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T. A. Hoyman

Lake Management Plan for East Alaska Lake
WDNR Lake Management Planning Grant, LPL-560

Prepared for

Town of Pierce

Kewaunee County, WI

December 27, 1999
NES Project No.: 13168002

NES
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1.0 INTRODUCTION

East Alaska Lake is an approximate 53-acre seepage lake located in Kewaunee County (Figure 1-1). It is considered a seepage lake because the primary source of water is precipitation or runoff with some supplemental groundwater inputs from the immediate drainage area. East Alaska Lake is connected to West Alaska Lake by a small stream that flows from the northeast corner of West Alaska Lake and drains into the southwest corner of East Alaska Lake. The Alaska Lakes are then ultimately connected to Lake Michigan by an approximate 1.5-mile intermittent stream located on the East Alaska Lake eastern shoreline. The lake supports a warmwater fishery, and has a maximum depth of 50 feet with an average depth of 17 feet. To date, a comprehensive lake management plan has not been completed, and anecdotal information from lake residents and users has suggested that water quality and lake health have declined during recent times. In fact, the Wisconsin Department of Natural Resources (WDNR) received correspondence from the East Alaska Lake Improvement Committee in 1996 in which concern was expressed over poor water quality in the lake.

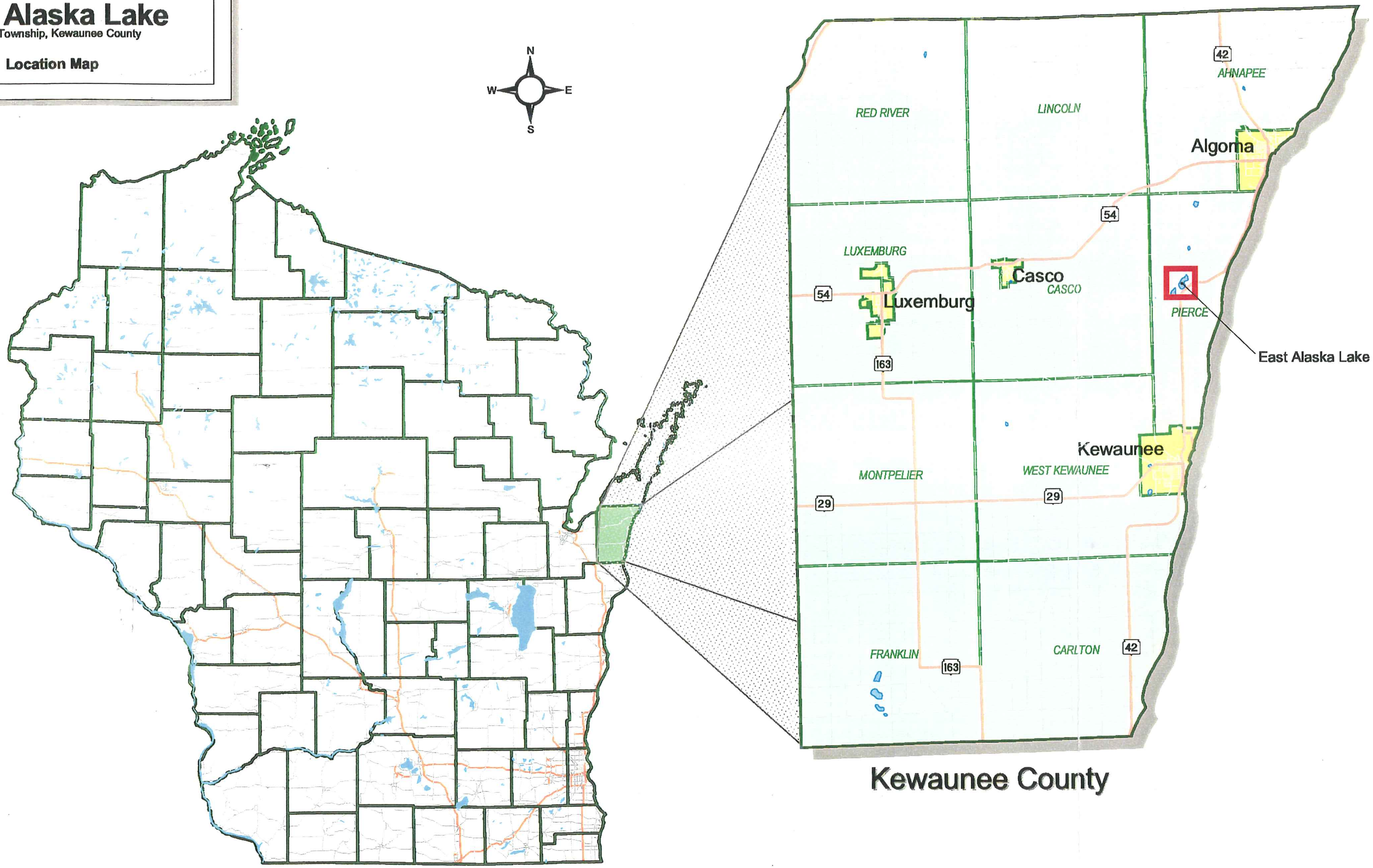
East Alaska Lake and its watershed are contained within the boundaries of the Town of Pierce. In 1997, the Town of Pierce conducted a community survey to examine the social and environmental concerns of town residents. Seventy-two percent of the survey respondents stated that protecting and preserving natural resources is important to them, and the survey identified inland lakes as one of the top reasons people choose to live in the Town of Pierce. In addition, the town is currently undergoing a land use planning process. Given the importance of the town's inland lake resources, the town wants to have the data necessary to adequately address lake management in their land use planning process.

Figure 1.1

East Alaska Lake

Pierce Township, Kewaunee County

Location Map



Kewaunee County

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FIGURE 1.1

In October of 1998, the Town of Pierce was awarded a WDNR Lake Management Planning Project Grant to conduct a baseline study of East Alaska Lake. The information collected through this study will be used to focus future monies on appropriate research, remediation, and protection efforts and will begin the process of improving the health of the lake. The lake study included a delineation of the watershed drainage basin, digital elevation modeling of watershed drainage patterns, identification of existing land uses in the East Alaska Lake watershed, examination of the impacts of existing land uses on water quality, water quality monitoring, and an aquatic vegetation analysis.

2.0 METHODOLOGY

2.1 Public Education and Involvement Program

Near the inception of the lake planning project (i.e., April 14, 1999), NES attended a Town of Pierce Ad Hoc Land Use Planning Committee meeting to present goals and objectives of the lake planning project and obtain input from the committee members regarding existing concerns. The primary concerns of committee members related to improving the existing health of the lake and enabling future lake protection.

On October 20, 1999, NES attended a Town of Pierce Board 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

Panchromatic 1992 digital orthophotography was obtained from the North American Photography Program and incorporated into a Geographic Information System (GIS) database containing the United States Geologic Survey (USGS) 1:24,000 scale topographic quadrangle maps for the East Alaska Lake Watershed (i.e., Algoma and Casco quadrangles). The orthophotography and topographic maps were used to define the preliminary watershed boundary and land coverages within the watershed. The preliminary data was then verified during an August 11, 1999 field review of the watershed. The only land coverage that was not derived in this manner was the wetland coverage. Wetland areas were derived based upon digital Wisconsin Wetland Inventory Maps obtained from the WDNR. This coverage was 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.

GIS software was also used to develop a Digital Elevation Model (DEM) of the lake's watershed. The source DEM used to generate contour lines for the East Alaska Lake Watershed was a USGS product that corresponds to the USGS topographic quadrangle map series. Each DEM is based on a 30x30 meter spacing of sampling points for elevation values based on the Universal Transverse Mercator (UTM) projection. For smaller scale applications, this elevation sampling provides a consistent elevation representation for generating ten foot contours, but at larger scales the contour lines generated by a 30-meter DEM should be viewed and interpreted with caution. The source DEM was smoothed to minimize any anamolous values and produce a more rounded contour line. Contour lines were generated from the smoothed DEM and then adjusted to fit the topographic characteristics of the lake. The adjusted contour lines do not represent a field verification of elevation values and should be used for general reference only.

The final component of the watershed definition process involved identification of Environmentally Sensitive Areas (ESA's) within the East Alaska 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 unable to support development (i.e., highly erodible soils).

2.3 Nonpoint Source Phosphorus Loading Analysis

Acreages for each land use 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).

Phosphorus loading coefficients to be used in the model were derived from data contained within the WILMS model, and loading estimates based upon watershed monitoring conducted in northern Virginia (Northern Virginia Planning District Commission 1979). A golf course phosphorus loading coefficient was not provided in either of these sources, and, as a result, a coefficient from an unpublished report prepared by Versar, Inc. was used (Versar 1991). The output from the WILMS model was used to partition the total phosphorus load for East Alaska Lake into the various land use categories.

2.4 Point Source and Septic System Discharge Inventory

An analysis of potential point source discharge sources within the East Alaska Lake Watershed was conducted through watershed field reviews, communication with Kewaunee County Land Conservation Department (LCD) staff, and a review of the *Twin-Door-Kewaunee Water Quality Management Plan* (Watermolen and Bougie 1995). The Kewaunee County Zoning Administrator provided information regarding the condition of household septic systems along the East Alaska Lake shoreline. In addition, WILMS was used to examine historic septic system phosphorus contribution to East Alaska Lake under a worst case pollutant scenario.

2.5 Water Quality Monitoring

East Alaska Lake water samples were collected by NES on February 24, May 25, July 15, and August 9, 1999. The lake planning project originally included five water quality samples (i.e., one winter, one spring, and three summer), however, due to unanticipated problems with water sampling equipment, a spring water sample could not be collected.

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 utilizing a Hydrolab Datasonde 4 Multiprobe and included pH, specific conductivity, and dissolved oxygen/temperature profiles.

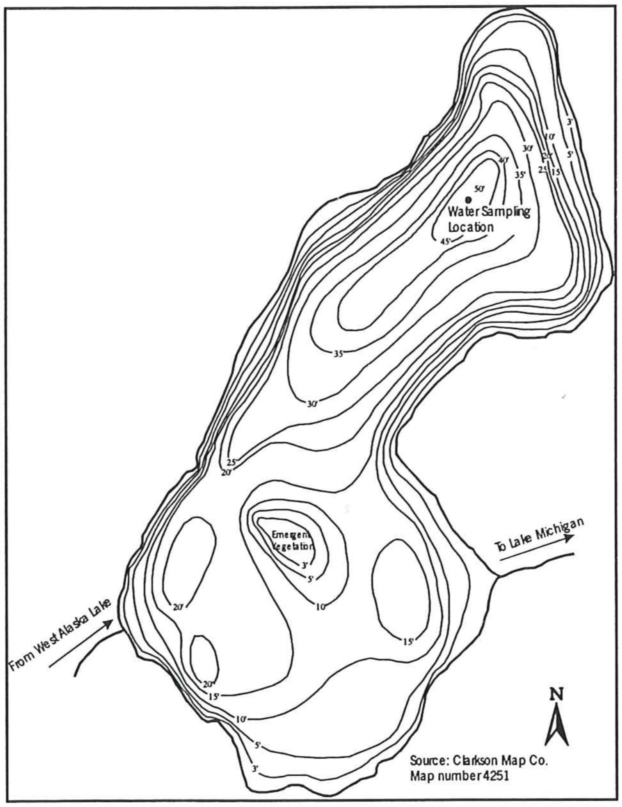

Figure 2-1 Location Of East Alaska Lake Water Quality Data Collection

In addition to 1999 in-lake monitoring, historic water quality data for East Alaska Lake was obtained from WDNR Self-Help Lake Monitoring records.

2.6 Aquatic Vegetation Analysis

2.6.1 Transect Survey

A quantitative aquatic vegetation survey was conducted by sampling eight transects located along the shoreline of the lake and interior island (Figure 2-2). On each transect, a ten-foot diameter circle was sampled within each of the four different depth ranges (Table 2-1). The maximum depth of sampling was determined through field observation of the approximate maximum depth of aquatic vegetation growth. at each sampling location, substrate type and species composition were recorded.

Table 2-1
Depth Ranges For Transect Sampling Of Aquatic Vegetation

Depth Code	Depth Range (feet)
1	0.0-1.5
2	1.5-3.0
3	3.0-5.0
4	5.0-10.0

A visual estimate of percent foliage cover for each species was also recorded at the sampling locations. Coverage is determined as the perpendicular projection to the ground from the outline of the aerial parts of the plant species and is typically reported as the percent of total area (e.g., substrate or water surface) covered (Brower et al. 1990). For emergent and floating leaved vegetation, the percent of water surface covered was used in the visual estimate, and for submergent vegetation the percent of substrate covered was used. After the collection of field data, the Daubenmire Classification Scheme (Mueller-Dumbois and Ellenberg 1994) was used to rank each species observed according to estimated foliage cover (Table 2-2). By providing a range of percent foliage cover for each rank, the Daubenmire Classification Scheme helps to minimize errors due to observer bias, visual estimation, etc.

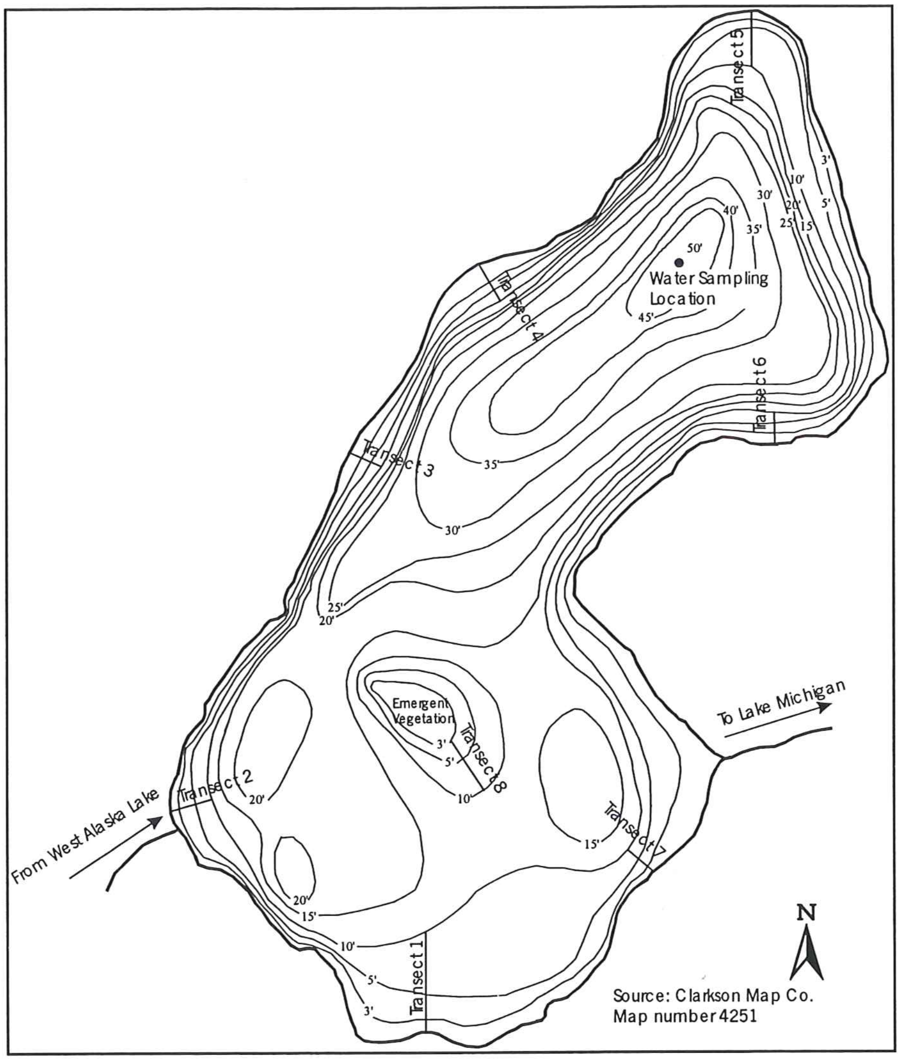

Figure 2-2 Location of Aquatic Vegetation Sampling Transects

Table 2-2
Daubenmire Classification Scheme for Ranking Based upon Estimated Foliage Cover

Percent Foliage Cover	Rank
0-5	1
5-25	2
25-50	3
50-75	4
75-95	5
95-100	6

The collected transect data was used to estimate *frequency of occurrence* and *relative frequency of occurrence* for each species observed. The *frequency of occurrence* is defined as the number of times a given species occurred on the eight observed transects. The *relative frequency of occurrence* is the frequency of that species divided by the sum of the frequencies of all species in the community (Brower et al. 1990).

2.6.2 Floristic Quality Assessment

A Florist Quality Assessment (FQA) was applied to the aquatic vegetation species list generated for East Alaska 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 East Alaska 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 East Alaska 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 East Alaska Lake.

3.0 RESULTS AND DISCUSSION

3.1 Watershed Definition

3.1.1 Physical Characteristics

East Alaska Lake has a direct hydraulic connection to West Alaska Lake (Figure 3-1). A small stream flows from the northeast corner of West Alaska Lake and drains. Figure 3-1 into the southwest corner of East Alaska Lake. The Alaska Lakes are

Figure 3.1

East Alaska Lake

Pierce Township, Kewaunee County

Watershed Boundaries for East and West Alaska Lakes

Map Legend

Lake Outlet Location

Watershed Boundary

Data Sources:
Orthophotography: USDA-NRCS 1992
Watershed Bounderies and Drainage Patterns: Northern Ecological Services

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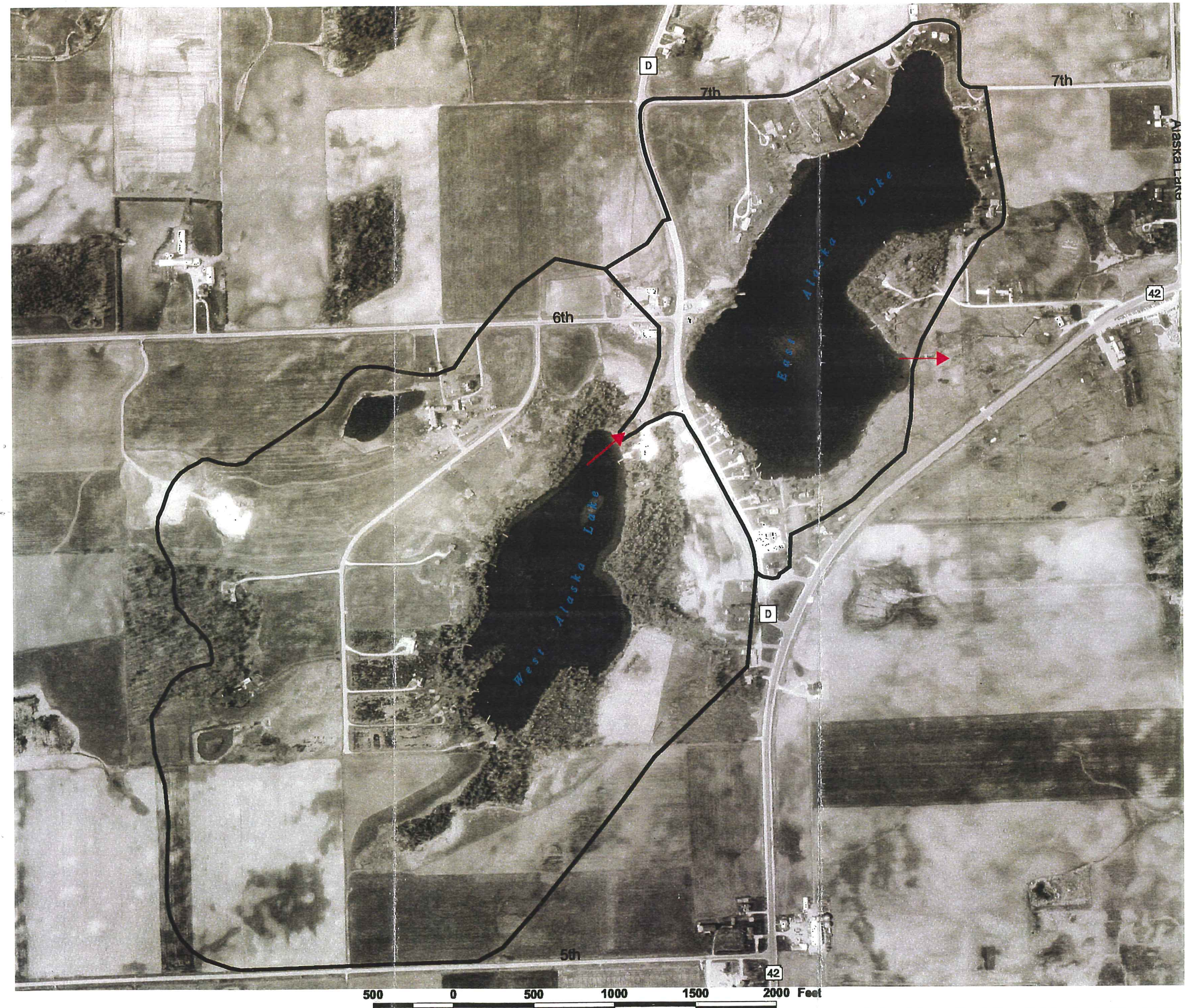

FIGURE 3.1

then ultimately connected to Lake Michigan by an approximate 1.5 mile intermittent stream located on the East Alaska Lake eastern shoreline.

The direct connection between West Alaska Lake and East Alaska Lake complicates the watershed analysis for this project. In effect, West Alaska Lake acts as a pollutant integrator by collecting surface water runoff from its surrounding watershed prior to discharge to East Alaska Lake. For this reason, the outlet from West Alaska Lake is probably best treated as a point source discharge to East Alaska Lake for the purpose of water quality analyses. For example, it would be misleading to analyze phosphorus loading estimates for surface runoff from both watersheds in a similar manner because runoff within the East Alaska Lake Watershed constitutes a direct input to East Alaska Lake while runoff within the West Alaska Lake Watershed does not. Because of discrepancies such as these, the majority of the watershed analyses within this report were focused within the East Alaska Lake Watershed. Estimation of some of the descriptive parameters (e.g., retention times and flushing rates), however, were done using the total watershed area (i.e., both lakes combined). In future studies, detailed sediment and nutrient loading estimates could be developed for the outlet from West Alaska Lake through collection of in-stream flow and pollutant concentration data.

A summary of the morphometric (i.e., lake shape) and hydrologic characteristics of East Alaska Lake are shown in Table 3-1, and drainage patterns within the East Alaska Lake watershed are graphically displayed in Figure 3-2. The tributary drainage area for the lake is only 62.6-acres. As a result, East Alaska Lake has a relatively small drainage basin to lake surface area ratio (DB:LA). 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 East Alaska Lake retention time is estimated at 4.13 years. According to Lillie and Mason (1983), the mean retention time for stratified seepage lakes in Wisconsin is 2.63 years. East Alaska Lake, therefore has a longer than average retention time for Wisconsin seepage lakes.

Figure 3.2

East Alaska Lake

Pierce Township, Kewaunee County

Digital Elevation Model

MAP AREA SHOWN IN RED

Map Legend

Symbol	Description
Watershed Boundary	
10 Foot Contour	
2 Foot Contour	

Digital Elevation Model (DEM) in Feet

- 694.092 - 699.262
- 699.262 - 704.431
- 704.431 - 709.600
- 709.600 - 714.770
- 714.770 - 719.939
- 719.939 - 725.108
- 725.108 - 730.278
- 730.278 - 735.447
- 735.447 - 740.616
- 740.616 - 745.786

Data Sources:
Watershed Boundaries: Northern Ecological Services
Contour and Digital Elevation Model (DEM): USGS
30 Meter Mosaiked DEMs
Contours Generated from DEMs
*Acreage totals approximate
Contour lines slightly adjusted to coincide with lake boundary

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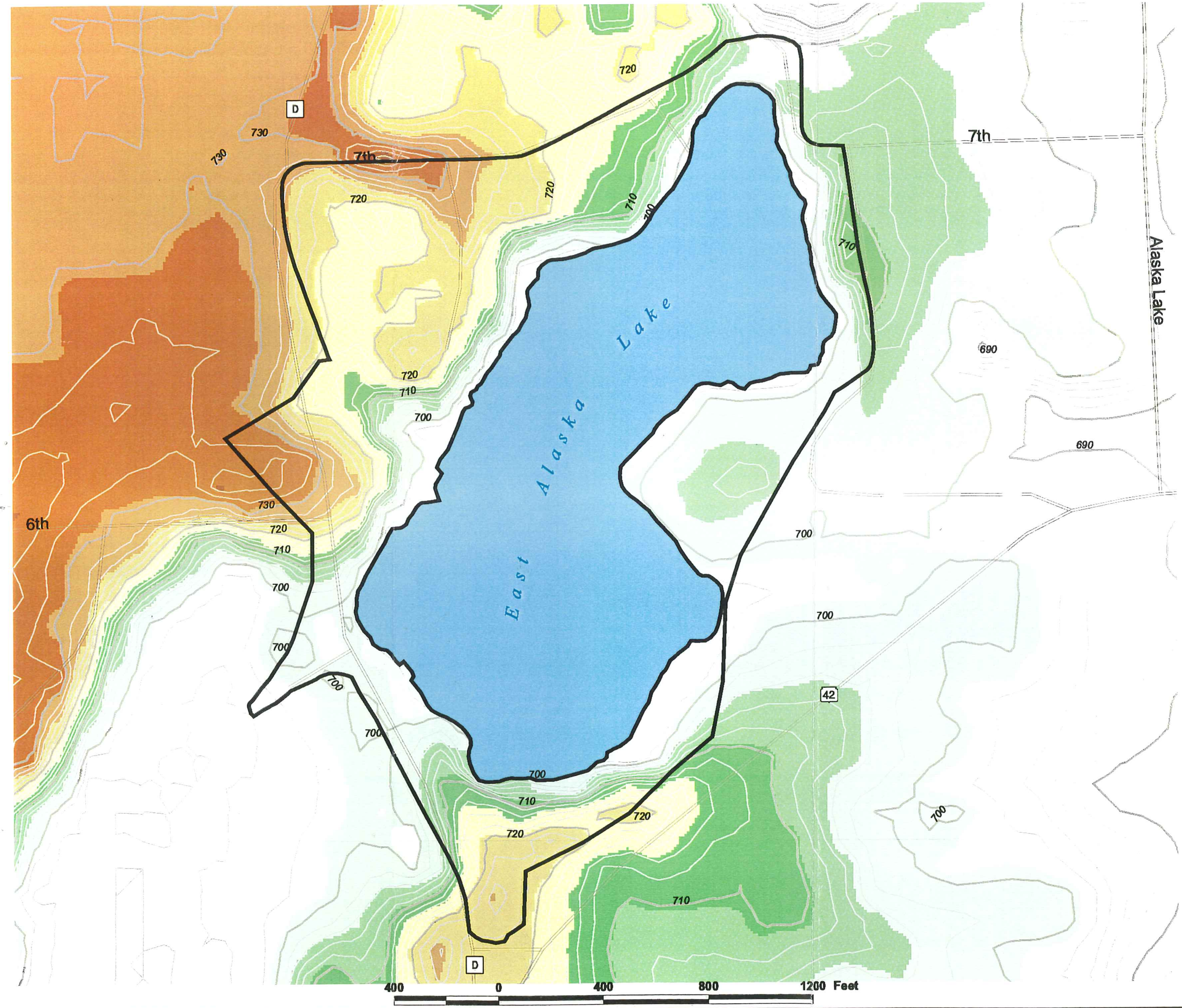

FIGURE 3.2

Table 3-1
Morphometric and Hydrologic Characteristics of East Alaska Lake

Parameter	Value
Lake Surface Area	53.0 acres
Lake Volume	901 acre-feet
Tributary Drainage Area	62.6 acres
Annual Watershed Runoff Volume	41.7 acre-feet
Annual Direct Precipitation Volume	15.1 acre-feet
Hydraulic Loading[1]	218.0 acre-feet/year
Areal Water Load[1]	4.11 feet/year
Drainage Basin to Lake Surface Area Ratio[1]	5.7
Hydraulic Retention Time[1]	4.13 years

[1]Assumes direct hydraulic loading from West Alaska Lake Watershed

3.1.2 Existing Land Coverage and Nonpoint Source Phosphorus Loading Analysis

The land use type covering the greatest acreage within the East Alaska Lake Watershed is low density residential (Table 3-2 and Figure 3-3). The golf course owned by the Alaskan Golf Club covers the fourth largest area in the watershed, but is potentially the largest contributor of phosphorus. Golf establishments, in general, tend to use relatively large amounts of fertilizer to maintain attractive, functional courses. As a result, the potential per acre phosphorus load resulting from this land use is relatively high. According to the WILMS analysis, golf course, agriculture, and low density residential land uses, respectively, produced the greatest phosphorus load to East Alaska Lake (Table 3-2).

Table 3-2
Land Coverages and Associated Phosphorus Loading within the East Alaska Lake Watershed

Land Coverage	Acreage	Annual Phosphorus Load (pounds/year)	Percent of Total Phosphorus Load
Low Density Residential (0.5 dwelling units/acre)	25.7	11.4	15.5%
Agriculture	17.8	15.9	21.5%
High Density Residential (1.5 dwelling units/acre)	7.8	6.3	8.5%
Golf Course	6.1	24.7	33.5%
Forest	2.3	0.2	0.3%
Grassland	1.4	0.4	0.5%
Industrial	0.7	0.7	0.9%
Wetland	0.5	0.1	0.1%
Barnyard	0.2	----	----

Figure 3.3

East Alaska Lake

Pierce Township, Kewaunee County

Land Use and Land Cover

MAP AREA SHOWN IN RED

Map Legend

Watershed Landuse Boundary

CODE	LANDUSE	ACRES*
AG	Agriculture	17.8
BY	Barnyard	0.2
IND	Industrial	0.7
FOR	Forest	2.3
GC	Golf Course	6.1
GRA	Grassland	1.4
HDR	High Density Residential	7.8
LDR	Low Density Residential	25.7
OW	Open Water	53.0
WET	Wetland	0.5

Data Sources:
Watershed and Land Use Boundaries: Northern Ecological Services
Contour and Digital Elevation Model (DEM): USGS
30 Meter Mosaiked DEMs
Contours Generated from DEMs
*Acreage totals approximate
Map Scale 1" = 400'

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400 0 400 800 1200 Feet

FIGURE 3.3

As can be seen in Table 3-2, the barnyard located on the Roger Teske farm was not included in the WILMS phosphorus loading analysis. The barnyard area was excluded because of previous remedial activities performed on the farm. According to conversations with Kewaunee County LCD staff, surface runoff from the barnyard historically drained directly to the lake. However, in 1995 a concrete manure storage facility and surface water diversion berms were constructed to contain and divert surface runoff from the barnyard. If the installed systems continue to work properly, surface runoff from the barnyard should no longer have a significant impact on the water quality of East Alaska Lake.

3.1.3 Environmentally Sensitive Areas

The ESA's within the East Alaska Lake Watershed are shown in Figure 3-4. The total ESA coverage is approximately 24.2 acres, which constitutes 39% of the total watershed area. The ESA's consist primarily of shoreland buffer and steep slopes with a small (0.5 acres) area of wetlands. As can be seen, much of the ESA acreage has already been developed, particularly in the shoreland zone. The extent of ESA acreage that has already been developed increases the importance of protecting the remaining area.

3.2 Point Source and Septic System Discharge Inventory

3.2.1 County Trunk Highway D Stormwater Drains

Currently, two stormwater drains are located along County Trunk Highway D to collect stormwater runoff from the roadway (Figure 3-3). Both drains discharge into East Alaska Lake, and provide a direct source of contaminants. Highway runoff can carry a unique range of pollutants including items such as flakes of metal from rusting vehicles, particles from vehicle exhaust, and tire and brake material. As a result of the above items, sediment, nutrients, and heavy metals can all be potential issues in highway runoff.

Figure 3.4

East Alaska Lake

Pierce Township, Kewaunee County

Environmentally Sensitive Areas

MAP AREA SHOWN IN RED

Map Legend

- Watershed Boundary
- 100 Foot Shoreland Buffer Approximately 13.6 Acres
- Steep Slopes Approximately 10.1 Acres
- Wetlands Approximately 0.5 Acre

Data Sources:
Orthophotography: USDA-NRCS 1992
Watershed Bounderies and ESAs: Northern Ecological Services
*Acreage totals approximate
Map Scale 1" = 400'

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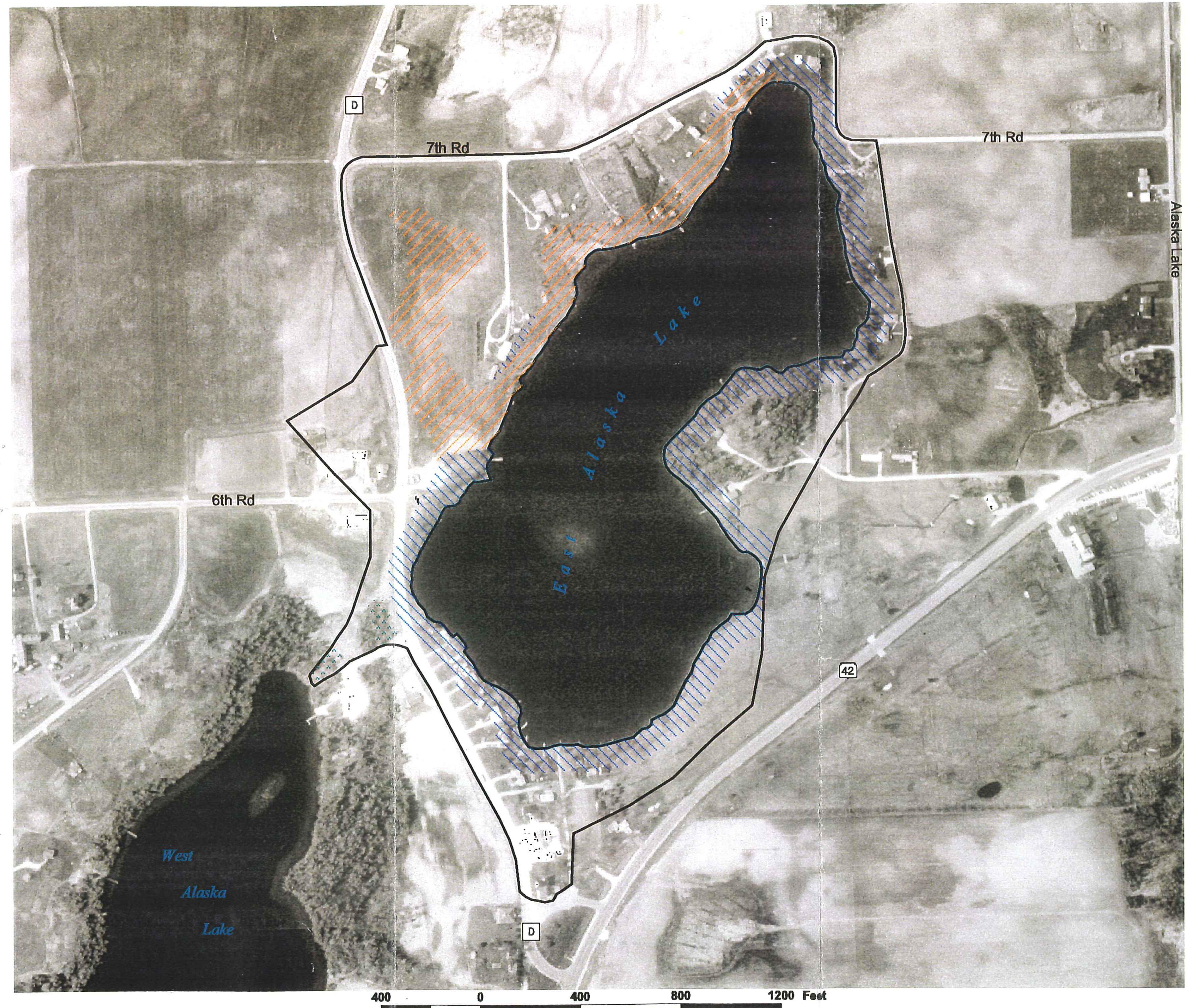

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FIGURE 3.4

Photographs 3-1 and 3-2 provide an example of the potential problems caused by the stormwater drains discharging into East Alaska Lake. During an August 11, 1999 site visit, fresh oil had been spread along County Trunk Highway D to prepare the surface for a future asphalt application. The oil was spread along the entire reach of County Trunk Highway D along the southwest lake shoreline. According to climatic data from the National Oceanic and Atmospheric Administration, the Green Bay area received 0.12 inches of precipitation on August 12, 1999. Assuming a similar amount of precipitation occurred in the East Alaska Lake area, highway surface runoff resulting from the event likely carried oil from the road directly into the lake.

To prevent issues like that described above, the Town of Pierce could approach the Kewaunee County Highway Department about rerouting the storm drain outlets such that they discharge either outside of the drainage basin or to an area that provides treatment prior to entering the lake. For example, the outlets could possibly be routed to an adjacent wetland or a ditch on the west side of the road.

3.2.2 West Alaska Lake Inlet

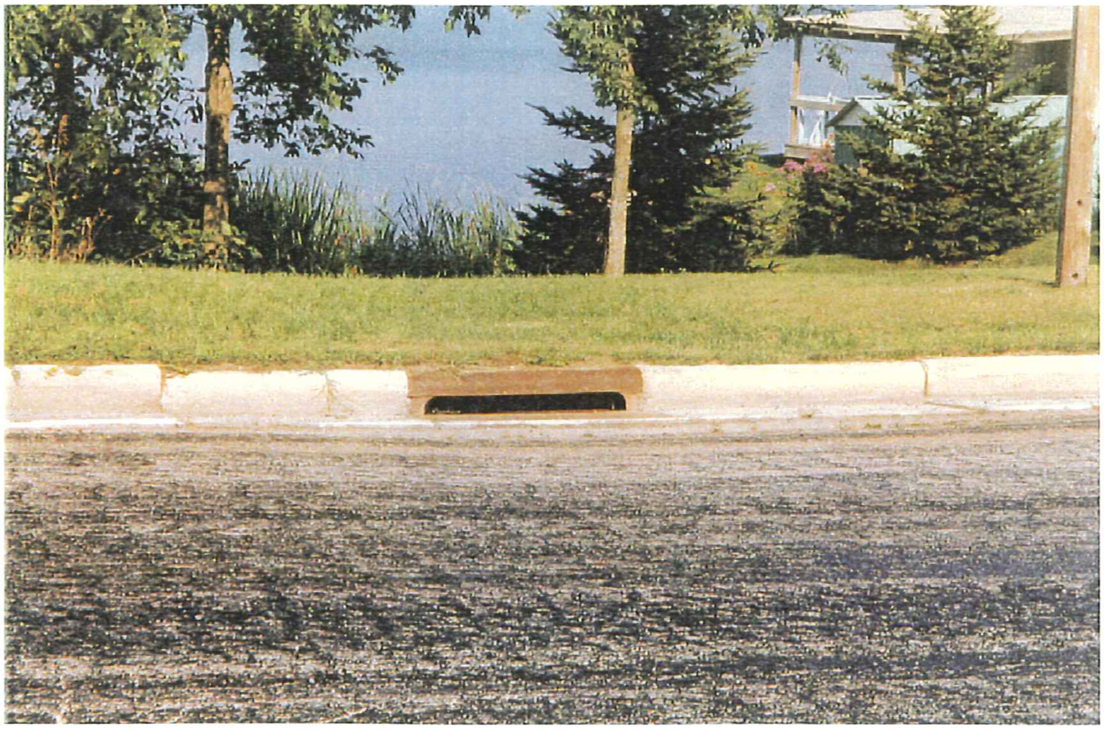
As mentioned in Section 3.1.1, West Alaska Lake outlets into East Alaska Lake via a stream flowing under County Trunk Highway D (Figure 3-1). The outlet from West Alaska Lake, in effect, serves as a point source discharge to East Alaska Lake. Water volume and pollutant load estimates for the West Alaska Lake outlet would assist in better defining the direct impact of West Alaska Lake on East Alaska Lake.

3.2.3 Agricultural Drain Tile Discharges

The watershed inventory work included an examination of existing agricultural drain tile discharges to the lake. In addition, Kewaunee County LCD staff provided information regarding drain tile inventory work that the Department had conducted.

One existing drain tile outlet was identified during the project. The discharge from the tile is located along the southwest shoreline of the lake (Figure 3-3). In the past, LCD staff has attempted to locate the network for this tile. Despite discussions with

Photograph 3-1 Fresh Oil Sign Looking South on County Trunk Highway D Near the Intersection of Sixth Road



Photograph 3-2 Fresh Oil on County Trunk Highway D and Location of Stormwater Drain which Discharges to East Alaska Lake

landowners and application of dye tests, the LCD has been unable to locate the tile network to date.

The drain tile discharge should be monitored in the future to determine the nutrient and sediment loads produced by the outlet. If the loads are considered significant, further efforts should be conducted to identify the drain network for the tile or options for removing the tile should be considered.

3.2.4 Alaska Farmers Cooperative Cheese Factory

Information regarding historic and current waste management at the Alaska Farmers Cooperative cheese factory was obtained from Tom Tewes, WDNR Lakeshore Basin Wastewater Specialist (Tewes, 1999, pers. comm.). According to an Industrial Waste Census Form completed by the Wisconsin State Board of Health, Section of Environmental Sanitation on September 21, 1953, the cheese factory discharged its wastewater to a settling tank and gravel filter that flowed to East Alaska Lake. At some point between 1953 and 1965, the wastewater was re-routed to a septic tank that discharged via a tile to a wooded area located outside of the East Alaska Lake Watershed east of State Highway 42. After 1965, that drainage tile was routed to an adsorption pond also located east of State Highway 42. Since approximately 1973, the factory has been landspreading its wash water and whey in compliance with a Wisconsin Pollutant Discharge Elimination System general permit. According to the *Twin-Door-Kewaunee Water Quality Management Plan* (Watermolen and Bougie 1995), the facility currently generates approximately 25,000 gallons of wastewater per day that is landspread on 650 usable acres that have been approved by the WDNR.

While the facility likely does not currently cause a direct impact to lake water quality, the lake could still be experiencing some effects of the historic waste discharges.

3.2.5 Septic System Discharges

Information regarding septic systems associated with houses and cottages on the East Alaska Lake shoreline was obtained from Mr. Glenn Selner, the Kewaunee County Zoning Administrator (Appendix A). Of particular interest were the sixteen older homes/cottages located along the south and southwestern shoreline. According to Mr. Selner, the septic systems for these homes were reviewed approximately five years ago and the majority of the systems were failing. Undoubtedly, these failed systems were resulting in a discharge of sewerage into the lake. Currently, all of the residences, except two, have installed new holding tanks that are operating properly. The two residences that have not have had citations issued requiring that the septic systems be updated.

While many of the problems with shoreline septic systems have been recently addressed, the systems have very likely had an historic impact on the lake. WILMS was used to provide some estimates of the extent of past impact.

Septic system analyses are typically based on estimates of the number of individuals per household and the duration of residency. For the WILMS analysis, 1990 census data for the Town of Pierce regarding number of persons per household (i.e., 2.74) was used, and information regarding the distribution of seasonal versus permanent residency in the Town of Pierce was obtained from the *Town of Pierce Community Survey Report* (Robert E. Lee & Associates 1997). Given that the systems were confirmed as failing systems prior to updates, a worst case analysis of phosphorus loading resulting from the systems was performed. Based upon the WILMS analysis, as much as 52 percent of the lake's past total annual phosphorus load (i.e., 40.6 pounds per year) could have resulted from failed septic systems. It must be noted that this estimate is vague at best, but does assist in understanding the extent of potential phosphorus loading that could have occurred in the past. It is also important to note that the analysis performed does not consider impacts from other potential septic system pollutants such as bacteria.

3.3 Water Quality Monitoring

3.3.1 Water Quality Data Summary

Table 3-3 summarizes the results of the water quality monitoring effort. In-lake surface total phosphorus levels during the study period averaged 0.024 mg/l. In-lake surface total nitrogen was measured once in May and equaled 1.22 mg/l. For the lake surface water, the nitrogen-to-phosphorus ratio was 31.3:1. 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 limiting nutrient is defined as the nutrient responsible for limiting primary production (e.g., algal growth) in a waterbody. When nitrogen-to-phosphorus ratios are less than 15:1, nitrogen is often the limiting nutrient. Clearly, the collected data suggests that East Alaska Lake is phosphorus limited. Therefore, the primary nutrient of concern relative to controlling algal growth and eutrophication (i.e., the process of lake aging which is often characterized by excessive primary production) is phosphorus.

Table 3-3
Water Quality Monitoring Results, East Alaska Lake
February 24, 1999 - August 9, 1999

Parameter	Sample	Date			
		2/24/99	5/25/55	7/15/99	8/9/99
Secchi (feet)		8.8	14.2	7.0	12.7
Cloud Cover (percent)		90	100	50	100
Temperature (degrees Celsius)	S	5.0	13.94	23.40	22.78
	B	4.0	7.78	8.50	17.85
PH (surface units)	S	NR	7.54	9.41	8.67
	B	NR	8.82	7.92	8.01
Dissolved Oxygen (mg/l)	S	14.8	11.6	8.31	7.44
	B	0.5	2.82	0.36	0.69
Conductivity (umhos/cm)	S	NR	521	434	456
	B	NR	485	855	520
Total Alkalinity (mg/l)	S	NR	200	NR	NR
	B	NR	187	NR	NR
Total Kjehldahl Nitrogen (mg/l)	S	NR	1.21	NR	NR
	B	NR	0.97	NR	NR
Ammonia Nitrogen (mg/l)	S	NR	0.189	NR	NR
	B	NR	0.018	NR	NR
NO_2 + NO_3 Nitrogen (mg/l)	S	NR	<0.01	NR	NR
	B	NR	0.015	NR	NR
Total Nitrogen (mg/l)	S	NR	1.22	NR	NR
	B	NR	0.985	NR	NR
Total Phosphorus (mg/l)	S	0.018	0.039	0.020	0.019
	B	0.082	0.020	0.144	0.373
Dissolved Phosphorus (mg/l)	S	<0.002	0.033	0.003	0.002
	B	0.031	0.003	0.064	0.293
Nitrogen/Phosphorus Ratio	S	---	31.3	---	---
	B	---	49.2	---	---
Chlorophyll a (ug/l)	S	NR	7.48	8.93	3.23
	B	NR	4.17	16.2	8.0
Total Suspended Solids (mg/l)	S	NR	5	NR	NR
	B	NR	<5	NR	NR
Calcium (mg/l)	S	NR	41	NR	NR
	B	NR	39	NR	NR

S = Surface, B = Bottom, NR = Not Recorded

3.3.2 East Alaska Lake Trophic Status

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 (oligrophic). 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 East Alaska Lake using the 1999 water quality monitoring data, and 1992 to 1995 WDNR Self-Help Lake Monitoring Secchi disk data (Figure 3-5). The WDNR Self-Help Lake Monitoring data can be found in Appendix B.

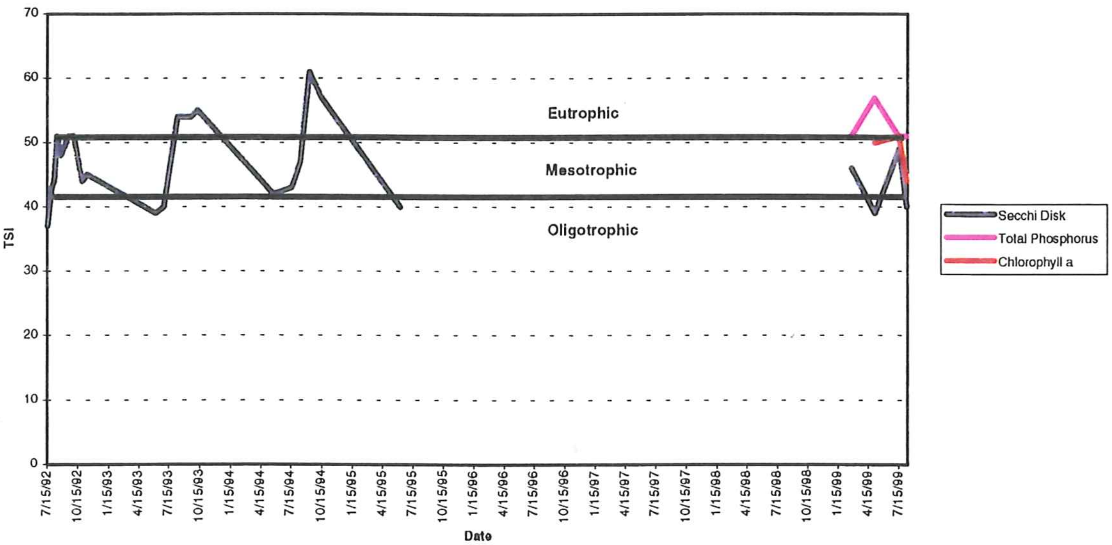
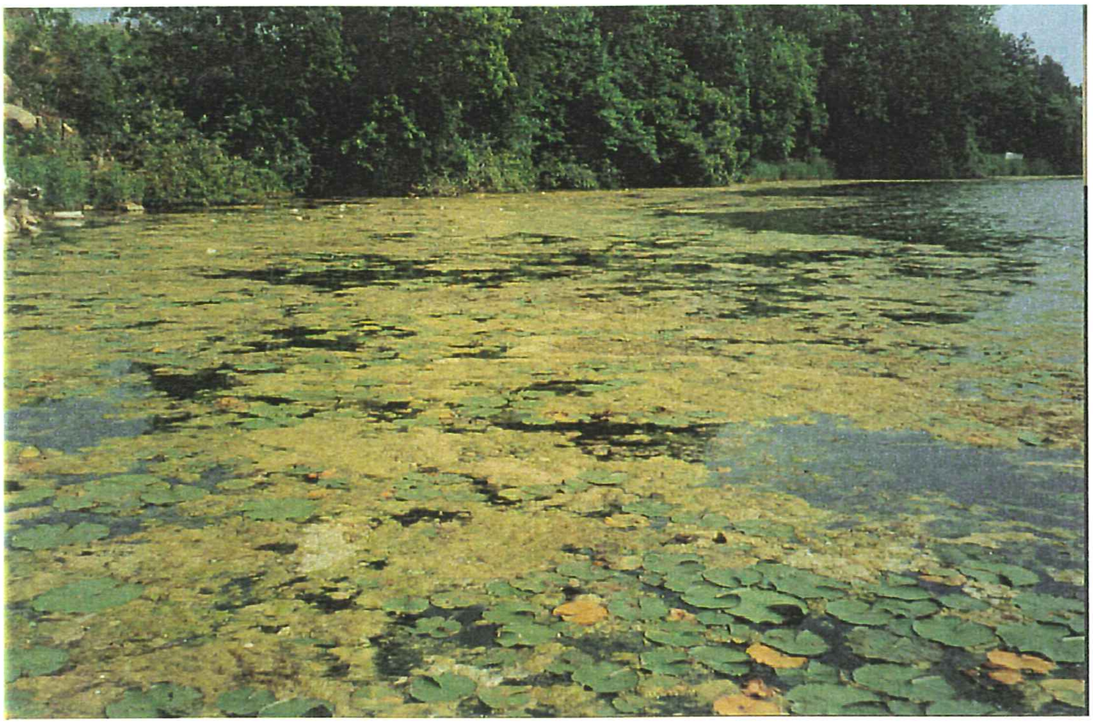


Figure 3-5 Trophic State Index Values for East Alaska Lake

The 1992 through 1995 and 1999 data for East Alaska Lake suggest that the lake fluctuates between mesotrophic and eutrophic conditions. Observations during the study period support the conclusion that the lake suffers from periods of poor water quality. Photographs 3-3 and 3-4 show the lake in June of 1999. Photograph 3-3 provides a view of the dense filamentous algal growth observed on the lake, and Photograph 3-4 demonstrates the apparent high concentration of suspended algae in the water column as evidenced by a noticeable "green" tinge to the water.



Photograph 3-3 **Filamentous Algal Growth on East Alaska Lake, June 1999**

Photograph 3-4 **East Alaska Lake Water Column, June 1999**

3.3.3 Dissolved Oxygen/Temperature Profiles

Figures 3-6 through 3-9 provide the dissolved oxygen and temperature profiles for the study period. In general, the profiles suggest that East Alaska Lake exhibits a clinograde oxygen profile. Clinograde profiles are indicative of lakes which are eutrophic and experience rapid depletion of oxygen in the hypolimnion (i.e., bottom waters) during stratified periods due to oxidative processes such as animal and plant respiration and bacterial decomposition of organic matter. The creation of anaerobic conditions in the hypolimnion during stratified periods excludes a portion of the lake from habitation by most animals and many plants. For example, in July the habitable portion of the water column extended to about 13 feet, and the remaining 27 feet of water were basically inhabitable due to low dissolved oxygen levels (Figure 3-8).

The August dissolved oxygen profile (Figure 3-9) demonstrates the processes that occur as a lake progresses toward turnover. Turnover is a phenomenon in which the lake circulates completely creating a uniform water column that is unstratified. Turnover occurs in the spring and fall and is driven by temperature changes and wind energy. The process of turnover mixes the oxygen-rich surface waters and nutrient laden bottom waters. This process is one of the methods by which nutrients released from the sediments are circulated through the water column. The August dissolved oxygen profile in Figure 3-9 exhibits a deepening of the epilimnion (i.e., surface waters). The epilimnion deepens during fall through progressively deeper circulation of oxygen-rich water. When circulation is complete, the water column will be uniformally saturated with oxygen in accordance with the maximum oxygen solubility as dictated by the lake's temperature. The recorded August profile is indicative of the terminal stages of fall turnover.

A review of all four temperature profiles reveals a depth at which the temperature abruptly and rapidly decreases. This depth is defined as the thermocline. As can be

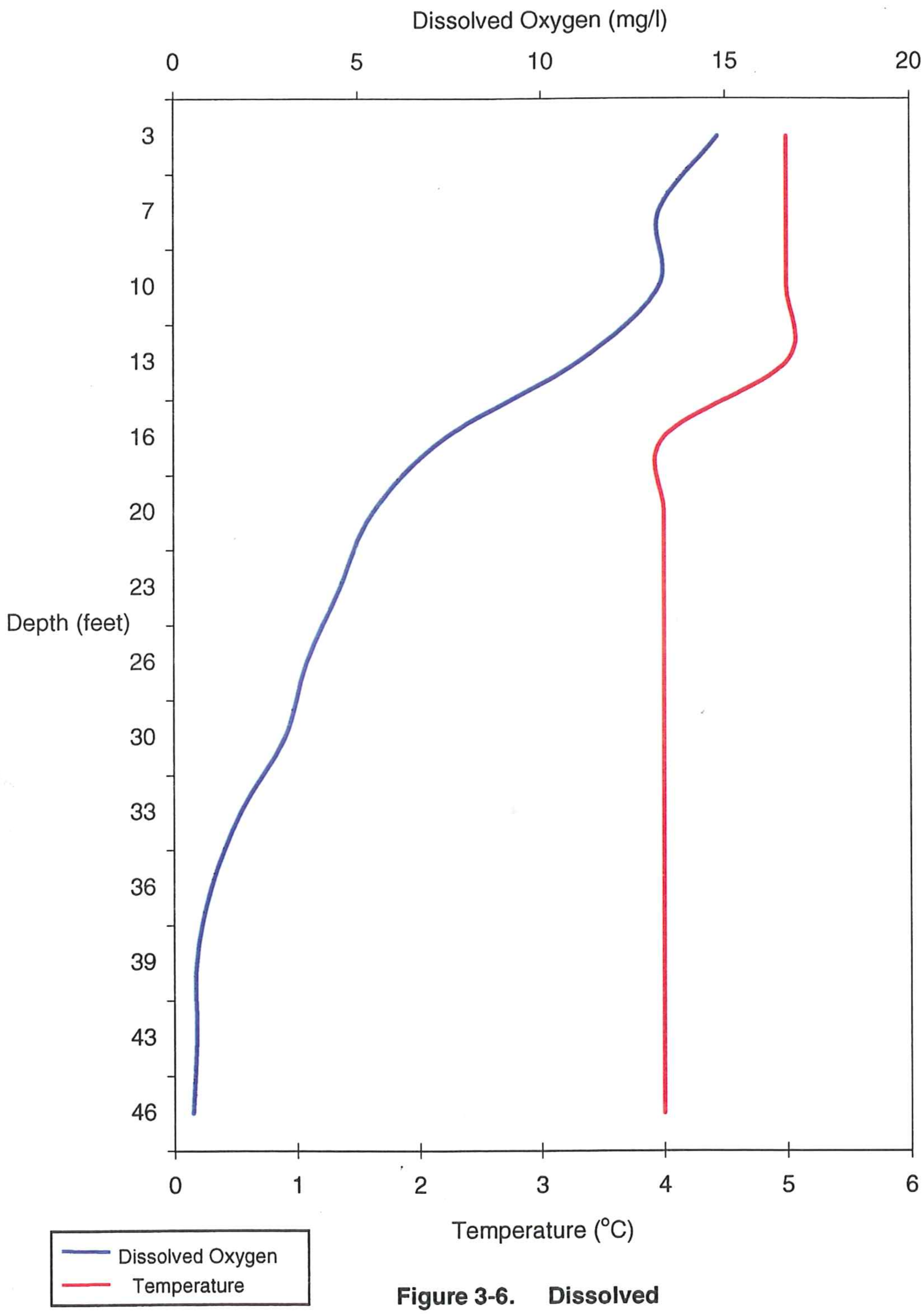


Figure 3-6. Dissolved Oxygen/Temperature Profiles for February 24, 1999

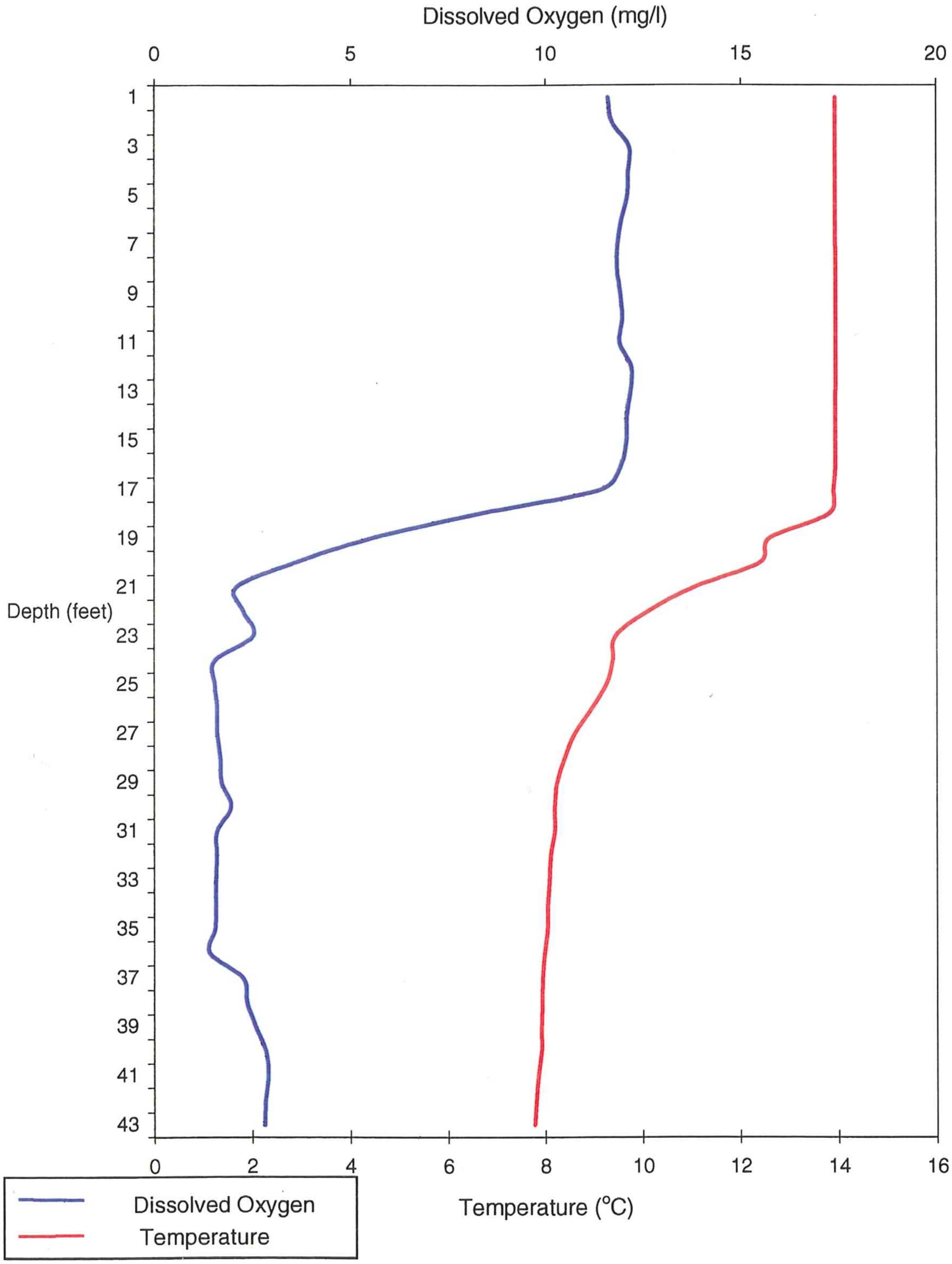


Figure 3-7. Dissolved Oxygen/Temperature Profiles for May 25, 1999

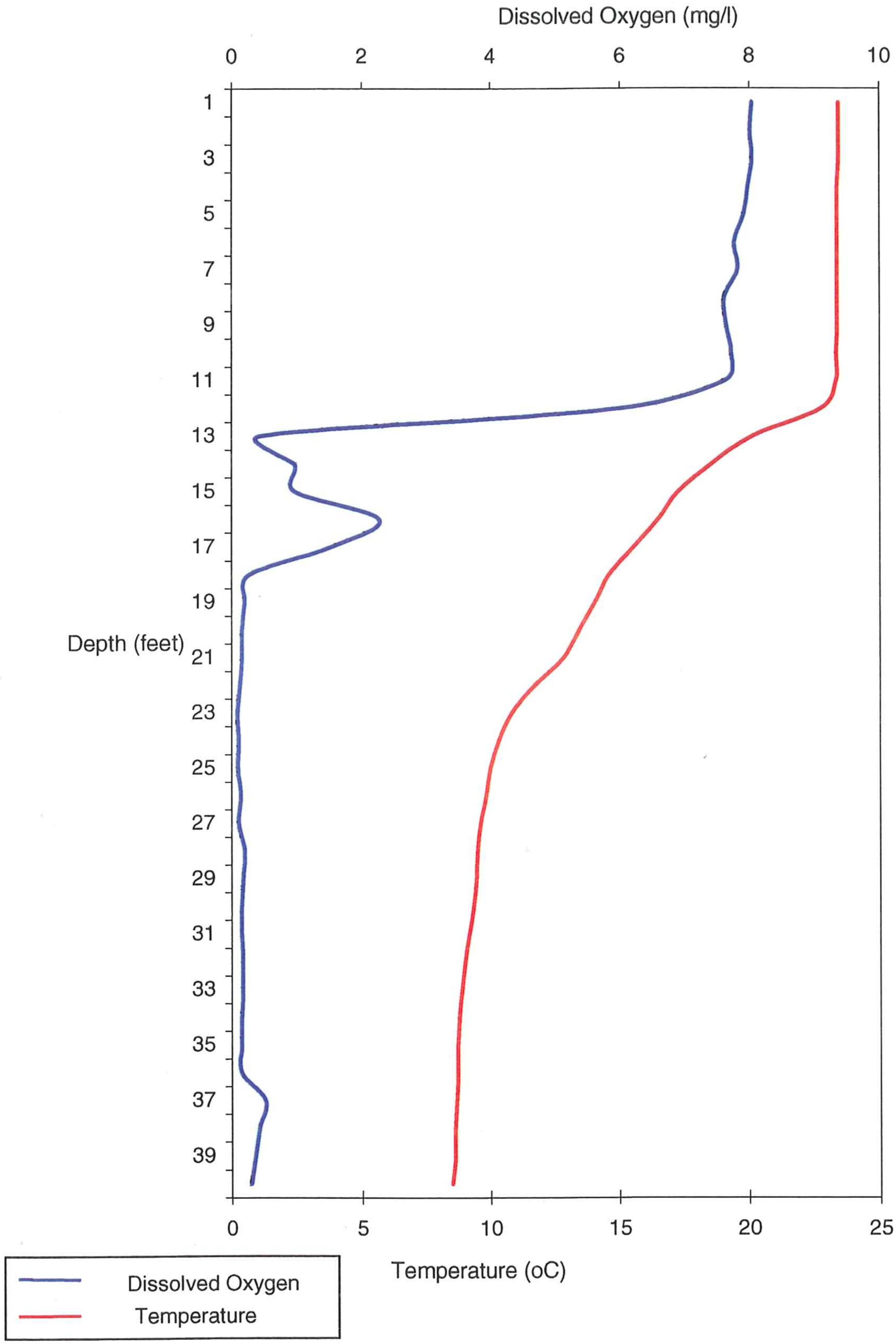


Figure 3-8. Dissolved Oxygen/Temperature Profiles for July 15, 1999

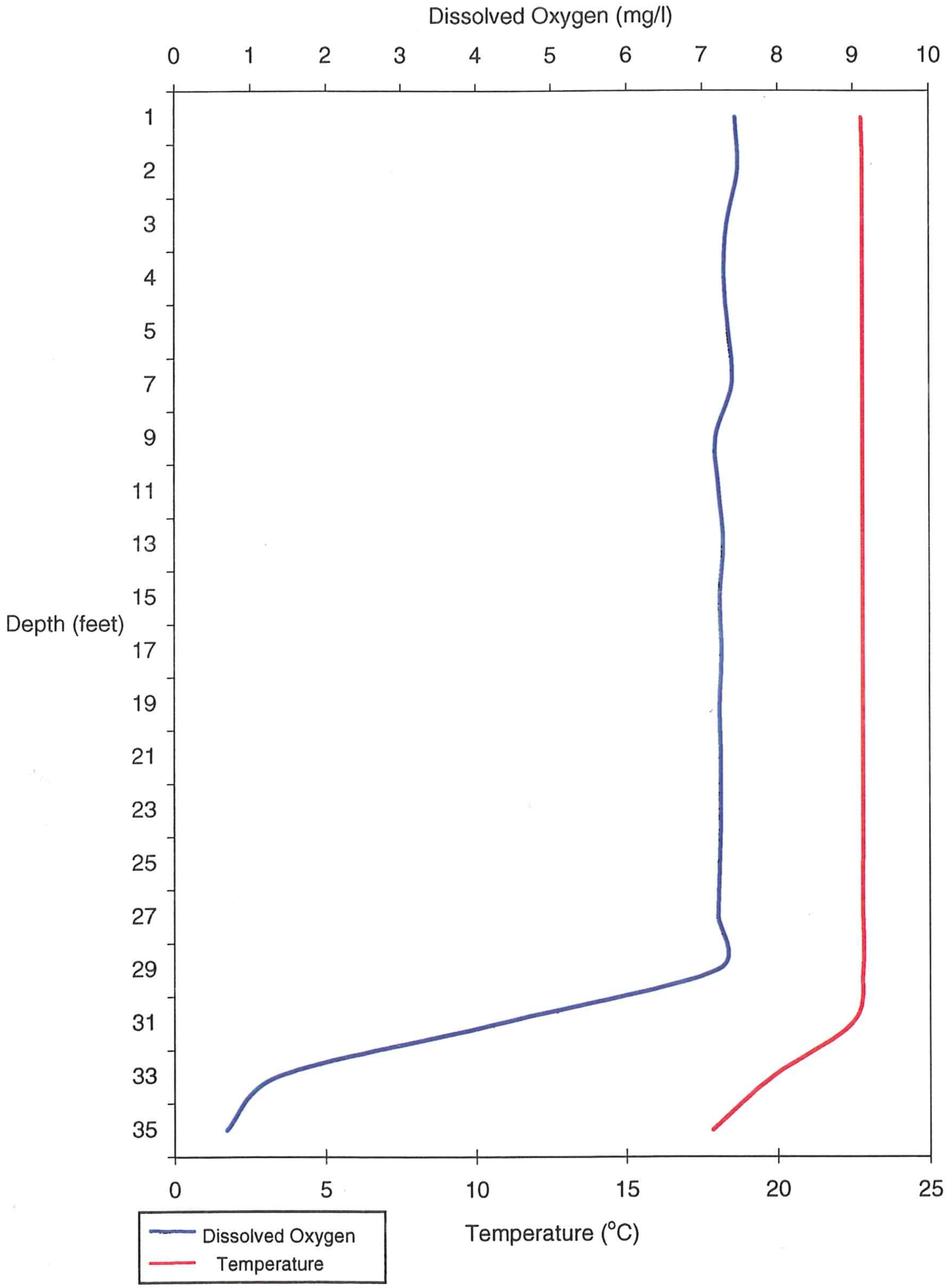


Figure 3-9. Dissolved Oxygen/Temperature Profiles for August 9, 1999

seen, the depth of the thermocline correlates well with the depth at which themaximum rate of dissolved oxygen depletion occurs. This phenomenon is not unusual as both the thermocline and zone of maximum rate of oxygen depletion indicate the maximum depth of circulation of the warm (due to solar radiation) and relatively oxygen-rich surface waters.

3.4 Aquatic Vegetation Analysis

3.4.1 Species Abundance and Distribution

A total of eight species of aquatic vegetation were observed in East Alaska Lake. The median species number for lakes in this region is 14 (Nichols 1999); therefore, East Alaska Lake has fewer species than typical for lakes within the same ecoregion.

The relative abundance of each species was qualitatively estimated as rare, infrequent, common, or abundant (Table 3-4). For comparison purposes, the relative abundance of each species in Wisconsin (Nichols and Vennie 1991) is also shown in Table 3-4. It is interesting to note that all of the species observed in East Alaska Lake are either common or abundant in Wisconsin, suggesting that the lake is not floristically unique. One of the species, curly leaf pondweed, is a non-native species that sometimes becomes a nuisance in lakes with poor water quality. Curly-leaf pondweed can tolerate low light and can outcompete native vegetation in waterbodies, like East Alaska Lake, which exhibit periods of poor water clarity.

Table 3-4
Aquatic Vegetation Observed in East Alaska Lake and Relative Abundance at the Lake and State Level

Common Name	Scientific Name	Nativity	Relative Abundance in East Alaska Lake	Relative Abundance in Wisconsin
		Emergent Vegetation		
Hard-stemmed bulrush	*Scirpus acutus*	Native	Infrequent	Common
Broad-leaved cattail	*Typha latifolia*	Native	Infrequent	Common
		Floating-leaved Vegetation		
White water lily	*Nymphaea tuberosa*	Native	Infrequent	Abundant
		Submergent Vegetation		
Spiked water milfoil	*Myriophyllum exalbescens*	Native	Abundant	Common
Sago pondweed	*Potamogeton pectinatus*	Native	Abundant	Abundant
Coontail	*Ceratophyllum demersum*	Native	Abundant	Abundant
Curly-leaf pondweed	*Potamogeton crispus*	Exotic	Common	Common
Common waterweed	*Elodea canadensis*	Native	Rare	Abundant

To assist in quantifying the abundance and distribution of the aquatic vegetation in East Alaska Lake, eight transects located along the shoreline of the lake and interior island were sampled (Figure 2-2). The data from the transect sampling can be found in Appendix C. Table 3-5 shows the maximum observed rooting depth, *frequency of occurrence*, *relative frequency of occurrence*, and mean Daubenmire classification ranking for each aquatic species observed in East Alaska Lake.

Table 3-5
Aquatic Vegetation Abundance and Distribution Data

Species	Maximum Observed Rooting Depth (feet)	Frequency of Occurrence (percent)	Relative Frequency of Occurrence (percent)	Mean Daubenmire Classification Ranking[1]
Myriophyllum exalbescens	13.0	100.0	21.1	2.4
Potamogeton pectinatus	9.0	100.0	21.1	2.4
Ceratophyllum demersum	13.0	100.0	21.1	1.6
Potamogeton crispus	9.0	75.0	15.8	1.4
Scirpus acutus	2.5	37.5	7.9	2.6
Nymphaea odorata	4.0	25.0	5.3	2.8
Typha latifolia	1.0	25.0	5.3	1.5
Elodea canadensis	4.0	12.5	2.6	2.3
Chara sp.	Not Applicable	75.0	Not Applicable	2.9

[1] Mean is for only those sample plots where a particular species was found.

The species with the highest frequencies of occurrence included spiked milfoil (*Myriophyllum exalbescens*), sago pondweed (*Potamogeton pectinatus*), coontail (*Ceratophyllum demersum*), and curly-leaf pondweed (*Potamogeton crispus*). The frequency of occurrence data provides an indication of the distribution of a particular species in the lake; however, the mean Daubenmire classification rankings provide an indication of the abundance of a particular species in the locations were it was observed. For example, while coontail was found along all of the sampled transects, its mean Daubenmire classification ranking (i.e., 1.6) indicates a foliage cover of only five to 20 percent. Conversely, white water lily (*Nymphaea tuberosa*) had a low frequency of occurrence (i.e., 25 percent), but had a relatively dense foliage cover (i.e., 25-50 percent) where it occurred.

In general, the maximum rooting depth is approximately 2.5 feet for emergent vegetation, 4.0 feet for floating-leaved vegetation, and 13.0 feet for submergent vegetation (Table 3-5).

3.4.2 Floristic Quality Assessment

The FQA completed for the East Alaska Lake aquatic vegetation indicated a mean native species coefficient of conservatism of 4.00. Nichols (1999) found that the median *C* for lakes in the region is 5.6. East Alaska Lake, therefore, appears to have a relatively low mean coefficient of conservatism.

Table 3-6
Coefficients of Conservatism for East Alaska Lake
Aquatic Vegetation

Common Name	Scientific Name	Coefficient of Conservatism
Spiked water milfoil	*Myriophyllum exalbescens*	7
White water lily	*Nymphaea tuberosa*	6
Hard-stem bulrush	*Scirpus acutus*	5
Sago pondweed	*Potamogeton pectinatus*	3
Coontail	*Ceratophyllum demersum*	3
Common waterweed	*Elodea canadensis*	3
Broad-leaved cattail	*Typha latifolia*	1
Curly-leaf pondweed	*Potamogeton crispus*	Non-native species
Mean *C*		4.00

The native floristic quality index for East Alaska Lake is 10.58. The median floristic quality index value for lakes in this region is 20.8 (Nichols 1999), indicating that East Alaska Lake is well below the regional average. Overall, the floristic quality assessment suggests that the aquatic vegetation of East Alaska Lake is indicative of disturbed conditions and relatively low floristic quality.

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 East Alaska Lake.

- East Alaska Lake is a stratified seepage lake with a relatively small drainage basin and a long retention time.
- East Alaska Lake is a mesotrophic to eutrophic, phosphorus-limited lake.
- The primary land uses in the watershed by acreage are low density residential, agriculture, high density residential, and golf course.
- The land uses responsible for the highest potential per acre phosphorus loads are golf course, agriculture, and low density residential.
- Approximately twenty-four acres, or 39% of the total East Alaska Lake Watershed area, were designated as ESA's.
- Current point source discharges identified include two County Trunk Highway D stormwater drains, the West Alaska Lake inlet, and an unmapped agricultural drain tile.
- Historically, East Alaska Lake was impacted by waste discharges from the Alaska Farmers Cooperative Cheese Factory, agricultural runoff, and failed septic systems.
- Failed septic systems may have been responsible for as much as 52 percent of the lake's historic phosphorus load.
- The floristic quality assessment suggests that the aquatic vegetation of East Alaska Lake has low floristic quality and is indicative of disturbed conditions.

- One exotic species, curly leaf pondweed, was present in the lake and had a high frequency of occurrence (75.0 percent).

4.2 Management Recommendations

The Town of Pierce is fortunate to have three inland lakes with public access located within their township. The lakes provide a valuable amenity and recreational opportunity for town residents. Protecting the health and quality of these lake resources will ensure that current and future residents can enjoy the lakes' aesthetic values and recreational opportunities.

The protection and improvement of East Alaska Lake will undoubtedly require cooperative efforts among both public and private entities. Below are listed the management recommendations identified during the Lake Planning Grant study. This list is not meant to be exhaustive, but, rather, it should provide the beginning of a comprehensive approach to managing the lake resource.

4.2.1 Future Monitoring

While it may seem like a great deal is known regarding East Alaska Lake, there is still additional data that should be collected to ensure that informed management decisions are made in the future. Those additional data needs include:

1. Continuation of the water quality monitoring program using the WDNR Long Term Trends Lake Monitoring Methods. A long term water quality database would help in better defining existing water quality and allow tracking of future water quality improvement or degradation.

2. Monitoring of the West Alaska Lake inlet to estimate hydraulic and pollutant loading to East Alaska Lake.

3. Mapping of the network for the agricultural drain tile discharge on the southwest shoreline, if possible, and monitoring the drain tile discharge to estimate hydraulic and pollutant loading.

4. Monitoring of the County Trunk Highway D stormwater drains to estimate hydraulic and pollutant loading.

5. Conducting a baseline assessment and characterization of the East Alaska Lake fishery.

6. A baseline study on West Alaska Lake to identify relationships between the two lakes and develop a comprehensive plan to protect both of the interconnected lakes.

4.2.2 Re-routing of County Trunk Highway D Stormwater Drains

The Town of Pierce should work with Kewaunee County to examine the feasibility of re-routing the stormwater drains located on County Trunk Highway D such that they no longer directly outlet to East Alaska Lake. Possible alternatives could include discharging stormwater to a nearby wetland area, a ditch on the west side of the road, a constructed infiltration basin, etc.

4.2.3 Construction of Sedimentation Basin Prior to the Culvert East of Teske Farms

As mentioned, improvements were made to the barnyard located on the Teske farm in 1995. As a result of those improvements, the barnyard should no longer have a significant impact on East Alaska Lake water quality; however, the culvert located east of the barnyard still provides a conduit for surface water runoff, including agricultural field runoff. The Town of Pierce could work with the LCD and Roger Teske to explore the feasibility of installing a sedimentation basin to treat runoff prior to discharging to the culvert. The basin could be constructed to incorporate wetland features, thereby, providing an amenity for the town. NES was able to locate outside funding sources for a similar project completed in Manitowoc, and identifying similar funding sources for this project could assist in defraying costs.

4.2.4 Golf Course Nutrient and Herbicide Management Plan

The Town of Pierce should contact the Alaskan Golf Club to inquire whether they are currently operating under a golf course Nutrient and Herbicide Management Plan. If they are not, the town should ask the Alaskan Golf Club to work with the LCD to develop an effective Nutrient and Herbicide Management Plan that meets the golf courses' needs while protecting East Alaska Lake water quality. A Nutrient and Herbicide Management Plan could be beneficial to both the town residents and the golf club owners by reducing unnecessary fertilizer and herbicide costs for the Alaskan Golf Club and protecting the lake's water quality. Further, the Town of Pierce should consider amending their zoning regulations to require future golf courses within their township to develop and adhere to an approved Nutrient and Herbicide Management Plan.

4.2.5 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. The Town of Pierce should 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.

4.2.6 In-lake Phosphorus Treatment

The results of this Lake Planning Grant study indicate that East Alaska Lake is currently suffering from periods of poor water quality and exhibits symptoms of excessive nutrient availability. Historically, the lake was severely impacted by multiple factors. Likely, the greatest historic impacts came from discharge of cheese factory wastes, surface runoff from agricultural practices (e.g., barnyards), and failed shoreline septic systems. Fortunately, the majority of the above sources have been controlled. The cheese factory has been landspreading its waste for approximately the last twenty-five years, the Teske farm installed a concrete manure storage facility and surface water diversions in 1995, and all but two of the failed septic systems have been replaced within the last decade. Further, citations requiring system replacement have been issued by the Kewaunee County Zoning Department for the two septic systems that have not been replaced.

Analyzing the above historic impacts within the context of East Alaska Lake's morphometric and hydrologic characteristics provides important insight into the reasons for current poor lake health. As mentioned earlier, East Alaska Lake has a small watershed area (62.6 acres) relative to its surface area (53.0 acres). Lakes with small watershed to surface area ratios often have long hydraulic retention times, and East Alaska Lake is not an exception to this rule. The East Alaska Lake retention time is 4.13 years, which is 57 percent longer than the mean retention time for similar lakes in Wisconsin. In general, lakes with long retention times accumulate a greater percentage of incoming nutrients than lakes with similar characteristics but shorter retention times. When a lake with a long retention time reaches its nutrient "saturation point", additional nutrient loading can cause a substantial decrease in water quality.

Research that has been conducted regarding nutrient dynamics in waterbodies suggests that lakes with long retention times and exacerbated nutrient loading pose a difficult management problem. In general, lakes with long retention times are the least sensitive to nutrient inputs due to their small watershed size and morphometric properties; however, when nutrient inputs and associated degradation of water quality do become a problem on these lakes, they are often the slowest to respond to a decrease in nutrient input (Lillie and Mason 1983).

In summary, East Alaska Lake has suffered substantial nutrient impacts in the past. Likely, the lake is still exhibiting symptoms of those impacts today. Fortunately, the primary sources of historic impacts have been controlled. For that reason, this lake may be suitable for in-lake remediation efforts that assist in controlling internal nutrient problems. Because of its long retention time, the lake has probably acted as a nutrient sink in the past, and is still circulating the nutrients accumulated during the years of high nutrient loading. A corrective treatment that effectively binds a portion of this historic phosphorus load and "removes" it from the lake system could provide substantial benefit. However, unless current watershed nutrient inputs are effectively controlled, a corrective treatment would only provide a temporary solution. Ideally, the additional corrective measures outlined in the above management recommendations should be implemented or, at a minimum, appropriately researched prior to an expensive in-lake remediation effort is begun.

To begin the process, the Town of Pierce should conduct a diagnostic feasibility study to examine the possibility of conducting an in-lake phosphorus treatment. Funding for up to 75 percent of the costs associated with this activity could be available through the WDNR Lake Protection Grant Program. NES could assist the town in exploring these options, and could provide information regarding possible funding sources if treatment is determined a viable option. The town should also consider developing partnerships to assist in this effort. Possible partners could include the East Alaska Lake Improvement Committee, Kewaunee County, and the Kewaunee County Watershed Partnership.

4.2.7 Management of Curly-Leaf Pondweed

Curly leaf pondweed is an exotic species from Europe that was first recorded in Wisconsin in 1905. Unlike native Wisconsin aquatic vegetation, curly leaf pondweed is a cool water specialist that thrives in the winter and spring. For this reason, it can provide winter aquatic habitat. However, the rapid growth of this pondweed in spring can cause problems for other aquatic vegetation, and the plant undergoes midsummer die-offs that can release large amounts of nutrients and trigger algal blooms (Borman et al. 1997).

In East Alaska Lake, curly leaf pondweed is relatively abundant, but where it occurs its aerial coverage only averages five to twenty-five percent. Reduction in the extent of this exotic species could be facilitated by the presence of well-established native species. Controlling curly leaf pondweed would not only help encourage establishment of additional native plant species, but may also assist in managing nutrient availability during periods of peak algal production.

Protecting or improving water quality is one method of controlling curly leaf pondweed. This pondweed is adapted to growing in lakes with poor water clarity; therefore, when water clarity is improved its ability to outcompete native vegetation is reduced. For this reason, an in-lake phosphorus treatment similar to that described in the previous section may improve water clarity and assist in controlling curly leaf pondweed at the same time.

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A

APPENDIX A

SEPTIC SYSTEM INFORMATION

KEWAUNEE COUNTY
ZONING DEPARTMENT

Glenn Selner, Administrator
Kewaunee County Courthouse
613 Dodge Street, Kewaunee, WI 54216

Telephone (920) 388-7192 • Fax (920) 388-7195

October 21, 1999

RECEIVED

OCT 25 1999

ROBERT E. LEE & ASSOC., INC.

Mr. Pat Robinson
2825 S. Webster Ave.
PO Box 2100
Green Bay, WI 54306

Dear Mr. Robinson:

Enclosed is the information you requested regarding East Alaska Lake. If you have any questions please feel free to call.

Sincerely,

Glenn Selner
Kewaunee County
Zoning Administrator

GS/cjk

East Alaska Lake
Septic System Inventory

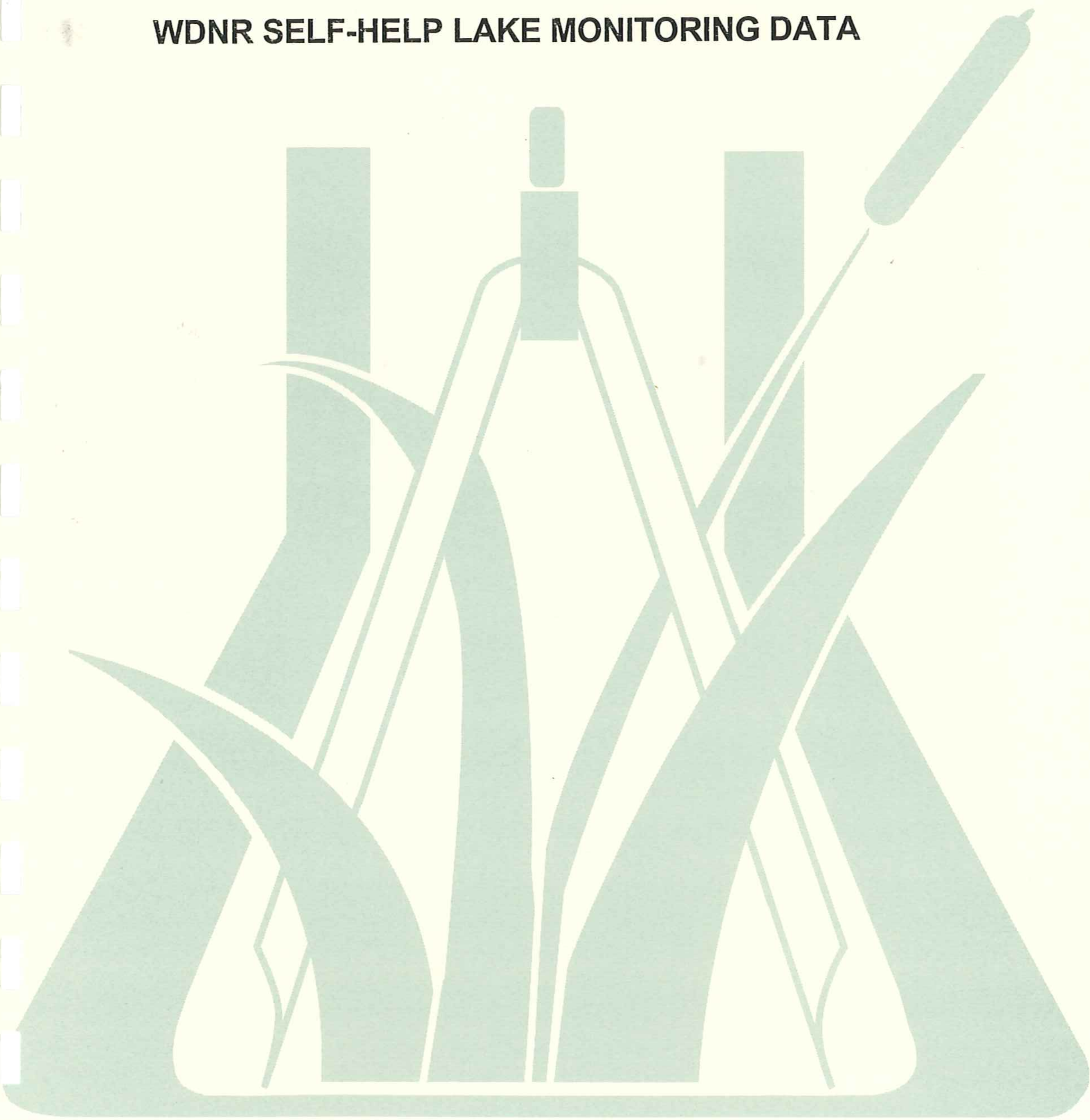
Address	Owner	System Type	Installation Date
E5277 **Seventh Road**	Randy Busch	Conventional	08-09-1994
E5279	Dieter Boigk	Conventional	05-08-1981
E5273	Tom Anderson	Conventional	07-03-1980
E5281	Mark Teske	Conventional	Unknown
E5291	John Josupait	Conventional	Replaced Tank 9-8-1998
E5295	Phil Gerlach	Conventional	1979
5301	James Pace	Conventional	1980
E5315	Nancy Dubois	Conventional	06-09-1981
5335	Kewaunee County	No Septic	
E5365	Jeffrey Kroening	Mound	07-24-1998
5379	David Baumann		Unknown
E5403	Jerome Neumann	Holding Tank	07-15-1985
6145 **East Lake Drive**	John Haegele	Conventional	Unknown
N6165	Patricia Vania	Conventional	Unknown
E5377 **Golf Drive**	Alan Stangel	Holding Tank	12-02-1998
E5379	Donald Dupart	Holding Tank	10-03-1996
E5381	Joseph Aulik		Unknown
5386	Robert Wood		Unknown
E5410	Gary Pazdera	Holding Tank	08-16-1984
5420	Raymond Harrell	Holding Tank	08-16-1984
N6001 **County Road D**	Leon Hostak		Unknown
N6007	Richard Feyen	Mound	05-05-1998
N6010	Jacqui's	Holding Tank	02-06-1985
N6024 Cheese Factory	Alaska Farmers Coop	Holding Tank	04-18-1985
N6028 House	Alaska Farmers Coop	Holding Tank	11-07-1989
N6032	Larry Fischer	Holding Tank	06-16-1989
N6038	Clara Eckert	Holding Tank	09-20-1991

N6046	Marion Dachelet	Holding Tank	10-27-1992
N6050	Joe/ Barbara Selner Trust	Holding Tank	09-05-1990
N6052	John Kraemer	Holding Tank	10-27-1992
N6054	Henry Kouba, Jr.	Holding Tank	1980
N6058	Elton Halverson	Holding Tank	10-15-1990
N6060	Herbert Barbian	Holding Tank	1980
N6061	Pierce Town Hall	Holding Tank	1978
N6064	Donald Melin	Holding Tank	Unknown
N6066	Richard Ramski	No Septic	
N6068	Clayton Roe	Holding Tank	06-25-1985
N5931 **State Road 42**	Jerome Polsin	Has Not Been Corrected	
N5933	Mary Higginbotham	Holding Tank	12-16-1993
N5935	Richard Bonner	Holding Tank	11-10-1992
N5937	Ken Hegerty	Holding Tank	Permit Issued 05-18-1999 Not Installed
N5939	Alvin Knappmiller	Has Not Been Corrected	

B

APPENDIX B

WDNR SELF-HELP LAKE MONITORING DATA



East Alaska Lake

1992

Kewaunee County
SD Volunteer(s): Terry Kroening
Site Name: Deep Hole

Waterbody #:0094200
Surface area: 53 acres
Lake depth: 50 feet
Lake type: stratified seepage
Georegion: Southeast

Date	SD	TSI (SD)
15-Jul-92	16	37
29-Jul-92	11	43
05-Aug-92	10	44
13-Aug-92	6	51
25-Aug-92	7.5	48
16-Sep-92	6	51
02-Oct-92	6	51
27-Oct-92	10.25	44
11-Nov-92	9	45

The average Secchi depth was 9.1 feet.
The TSI(SD) values ranged from 37 to 51.

SD=Secchi Depth in feet; CHL=Chlorophyll-a in ug/L; TP=Total Phosphorus in ug/L.

East Alaska Lake

1993

Kewaunee County

SD Volunteer(s): Terry K. Kroening

Site Name: Deep Hole

Waterbody #:0094200

Surface area: 53 acres

Lake depth: 50 feet

Lake type: stratified seepage

Georegion: Southeast

Date	SD	TSI (SD)
04-Jun-93	14	39
29-Jun-93	13.5	40
14-Jul-93	9.25	45
08-Aug-93	5	54
19-Sep-93	5	54
07-Oct-93	4.5	55

The minimum Secchi clarity was 4.5 feet.
The maximum Secchi clarity was 14 feet.
The average Secchi clarity was 8.5 feet.
The TSI(SD) values ranged from 39 to 55.

East Alaska Lake

1994

Kewaunee County

SD Volunteer(s): Terry L. Kroening

Site Name: Deep Hole

Waterbody #:0094200

Surface area: 53 acres

Lake depth: 50 feet

Lake type: stratified seepage

Georegion: Southeast

Date	SD	TSI (SD)
22-May-94	11.5	42
17-Jul-94	11	43
11-Aug-94	8	47
08-Sep-94	3	61
14-Oct-94	4	57

The minimum Secchi clarity was 3 feet.
The maximum Secchi clarity was 11.5 feet.
The average Secchi clarity was 7.5 feet.
The TSI(SD) values ranged from 42 to 61.

Self-Help Lake Monitoring 1995 Annual Report

EAST ALASKA LAKE

Kewaunee County
WATERBODY NUMBER : 94200

LAKETYPE :mixed seepage
DNR DISTRICT :LM
DNR REGION : NE
GEOREGION : Southeast

GROUP	SITE	VOLUNTEER NAME	VOL. ID
492	Deep Hole	TERRY KROENING	492

GROUP	DATE	SD(ft)	SD(m)	CHL	TP	TSI(SD)	TSI(CHL)	TSI(TP)
492	6/7/95	13.00	3.96			40		

DATA SUMMARY:

Average SD(ft):	13
Minimum SD(ft):	13
Maximum SD(ft):	13
Average Chl:	0
Minimum Chl:	0
Maximum Chl:	0
Average TP:	0
Minimum TP:	0
Maximum TP:	0

DATE	VOLUNTEER COMMENTS
6/7/95	Sunny, light wind, strong undertow.

SD = Secchi disk depth measured in feet & converted to meters; Chl = Chlorophyll a in micrograms per liter (ug/L); TP = Total phosphorus in ug/L, surface sample only; TSI(SD), TSI(CHL), TSI(TP) = Trophic state index based on SD, Chl, or TP respectively; Depth measured in feet; Temp. = Temperature in degrees Fahrenheit; D.O. = Dissolved oxygen in parts per million.

C

APPENDIX C

AQUATIC VEGETATION TRANSECT SAMPLING DATA

Aquatic Vegetation Inventory Data

Date: June 22, 1999
Observer: Patrick Robinson

Lake: East Alaska Lake, Kewaunee County
Sheet: 1 of 6

Transect	Depth Code	Depth (feet)	Substrate	Species	Daubenmire Classification Rank
1	1	1.0	Sandy muck	*Scirpus acutus*	3
				Nymphaea tuberosa	3
				Potamogeton pectinatus	2
				Myriophyllum exalbescens	2
				Ceratophyllum demersum	1
	2	2.5	Sandy muck	*Scirpus acutus*	1
				Nymphaea tuberosa	3
				Potamogeton pectinatus	3
				Ceratophyllum demersum	3
				Myriophyllum exalbescens	3
	3	4.0	Sandy muck	*Nymphaea tuberosa*	3
				Potamogeton pectinatus	2
				Myriophyllum exalbescens	1
				Ceratophyllum demersum	2
				Potamogeton crispus	1
	4	6.5	Muck	*Ceratophyllum demersum*	1
				Chara sp.	6
2	1	1.0	Gravel with cobble	*Nymphaea tuberosa*	3
				Potamogeton pectinatus	2
				Myriophyllum exalbescens	2
				Ceratophyllum demersum	2
				Elodea canadensis	1
	2	2.5	Muck	*Elodea canadensis*	4
				Ceratophyllum demersum	2
				Potamogeton pectinatus	1
				Myriophyllum exalbescens	1
				Potamogeton crispus	1

Aquatic Vegetation Inventory Data

Date: June 22, 1999
Observer: Patrick Robinson

Lake: East Alaska Lake, Kewaunee County
Sheet: 2 of 6

Transect	Depth Code	Depth (feet)	Substrate	Species	Daubenmire Classification Rank
				Nymphaea tuberosa	2
	3	4.0	Muck	*Nymphaea tuberosa*	3
				Potamogeton pectinatus	2
				Myriophyllum exalbescens	1
				Ceratophyllum demersum	3
				Potamogeton crispus	1
				Elodea canadensis	2
	4	7.0	Muck	*Potamogeton pectinatus*	2
				Ceratophyllum demersum	2
				Myriophyllum exalbescens	2
				Potamogeton crispus	2
3	1	1.0	Sandy; marly	*Potamogeton pectinatus*	3
				Myriophyllum exalbescens	3
				Ceratophyllum demersum	1
				Nymphaea tuberosa	3
	2	2.5	Sandy muck	*Nymphaea tuberosa*	2
				Potamogeton pectinatus	3
				Myriophyllum exalbescens	3
				Ceratophyllum demersum	2
				Potamogeton crispus	2
	3	4.0	Sandy muck	*Potamogeton pectinatus*	3
				Myriophyllum exalbescens	3
				Potamogeton crispus	2
				Ceratophyllum demersum	2
				Chara sp.	3
	4	7.0	Sandy muck	*Myriophyllum exalbescens*	4
				Potamogeton crispus	2

Aquatic Vegetation Inventory Data

Date: June 22, 1999
Observer: Patrick Robinson

Lake: East Alaska Lake, Kewaunee County
Sheet: 3 of 6

Transect	Depth Code	Depth (feet)	Substrate	Species	Daubenmire Classification Rank
				Potamogeton pectinatus	2
				Ceratophyllum demersum	2
				Chara sp.	3
4	1	1.0	Sandy; marly	*Myriophyllum exalbescens*	2
				Ceratophyllum demersum	2
				Typha latifolia	2
				Scirpus acutus	2
				Potamogeton pectinatus	2
				Nymphaea tuberosa	5
				Chara sp.	2
	2	2.5	Sandy; marly	*Nymphaea tuberosa*	5
				Potamogeton pectinatus	1
				Myriophyllum exalbescens	1
				Ceratophyllum demersum	1
				Chara sp.	2
	3	4.0	Sandy; marly	*Chara sp.*	2
				Potamogeton pectinatus	4
				Myriophyllum exalbescens	4
				Ceratophyllum demersum	1
	4	6.0	Sandy muck	*Potamogeton crispus*	1
				Potamogeton pectinatus	2
				Myriophyllum exalbescens	4
				Ceratophyllum demersum	1
5	1	1.0	Gravel with cobbles	*Ceratophyllum demersum*	1
				Typha latifolia	1
	2	2.5	Gravel with cobbles	*Myriophyllum exalbescens*	1
				Potamogeton crispus	2

Aquatic Vegetation Inventory Data

Date: June 22, 1999
Observer: Patrick Robinson

Lake: East Alaska Lake, Kewaunee County
Sheet: 4 of 6

Transect	Depth Code	Depth (feet)	Substrate	Species	Daubenmire Classification Rank
				Potamogeton pectinatus	2
				Ceratophyllum demersum	2
				Chara sp.	3
				Nymphaea tuberosa	2
	3	3.5	Sandy muck-gravel	*Nymphaea tuberosa*	1
				Potamogeton crispus	1
				Ceratophyllum demersum	2
				Potamogeton pectinatus	2
				Myriphyllum exalbescens	2
				Chara sp.	1
	4	6.0	Sandy muck	*Potamogeton crispus*	1
				Potamogeton pectinatus	3
				Myriophyllum exalbescens	2
				Ceratophyllum demersum	1
6	1	1.0	Sandy muck-gravel	*Nymphaea odorata*	4
				Potamogeton pectinatus	3
				Ceratophyllum demersum	1
				Myriophyllum exalbescens	3
	2	2.5	Sandy; marly	*Ceratophyllum demersum*	1
				Potamogeton pectinatus	4
				Nymphaea tuberosa	3
				Myriophyllum exalbescens	2
	3	4.0	Sandy; marly	*Nymphaea tuberosa*	1
				Potamogeton pectinatus	4
				Myriophyllum exalbescens	2
				Ceratophyllum demersum	1
	4	9.0	Sandy muck	*Potamogeton pectinatus*	4

Aquatic Vegetation Inventory Data

Date: June 22, 1999
Observer: Patrick Robinson

Lake: East Alaska Lake, Kewaunee County
Sheet: 5 of 6

Transect	Depth Code	Depth (feet)	Substrate	Species	Daubenmire Classification Rank
				Ceratohyllum demersum	2
				Potamogeton crispus	1
7	1	1.0	Sandy gravel	*Potamogeton pectinatus*	3
				Myriophyllum exalbescens	3
				Ceratophyllum demersum	1
	2	3.0	Sandy muck	*Nymphaea tuberosa*	2
				Myriophyllum exalbescens	3
				Potamogeton pectinatus	3
				Ceratophyllum demersum	1
				Chara sp.	2
	3	4.0	Sandy muck	*Potamogeton pectinatus*	2
				Chara sp.	2
				Myriophyllum exalbescens	4
				Ceratophyllum demersum	1
	4	7.0	Muck	*Myriophyllum exalbescens*	4
				Potamogeton pectinatus	2
				Ceratophyllum demersum	2
				Chara sp.	2
8	1	2.5	Sandy; marly	*Ceratophyllum demersum*	2
				Potamogeton pectinatus	1
				Nymphaea tuberosa	3
				Myriophyllum exalbescens	2
				Scirpus acutus	2
	2	2.5	Sandy muck	*Potamogeton pectinatus*	1
				Myriophyllum exalbescens	3
				Ceratophyllum demersum	1
				Nymphaea tuberosa	3

Aquatic Vegetation Inventory Data

Date: June 22, 1999
Observer: Patrick Robinson

Lake: East Alaska Lake, Kewaunee County
Sheet: 6 of 6

Transect	Depth Code	Depth (feet)	Substrate	Species	Daubenmire Classification Rank
				Scirpus acutus	2
	3	4.5	Muck	*Myriophyllum exlabescens*	1
				Potamogeton pectinatus	3
				Chara sp.	6
	4	10.0	Muck	*Ceratophyllum demersum*	3
				Chara sp.	2
				Myriophyllum exalbescens	1