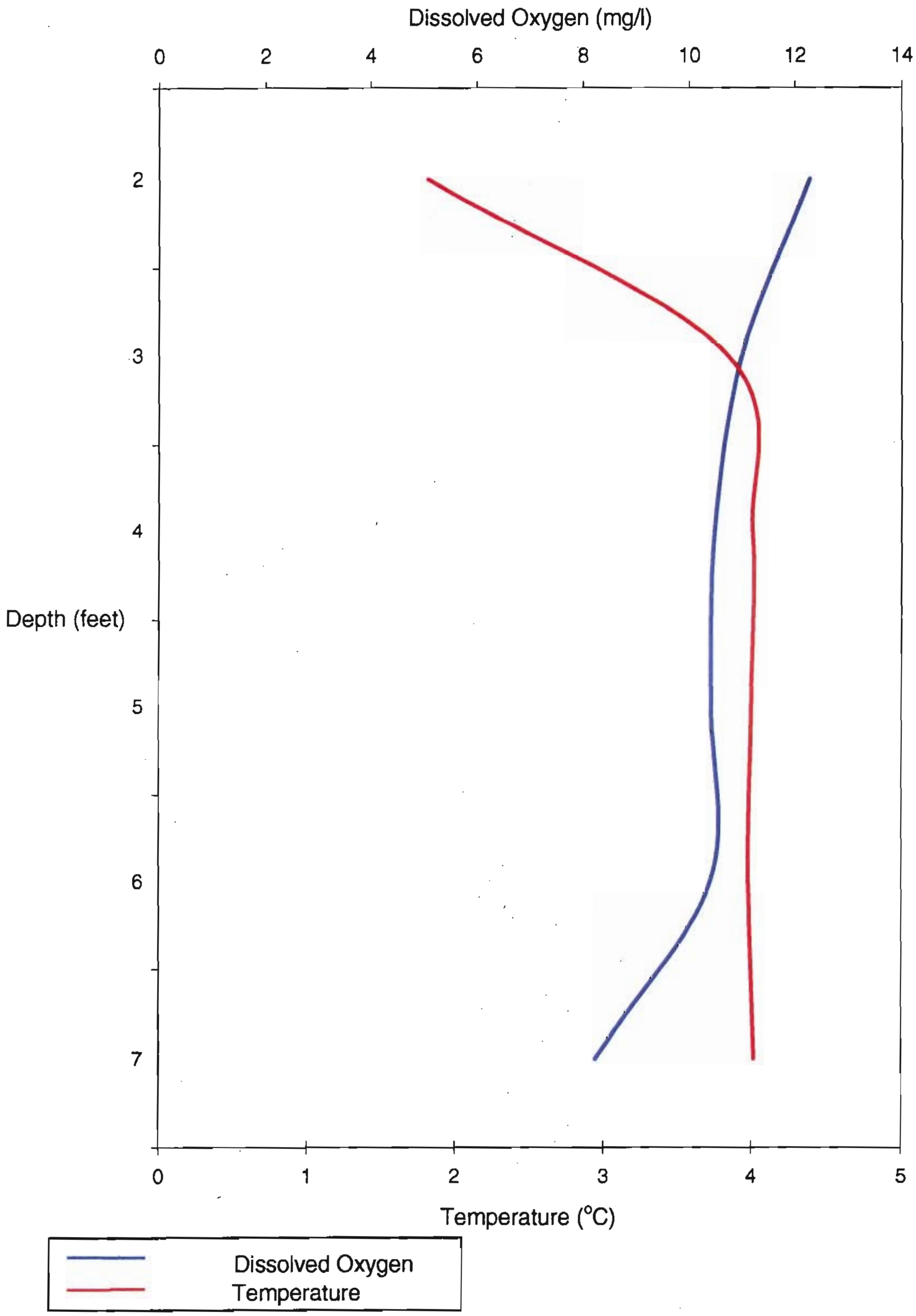


Figure 3-7. Dissolved Oxygen/Temperature Profiles for January 26, 2000

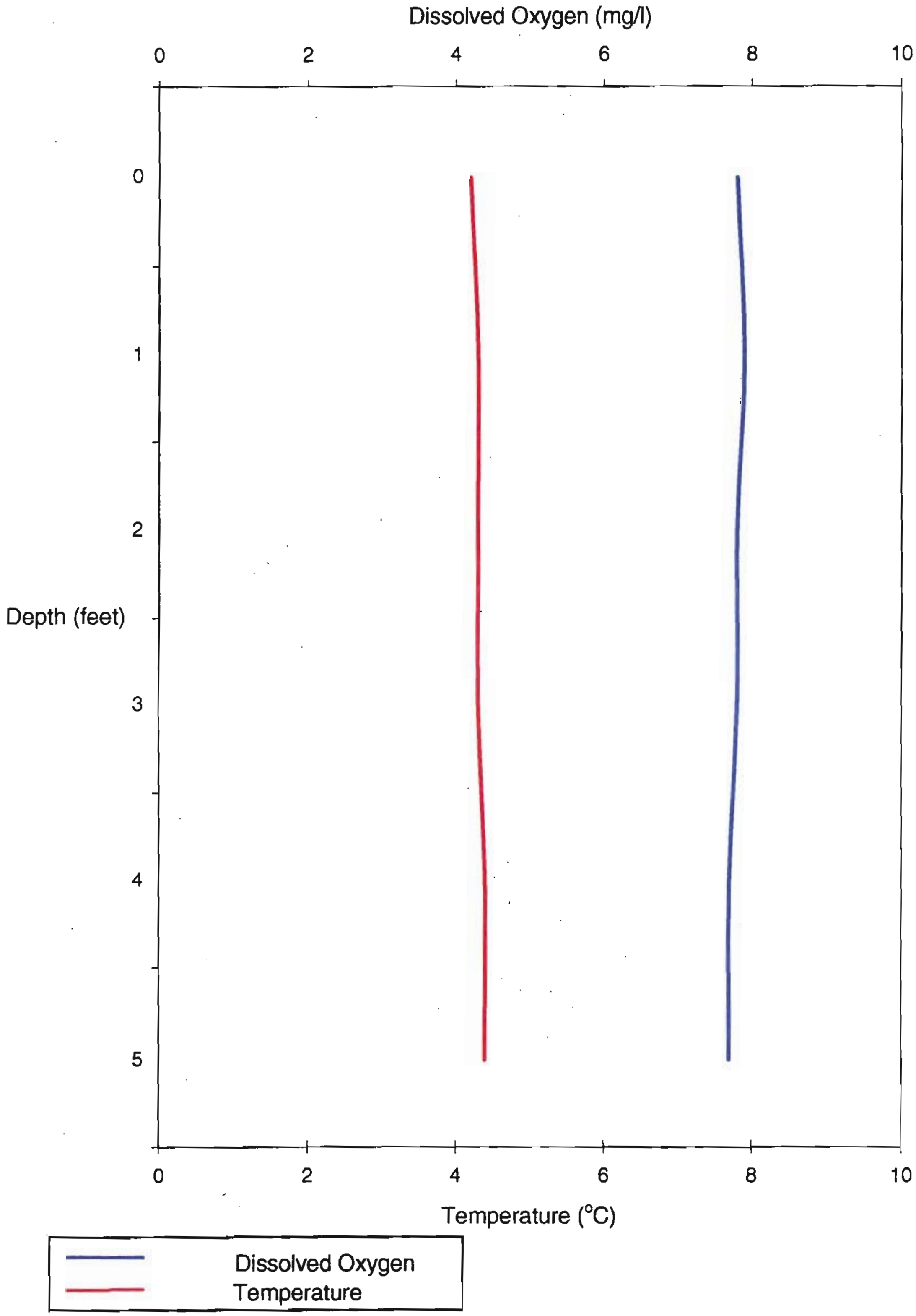


Figure 3-8. Dissolved Oxygen/Temperature Profiles for April 18, 2000