Illinois EPA Clean Lakes Program

Phase 1 Diagnostic/Feasibility Study of Kinkaid Lake, Jackson County, IL

(Final Report - September 2006)

Cochran & Wilken, Inc.

5201 South Sixth Street Road, Springfield, IL 62703-5143
1339 Walnut Street, Murphysboro, IL 62966-2026

with assistance from:

Kinkaid-Reed's Creek Conservancy District
Illinois Environmental Protection Agency

Illinois Clean Lakes Program

Phase 1 Diagnostic/Feasibility Study of Kinkaid Lake, Jackson County, Illinois

Prepared by:

Cochran & Wilken, Inc.
CONSULTING ENGINEERS & SCIENTISTS

5201 South Sixth Street Road
Springfield, Illinois 62703
217-585-8300

1339 Walnut Street
Murphysboro, Illinois 62966
618-684-5808

in cooperation with

Kinkaid-Reed's Creek Conservancy District
Illinois Environmental Protection Agency

September 2006

This report was financed in part by a grant from the Illinois Environmental Protection Agency under the Illinois Clean Lakes Program. The contents do not necessarily reflect the views or policies of that agency.

List of Tables

List of Figures

ACKNOWLEDGMENTS

This report was funded by the Kinkaid-Reed's Creek Conservancy District (KRCCD) and by a grant from the Illinois Environmental Protection Agency under the Illinois Clean Lakes Program (ICLP), and was conducted by Cochran & Wilken, Inc. through the Illinois Environmental Protection Agency.

Several Cochran & Wilken, Inc. staff members contributed to this investigation. Gary Raines was the project leader and coordinator; Peter Berrini provided writing, internal review, and quality control and quality assurance. Research and additional writing and review were performed by Ryan Keith. Gary Raines and field crew completed the sedimentation survey and macrophyte study. Doug McQueen and Michael Grove drafted figures and diagrams for the Report using Autocad. The cooperation and assistance of the KRCCD was much appreciated. David Fligor and his staff were extremely helpful throughout the project and were responsible for the volunteer monitoring, sampling, and staff gage monitoring. Scott Martin of the U.S.D.A. - Natural Resources Conservation Service provided valuable information regarding the Kinkaid Lake watershed. Shawn Hirst from the Illinois Department of Natural Resources provided important fisheries information. The phytoplankton analysis was completed by Dr. Lawrence O'Flaherty of Western Illinois University. Analyses of water samples were performed by the Illinois EPA laboratories unless otherwise noted. Appreciation is also extended to all others who contributed to this project.

Special thanks to Gregg Good and Teri Holland of the Illinois Environmental Protection Agency - Surface Water Section, Lakes Unit for their assistance throughout the project. The critical review of Teri Holland was greatly appreciated.

Executive Summary

Illinois EPA Clean Lakes Program

Phase 1 Diagnostic/Feasibility Study of Kinkaid Lake

Jackson County, Illinois

In the fall of 2002, Cochran & Wilken, Inc., through a grant provided by the Illinois Environmental Protection Agency and funding provided by the Kinkaid-Reed's Creek Conservancy District (KRCCD), undertook a detailed Phase 1 Diagnostic/Feasibility Study of Kinkaid Lake located in Jackson County, Illinois. The major objectives of the study were to evaluate the current condition of the lake, investigate potential alternatives for restoring the water quality and enhancing the recreational and aesthetic qualities, and to develop a comprehensive management plan for consideration as Phase 2 Clean Lakes Program implementation project.

Kinkaid Lake is a 951 hectare (2,350-acre) reservoir located in the northwest portion of Jackson County, Illinois. Construction on the lake began in 1968 and in 1970 the lake was filled for the first time. The lake is impounded by an earthen dam, combined with an open channel spillway constructed in natural rock, and maintains a normal pool elevation of 420.0 feet above sea level. The Kinkaid Lake watershed consists mainly of woodland and grasslands and covers approximately 15,595 hectares (38,535 acres). Two main tributaries named Kinkaid Creek and Little Kinkaid Creek that enter the lake from the northwest. Today Kinkaid Lake is managed by KRCCD, the Illinois Department of Natural Resources, and the United States Forest Service.

A hydrologic budget was developed for the Phase 1 sampling period that began in May of 2003 and ended in April of 2004. The hydrologic budget showed that approximately 53,509,201 cubic-meters (43,398 acre-ft) of inflow entered the lake during this period. Direct lake precipitation and runoff from the watershed contributed 8,094 and 35,304 acre-feet or 18.7% and 81.3% of the total hydrologic inputs, respectively. Approximately 1.75% of the total water outflow was either by groundwater movement or otherwise unaccounted for. The net outputs from the lake totaled 52,571,098 cubic meters (42,637 acre-feet). Evaporation and the public water supply withdrawals accounted for 8,407 and 113 acre-feet or 19.7% and 0.3%, respectively.

During the monitoring period, discharges over the spillway accounted for 80% or 34,117 acre-feet.

Secchi transparency depth measurements were consistently less than five feet during the study period with the majority of the turbidity (murkiness) caused by algae and suspended soil particles in the water. The Secchi depths during the sampling period ranged from a high of 149.6 cm (58.9 inches) near the dam to a low of 31.5 cm (12.4 inches) in the upper portion of the lake.

The lake experienced low dissolved oxygen levels during extended periods of the summer indicating anoxic conditions. The typical summer dissolved oxygen concentrations ranged from 8.0 mg/l at the surface to 0.01 mg/l near the bottom.

Analysis conducted during the Phase 1 study period indicated that high nutrient concentrations were present in the lake. The developed nutrient budgets indicated that the watershed was a source of approximately 87.1% of the phosphorus and 88.8% of the nitrogen influxes. Total phosphorus concentrations in the lake ranged from 0.009 mg/l to 0.295 mg/l while total nitrogen concentrations ranged from 0.06 mg/l to 5.87 mg/l.

Several biological resources of the lake were unbalanced during the 2003 sampling period. Sparse aquatic vegetation growth and high algae growth occurred during the summer months. In particular, blue-green algae, reached a "bloom" status (greater than or equal to 1 million units per liter) on several occasions during the summer. In addition to the relatively sparse population of aquatic macrophytes, degraded water quality and diminished habitat has impacted the existing fisheries population.

During the Phase 1 monitoring period, the sediment budget determined that sediment inputs totaled 32,909,096 kg (36,276 tons) and the lake had a trapping efficiency of 94.0%. Loading from the watershed accounted for 49.3% or 17,876 tons, with shoreline erosion accounting for the remaining 50.7% or 18,400 tons. A sedimentation survey was completed in 2002 for the upper end and select bays within the lake. For the areas surveyed, 1,160,025 cubic yards (719.1 acre-feet) or 51.4% of the water storage capacity has been lost due to sedimentation. Over the thirty-five year history of the lake, the annual sediment loading to Kinkaid Lake was estimated to be

33,114 cubic yards. The 2002 sedimentation survey indicated that the upper end of the lake has been impacted to the greatest degree. Sediment analyses of samples collected by the Illinois Environmental Protection Agency did not warrant any hazardous classification and would not require any specialized handling procedures if dredged.

Pursuant to the information collected during the study period, potential alternatives for water quality improvement were developed. The major areas of concern that were addressed are as follows, sedimentation and shallow water depths, turbid water, shoreline erosion, unbalanced aquatic vegetation growth, and enhance fishery and aquatic community. Based on the results of this study, the following objectives and means to accomplish these objectives were recommended for water quality and aesthetic/recreational improvement:

- Reduce the amount of sediment being delivered to the lake by installing Best Management Practices (BMPs) such as gully and stream bank stabilization, filter strips, and grassed waterways in the watershed.
- Remove accumulated sediment (approximately 600,000 cubic yards) that has caused shallow water depths in the upper east end of the lake by hydraulic dredging.
- Improve water quality for aesthetics and to support a more balanced aquatic plant community by installing BMPs in the watershed, and by removing accumulated sediment in the upper end of the lake.
- Stabilize eroded shoreline in specified areas with moderate and sever shoreline erosion. Rip rap with geotextile fabric revetments and break waters are the primary shoreline stabilization methods.
- Improve fisheries population and habitat by implementing water quality improvements mentioned above, and install artificial habitat structures in strategic locations.
- Control invasive exotic plant species (Eurasian water milfoil) in select areas of the lake to improve access and recreational opportunities.

Information from the Phase 1 Report was used to submit a grant application in May 2005 and obtain funding from the Non-Point Source Pollutant Control Program (Section 319). A Section 319-grant application was submitted to the Illinois EPA in May 2005 for funding for several sediment and nutrient control ponds, gully stabilization, and shoreline stabilization, and an educational program. Subsequent project funding was approved in September 2005 and project implementation began shortly thereafter.

The finalized Phase 1 Report can be used to apply for a Phase 2 Grant under the Illinois Clean Lakes Program or an additional grant under the Section-319 Non-Point Source Pollution Control Program in order to implement the recommended lake and watershed restoration alternatives.

Part 1

Diagnostic Study of Kinkaid Lake

Jackson County, Murphysboro, Illinois

INTRODUCTION

A Diagnostic Study was undertaken on Kinkaid Lake to identify and quantify existing water quality problems and other factors affecting the reservoir's recreational, aesthetic, and ecological qualities. The Illinois Environmental Protection Agency (Illinois EPA) funded 60 percent of the study under the Illinois Clean Lakes Program (ICLP), with the remaining 40 percent funding contributed by the Kinkaid-Reed's Creek Conservancy District (KRCCD). The Illinois Environmental Protection Agency was responsible for grant administration and program management. Cochran & Wilken, Inc., conducted the research study with assistance from the Kinkaid-Reed's Creek Conservancy District, the U.S. Forest Service, Illinois Department of Natural Resources, the USDA - Natural Resources Conservation Service, and the Illinois Environmental Protection Agency.

A. Lake Identification and Location

Kinkaid Lake is a 2,350-acre reservoir located in the northwest portion of Jackson County, Illinois. Construction on the lake began in 1968 and in 1970 the lake was filled for the first time. The lake is impounded by an earthen dam, combined with an open channel spillway constructed in natural rock, and maintains a normal pool elevation of 420.0 feet above sea level. The Kinkaid Lake watershed covers approximately 15,595 hectares (38,535 acres) of land with two main tributaries named Kinkaid Creek and Little Kinkaid Creek that enter the lake from the northwest (Figure 1). These tributaries originate in northwestern Jackson County and each flows approximately 8.1 kilometers (5.0 miles) before entering Kinkaid Lake. Several smaller inlet channels and storm drains enter the lake system at various points along the 132 km (82 miles) of shoreline. When built, Kinkaid Lake had a maximum depth of 24.4 meters (80.0 ft.) and a mean depth of 8.7 meters (28.7 ft.), and the average hydraulic retention time of the lake system was calculated to be approximately 1.722 years (Table 1). The storage capacity of Kinkaid Lake is approximately 97,445,631 m^3 (79,000.0 acre-ft). A bathymetric map of Kinkaid Lake is shown in Figure 2.

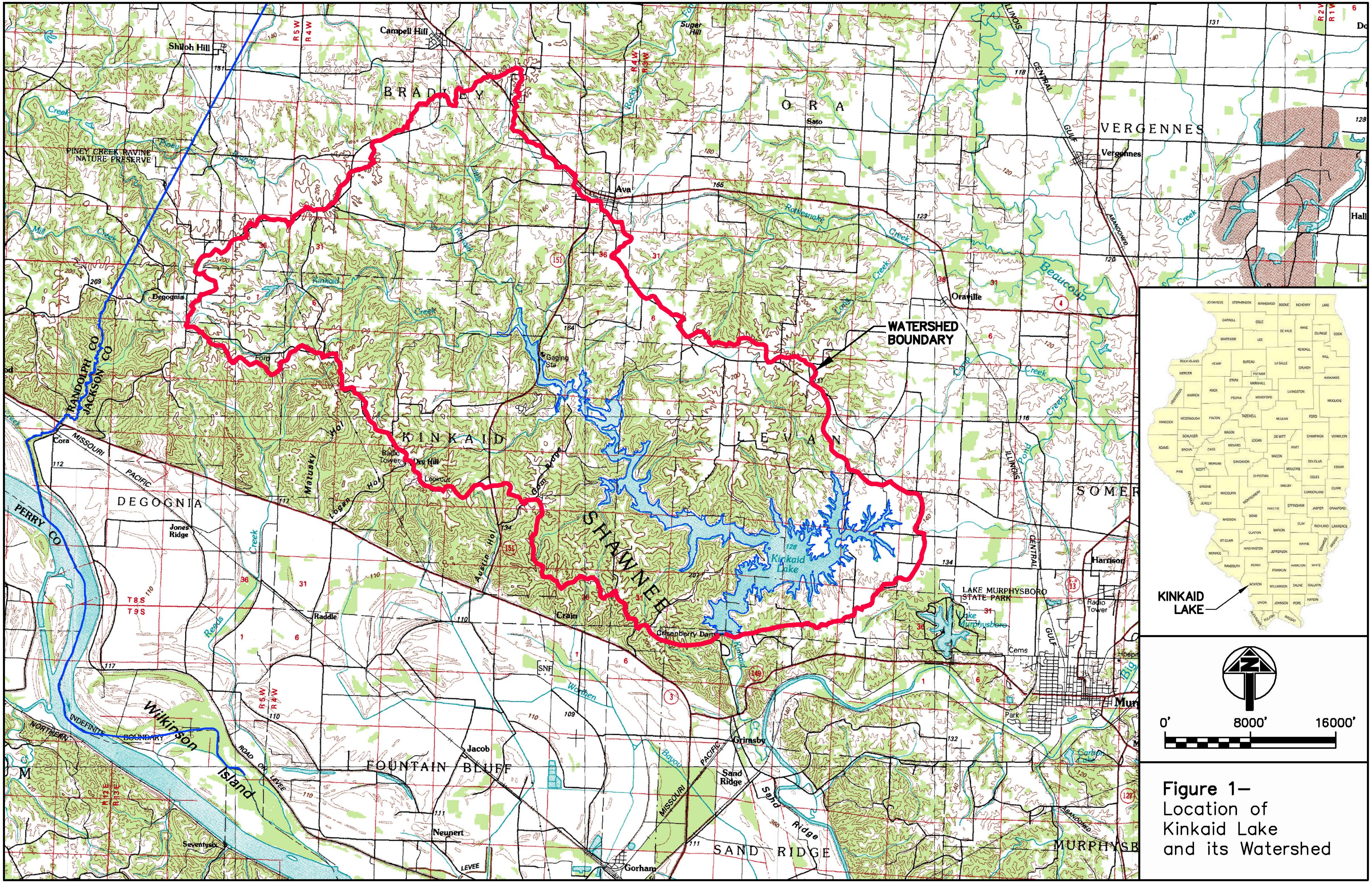


Figure 1— Location of Kinkaid Lake and its Watershed

Table 1 - Identification and Location of Kinkaid Lake

Parameter	Description
IEPA Storet Code	RNC
State	Illinois
County	Jackson
Ownership	USFS, IDNR, & KRCCD
Nearest Municipality	Murphysboro & Ava
Latitude	37 Degrees 47' 32" N
Longitude	89 Degrees 25' 50" W
Location	T8S, R3W & R4W, Sections Many
USEPA Region	5
USEPA Major Basin	Mississippi River
USEPA Minor Basin	Big Muddy River
Major Tributary	Kinkaid Creek and Little Kinkaid Creek
Receiving Water Body	Kinkaid Creek and Big Muddy River
Applicable Water Quality Standards	State of Illinois Rules & Regulations, Title 35: Environmental Protection, Subtitle C: Water Pollution, Ch. 1: Pollution Control Board, Parts 302, Subpart B: General Use Water Quality Stds. And Subpart C: Public & Food Processing Water Supply Stds.
Surface Area	2,350 acres
Watershed Area	38,535 acres
Shoreline Length	73 miles
Maximum Depth	70 feet
Mean Depth	28.7 feet
Normal Pool Elevation	420.0 feet above sea level
Hydraulic Retention Time	1.722 years
Storage Capacity	79,000 acre/feet

Source: Illinois EPA and USGS

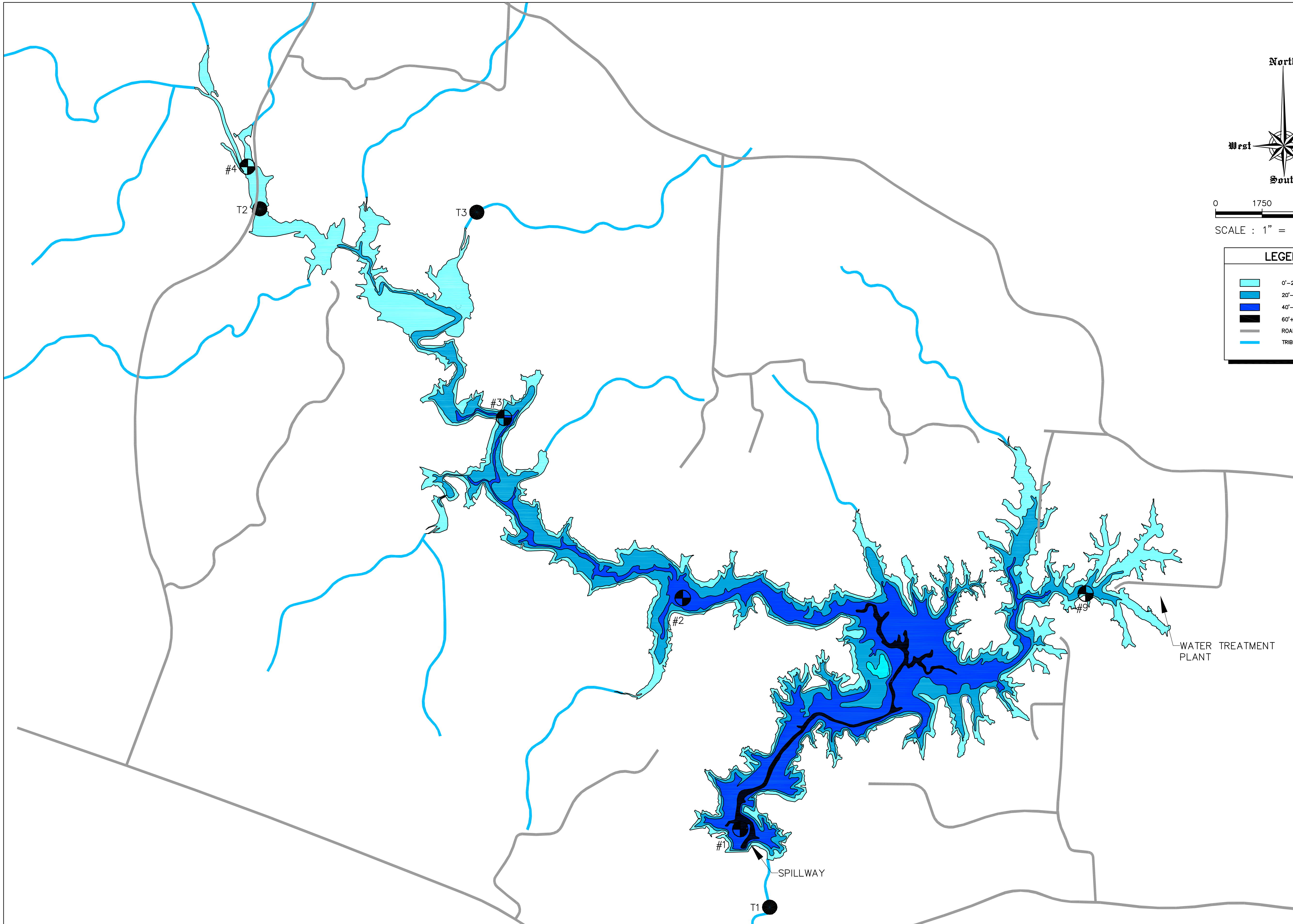


Figure 2–
Bathymetric Map
of Kinkaid Lake

B. Geological and Soils Description of Drainage Basin

1. Geological and Topographical Description

The Kinkaid Lake and its watershed are located in northwestern Jackson County, which lies in the lower southwestern portion of Illinois. The study area lies mostly within the Shawnee Hill Section of the Interior Low Plateaus Province physiographic area with the northern part of the watershed being within the transitional zone of the Till Plains Section of the Central Lowland Province with Roxana Silts and/or Peoria Loess (Wisconsin) soils overly diamictons (glacial till) of the Glasford Formation (Illinoian). The thickness of the loess is variable, ranging from less than 5 to 20 feet thick. The till is generally loam or clay loam in texture and is called Vandalia Till. Within the watershed, maximum thickness of the surficial deposits seldom exceed 25 to 50 feet. Stream dissection has also exposed the underlying Pennsylvanian and Mississippian-aged shale, sandstone, and limestone, which is primarily found in the gullies and stream channels of the area. The surface texture of the soils in the majority of the watershed is silt loam, which is reflective of the characteristics of the loess cover that blankets the region. This material is erosive and is easily removed if exposed to running water (Windhorn, 2000).

2. Groundwater Hydrology

The Illinois State Geological Survey publication entitled Groundwater Geology In Southern Illinois: A Preliminary Geologic Report, 1956 was consulted to help determine the occurrence of groundwater present in the Kinkaid Lake watershed. The study area includes the Mississippian-Chester formation that consists of sandstone, limestone, and shale with water-yielding strata from sandstone and creviced limestone strata, which is believed to yield fresh water beneath Pennsylvanian formation. The Pennsylvanian formation includes shale, sandstone, limestone, and coal, which is generally not water yielding except for small supplies available from sandstone strata.

3. Description of Soils

The major soil types occurring in the Kinkaid Lake watershed and surrounding area consist mainly of the Alford-Wellston soil association with a portion of the watershed being in the Hosmer association. The Alford-Wellston association generally consists of well-drained soils that formed in loess or loess materials that weathered from bedrock on uplands. The Homser association generally consists of moderately well drained soils that formed in loess on uplands.

An inventory of all soil types found in the Kinkaid Lake watershed is listed in Table 2. The listing for soil type contains a numerical description (214C2) where the first number (214) indicates the soil name, the capital letter (C) provides a slope range and the third part (2) describes the degree of erosion.

Table 2 - Kinkaid Lake Watershed Soil Types

Soil Symbol	Soil Type
8E	Hickory silt loam, 18 to 30 percent slopes
8E3	Hickory soils, 15 to 30 percent slopes, severely eroded
8G	Hickory silt loam, 30 to 50 percent slopes
214B	Hosmer silt loam, 2 to 7 percent slopes
214C2	Hosmer silt loam, 7 to 12 percent slopes, eroded
214C3	Hosmer silty clay loam, 7 to 12 percent slopes, severely eroded
214D2	Hosmer silt loam, 12 to 18 percent slopes, eroded
214D3	Hosmer silty clay loam, 12 to 18 percent slopes, severely eroded
308B2	Alford silt loam, 2 to 6 percent, eroded
308C2	Alford silt loam, 6 to 12 percent, eroded
308C3	Alford silty clay loam, 6 to 12 percent slopes, severely eroded
308D2	Alford silt loam, 12 to 18 percent slopes, eroded
308D3	Alford silty clay loam, 12 to 18 percent slopes, severely eroded
308E	Alford silt loam, 18 to 30 percent slopes
331	Haymond silt loam
333	Wakeland silt loam
382	Belknap silt loam
427	Burnside silt loam
852E	Alford-Wellston silt loams, 15 to 30 percent slopes
976G	Neotoma-Rock outcrop complex, 25 to 55 percent slopes
977G	Neotoma-Wellston complex, 30 to 50 percent slopes
999D	Alford-Hickory silt loams, 12 to 18 percent slopes
999D3	Alford-Hickory Complex, 12 to 18 percent slopes, severely eroded
999E	Hickory-Alford Complex, 18 to 30 percent slopes, severely eroded

Source: United State Department of Agriculture, Soil Conservation Service

Major soil type descriptions provided by the United States Department of Agriculture, Natural Resources Conservation Service are summarized below in order in which they are listed in the Jackson County, Illinois Survey, 1979.

<u>8G – Hickory Silt Loam</u> – This moderately steep and steep, moderately well drained or well-drained soil is on side slopes just above bottom uplands or along drainageways near bottomlands. Typically, the surface layer is dark grayish brown silt loam about 2-inches thick, and the subsurface layer is brown silt loam 30-inches thick. Water and air move through this soil at a moderate rate, and surface runoff is very rapid. Most areas of this soil are in pasture or woodland.

<u>214B – Hosmer Silt Loam</u> – This gently sloping, moderately well drained soil is on convex ridge tops, knolls, and side slopes along drainage ways. Typically, the surface layer is brown silt loam about 9-inches thick, and the subsoil is strong brown light silty clay that is about 41-inches thick. Water and air move through the upper part of the soil at a moderate rate and through the compact lower part at a very slow rate. Most areas of this soil are farmed.

<u>214C2 and 214C3 – Hosmer silt loam</u> – These sloping, moderately well drained soils are on narrow ridgetops and sideslopes, and along drainageways. Typically, the surface layers are 4 to 6 inches thick and are yellowish-brown silt loam or silt clay loam. The subsoils range from 37 to 41-inches in thickness and are comprised of two portions. The upper portions range from 10 to 14-inches in thickness and are strong brown to yellowish brown light silty clay loam over mottled yellowish brown heavy silt loam. The lower portions are about 27-inch thick and are very firm, compact silt loam. Water and air move through the upper subsoils at moderate rates and through the compact lower subsoils at very slow rates. Most areas of this soil are farmed.

<u>308C2 and 308D3 – Alford silt and silty clay loams</u> - These sloping to strong sloping, well-drained soils are mainly along sideslopes along drainageways. The surface layers are yellowish-brown silt loam to strong brown silty clay loam that range from 4 to 7-inches thick. The lower subsoils range from 50 to 58-inches thick and consist of strong brown silty clay loam and brown heavy silt loam. Water and air move through these soils at a moderate rate. Many of these areas are farmed, and some remain in native hardwoods.

852E – Alford-Wellston silt loams – These moderately steep to steep, well-drained soils are typically found on long hillside slopes above and below escarpments, and along drainageways. Alford soils have dark grayish brown silt loam surface layer about 3-inches thick and a 7-inch subsurface layer that is yellowish-brown silt loam. The Wellston soils have dark grayish-brown silt loam surface layer about an inch thick. The subsurface layer is 5 inches and yellowish-brown silt loam. Water and air move through these soils at a moderate rate. Most of these soils are in woodlands.

976G – Neotoma-Rock outcrop complex – This steep to very steep, well drained to excessively well-drained soil is on hillsides and at the head of drainageways. Neotoma soils have very dark grayish brown stony loam surface layers about 2-inches thick. The subsurface layer is brown cobbly light loam about 12-inches thick. The rock outcrop areas are largely bedrock escarpments that are mainly sandstone with shale, siltstone, or limestone. Water and air move through these soils at a moderate to moderately rapid rate. This soil is best suited for trees.

977G – Neotoma-Wellston complex – This very steep, well-drained soil is found on hillsides and along drainageways. Neotoma soils have very dark grayish brown stony loam surface layers about 2-inches thick. The subsurface layer is brown cobbly light loam about 18-inches thick. The Wellston soils have a dark grayish-brown silt loam surface layer about an inch thick. The subsurface layer is 5-inches and yellowish-brown silt loam. Water and air move through this soil at a moderate to moderately rapid rate. This soil is best suited for trees.

999E – Hickory-Alford silt loams – This moderately steep to steep, moderately well drained to well-drained soil is found on hillsides. Hickory soils typically have a dark grayish brown silt loam surface layer about 2-inches thick and a brown silt loam subsurface layer about 3-inches thick. Alford soils have a dark grayish brown silt loam surface layer about 3-inches thick and a 7-inch subsurface layer that is yellowish-brown silt loam. Water and air move through these soils at a moderate rate. Most of these areas are in native hardwoods.

C. Description of Public Access

Public access to Kinkaid Lake and the surrounding area is managed by the Kinkaid-Reed's Creek Conservancy District (300 acres), the Illinois Department of Natural Resources (4,000 acres), and the US Forest Service (5,000 acres). Figure 3 illustrates the areas managed by IDNR. Generally, the USFS manages areas to the west of the areas managed by IL DNR. The KRCCD manages a relatively small area near the water treatment plant and marina areas, which are located in the eastern portion of the lake. The Kinkaid Marina and Campground complex is leased from the Conservancy District and is open for public use. Public boat launch ramps and parking are provided at the Mount Joy area, the Paul Ice area, and the Johnson Creek area. Picnic facilities are provided at the Paul Ice area, the spillway area, the Johnson Creek area, the Buttermilk Hill area, and the Glenn Schlimpert area. Camping is also available at the Marina and the Johnson Creek area. Public hunting is available throughout the surrounding areas of the Lake and is managed by the aforementioned agencies. A public beach with showers and restrooms are available at the Johnson Creek Recreation Area. The beach is open daily from 6 AM to 10 PM from May 1 through September 9. No fees for swimming are charged and no lifeguards are provided. According to USFS personnel the beach is sparsely used due to siltation in the upper portion of Kinkaid Lake and no other records have been kept on beach usage (USFS personal communication, 2006). It is estimated that the annual visitor-days to the Kinkaid Lake area is in excess of 500,000 visitors-days per year, with those numbers increasing (Fligor personal communication, 2005).

The major access roads that lead to Kinkaid Lake are Route 149, which runs east-west and is located to the south of the lake; Route 151, which runs in a north-south direction directly west of the lake; and Ava Road that runs along the northern portion of the lake (see Figure 3). There is no public transportation directly to the lake at this time. The USFS, IDNR, and KRCCD do not charge any fees for resident or non-resident swimming or boating on Kinkaid Lake.

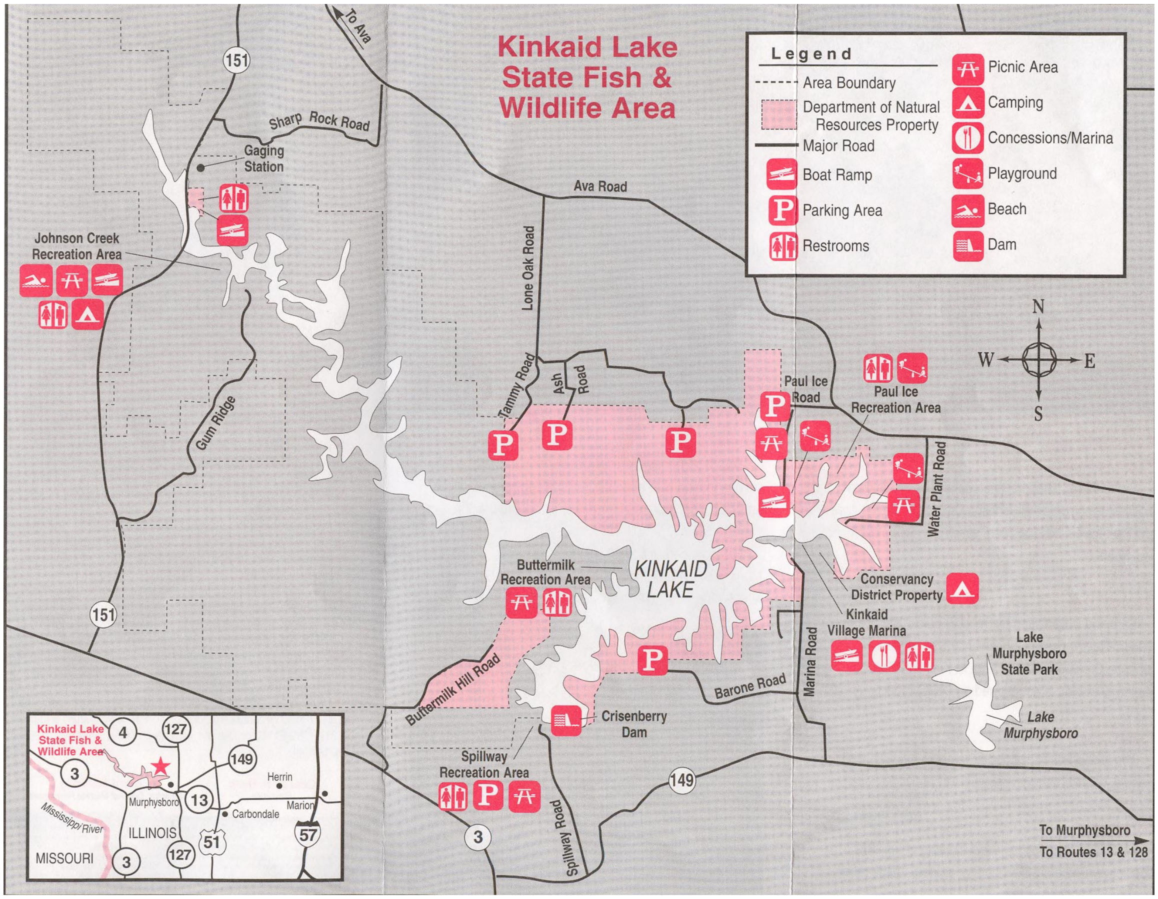


Figure 3. Major Access Roads and Public Access to Kinkaid Lake

D. Description of Population Size and Economic Structure

The major population centers located within close proximity to the Kinkaid Lake system include Murphysboro and Carbondale. The total population for these towns as of the 2000 Census was 13,295 for Murphysboro and 20,681 for Carbondale. In 2000, the total population for Jackson County was 59,612.

The largest industries for the Kinkaid Lake area as of the 2000 U.S. Census were educational, health, and social services (37.4 percent); retail trade (12.1 percent); arts, entertainment, recreation, accommodation, and food services (9.2 percent); manufacturing (6.8 percent); public administration (6.2 percent); and professional, scientific, management, and administration (5.4 percent). The following industries making up the remaining 22.9 percent were construction (4.2 percent); finance, insurance, and real estate (4.2 percent); other services (4.2 percent); transportation, warehousing, and utilities (4.0 percent); information (3.1 percent); agriculture, forestry, fishing, hunting, and mining (1.9 percent); and wholesale trade (1.2 percent).

In 2000, the median household income within Jackson County was $24,946, and the median incomes for Murphysboro and Carbondale were $25,551 and $39,750, respectively.

E. Summary of Historical Lake Uses

Kinkaid Lake is a 2,350-acre surface impoundment (reservoir) that was constructed in 1968 for municipal water needs and recreational opportunities. The lake serves as the primary water supply for ten municipalities and three water districts that serve an estimated 27 to 30 thousand people. The lake is also used for water-based recreation. KRCCD estimate that overall lake usage is increasing and that between one-half to three-quarters of a million visitors annually (i.e., 1 user during 1 day = 1 visitor day) (Fligor personal communication, 2006). Table 3 provides a list of the major recreational uses and associated facilities at Kinkaid Lake.

Table 3 - Major Recreational Uses and Associated Facilities at Kinkaid Lake

Available Lake Uses	Available Recreational Facilities
Fishing	Entire Lake
Canoeing/Sailing	Entire Lake
Motor Boating	Entire Lake
Camping	Kinkaid Village or Johnson Creek Area
Swimming	Johnson Creek Beach or Lake
Skiing	Lower Portions of Lake
Picnicking	Paul Ice, Glenn Schlimpert, and Johnson Creek Areas
Hiking	Forest Service Trail and IDNR Trail
Horseback Riding	Johnson Creek Area

F. Population Segments Adversely Affected by Lake Degradation

Kinkaid Lake, as mentioned previously, provides municipal water supply for several municipalities and water districts in the Kinkaid Lake area. Together, the public water supply and recreation/tourism provided by Kinkaid Lake enhances the prosperity of the entire region (personal communication with KRCCD, 2006).

Degraded water quality and decreased access to the lake and surrounding facilities could significantly impact the local communities that utilize the lake and adjacent areas. The loss of revenue associated from various water activities in the Kinkaid Lake area would be significant. Loss of desired water quality can also impact property values in and around the lake.

G. Comparison of Lake Uses to Other Lakes in Region

Figure 4 illustrates the public lakes greater than 8.1 hectares (20.0 acres) that are located within 80 km (50 miles) of Kinkaid Lake. Table 4 lists information for the public lakes that are located within a 80 km (50.0 mile) radius. There were a total of 51 lakes within the study area with 41 lakes being located in Illinois and 10 lakes located in Missouri.

Table 4. Publicly Owned Lakes within 80 km (50 mi.) of Kinkaid Lake

Lake	State	County	Area (acres)	Max Depth (ft.)	Public Access	Launch Ramp	Recreational Facilities	Distance in Miles
Lake Murphysboro	IL	Jackson	145	40	Y	Y	B,F,C,P	2
Carbondale City Lake	IL	Jackson	136	21	Y	Y	B,F,P	12
Elkville City Lake	IL	Jackson	59	12	Y	N	B,F	11
Cedar Lake	IL	Jackson	1,800	60	Y	Y	B,F,C,P,SW	11
Grassy Lake	IL	Union	310	5	Y	N	B,F,P	26
Lyrle Lake	IL	Union	260	9	Y	N	B,F	31
Horseshoe Lake	IL	Alexander	1,890	6	Y	Y	B,SK,C,P,F	47
Crab Orchard Lake	IL	Williamson	6,965	36	Y	Y	B,SK,C,P	24.5
Lake of Egypt	IL	Williamson	2,300	52	Y	Y	B,F,SK,C,P	18
Little Grassy Lake	IL	Williamson	1,000	77	Y	Y	B,F,C,P	29
Devil's Kitchen Lake	IL	Williamson	810	90	Y	Y	B,F,C,P	20.5
Marion City Lake	IL	Williamson	128	18	Y	Y	B,F	26.5
Johnson City Lake	IL	Williamson	59	11	Y	N	B,F	31
Herrin Lake #1	IL	Williamson	51	14	Y	Y	P	20.5
Herrin Lake #2	IL	Williamson	46	17	Y	Y	B,F	24
Arrowhead Lake	IL	Williamson	30	Unk	Y	Y	B,F,C,P	28
Lake Benton	IL	Franklin	68	30	Y	Y	B,SK,C,P,F,SW	33
Lake Hamilton	IL	Franklin	34	18	Y	N	B,F,C	32.5
West Frankfort New Res.	IL	Franklin	214	15	Y	Y	B,F,C,SW	37
West Frankfort Old Res.	IL	Franklin	147	20	Y	Y	B,F,C	35
Christopher Old Res.	IL	Franklin	20	17	Y	N	B,F,C	21.5
Christopher New Res.	IL	Franklin	38	23	Y	N	B,F,C	22
Lake Zeigler	IL	Franklin	55	20	Y	N	B,F,C,P	22
Sesser Reservoir	IL	Franklin	43	15	Y	N	B,F,C,P	23

NA - Not Available
B = Boating; SK = Skiing; C = Camping; P = Picnicking; F = Fishing; SW = Swimming

Source: Illinois State Atlas,1980 and Illinois & Missouri Atlas & Gazetteer, 2002.

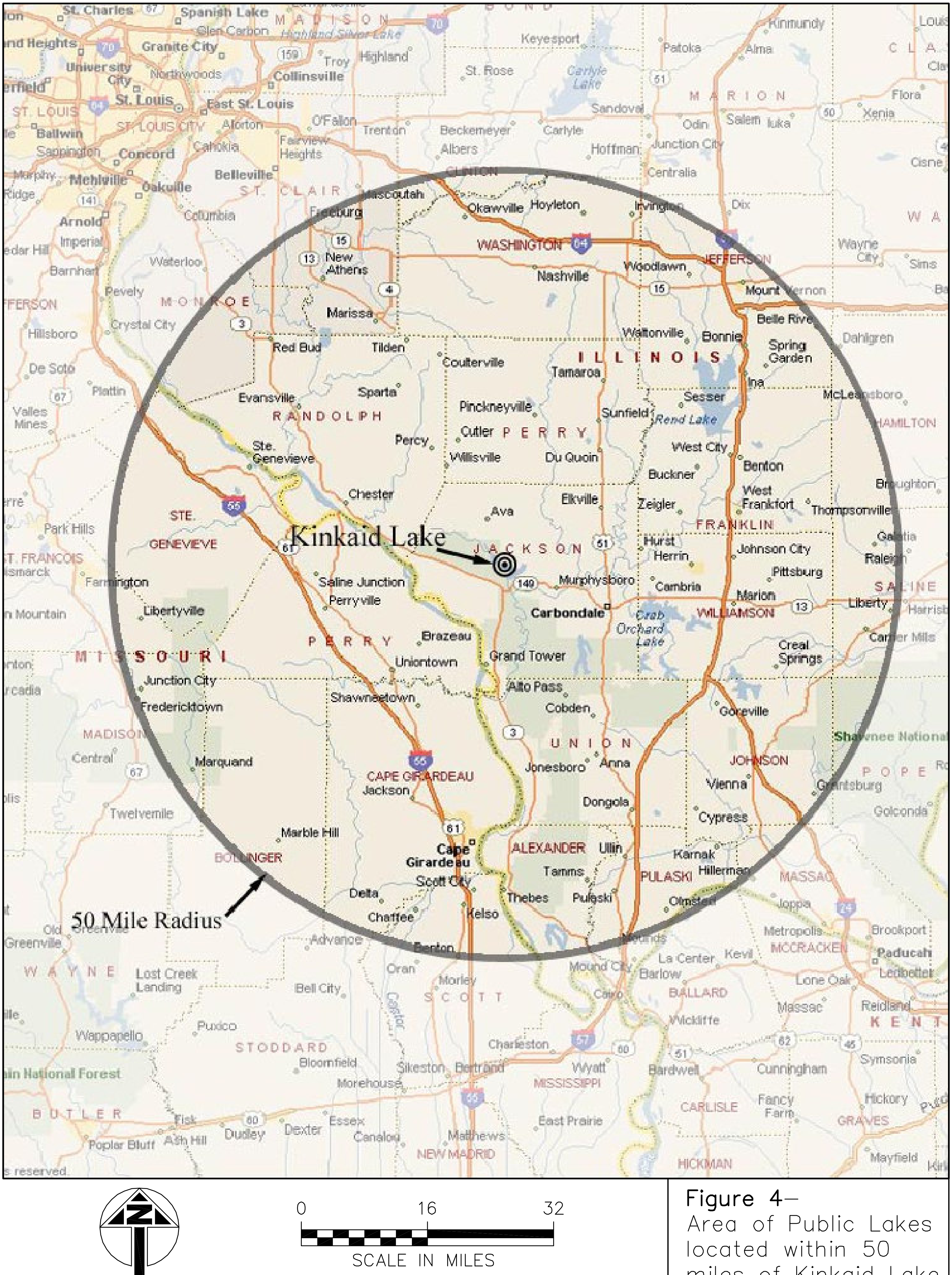


Figure 4–
Area of Public Lakes located within 50 miles of Kinkaid Lake

Table 4 (Continued). Publicly Owned Lakes within 80 km (50 mi.) of Kinkaid Lake

Lake	State	County	Area (acres)	Max Depth (ft.)	Public Access	Launch Ramp	Recreational Facilities	Distance in Miles
Lake Moses	IL	Franklin	170	30	Y	N	B,F,C,P	27
DuQuoin City Reservoir	IL	Perry	183	30	Y	Y	B,F,C	33
Pinckneyville Reservoir	IL	Perry	165	33	Y	Y	B,F,P	21
Randolph County Lake	IL	Randolph	84	40	Y	Y	B,F,C,P	21
Sparta New City Lake	IL	Randolph	40	12	Y	N	B,F,C,P	17.5
Sparta Old Reservoir	IL	Randolph	32	18	Y	N	B,F	21.5
Coulterville City Res.	IL	Randolph	32	30	Y	N	B,F,P	25.5
Washington County Lake	IL	Washington	248	25	Y	Y	B,F,C,P	33
Nashville City Reservoir	IL	Washington	40	22	Y	Y	B,F,P	37
Ashley City Reservoir	IL	Washington	22	27	Y	N	NA	40
Mermet Lake	IL	Massac	452	12	Y	Y	B,F,C,P	49
Lake Glendale	IL	Pope	79	14	Y	Y	B,F,SW,P,C	49
Harrisburg Reservoir	IL	Saline	209	30	Y	Y	B,F,P	45.5
Eldorado Reservoir	IL	Saline	98	18	Y	N	B,F,P	50
Lake McLeansboro	IL	Hamilton	75	20	Y	Y	B,F,P	49.5
Rend Lake	IL	Jefferson	18,900	30	Y	Y	B,F,C,P	30
Raccoon Creek Res.	IL	Marion	970	8	Y	Y	B,F,P	50
Baldwin Lake	IL	St. Clair	2,018	42	Y	Y	B,F,C,P	34
Lake Wanda Lee	MO	St. Genevieve	220	NA	NA	NA	NA	NA
Lake Anne	MO	St. Genevieve	NA	NA	NA	NA	NA	NA
Lake Ski	MO	St. Genevieve	NA	NA	NA	NA	NA	NA
Butterfly Lake	MO	St. Genevieve	85	NA	NA	NA	NA	NA
Marquette Lakes	MO	Scott	NA	NA	NA	NA	NA	NA
Lake Girardeau	MO	Cape Girardeau	350	NA	NA	NA	NA	NA
Goose Creek Lake	MO	St. Francois	62	NA	NA	NA	NA	NA
Nims Lake	MO	St. Francois	NA	NA	NA	NA	NA	NA
City Lake	MO	St. Francois	NA	NA	NA	NA	NA	NA
Lake Kah-Tan-Da	MO	Perry	NA	NA	NA	NA	NA	NA

NA - Not Available
B = Boating; SK = Skiing; C = Camping; P = Picnicking; F = Fishing; SW = Swimming

Source: Illinois State Atlas,1980 and Illinois & Missouri Atlas & Gazetteer, 2002.

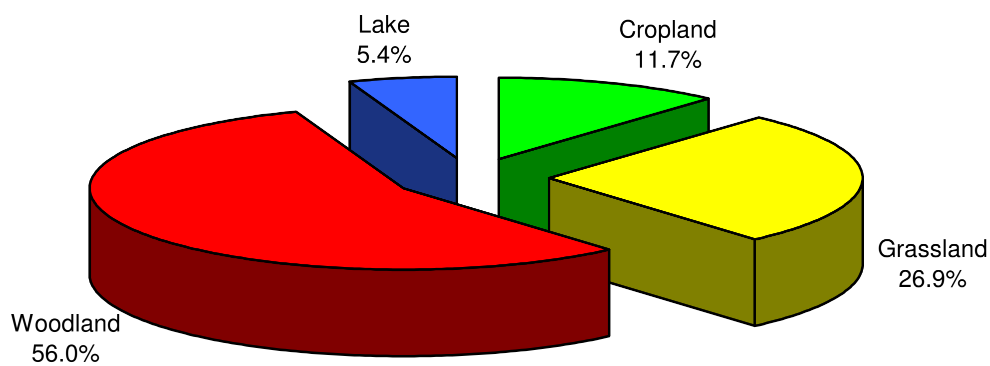
H. Description of Point Source Pollution Discharges

The only known point source discharge point within the Kinkaid Lake watershed is the Kinkaid water treatment plant operated by the Kinkaid-Reed's Creek Conservancy District (KRCCD). The KRCCD property is located at the east end of the lake and is illustrated in Figure 3. The National Pollutant Discharge Elimination System (NPDES) permit for the water plant is G640136.

I. Land Uses and Non-Point Source Pollution Loadings

The Kinkaid Lake watershed encompasses approximately 15,594.6 hectares (38,535 acres) of land in north-central Jackson County. The major land use occurring within the boundaries of the watershed is forested woodlands with 56.0 percent of the total land use (Figure 5). The next most prevalent land uses are grassland or pasture and cropland areas, which make up 26.9 and 11.7 percent, respectively. Kinkaid Lake consists of 5.4 percent of the total watershed.

Figure 5 - Land Uses within the Kinkaid Lake Watershed.



Source: Windhorn, 2000

Table 5 - Estimated Sediment Sources to Kinkaid Lake

Erosion Source	Area in Acres	Total Erosion (Tons/Yr)	Sediment Delivery Ratio	Est. Sediment Delivered to Lake (Tons/Yr)	Percentage
Sheet/Rill Erosion					
Cropland					
A/B Slopes	3,364	13,120	0.33	4,329	5.3%
C Slopes	1,420	14,058	0.54	7,591	9.3%
D Slopes	475	7,505	0.68	5,103	6.3%
Grassland	12,160	6,080	0.3	1,824	2.2%
Woodland	25,260	2,526	0.65	1,642	2.0%
Water	2,445				
Total	45,124	43,289			
Ephemeral Erosion	NA	5,525	0.85	4,696	5.8%
Gully Erosion	NA	38,700	0.9	34,830	42.7%
Streambank Erosion	NA	3,300	0.95	3,135	3.8%
Shoreline Erosion	NA	18,400	1	18,400	22.6%
Total			109,214	81,551	100.0%
Estimated Annual Sediment Delivery to Lake (WTF=0.81)				66,056.58	

Source: Windhorn, 2000.

Table 5 summarizes an estimate of the annual solids loading to Kinkaid Lake related to the specific acreage of land use type within the watershed. A loading coefficient was applied to each land use area (in acres) to develop estimated amounts of sediment delivered to the lake (Windhorn, 2000).

Table 6. Estimated Non-Point Source Loadings to Kinkaid Lake by Major Land Use

Annual Loading	Land Area in Acres	Suspended Solids Export/Input Rate (Lbs/AC/YR)	Suspended Solids Annual Loading (Tons/YR)	Total Nitrogen Export/Input Rate (Lbs/AC/YR)	Total Nitrogen Annual Loading (Tons/YR)	Total Phosphorus Export/Input Rate (Lbs/AC/YR)	Total Phosphorus Annual Loading (Tons/YR)
Cropland	5,259	160	420.72	8.03	21.11	1.96	5.15
Grassland	12,160	25	152	3.12	18.97	0.54	3.28
Woodland	25,260	10	126.3	2.23	28.16	0.22	2.78
Lake	2,445	NA	NA	NA	NA	NA	NA
Total	45,124		699.02		68.25		11.22

Source: Windhorn, 2000

Table 6 lists the estimated annual nutrient and solids loading for various land uses within the Kinkaid Lake watershed. Approximately, 699.0 tons/yr (634,122 kg/yr) of suspended solids, 68.25 tons/yr (61,915 kg/yr) of total nitrogen, and 11.22 tons/yr (10,179 kg/yr) of total phosphorus could be annually delivered to Kinkaid Lake. However, the actual measured concentrations from the Phase 1 (2003-04) sampling period within the sediment and nutrient budgets yielded different results, suggesting inaccuracy and underestimate of the loading estimates in Table 6. The estimates in Table 6 also do not account for non-point sources generated from eroded shoreline.

Similar problems involving large discrepancies between estimated loading rates and those derived from watershed monitoring were reported for lake restoration studies conducted in Illinois by Cochran & Wilken, Inc. (1991) on Paris Twin Lakes, by Kothandaraman and Evans (1983) on Johnson Sauk Trail Lake and Lake Le-Aqua-Na, by Kirschner and Sefton (1983) on the Skokie Lagoons, and by the Illinois Natural History Survey (1983) on Lake of the Woods. These studies reported that estimated loading rates gave results much different than those derived from stream monitoring data. These differences are probably related to the spatial distribution of land use in the watershed, stormwater management practices, and the problems related to predicting average export rates for a non-homogeneous watershed.

J. Current and Past Restoration Activities

The Kinkaid-Reed's Creek Conservancy District, the Illinois Department of Natural Resources, and the U.S. Forest Service have supported and completed the following improvements to Kinkaid Lake and its watershed. In addition, over the years several local clubs and volunteer groups including local Boy Scout troops, fishing clubs, Friends of Kinkaid Lake, and the Kinkaid Area Watershed Project have also worked on improving the Lake (personal communication with KRCCD). The following are some of the major lake restoration activities that have taken place at Kinkaid Lake.

1998 – Cypress trees planted near Mount Joy boat ramp.

1999 – Mount Joy boat launch ramp expanded to six lanes and parking expanded to accommodate an additional 100 vehicles and boat trailers.

1999 – Fish retainer installed at the spillway and increased the height of the dam by two-feet.

1996-2001 – Approximately 3,600 linear feet of shoreline stabilization.

2001 – New access road constructed from State Route 149 to the Mount Joy access area and the Kinkaid Village Marina.

2002 – Repairs to the lake spillway at a cost of $2 million dollars.

2002 – Glenn Schlimpert Recreation Area remodeled with ITC cadets.

2002 – Facility upgrade of public boat launches to handicap assessable with new comfort stations and parking lot resurfacing.

K. Baseline and Current Limnological Data

Baseline and current limnological data for Kinkaid Lake is based on sampling conducted through the Illinois EPA Ambient Lake Monitoring (ALMP) and the Illinois Clean Lakes (ICLP) programs. Current data was generated from samples collected during the Phase 1 study monitoring period (April 2003 through March 2004). All data reported prior to the Phase 1 study period (2003), and available in US EPA STORET, are considered historical data. The historical datasets chosen for comparison purposes in this report were obtained from sampling conducted in 1985 and 1994 and were chosen based on availability and completeness in relation to the Phase 1 study-period data. Current and historical data for Kinkaid Lake were organized and analyzed by parameter according to the Illinois EPA ambient sampling period (May through October). Summaries of the current and historical data are provided in Appendix A.

The water quality data analyzed by the Illinois EPA laboratories for this Phase I study period was distributed electronically by the Illinois EPA with two disclaimers (Appendix A). In addition to the disclaimers, information regarding data quality from the Illinois EPA laboratories during this time period is provided in the biannual update to the Integrated Report. The most recent Integrated Report, the *Illinois Integrated Water Quality Report and Section 303(d) list – 2006* (available on the Illinois EPA website at www.epa.state.il.us/water/water-quality/report-2006/2006-report.pdf), contains the following paragraph on page 36.

Based on Illinois EPA review of surface-water results analyzed by Illinois EPA laboratories, some available data failed to meet quality control criteria or failed to meet data quality objectives. For these analytes, the Illinois EPA intends to further review the results of samples collected after 12/31/2003, and therefore does not intend to use the data until a complete review of samples has been conducted. Data sets not used were: ammonia collected from 01/01/1997 through 12/31/1999 and 10/01/2002 through 12/31/2003; phenols and total Kjeldahl nitrogen data collected from 01/01/1999 through 12/31/2003; and phosphorus, nitrate/nitrite, chloride, alkalinity, sulfate, cyanide, chlorophyll, total suspended solids, volatile suspended solids and total dissolved solids collected from 10/01/2002 through 12/31/2003.

Based on the information provided in the 2006 Integrated Report and the specific disclaimer for surface water data (Appendix A), the results obtained for the following parameters analyzed by Illinois EPA laboratories during the Phase I study period are to be interpreted with caution: ammonia, total Kjeldahl nitrogen, phosphorus, nitrate/nitrite, chlorophyll, total suspended solids, and volatile suspended solids.

1. Historical and Current Lake Water Quality

Kinkaid Lake has a long association with Illinois EPA and their monitoring programs. The Illinois EPA ambient water quality monitoring at Kinkaid Lake began in 1981. This monitoring program provides an intensive analysis of the limnological characteristics of the lake system and includes a wide range of water quality parameters. The VLMP monitoring at Kinkaid Lake began in 1979 and supplements the more intensive Illinois EPA ambient data collection (IEPA personnel communication).

Kinkaid Lake Ambient Monitoring Program currently has five (5) sampling stations, RNC-1, RNC-2, RNC-3, RNC-4, and RNC-9 (see Figure 6). RNC-1 (Site 1) is the deepest sampling station and is located in the southern portion of the lake near the spillway (Crisenberry Dam). RNC-2 (Site 2), RNC-3 (Site 3) and RNC-4 (Site 4) are located in the northwestern “upper arm” of the lake, and RNC-9 (Site 9) is located in the eastern portion of the lake near the water plant. As the current sampling station designations indicate, historically there have been more sampling sites than are currently sampled. Sites 5, 6, 7, and 8 were a part of another sampling program that was terminated in 1986 (IEPA personnel communication). RNC-9 was created when the Illinois EPA ALMP began incorporating public water supply intake sites as a sampling location.

In-lake water quality sampling was conducted during the Phase 1 monitoring period between April 2003 and March 2004 at Sites 1, 2, 3, 4, and 9. During the yearlong sampling period, water quality samples were collected in order to establish a baseline (2003-2004) condition. Samples were collected twice monthly April through October 2003 and monthly thereafter through the end of March 2004. IEPA personnel collected water quality samples five times during the study period and the remainder of the in-lake sampling was conducted by KRCCD and Cochran & Wilken, Inc. personnel.

Surface samples were collected at 0.30 meters (1.0 ft.) of the surface at all five sampling locations within the lake. In addition to the collection of surface water samples, "bottom" samples were collected approximately two feet from the bottom at Site 1, which was the deep-water sampling station. A mid-depth (intake) sample was also collected at Site 9. Sampling procedures for each trip also included a water transparency reading (Secchi disk transparency depth), an integrated chlorophyll sample obtained at approximately twice the Secchi depth, and a dissolved oxygen and temperature profile (DO/temperature). The Illinois EPA ambient sampling program has produced a historical record of water quality data at Kinkaid Lake. A complete summary of historical (1985 and 1994) and current Phase 1 (2003-04) water quality data is provided in Appendix A.

As mentioned previously, samples were collected at one foot below the surface and near bottom at Site 1 during the Phase 1 monitoring period. Generally, samples collected near bottom (two feet off the bottom) contained higher concentrations of analytes than those samples collected one foot below the surface (Appendix A). These variances were observed for the following parameters: total ammonia-nitrogen, total Kjeldahl nitrogen, nitrate-nitrite, total phosphorus, and dissolved phosphorus.

Historical and Phase 1 data (i.e., monthly means) collected from surface samples at Sites RNC-1, RNC-3, RNC-4, and RNC-9 (historically RNC-6) were analyzed for comparative purposes in the following discussions: water transparency, pH and alkalinity, conductivity, suspended solids, nitrogen, phosphorus, and chlorophyll. In addition, dissolved oxygen and temperature profiles were also developed for the Phase 1 monitoring period.

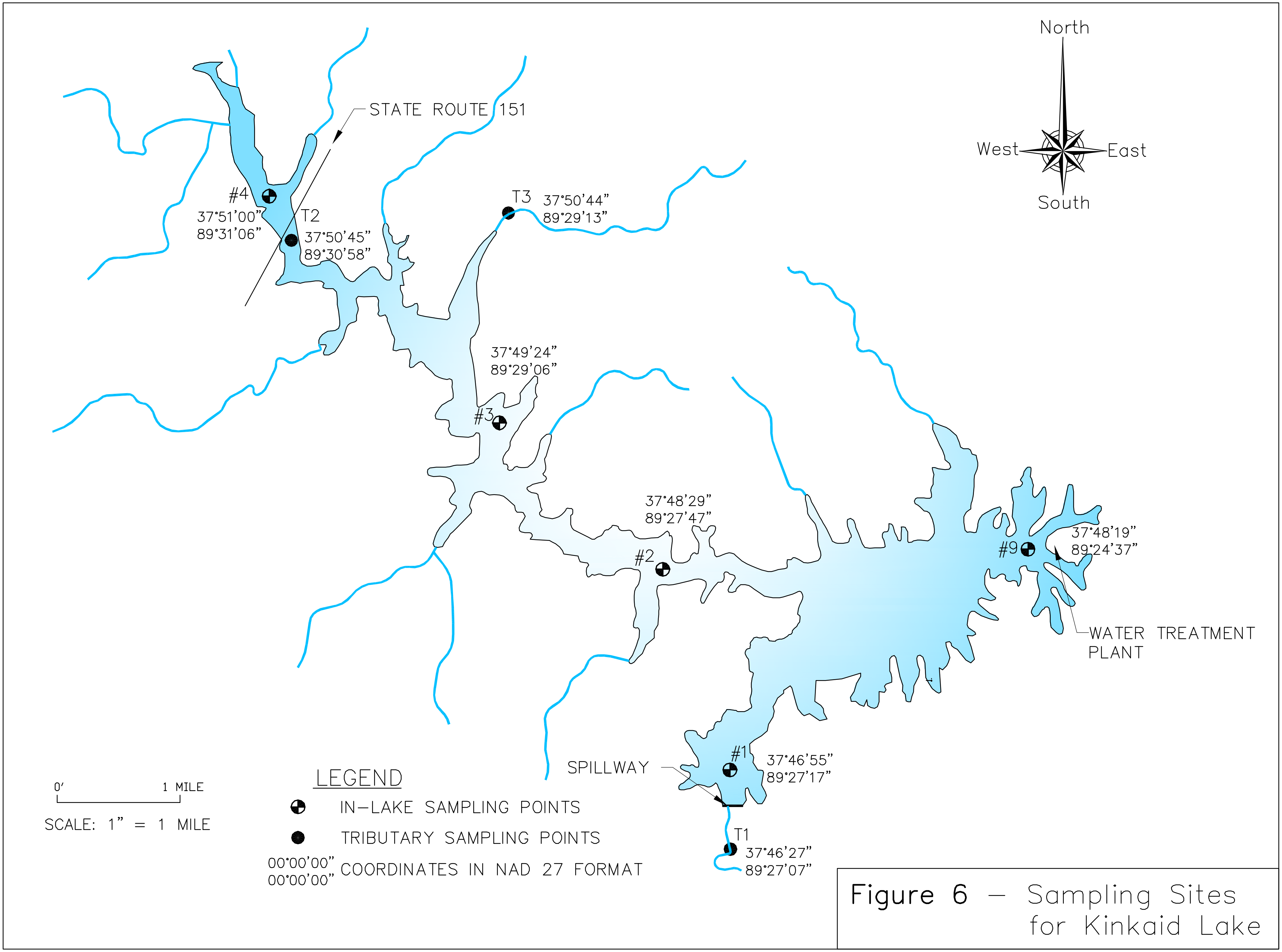


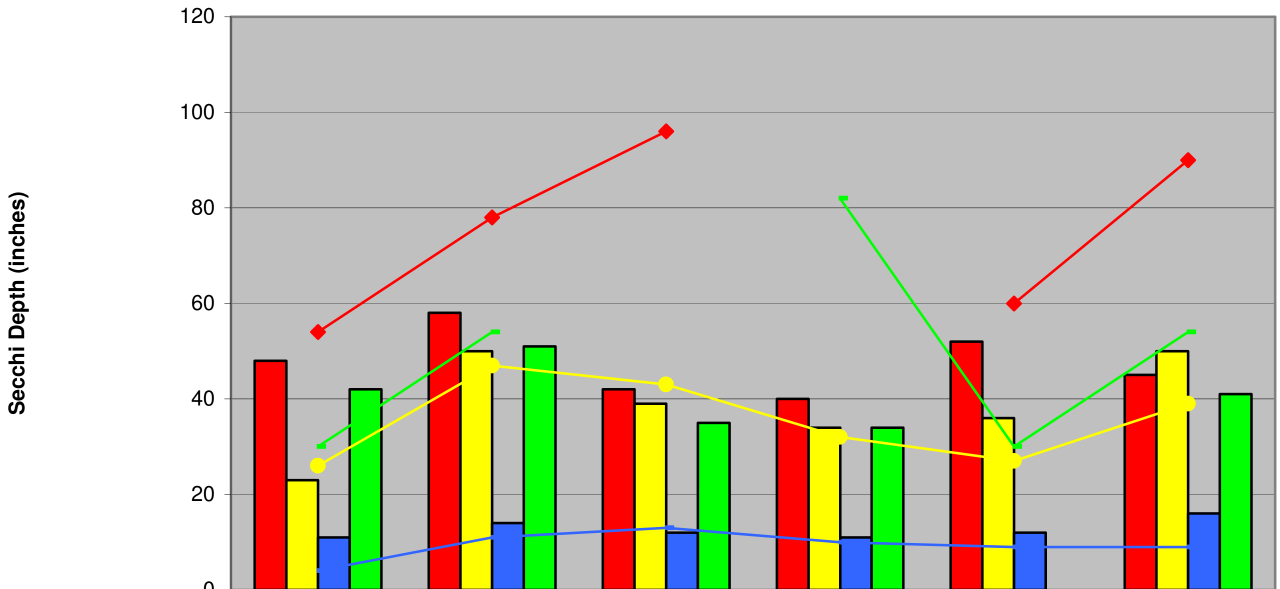
Figure 6 – Sampling Sites for Kinkaid Lake

a. Water Transparency

Lake water transparency was measured using a simple, inexpensive device known as a Secchi disk. The Secchi disk is a 20.0 cm (7.9 inch) disk with alternating black and white patterns that is lowered into the water column until it disappears. The corresponding depth at which the disk is no longer visible with the naked eye is known as the Secchi depth.

A comparison between Phase 1 and historical data indicates that mean Secchi disc transparency depths (Secchi depths) recorded during the Phase 1 monitoring period were slightly lower (i.e., more turbid) than the historical Secchi depths, but were generally within one standard deviation of the historical mean for each site. Secchi depths were typically higher in the spring and lower in the summer months when algal productivity is known to be highest. Declines in Secchi depth during the Phase 1 period may be attributed to an increase in suspended materials within the lake. An increase in algal productivity or an increase in suspended solids may negatively correlate with Secchi depth measurements due to a decrease in light penetration. Kinkaid Lake Secchi depths are displayed in Figure 7.

Figure 7. Kinkaid Lake - Monthly Mean Secchi Transparency Depth Comparisons for the Phase 1 (2003) and Historical (1985 and 1994) Periods



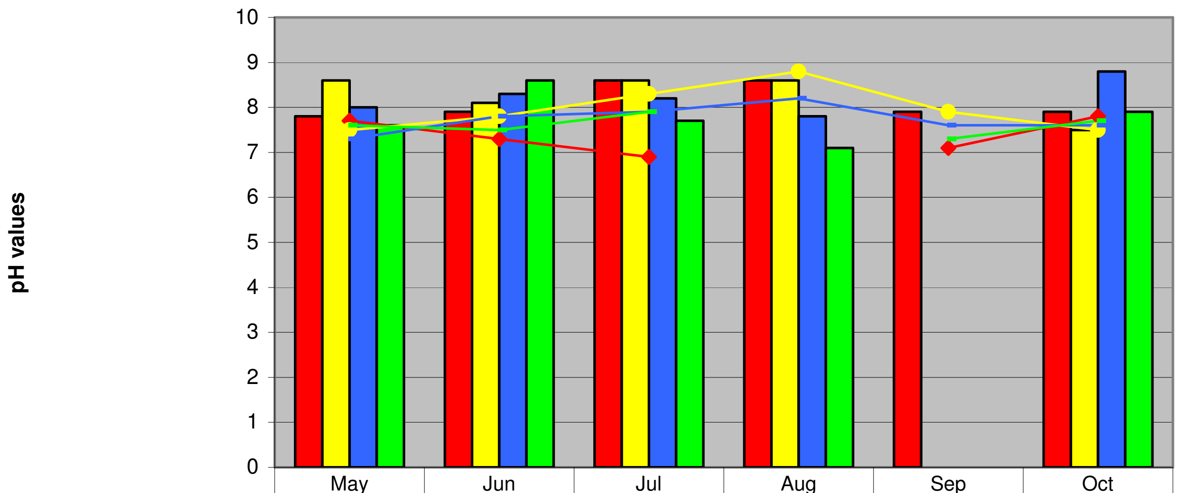
	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	48	58	42	40	52	45
RNC-3 - Phase I	23	50	39	34	36	50
RNC-4 - Phase I	11	14	12	11	12	16
RNC-9 - Phase I	42	51	35	34		41
RNC-1 - Historical	54	78	96		60	90
RNC-3 - Historical	26	47	43	32	27	39
RNC-4 - Historical	4	11	13	10	9	9
RNC-6 - Historical	30	54		82	30	54

b. pH and Alkalinity

When measuring the degree of acidity in a waterbody, a logarithmic scale ranging from 0 to 14 is used to measure the concentration of hydrogen ions. This scale is known as the pH scale. A measurement along the lower portion of the scale, 0 to 7 indicates the degree of acidity while a measurement along the upper portion, 7 to 14 indicates the degree of alkalinity. A seven on the pH scale is considered to be neutral. Generally, lakes in Illinois are well buffered by limestone bedrock, which may neutralize acidic activity. These lakes typically range from 6 to 9 on the pH scale.

During Phase 1 sampling, surface measurements of pH at Kinkaid Lake ranged from a high of 8.8 at Site 4 in October 2003 to a low of 7.1 at Site 9 in August 2003. Overall, the mean pH readings during the Phase 1 monitoring period were slightly higher but were within one standard deviation of the historical mean for each site (see Figure 8). Changes in pH during the season may be attributed to algal productivity, increased CO_2 from respiration accompanying decomposition, and nitrogen assimilation in the water column. Based on available data, pH measurements exhibited normal and expected fluctuations and remained similar to other Illinois lakes. In accordance with the water quality standard set forth in Title 35, Subtitle C, Ch. 1, Part 302, all pH readings collected during the Phase 1 period were within than range of 6.5 to 9.0.

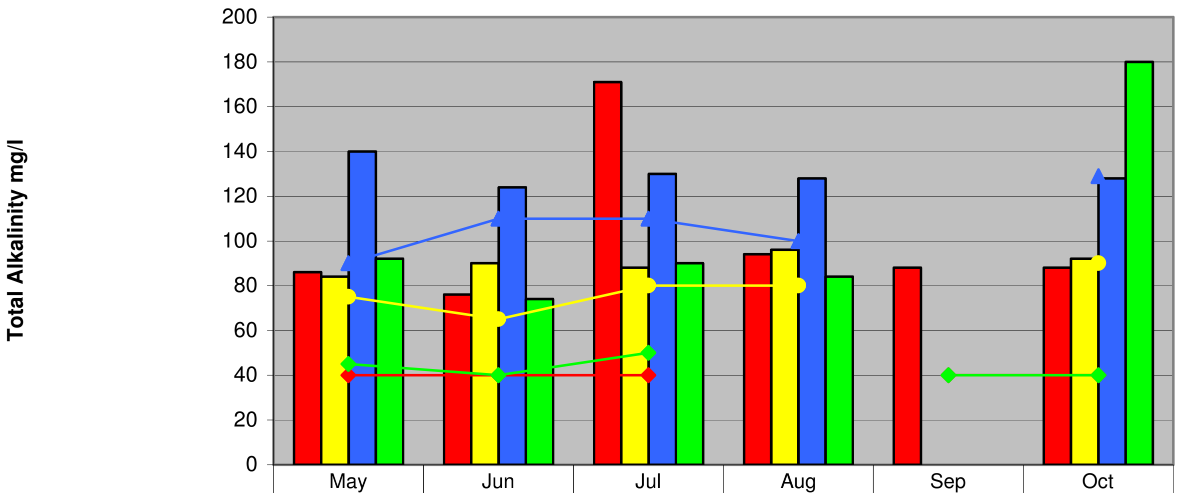
Figure 8. Kinkaid Lake - Monthly Mean pH Comparisons for the Phase 1 (2003) and Historical (1985 and 1994) Periods



	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	7.8	7.9	8.6	8.6	7.9	7.9
RNC-3 - Phase I	8.6	8.1	8.6	8.6		7.5
RNC-4 - Phase I	8	8.3	8.2	7.8		8.8
RNC-9 - Phase I	7.6	8.6	7.7	7.1		7.9
RNC-1 - Historical	7.7	7.3	6.9		7.1	7.8
RNC-3 - Historical	7.5	7.8	8.3	8.8	7.9	7.5
RNC-4 - Historical	7.3	7.8	7.9	8.2	7.6	7.6
RNC-6 - Historical	7.6	7.5	7.9		7.3	7.7

Buffering capacity is defined by the ability of the waterbody to neutralize acid. This capacity is better known as alkalinity. Total alkalinity measures the amount of acid needed to lower the pH of the water to 4.5. A high alkalinity concentration indicates an increased ability to neutralize pH and resist changes, whereas a low alkalinity concentration indicates that a water body is vulnerable to changes in pH. Total alkalinity measurements during the Phase 1 sampling period ranged from a low of 74 mg/l at Site 9 in June 2003 to a high of 140 mg/l at Site 4 in May 2003 (Figure 9). In general, Kinkaid Lake remained well buffered throughout the Phase 1 monitoring period.

Figure 9. Kinkaid Lake - Monthly Mean Total Alkalinity Comparisons for the Phase 1 (2003) and Historical (1985 and 1994) Periods

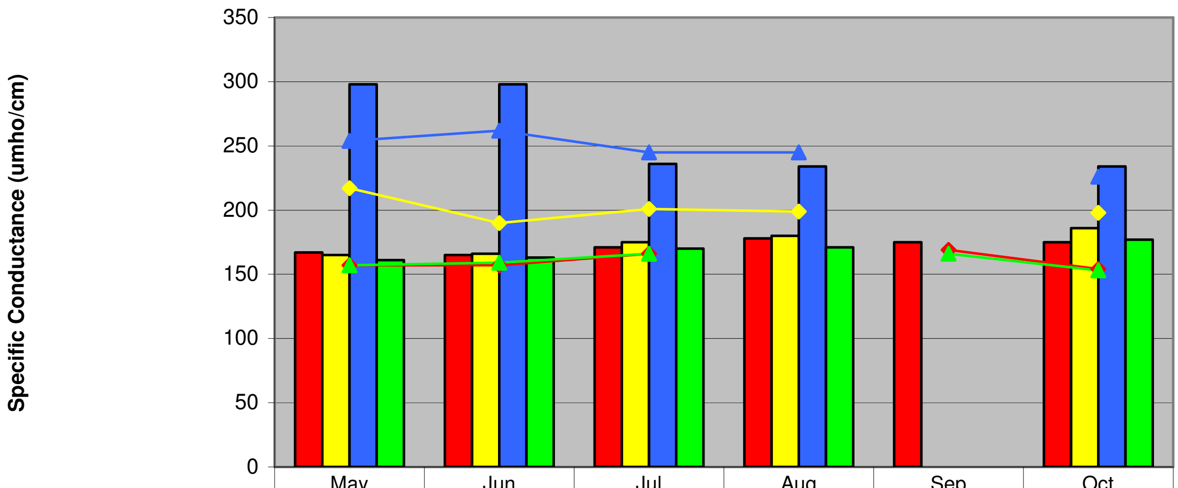


	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	86	76	171	94	88	88
RNC-3 - Phase I	84	90	88	96		92
RNC-4 - Phase I	140	124	130	128		128
RNC-9 - Phase I	92	74	90	84		180
RNC-1 - Historical	40	40	40		40	40
RNC-3 - Historical	75	65	80	80		90
RNC-4 - Historical	90	110	110	100		129
RNC-6 - Historical	45	40	50		40	40

c. Conductivity

Conductivity is a measure of water's ability to conduct an electrical current. The ability to carry a current is often driven by the dissolved materials present in a water column. These materials can include dissolved ions and other materials in the water and thus are directly proportional to the concentration of total dissolved solids (TDS) present in the water column. Typically, the TDS concentrations represent 50-65 percent of the conductivity measurements. Kinkaid Lake conductivity measurements remained relatively constant throughout the Phase 1 monitoring period ranging from a low of 165 umhos/cm at Site 1 to a high of 298 umhos/cm at Site 4. While the mean measurements for conductance from the Phase 1 monitoring period were slightly lower than the historical data, the Phase 1 mean remained within 1 standard deviation of the historic average and also remained similar to other Illinois lakes. Figure 10 portrays the Phase 1 conductivity measurements (bars) and the historical means (lines) for each site.

Figure 10. Kinkaid Lake - Monthly Mean Conductivity Comparison for the Phase 1 (2003) and Historical (1985 and 1994) Periods

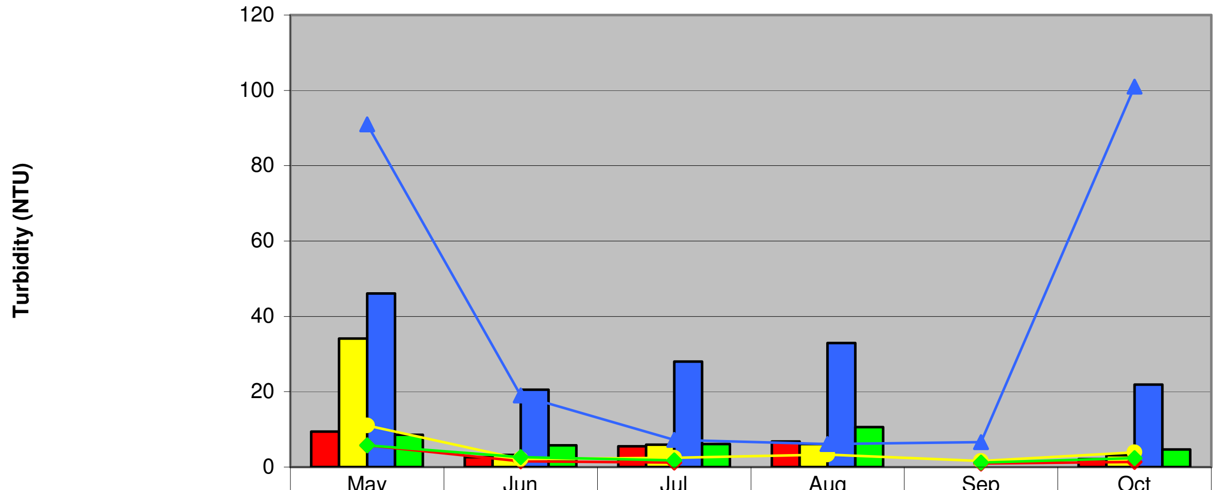


	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	167	165	171	178	175	175
RNC-3 - Phase I	165	166	175	180		186
RNC-4 - Phase I	298	298	236	234		234
RNC-9 - Phase I	161	163	170	171		177
RNC-1 - Historical	157	157	166		169	154
RNC-3 - Historical	217	190	201	199		198
RNC-4 - Historical	254	262	245	245		226
RNC-6 - Historical	157	159	166		166	153

d. Turbidity

Turbidity can be defined as the degree of opaqueness in a lake, and it is measured using a calibrated turbidity meter. Increased turbidity can limit light penetration and can negatively impact aquatic vegetation growth. Turbidity measurements in a lake are most often affected by color, which may be directly proportional to the amount of suspended material in the water column. Turbidity measurements conducted at Kinkaid Lake during the Phase 1 sampling period ranged from a low of 2.1 NTU in the October at Site 1 to a high of 46.1 NTU at Site 4 in May (see Figure 11). Excluding the turbidity data collected in May, the highest turbidity measurements were generally found at all monitoring locations in late summer (August), which may be attributed to a significant increase in algal biomass production. Despite the increases, a high degree of variability in the data, due to few collected and analyzed samples, makes these observations speculative at best.

Figure 11. Kinkaid Lake - Monthly Mean Turbidity Comparison for the Phase 1 (2003) and Historical (1985 and 1994) Periods

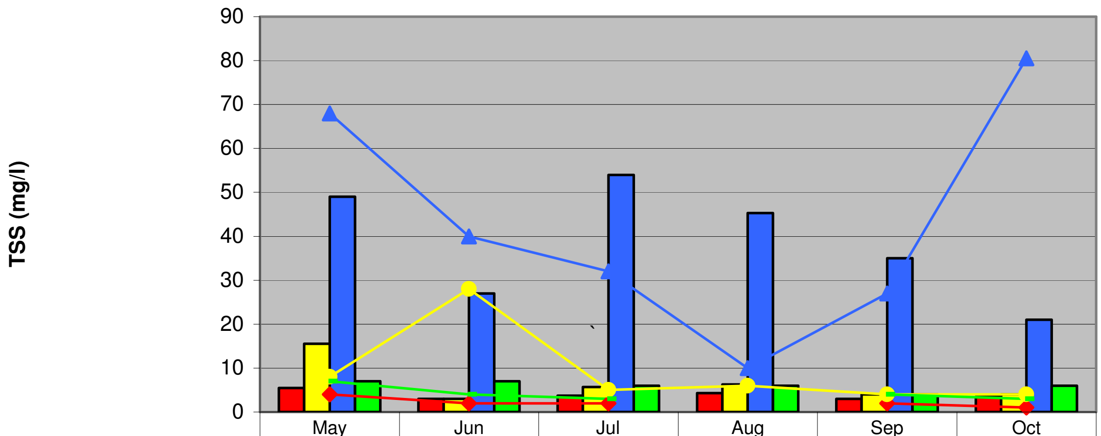


	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	9.4	2.6	5.5	6.8		2.1
RNC-3 - Phase I	34.1	3.2	5.9	6.1		3.1
RNC-4 - Phase I	46.1	20.5	28	32.9		21.9
RNC-9 - Phase I	8.6	5.8	6.1	10.6		4.7
RNC-1 - Historical	5.8	1.5	1.2		0.9	1.4
RNC-3 - Historical	11	2.1	2.5	3.3	1.6	3.9
RNC-4 - Historical	91	19	7.2	6.1	6.6	101
RNC-6 - Historical	5.8	2.6	1.8		1.2	2.4

e. Suspended Solids

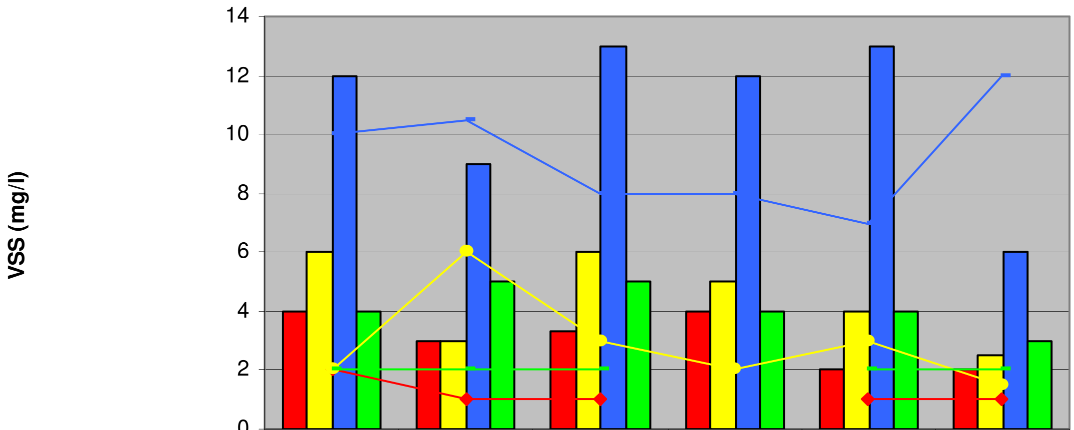
Suspended solids concentrations in a lake most often consist of soil particles, organic material, and other debris that are present in the water column. Secchi depth measurements and solids concentrations are represented by an inverse relationship. As the total suspended solids concentration increases at a given sampling location, the Secchi depth or water transparency often decreases. Total suspended solids concentrations can be an important indicator of the type and degree of turbidity in a lake as related to water quality. Total suspended solids (TSS) and volatile suspended solids (VSS) were measured to assess the average concentration of suspended material in the water column at each sampling location. The TSS concentration represents inorganic (non-volatile) particles and the VSS concentration represents organic (volatile) particles present in the water column (see Figures 12 and 13). The Phase 1 mean TSS and VSS concentrations were generally higher than the historical data but were within 1 standard deviation.

Figure 12. Kinkaid Lake - Monthly Mean TSS Concentrations for the Phase 1 (2003) and Historical (1985 and 1994) Periods



	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	5.5	3	3.7	4.3	3	3.5
RNC-3 - Phase I	15.5	3	5.7	6.3	4	4
RNC-4 - Phase I	49	27	54	45.3	35	21
RNC-9 - Phase I	7	7	6	6	4	6
RNC-1 - Historical	4	2	2		2	1
RNC-3 - Historical	8	28	5	6	4	4
RNC-4 - Historical	68	40	32	10	27	80.5
RNC-6 - Historical	7	4	3		4	3

Figure 13. Kinkaid Lake - Monthly Mean VSS Concentrations for the Phase 1 (2003) and Historical (1985 and 1994) Periods



	May	Jun	Jul	Aug	Sep	Oct
RNC-1- Phase I	4	3	3.3	4	2	2
RNC-3 - Phase I	6	3	6	5	4	2.5
RNC-4 - Phase I	12	9	13	12	13	6
RNC-9 - Phase I	4	5	5	4	4	3
RNC-1- Historical	2	1	1		1	1
RNC-3 - Historical	2	6	3	2	3	1.5
RNC-4 - Historical	10	10.5	8	8	7	12
RNC-6 - Historical	2	2	2		2	2

In order to more accurately determine the types and amounts of suspended solids in the lake, a volatile suspended solids (VSS) analysis is often performed in conjunction with the TSS analysis. The VSS concentration represents the organic portion of the total suspended solids concentration. Organic constituents often include plankton and additional plant and animal debris that is present in the water column.

According to the Phase 1 monitoring data, the mean VSS concentration was approximately 65 percent of the TSS concentration indicating that a high organic component was present. This level of organically based solids correlated with the high algal productivity and chlorophyll levels present in Kinkaid Lake.

TSS and VSS data failed to meet data quality control criteria or failed to meet data quality objectives for the study period. Please see Appendix A for additional information.

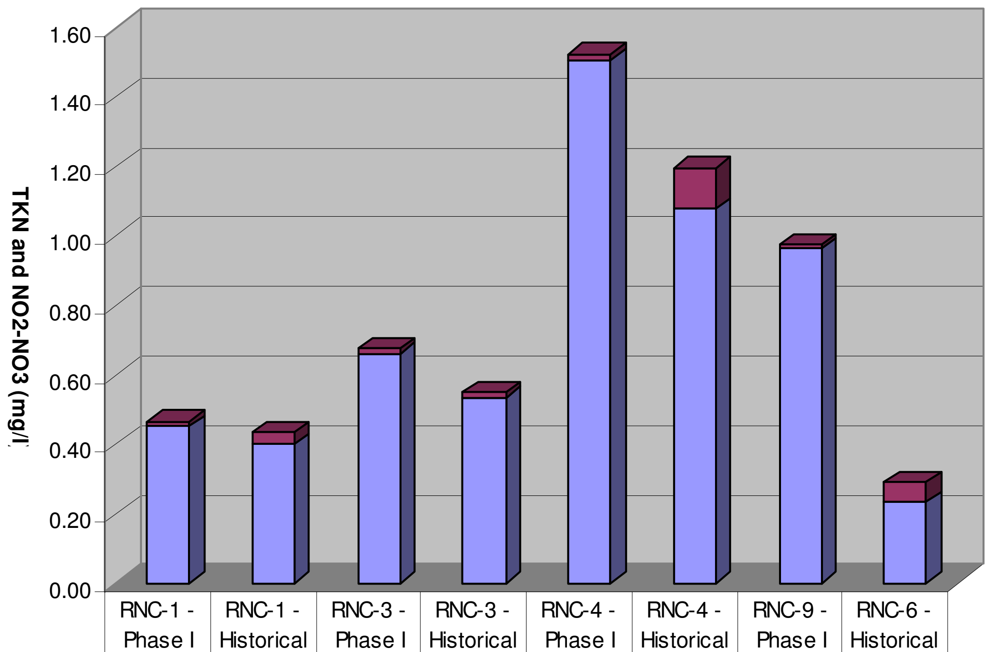
f. Nitrogen

Nitrogen is one of a handful of chemicals that are essential in freshwater ecosystems. Biota in the lake greatly depend upon an interaction with the nitrogen cycle for daily activities. The diversity of species within a water body is often influenced by the degree of available nitrogen forms. These forms include gaseous nitrogen (N_2), nitrates (NO_3-), nitrites (NO_2-), ammonia nitrogen (NH_3-N), ammonium (NH_4+), and dissolved organic nitrogen (DON). Inorganic forms of nitrogen such as nitrate-nitrite and ammonia found in excess may be detrimental to lake ecosystems. For example, Sawyer (1952) indicated that inorganic nitrogen concentrations in excess of 0.30 mg/l are considered sufficient to stimulate excessive algal growth. In addition, high concentrations of ammonia can also be toxic to many fish and other aquatic organisms.

Nitrogen measurements conducted at Kinkaid Lake included NH_3-N, NO_2-NO_3, NH_3-N, and total Kjeldahl nitrogen (TKN). TKN is a measurement of both organic and ammonia-nitrogen. The NH3-N concentration represents only the ammonia-nitrogen (unionized), NH_4+ represents the ammonium or ionized ammonia-nitrogen, and NO_2-NO_3 represents the nitrites and nitrates. A total nitrogen concentration can be obtained by adding the TKN to the NO_2-NO_3 measurements.

Figure 14 graphically portrays the mean total nitrogen measurements for each of the monitoring sites during both the Phase 1 (2003-04) and historical (1985 and 1994) monitoring periods. In general, the total nitrogen percentages provide a relationship of the sources of nitrogen in the water body. Based on the historical and current data available, more than 80% of the nitrogen in Kinkaid Lake has been from organic and ammonia nitrogen sources (TKN). During the Phase 1 monitoring period, the ammonia and organic nitrogen components represented greater than 90% of the nitrogen sources in Kinkaid Lake. The increase in organic and ammonia sources of nitrogen may be correlated to an increase in biomass. Sources of increased organic nitrogen may include, algae and macrophyte growth, while sources of ammonia nitrogen may be from fish waste, atmospheric input and decomposing organic material in the lake (by microbes and bacteria).

Figure 14. Kinkaid Lake - Monthly Mean Total Nitrogen Comparison for the Phase 1 (2003) and Historical (1985 and 1994) Periods

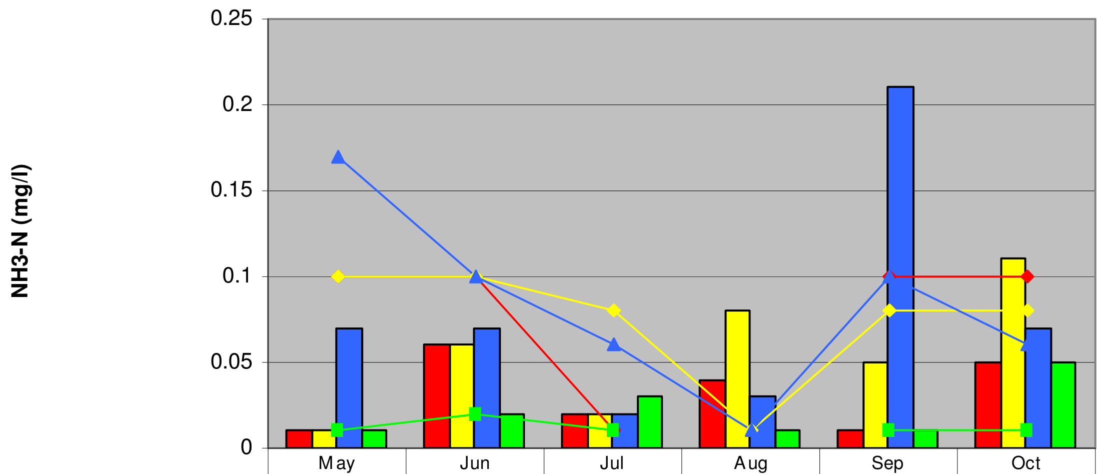


	RNC-1 - Phase I	RNC-1 - Historical	RNC-3 - Phase I	RNC-3 - Historical	RNC-4 - Phase I	RNC-4 - Historical	RNC-9 - Phase I	RNC-6 - Historical
NO2-NO3	0.01	0.03	0.01	0.02	0.02	0.12	0.01	0.06
TKN	0.45	0.40	0.66	0.54	1.51	1.08	0.97	0.23

The Illinois General Water Quality Standards for ammonia-nitrogen vary according to water temperature and pH, with the allowable concentrations decreasing as temperature and pH increase. The allowable concentration of ammonia-nitrogen varies from 1.5 mg/l to 13.0 mg/l. As mentioned above, sources of ammonia-nitrogen may be from decomposition of organic material by bacteria, atmospheric sources, and fish excretion. Ammonia, in certain concentrations may be toxic to fish and other aquatic organisms and must be converted to ammonium (NH_4^+) through the formation of NH_3OH) or nitrate (NO_3^-) before uptake by plants can occur. In contrast to ammonia, ammonium (NH_4^+) is not toxic to aquatic organisms and is readily available for uptake by phytoplankton and macrophytes. The total amount of ammonia and ammonium in the waterbody at any certain time is strictly dependent upon the balance between pH, animal excretion, plant uptake, and activity of bacteria. Due to the high degree of variability possible, data should be interpreted carefully.

The Phase 1 data suggests that ammonia levels were slightly lower compared to the historical mean concentrations (see Figure 15). These findings maybe attributed to the uncertainty of the validity of the Phase 1 analytical data (see Appendix A for Illinois EPA data disclaimer). In the pH range found to occur in Kinkaid Lake, as temperature rises, a higher percentage of ammonia was present in the water compared to conditions found at lower pH and temperatures. The overall importance of this trend is that NH_3 dissolves and forms NH_4OH. The concentrations measured in Kinkaid Lake did not approach the toxic levels during the Phase 1 monitoring period, nor did any samples approach the water quality standard for total ammonia nitrogen of 15 mg/l as set forth in Title 35, Subtitle C, Ch. 1, Part 302. Ultimately, as pH and temperature decrease, ammonium hydroxide disassociates and forms NH_4+, which is immediately taken up by phytoplankton and macrophytes in the water. This source of nitrogen is often referred to as a “regenerated nitrogen” source as compared to more anthropogenic sources commonly found in lakes with higher inflows. Concentrations can be further correlated with the pH of the lake. Overall, this “regenerated nitrogen” source is readily taken up (utilized) by biota in the lake thus contributing to a higher biomass.

Figure 15. Kinkaid Lake - Monthly Mean Un-Ionized Ammonia (NH_3-N) Comparison for the Phase 1 (2003) and Historical (1985 and 1994) Periods



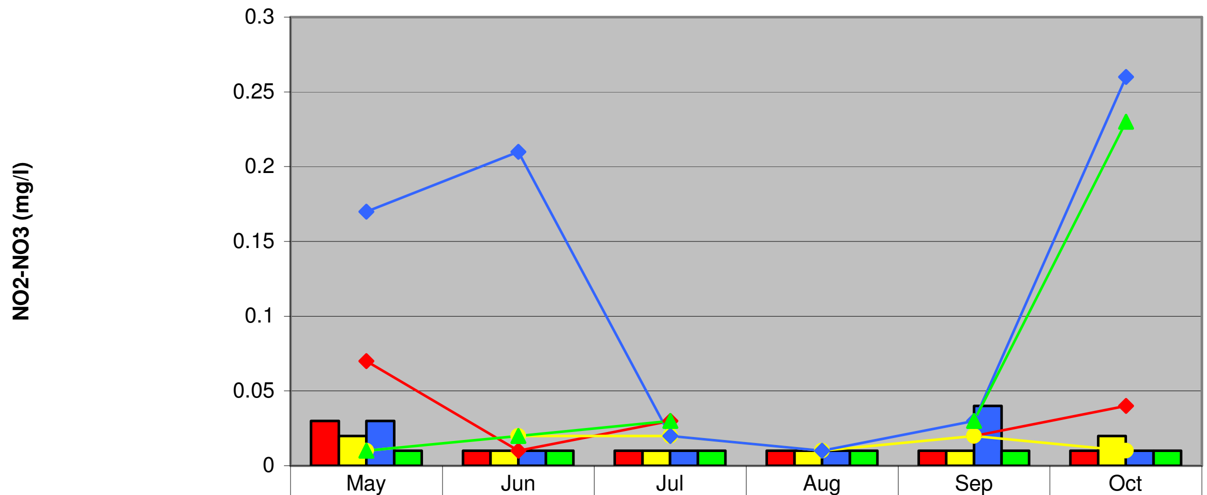
	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	0.01	0.06	0.02	0.04	0.01	0.05
RNC-3 - Phase I	0.01	0.06	0.02	0.08	0.05	0.11
RNC-4 - Phase I	0.07	0.07	0.02	0.03	0.21	0.07
RNC-9 - Phase I	0.01	0.02	0.03	0.01	0.01	0.05
RNC-1 - Historical	0.1	0.1	0.01		0.1	0.1
RNC-3 - Historical	0.1	0.1	0.08	0.01	0.08	0.08
RNC-4 - Historical	0.17	0.1	0.06	0.01	0.1	0.06
RNC-6 - Historical	0.01	0.02	0.01		0.01	0.01

In addition to ammonia, nitrate and nitrite were also analyzed as sources of nitrogen. In typical surface waters, nitrate is often discussed as the combined inorganic portion of the nitrogen cycle since nitrite is usually present in only small quantities with the presence of oxygen. Figure 16 graphically portrays the nitrate and nitrite concentrations of Kinkaid Lake.

NO_2-NO_3 concentrations ranged from a low of 0.010 mg/l (multiple dates) to a high of 0.040 mg/l at Site 4 in September. Mean concentrations observed during the Phase 1 period were lower than the historical average and were often below one (1) standard deviation of the historical mean, indicating that the difference may be statistically significant. However, these findings maybe attributed to the uncertainty of the validity of the Phase 1 analytical data (see Appendix A for Illinois EPA data disclaimer). As discussed above, the data indicate that the sources of nitrogen in Kinkaid Lake were predominantly of organic and ammonia origin. Concentrations observed during the Phase 1 monitoring period appear to support that claim.

Ammonia-nitrogen, Kjeldahl nitrogen, and nitrate-nitrate data failed to meet data quality control criteria or failed to meet data quality objectives for the study period. Please see Appendix A for additional information.

Figure 16. Kinkaid Lake - Monthly Mean NO_2-NO_3 Comparison for the Phase 1 (2003) and Historical (1985 and 1994) Periods



	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	0.03	0.01	0.01	0.01	0.01	0.01
RNC-3 - Phase I	0.02	0.01	0.01	0.01	0.01	0.02
RNC-4 - Phase I	0.03	0.01	0.01	0.01	0.04	0.01
RNC-9 - Phase I	0.01	0.01	0.01	0.01	0.01	0.01
RNC-1 - Historical	0.07	0.01	0.03		0.02	0.04
RNC-3 - Historical	0.01	0.02	0.02	0.01	0.02	0.01
RNC-4 - Historical	0.17	0.21	0.02	0.01	0.03	0.26
RNC-6 - Historical	0.01	0.02	0.03		0.03	0.23

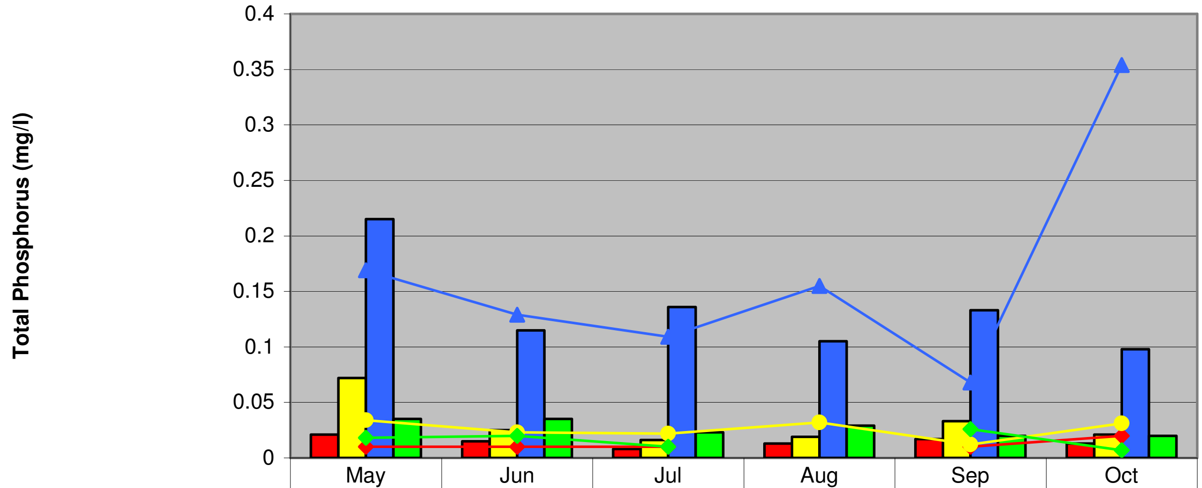
g. Phosphorus

Phosphorus may be found in low concentrations in Illinois lakes throughout all seasonal periods of the year. Phosphorus is typically the limiting nutrient in a lake ecosystem and additional or elevated loading of phosphorus to the lake will generally stimulate additional plant and algae growth. The control of phosphorus within a lake ecosystem is typically a primary focus for lake restoration and protection efforts. Often, the majority of phosphorus that is delivered to streams and lakes is tightly bound to sediment particles that are running off agricultural fields and construction sites in the watershed. Additional sources of phosphorus may include internal recycling from anaerobic decomposition of organic matter at the bottom of the lake, leaking septic systems, waterfowl, atmospheric deposition, and/or point source pollution. According to the Illinois General Water Use Standards set forth in Title 35, Subtitle C, Ch. 1, Part 302, phosphorus as "P" should not exceed 0.05 mg/l in any reservoir or lake with a surface area of 8.1 hectares (20 acres) or more. Several discrete in-lake water samples collected at RNC-3, RNC-4, and RNC-9 during the Phase 1 period were in excess of 0.50 mg/l; however, these individual samples did not cause the monthly mean to exceed the water quality standard.

Figure 17 portrays the total phosphorus concentrations for Kinkaid Lake. Phosphorus concentrations during the Phase 1 period ranged from a low of 0.013 mg/l at Site 1 in October to a high of 0.215 mg/l at Site 4 in May. Despite relatively high concentrations, total phosphorous concentrations remained fairly consistent with the historical mean for each site. In general, most dates were within one standard deviation of the historical mean indicating a strong relationship between the two periods of analysis.

Total phosphorus and dissolved phosphorus data failed to meet data quality control criteria or failed to meet data quality objectives for the study period. Please see Appendix A for additional information.

Figure 17. Kinkaid Lake - Monthly Mean Total Phosphorus Comparison for the Phase 1 (2003) and Historical (1985 and 1994) Periods

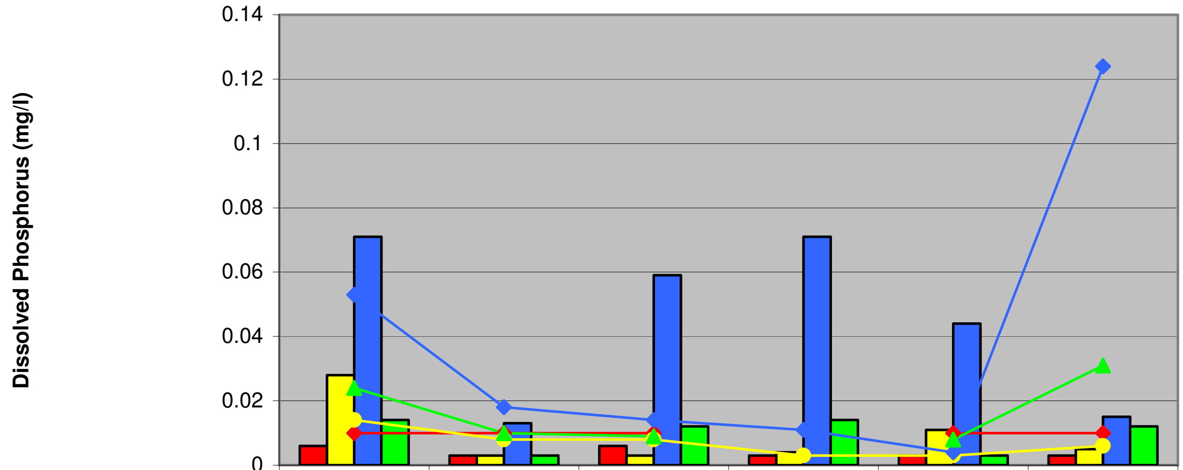


	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	0.021	0.015	0.008	0.013	0.017	0.013
RNC-3 - Phase I	0.072	0.025	0.016	0.019	0.033	0.021
RNC-4 - Phase I	0.215	0.115	0.136	0.105	0.133	0.098
RNC-9 - Phase I	0.035	0.035	0.023	0.029	0.02	0.02
RNC-1 - Historical	0.01	0.01	0.01		0.01	0.02
RNC-3 - Historical	0.034	0.023	0.022	0.032	0.012	0.031
RNC-4 - Historical	0.169	0.129	0.109	0.155	0.068	0.354
RNC-6 - Historical	0.018	0.02	0.01		0.026	0.007

Dissolved phosphorus is generally found in much smaller concentrations than total phosphorus and is readily available for uptake by biotic consumption. For this reason, dissolved phosphorus concentrations are variable and difficult to use as an indicator of nutrient availability. Dissolved phosphorus concentrations for the Phase 1 period ranged from a low of 0.003 mg/l at multiple Sites to a high of 0.071 mg/l at Site 4 in May.

Figure 18 displays the Phase 1 and historical data available for dissolved phosphorus in Kinkaid Lake. In general, dissolved phosphorus concentrations represented approximately 27 to 36% of the total phosphorous at the various Sites. Higher concentrations of dissolved phosphorus can be indicative of their source, which is often anaerobic degeneration of organic matter from lake bottoms (Kothandaraman and Evans, 1983).

Figure 18. Kinkaid Lake - Monthly Mean Dissolved Phosphorus Comparison for the Phase 1 (2003) and Historical (1985 and 1994) Periods



	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	0.006	0.003	0.006	0.003	0.003	0.003
RNC-3 - Phase I	0.028	0.003	0.003	0.004	0.011	0.005
RNC-4 - Phase I	0.071	0.013	0.059	0.071	0.044	0.015
RNC-9 - Phase I	0.014	0.003	0.012	0.014	0.003	0.012
RNC-1 - Historical	0.01	0.01	0.01		0.01	0.01
RNC-3 - Historical	0.014	0.008	0.008	0.003	0.003	0.006
RNC-4 - Historical	0.053	0.018	0.014	0.011	0.004	0.124
RNC-6 - Historical	0.024	0.01	0.009		0.008	0.031

h. Chlorophyll

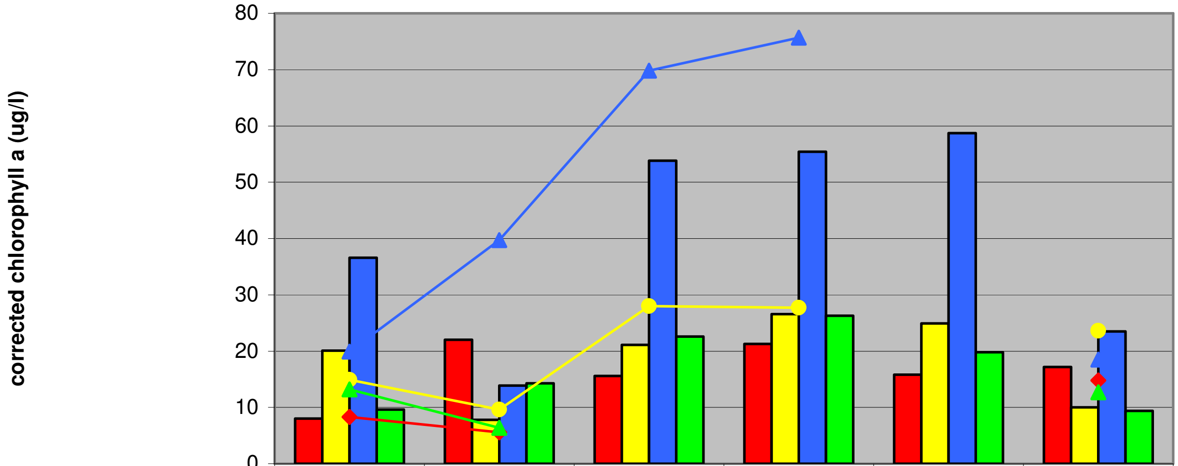
Chlorophyll measurements are commonly made in a lake to estimate the type and amount of algal productivity present in the water column. The chlorophyll a pigment is present in green algae, blue-green algae, and also in diatoms. This photosynthetic pigment is responsible for growth in the species that are typically found in Illinois and can be measured in order to estimate the type and amount of productivity in the water column. Chlorophyll a is often used to indicate the degree of eutrophication in a lake. For example, concentrations of chlorophyll a that exceed 20 µg/l indicate that a lake may be exhibiting eutrophic conditions (Illinois EPA, 1996).

In addition to the chlorophyll a concentrations, chlorophyll b, chlorophyll c, and phaeophytin can also be measured to further estimate the extent of algal diversity and productivity. Chlorophyll b is most common in the green species and serves as an auxiliary pigment for photosynthesis. Chlorophyll c is most common in diatom species and also serves as an auxiliary pigment. Algal productivity and diversity can be estimated by determining the concentrations of each pigment in the sample. For example, since green algal species contain both chlorophyll a and chlorophyll b, higher levels of both a and b may be expected, if green algal species are dominating. Blue-green species contain only chlorophyll a pigments and lack chlorophyll b and c. High concentrations of chlorophyll a only in a particular sample may indicate that blue-green algal species are dominant. Species of diatoms contain both chlorophyll a and chlorophyll c pigments. Higher concentrations of both chlorophyll a and c may indicate that diatom species are dominating. Phaeophytin results from the breakdown of chlorophyll a, and a large amount indicates a stress algal population and recent algal die-off. Phaeophytin has a similar absorption peak in the same spectral region as chlorophyll a. Corrected chlorophyll a values refer to a modified laboratory method necessary to make a correction when phaeophytin concentration becomes significantly high.

The chlorophyll a concentrations during the Phase 1 period ranged from 8 µg/l at Site 1 in May to 58.7 µg/l at Site 4 in September (see Figure 19). The highest concentrations of chlorophyll a occurred from July through September when algal productivity was at its highest levels. Since chlorophyll a concentrations far exceeded chlorophyll b and c concentrations, it was evident that blue-green algae were the dominant algal species (see Table 7).

Chlorophyll data failed to meet data quality control criteria or failed to meet data quality objectives for the study period. Please see Appendix A for additional information.

Figure 19. Kinkaid Lake - Monthly Mean Corrected Chlorophyll a Comparison for the Phase 1 (2003) and Historical (1985 and 1994) Periods



	May	Jun	Jul	Aug	Sep	Oct
RNC-1 - Phase I	8	22	15.6	21.3	15.8	17.2
RNC-3 - Phase I	20.1	7.8	21.1	26.6	24.9	10
RNC-4 - Phase I	36.6	13.9	53.8	55.4	58.7	23.5
RNC-9 - Phase I	9.6	14.3	22.6	26.3	19.8	9.4
RNC-1 - Historical	8.3	5.6				14.8
RNC-3 - Historical	14.9	9.6	28	27.7		23.6
RNC-4 - Historical	19.9	39.7	69.8	75.7		18.5
RNC-6 - Historical	13.2	6.4				12.7

Table 7. Kinkaid Lake - Monthly Mean Chlorophyll Summary for the Phase 1 (2003) and Historical (1985 and 1995) Periods

	chlorophyll a	chlorophyll b	chlorophyll c	phaeophytin
RNC-1 - Phase 1	10.5	0.5	1.2	0.5
RNC-3 - Phase 1	14	0.5	1.7	0.5
RNC-4 - Phase 1	40.3	5.4	9.2	5.6
RNC-9 - Phase 1	13	0.4	1.4	0.4
RNC-1 - Historical	9.6	0.6	3.7	3
RNC-3 - Historical	20.1	2.5	4.3	3.1
RNC-4 - Historical	38.6	9.3	8.6	6.2
RNC-6 - Historical	10.8	0.4	2.8	2

All results reported in µg/l (ppb).

i. Dissolved Oxygen and Temperature

According to the Illinois General Use Water Quality Standards, dissolved oxygen concentrations should not fall below 5.0 mg/l and should be at least 6.0 mg/l during 16 hours of any 24-hour period. Most aquatic organisms, including fish, require adequate concentrations of dissolved oxygen in the water column in order to survive. In temperate lakes with sufficient water depth (i.e., generally greater than 1.8 to 2.4 meters (6.0 to 8.0 ft)), there is a seasonal variation in temperature throughout the water column.

As air temperatures rise in early spring, the upper layers of water warm up and mix with the colder water below as a result of wind and rain. Gradually, this mixing process diminishes and the lake begins to thermally stratify or separate into distinctly different layers. The upper layer of warmer water is known as the epilimnion and is separated from the lower cooler layer or hypolimnion, by a transition zone known as the thermocline, where a rapid change in temperature generally occurs. The most important aspect of thermal stratification in relation to lake eutrophication is the summer stratification period when the hypolimnion becomes anaerobic or devoid of dissolved oxygen due to the increase in highly oxidizable material and the extended isolation from the atmosphere. When dissolved oxygen levels remain consistently below 5.0 mg/l and approach 0.0 mg/l, the conditions for chemical reduction become more favorable and the nutrient rich bottom sediments begin releasing nutrients such as ammonia and phosphorus, and minerals such as iron, manganese, and copper to the overlying waters.

During the Phase 1 sampling period, dissolved oxygen (DO) concentrations and temperature profiles were developed for Sites 1 and 3. Due to the wide array of hydraulic conditions within Kinkaid Lake, DO/Temp profiles were developed for these sites based on their more lacustrine-limnetic conditions of Site 1 and more riverine conditions of Site 3. Dissolved oxygen is an important component for respiration of aquatic life and thus is important for the overall health of the lake. Sources of oxygen can include inflow from tributaries, exchange with the atmosphere, and photosynthetic activity by aquatic plants and phytoplankton. Oxygen consumption on the other hand, can deplete valuable oxygen from the water column. Sources of oxygen consumption may include outflow, such as water discharge from the lake, respiration by fish and other oxygen consuming organisms, and biological consumption, such as the decomposition of dead plant and animal material.

Dissolved oxygen and temperature data for Sites 1, 2, 3, and 4 are located in the Appendix C. Isopleth charts developed for dissolved oxygen in mg/l (ppm) and temperature (degrees Centigrade) (Figures 20A and 20B and 21A and 21B) reflect the seasonal variations for Sites 1 and 3 during the 2003-2004 Phase 1 monitoring period.

Dissolved oxygen levels for Sites 1 and 3 ranged from a high of 8.0 mg/l near the surface to a low of 0.2 mg/l near the bottom during the summer months. Deeper locations display extended periods of depleted oxygen levels below a depth of 4.5 m (15 ft.) indicating anaerobic conditions (DO less than 1.0 mg/l) between the months of June and September. The other in-lake sampling sites also contained low dissolved oxygen concentrations throughout the Phase 1 monitoring period. This condition normally occurs due to a high oxygen demand as a result of decomposing material in the nutrient rich sediment. Thermal stratification began in late May as indicated by a decrease in DO and temperature per foot of water depth, and remained stratified until late September.

Figure 20-A – Dissolved Oxygen Isopleth (mg/L) for Kinkaid Lake-Site 1

Figure 20-B–Temperature Isopleth(°C) for Kinkaid Lake-Site 1

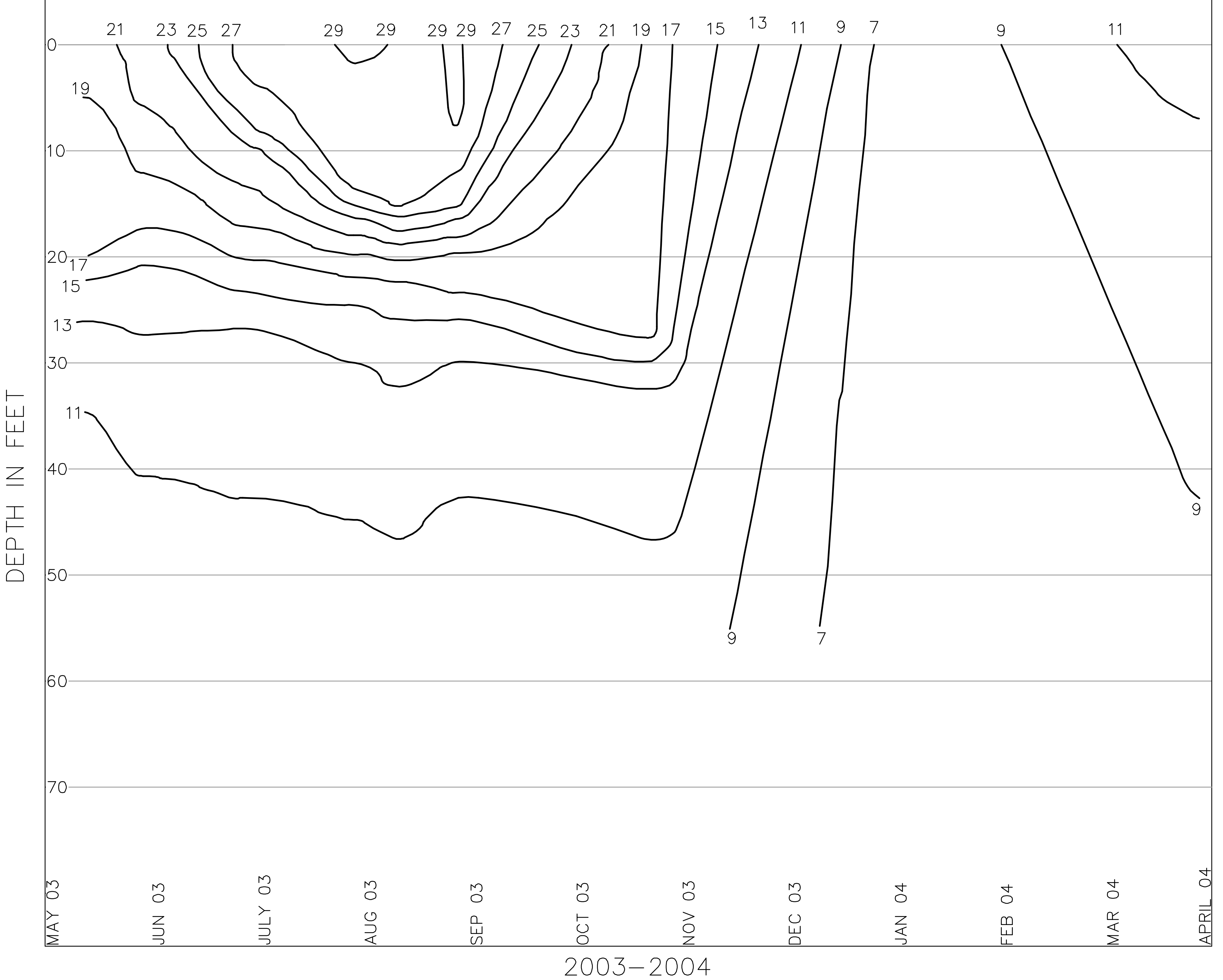


Figure 21-A – Dissolved Oxygen Isopleth (mg/L) for Kinkaid Lake-Site 3

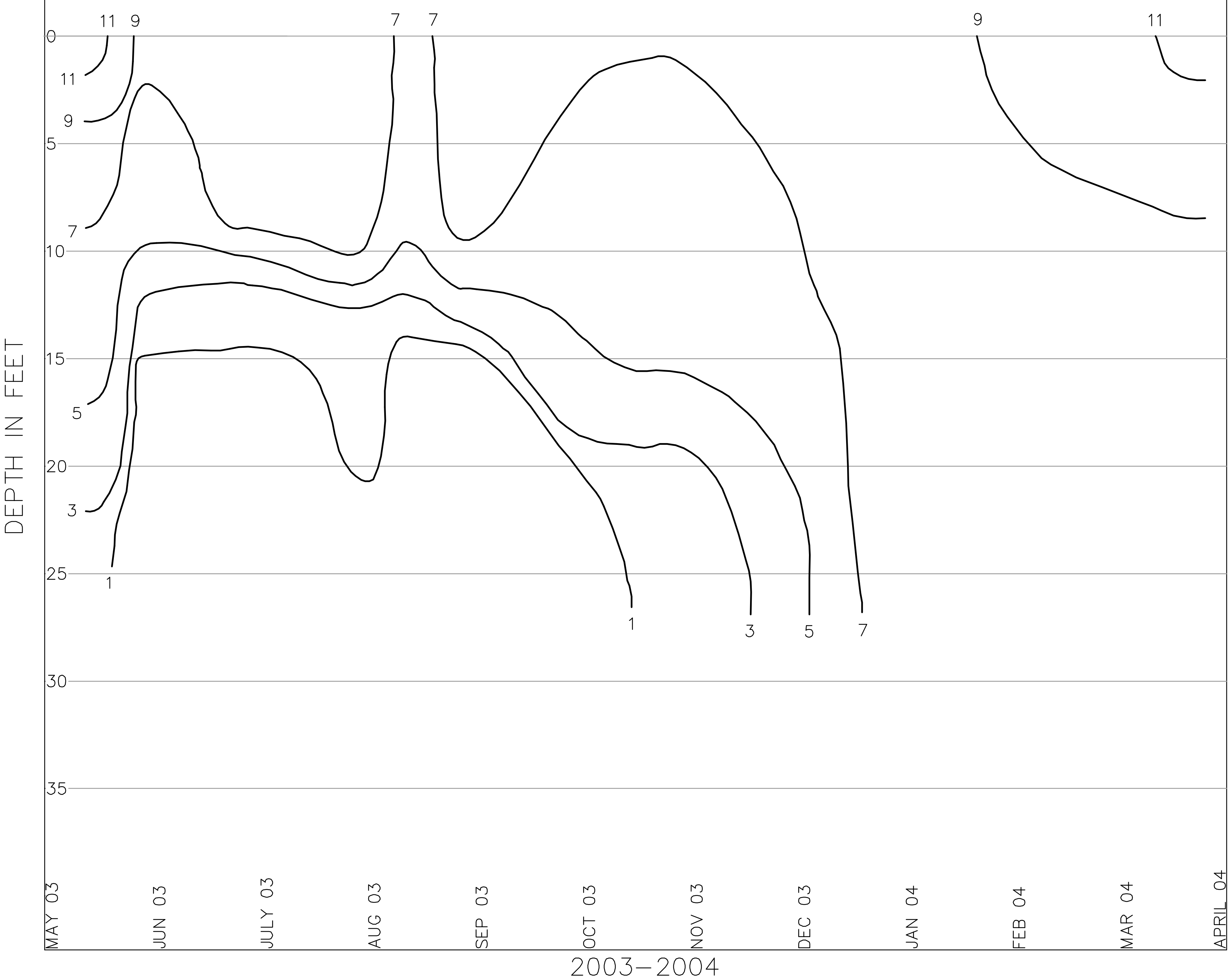
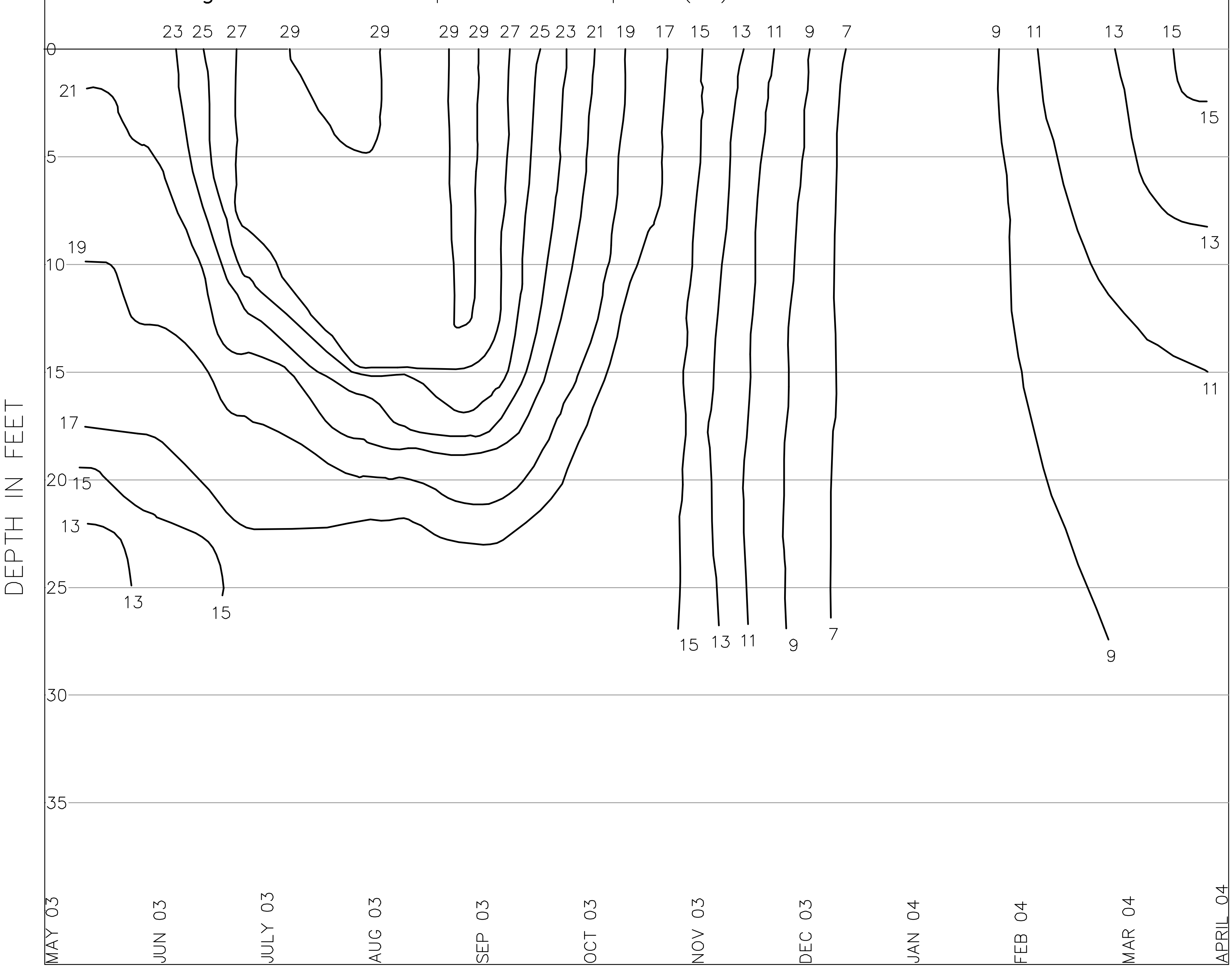


Figure 21-B–Temperature Isopleth(°C) for Kinkaid Lake-Site 3



2. Trophic Condition

The physical, chemical, and biological data obtained from baseline sampling are used to quantitatively describe the degree of eutrophication, or the trophic state, through the calculation of an index number. The trophic state index (TSI) number for the lake is of great value to the consultant, lake manager, and the user population. An index number, when properly interpreted, allows comparison of the existing condition of the lake with that of the past. Carlson (1977) has developed a useful trophic state index for lakes with algal turbidity and minimal aquatic vegetation (Table 8). This index is based on the amount of algal biomass in surface water, using a scale of 0 to 100. The scale uses a log transformation of Secchi disk transparency values as a measure of algal biomass. However, the accuracy of Carlson's index may vary as a result of water coloration or suspended materials other than algae. Since chlorophyll and total phosphorus concentrations are often correlated with transparency, an index number can also be calculated from these parameters. Table 8 lists the TSI numbers from 0 to 100 with the associated Secchi transparency depths, surface phosphorus and chlorophyll a concentrations.

Table 8 - Carlson's Completed Trophic State Index

TSI	Secchi Depth (m)	Secchi Depth (ft)	Surface Phos. (mg/m3)	Surface Chloro. (mg/m3)
0	64	220	0.75	0.04
10	32	106	1.5	0.12
20	16	52.5	3	0.34
30	8	26	6	0.94
40	4	13	12	2.6
50	2	6.6	24	6.4
60	1	3.3 (39")	48	20
70	0.5	1.6 (20")	96	56
80	0.25	0.8 (10")	192	154
90	0.13	0.4 (5")	384	427
100	0.06	0.2 (2.5")	768	1,183

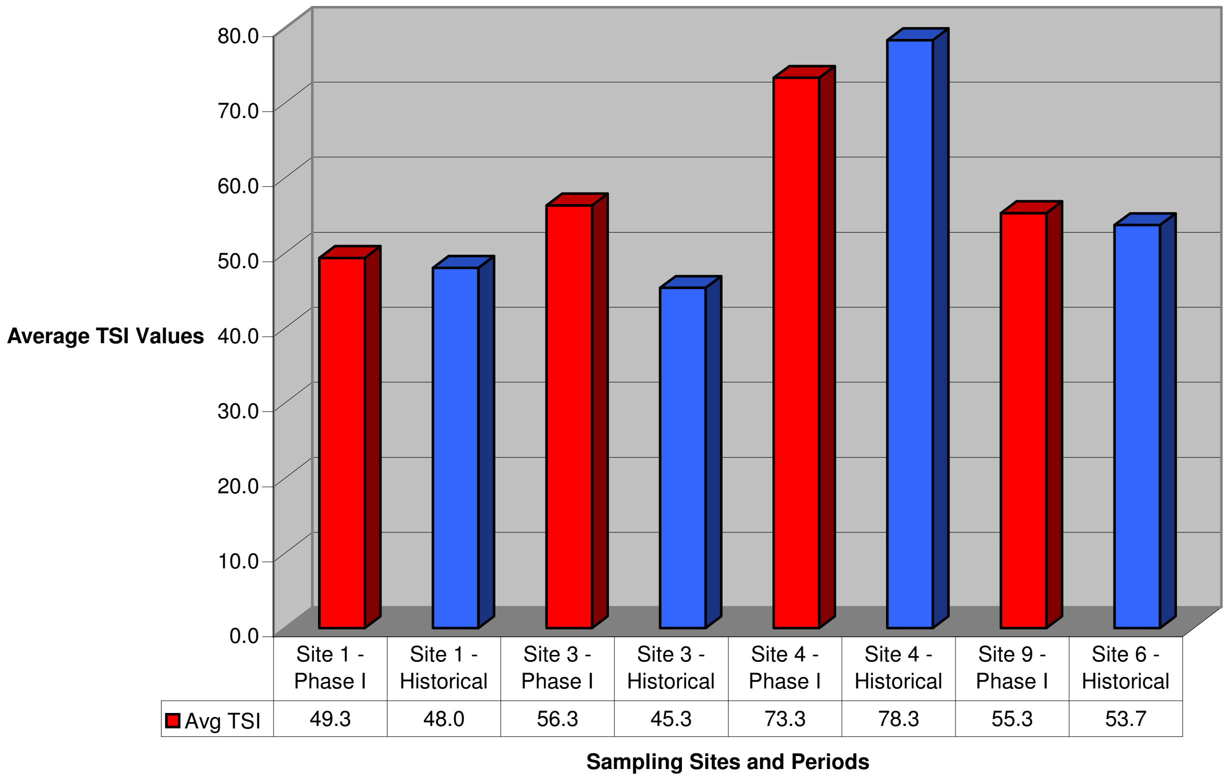
Source: Carlson, 1977

The trophic condition of Kinkaid Lake for each sampling site has been calculated according to the Trophic State Index (TSI) developed by Carlson as shown above. Trophic state indices include mean Secchi disk transparency, total surface phosphorus and Chlorophyll a concentrations for Site 1, Site 2, Site 3, and Site 4 during the Phase 1 monitoring period (2003-04) and historical data from 1985 and 1994. Historical data was based on data obtained from the USEPA STORET website. The calculated mean TSI values for Sites 1 through 4 are shown in the following Table 9 and graphically represented in Figure 22.

Table 9 – Monthly Mean TSI Values for Kinkaid Lake for the Phase 1 (2003) and Historical (1985 and 1995) Periods

		Secchi TSI	**Total Phos TSI**	**Chloro a TSI**
Phase 1	Site 1	55	40	53
	Site 3	62	51	56
	Site 4	78	75	67
	Site 9	60	51	55
Historical	Site 1	51	40	53
	Site 3	60	54	22
	Site 4	81	88	66
	Site 6	63	45	53

Figure 22. Calculated TSI Comparison for Kinkaid Lake for the Phase 1 (2003) and Historical (1985 and 1994) Periods



According to the Lake Assessment Criteria as listed in the 1994-95 Illinois Water Quality Report (Carlson, 1977), lakes having a mean Trophic State Index (TSI) greater than 50.0 and less than 70.0 are characterized as being eutrophic. Since the average TSI values during the Phase 1 sampling period for Sites 1, 3, 5, and 9 were 49.3, 56.3, 73.3, and 55.3, respectively, Kinkaid Lake can be characterized as being moderately eutrophic. Generally, the Phase 1 mean TSI indices were similar to the historical TSI values (Table 9), which may indicate that algal productivity has remained static.

3. Limiting Algal Nutrient

The weight to volume ratio of total nitrogen (mg/l) to total phosphorus (mg/l) is often used to determine which nutrient is limiting algal growth in a lake or reservoir. Since the nitrogen to phosphorus ratio (by weight in mg/l) in algal cell tissue is typically

7 to 1, it is assumed that when the ratio of total nitrogen (mg/l) to total phosphorus (mg/l) is greater than 10 to 1, phosphorus is generally the limiting nutrient (Horne, 1994). When ratios are less than 10 to 1, nitrogen is generally the limiting nutrient. Figure 23 graphically represents the mean total nitrogen (Total N) to total phosphorus (Total P) ratio for Sites 1, 3, 4, and 9 during the Phase 1 sampling period. The total nitrogen to total phosphorus ratios for Kinkaid Lake during the Phase 1 monitoring year are shown in Table 10. The mean TN to TP ratios for Sites 1, 3, and 9 during the Phase 1 monitoring year exceeded 30 to 1, and Site 4 had a ratio of 18. The total nitrogen-total phosphorus ratio indicates that Kinkaid Lake can be considered a phosphorus-limited lake.

Figure 23. Comparison of Phase 1 (2003) Monthly Mean TN to TP Ratios for Kinkaid Lake

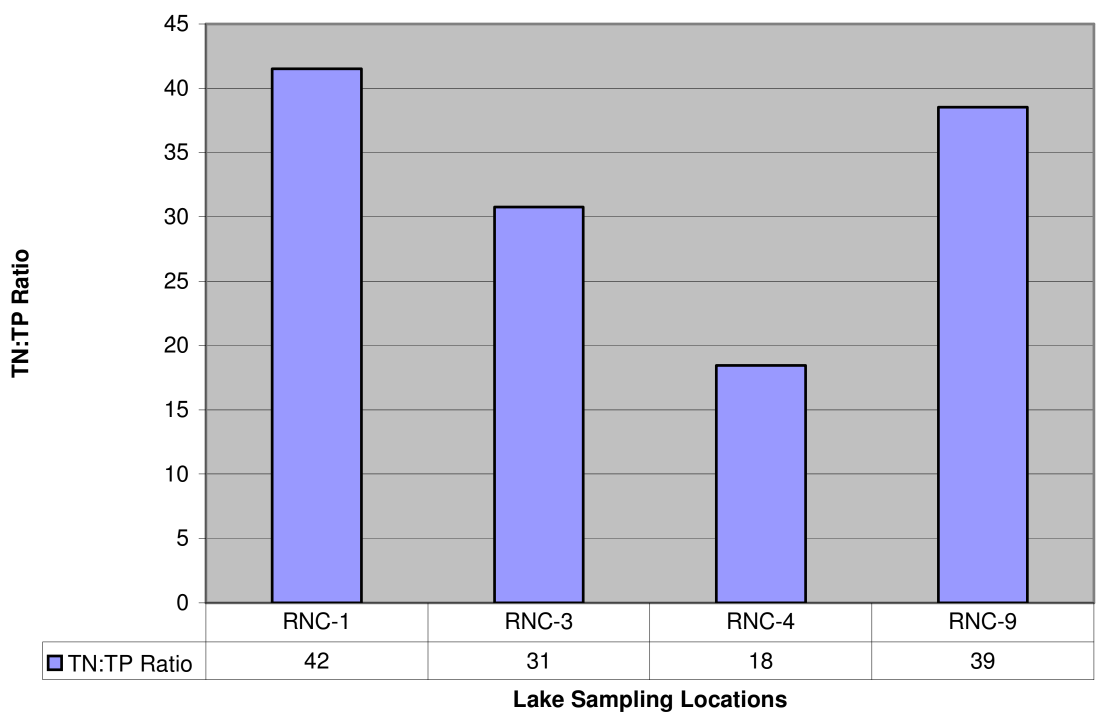


Table 10 – Kinkaid Lake Nitrogen to Phosphorus Ratios for the Phase 1 (2003) Period

Monitoring Site	Sample Date	TKN mg/l	NO2-NO3 mg/l	T Nitrogen mg/l	TPhos mg/l	TN : TP Ratio
RNC-1	05/28/03	0.67	0.01	0.68	0.033	21
RNC-1	06/25/03	0.06	<0.01	0.06	0.015	4
RNC-1	07/08/03	0.51	<0.01	0.51	0.010	51
RNC-1	07/30/03	0.64	<0.01	0.64	0.012	53
RNC-1	08/12/03	0.76	<0.01	0.76	0.010	76
RNC-1	08/26/03	0.68	<0.01	0.68	0.010	68
RNC-1	08/28/03	0.59	<0.01	0.59	0.019	31
RNC-1	09/16/03	0.14	<0.01	0.14	0.017	8
RNC-1	10/15/03	0.56	<0.01	0.56	0.009	62
RNC-1	10/23/03	0.14	<0.01	0.14	0.017	8
RNC-1	11/29/03	0.83	0.05	0.88	0.011	80
RNC-1	12/30/03	0.04	0.39	0.44	0.012	36
RNC-3	05/28/03	0.90	0.02	0.92	0.072	13
RNC-3	06/25/03	0.74	<0.01	0.74	0.025	30
RNC-3	07/08/03	0.69	<0.01	0.69	0.034	20
RNC-3	07/29/03	0.54	<0.01	0.54	0.010	54
RNC-3	07/30/03	0.79	<0.01	0.79	0.021	38
RNC-3	08/12/03	0.92	<0.01	0.92	0.018	51
RNC-3	08/26/03	0.78	<0.01	0.78	0.020	39
RNC-3	08/28/03	0.11	<0.01	0.11	0.020	6
RNC-3	09/16/03	0.57	<0.01	0.57	0.033	17
RNC-3	10/15/03	0.73	<0.01	0.73	0.021	35
RNC-3	10/23/03	0.21	0.03	0.24	0.020	12
RNC-3	11/29/03	0.95	0.15	1.10	0.021	52
RNC-3	12/30/03	0.60	0.34	0.94	0.028	34
RNC-4	05/28/03	1.60	0.47	2.07	0.215	10
RNC-4	06/25/03	1.72	<0.01	1.72	0.115	15
RNC-4	07/08/03	1.05	0.02	1.07	0.136	8
RNC-4	07/29/03	1.27	<0.01	1.27	0.149	9
RNC-4	07/30/03	1.03	<0.01	1.03	0.124	8
RNC-4	08/12/03	1.63	0.01	1.64	0.021	78
RNC-4	08/26/03	1.14	0.04	1.18	0.150	8
RNC-4	08/28/03	5.33	<0.01	5.33	0.143	37
RNC-4	09/16/03	1.36	0.04	1.40	0.133	11
RNC-4	10/15/03	0.91	<0.01	0.91	0.085	11
RNC-4	10/23/03	0.36	0.01	0.37	0.091	4
RNC-4	11/29/03	1.42	0.29	1.71	0.073	23
RNC-9	05/28/03	0.010	0.57	0.58	0.035	17
RNC-9	06/25/03	0.020	1.02	1.04	0.035	30
RNC-9	07/08/03	0.020	0.69	0.71	0.032	22
RNC-9	07/29/03	0.030	0.41	0.44	0.010	44
RNC-9	07/30/03	0.010	0.47	0.48	0.028	17
RNC-9	08/12/03	0.010	1.09	1.10	0.024	46
RNC-9	08/26/03	0.010	0.84	0.85	0.020	42
RNC-9	08/28/03	0.010	5.86	5.87	0.044	133
RNC-9	09/16/03	0.050	0.59	0.64	0.020	32
RNC-9	10/15/03	0.050	0.64	0.69	0.021	33
RNC-9	10/23/03	0.010	0.16	0.17	0.018	9
RNC-9	11/29/03	0.160	0.67	0.83	0.022	38
RNC-9	12/30/03	0.150	0.51	0.66	0.012	55
RNC-9	01/12/04	0.040	0.48	0.52	0.025	21

4. Sediment Quality and Sedimentation

a. Chemical Characteristics

Composite grab samples were collected at Site 1 and Site 4 during the Phase 1 monitoring period, and lake sediment samples were analyzed for metals and organics in the sediment. The Phase 1 sampling period results for metals and organics for Site 1 and Site 4 are listed in Tables 11 and 12. Most of the parameters at Site 1 and Site 4 (see Tables 11 and 12) were found to be within the low to normal range for Illinois lake sediment (Table 13). However, a few inorganic and metal parameters at Site 1 (i.e., total phosphorus, arsenic, manganese, silver, and barium) were slightly elevated. Laboratory analyses of the sediment cores indicate that the lake sediment is non-hazardous and would not require disposal in a special hazardous facility if any sediment were to be removed.

Table 11. Kinkaid Lake - Phase 1 (2003) Sediment Grab Analysis for Metals

	Units	**RNC-1**	**RNC-4**
Phosphorus-P	mg/kg	1,300	508
TOC	mg/kg	0.48	0.20
Kjeldahl-N	mg/kg	3,800	1,300
% Solids	%	20.3	68.5
Soilds, Vol	mg/kg	10.5	2.4
Mercury	mg/kg	<0.1	<0.1
Potassium	mg/kg	1,200	370
Barium	mg/kg	340	54
Cadmium	mg/kg	<0.5	<0.5
Chromium	mg/kg	17	6.6
Copper	mg/kg	23	6.2
Iron	mg/kg	28,000	9,400
Lead	mg/kg	18	7.7
Manganese	mg/kg	6,400	400
Nickel	mg/kg	25	8.6
Silver	mg/kg	<2.9	<0.5
Zinc	mg/kg	65	25
Arsenic	mg/kg	20	4.7

Table 12. Kinkaid Lake - Phase 1 (2003) Sediment Core Analysis for Organics

	Units	**RNC-1**	**RNC-4**
Total PCBs	µg/kg	<10	<10
Hexachlorobenzene	µg/kg	<1	<1
Trifluralin	µg/kg	<10	<10
Alpha-BHC	µg/kg	<1	<1
Gamma-BHC (Lindane)	µg/kg	<1	<1
Atrazine	µg/kg	<50	<50
Heptachlor	µg/kg	<1	<1
Aldrin	µg/kg	<1	<1
Alachlor	µg/kg	<10	<10
Metribuzin	µg/kg	<10	<10
Metolachlor	µg/kg	<25	<25
Heptachlor Epoxide	µg/kg	<1	<1
Pendimethalin	µg/kg	<10	<10
Gamma-Chlordane	µg/kg	<2	<2
Alpha-Chlordane	µg/kg	<2	<2
Total Alpha and Gamma Chlordane	µg/kg	<5	<5
Dieldrin	µg/kg	<1	<1
Captan	µg/kg	<10	<10
Cyanazine	µg/kg	<25	<25
Endrin	µg/kg	<1	<1
P,P'-DDE	µg/kg	<1	<1
P,P'-DDD	µg/kg	<1	<1
P,P'-DDT	µg/kg	<1	<1
Total DDT	µg/kg	<10	<10
Methoxychlor	µg/kg	<5	<5
Acetochlor	µg/kg	<25	<25

Table 13. Classification of Illinois Lake Sediment

Parameter	Unit	Low	Normal	Elevated	Highly Elevated
PCB's	ug/kg	n/a	less than 10	10 to <89	89 or greater
Aldrin	ug/kg	n/a	less than 10	1 to <1.2	1.2 or greater
Diedrin	ug/kg	n/a	less than 3.4	3.4 to <15	15 or greater
DDT	ug/kg	n/a	less than 10	10 to 180	180 or greater
Chlordane	ug/kg	n/a	less than 5	5 to 12	12 or greater
Endrin	ug/kg	n/a	less than 1	n/a	1 or greater
Methoxychlor	ug/kg	n/a	less than 5	n/a	5 or greater
alpha-BHC	ug/kg	n/a	less than 1	n/a	1 or greater
gamma-BHC	ug/kg	n/a	less than 2	n/a	1 or greater
HCB	ug/kg	n/a	less than 3	n/a	1 or greater
Heptachlor Epoxide	ug/kg	n/a	less than 4	1 to <1.6	1.6 or greater
Phosphorus	mg/kg	less than 394	394 to <1115	1115 to <2179	2179 or greater
Total Kjeldahl Nitrogen	mg/kg	less than 1300	1300 to <5357	5357 to <11700	11700 or greater
Cadmium	mg/kg	n/a	less than 5	5 to <14	14 or greater
Copper	mg/kg	less than 16.7	16.7 to <100	100 to <590	590 or greater
Lead	mg/kg	less than 14	14 to <59	59 to <339	339 or greater
Mercury	mg/kg	n/a	less than 0.15	0.15 to <0.701	0.701 or greater
Cyanide	mg/kg	n/a	n/a	n/a	n/a
Arsenic	mg/kg	less than 4.1	4.1 to <14	14 to <95.5	95.5 or greater
Chromium	mg/kg	less than 13	13 to <27	27 to <49	49 or greater
Iron	mg/kg	less than 16000	16000 to <37000	37000 to <56000	56000 or greater
Manganese	mg/kg	less than 500	500 to <1700	1700 to <5500	5500 or greater
Zinc	mg/kg	less than 59	59 to <145	145 to <1100	1100 or greater
Nickel	mg/kg	less than 14.3	14.3 to <31	31 to 43	43 or greater
Silver	mg/kg	n/a	less than 0.1	0.1 to <1	1 or greater
Potassium	mg/kg	less than 410	410 to <2100	2100 to <2797	2797 or greater
Barium	mg/kg	less than 94	94 to <271	271 to <397	397 or greater

Source: Mitzlefelt, 1996

b. Sedimentation

Erosion and sedimentation are natural geophysical processes that allow fine-grained silts, clays, and detritus to be delivered to lakes and reservoirs. Sedimentation can lead to a significant loss of original water depth and may be considered detrimental if allowed to progress. The average rate of reservoir capacity loss in Illinois has been reported to be approximately 0.6 percent per year (Roseboom et al., 1979). Lakes and reservoirs often act as sediment traps and are capable of trapping as much as 90 percent of the sediments that are carried from agricultural fields and unprotected construction sites. In addition to causing a loss in water depth and storage capacity, accumulated sediments can contribute to internal nutrient recycling from resuspension and/or anaerobic decomposition.

In 2002, Cochran & Wilken, Inc. conducted a lake sedimentation survey in the upper portion of the lake to determine the impact of accumulated sediment near the State Route 151 bridge area (sub-areas A through D) and in 2003, additional survey work was completed throughout select bays in the lake (sub-areas E through M) that included Sharp Rock Falls, Hidden Neck, Cochran Bay, Harris Bay, Levan Bay, Reiman Neck, Graff Bay, Reiman Bay, and Imhoff Neck. The sedimentation survey sub-areas were divided into segments. Figure 24 illustrates the approximate locations of the various sub-areas within the sedimentation survey. Cross-sections of each segment within the survey were located by global positioning systems (GPS) and are provided in Appendix D.

In the area located west of State Route 151, several cross-sections were obtained. Due to excessive sedimentation, much of this area is essentially dry land. In order to quantify the sediment deposited in this area, the contour mapping of the original lakebed was used to compliment the information available from the cross-sections. The contour mapping was originally prepared by the State of Illinois, Department of Public Works and Buildings, Division of Waterways in 1971 and was obtained from the Kinkaid-Reed's Creek Conservancy office. The sedimentation survey proceeded down stream into the lake and was terminated at the east end of the bay located east of the Johnson Creek beach, at the point which the lake narrows between two large rock outcroppings. At this point, the water depth was approximately ten feet, and the sediment depth had tapered to 3.0 feet.

Water depth measurements were located horizontally in terms of X-Y coordinates using the global position system (GPS) unit. Actual water depths (Z-coordinates) were determined using a flat steel disk of eight-inch diameter, suspended by a flexible line, which was measured after each depth determination by steel tape. This method allowed accurate water depth determination over soft bottom materials, as the flat disk comes to rest on the sediment surface, rather that penetrating the material.

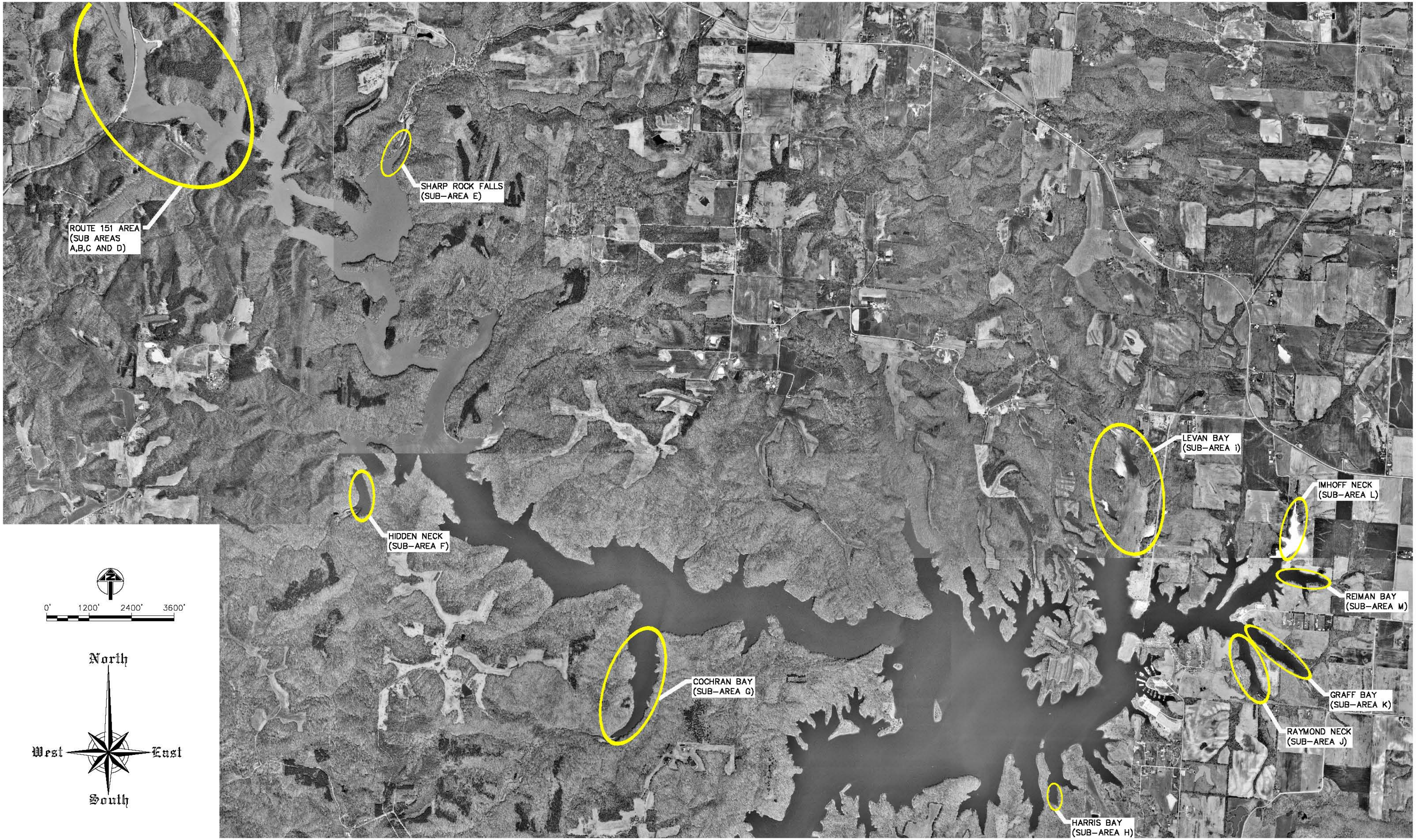


Figure 24– Sediment Survey Location Map (Detailed Sedimentation Survey Cross-sections provided in Appendix D)

After the water depth was determined at each point, the sediment depth was also measured and recorded. Sediment depths were determined using a one-inch diameter aluminum range pole. The range pole was pushed through the soft sediment until the hard, original lake bottom was reached. The total length of pole at the water surface was then determined, and this length, less the water depth, yielded the actual sediment depth at the respective points.

The data from the soundings of the lake bottom were then plotted as cross-sections so that a profile of the existing sediment and the original lake bottom could be developed. The average end-area-method was applied to each of the cross sections to calculate the quantity of accumulated sediment and remaining water volume. To this information was added the volume calculated for the area west of State Route 151 as referenced above, with the summation representing the volume of sediment accumulated in the lake in the study area. The results of the sedimentation surveys are presented in Table 14.

Table 14. Kinkaid Lake - 2002 Sedimentation Survey Summary

Lake Segment	Original Capacity (cubic yards of water)	Existing Capacity (cubic yards of water)	Amount of Sediment (cubic yards)	Percent of Capacity Loss
1	42,013	19,443	22,570	53.7%
2	27,767	13,962	13,807	49.7%
3	3,688	2,569	1,119	30.3%
Subtotal A	**73,468**	**35,974**	**37,496**	**51.0%**
4	37,186	15,036	22,150	59.6%
5	27,272	12,076	15,196	55.7%
6	72,001	31,844	40,157	55.8%
7	118,508	50,776	67,732	57.2%
8	124,844	67,415	57,429	46.0%
9	107,599	69,057	38,542	35.8%
10	86,390	58,816	27,574	31.9%
Subtotal B	**573,800**	**305,020**	**268,780**	**46.8%**
Subtotal C	**459,296**	**291,392**	**167,904**	**36.6%**
Subtotal D	**629,561**	**142,375**	**487,186**	**77.4%**
11	2,639	822	1,817	68.9%
12	7,366	3,088	4,278	58.1%
13	7,647	3,556	4,091	53.5%
Subtotal E	**17,652**	**7,466**	**10,186**	**57.7%**
14	11,527	4,765	6,763	58.7%
15	36,482	19,899	16,584	45.5%
16	53,034	36,999	16,036	30.2%
Subtotal F	**101,043**	**61,663**	**39,383**	**39.0%**
17	6,156	2,283	3,873	62.9%
18	13,924	6,093	7,831	56.2%
19	20,964	14,462	6,502	31.0%
Subtotal G	**41,044**	**22,838**	**18,206**	**44.4%**
20	2,927	1,287	1,640	56.0%
21	15,657	11,072	4,585	29.3%
Subtotal H	**18,584**	**12,359**	**6,225**	**33.5%**
22	37,500	16,933	20,567	54.8%
23	57,655	35,127	22,528	39.1%
24	73,000	54,460	18,540	25.4%
Subtotal I	**168,155**	**106,520**	**61,635**	**36.7%**
25	3,680	1,247	2,433	66.1%
26	17,774	9,205	8,569	48.2%
27	11,921	8,147	3,775	31.7%
Subtotal J	**33,375**	**18,599**	**14,777**	**44.3%**
28	2,969	1,102	1,867	62.9%
29	25,778	14,037	11,741	45.5%
30	43,844	32,951	10,893	24.8%
Subtotal K	**72,591**	**48,090**	**24,501**	**33.8%**
31	5,853	1,999	3,854	65.8%
32	8,491	4,398	4,092	48.2%
33	8,617	5,785	2,831	32.9%
Subtotal L	**22,961**	**12,182**	**10,777**	**46.9%**
34	5,500	2,885	2,615	47.5%
35	20,060	13,580	6,480	32.3%
36	18,670	14,796	3,874	20.7%
Subtotal M	**44,230**	**31,261**	**12,969**	**29.3%**
Total *	**2,255,760**	**1,095,739**	**1,160,025**	**51.4%**

* Note: The deepest areas of the lake were not included in the sediment survey results since water depths were generally greater and sediment deposits were not considered to be problematic to recreational access.

For those sub-areas of the lake that were surveyed, approximately 1,160,025 cubic yards of sediment have been deposited, which represents approximately a 51 percent water storage capacity loss (for those sub-areas surveyed) over the 35-year life of the lake. This would suggest that an average of approximately 33,144 cubic yards of sediment have been deposited in these surveyed areas on an annual basis.

c. Shoreline Erosion

In 2003, Cochran & Wilken, Inc. staff completed a shoreline erosion survey of Kinkaid Lake in order to determine the extent of its contribution to lake water degradation. Shoreline erosion impairs lake usage and access by adding turbidity and decreasing storage capacity. The loss of shoreline soils may also jeopardize the stability of infrastructure such as bridges, roads, docks, etc. In addition, shoreline loss reduces the overall aesthetic appeal of the lake.

The methodologies used during the survey rated erosion severity by vertical measurements of the eroded zones. An estimate was made to determine the horizontal length of each eroded zone and a vertical measurement was recorded and applied to the following criteria: bank heights of less than 1 foot were classified as having no erosion; bank heights of 1 to 3 feet were classified as having slight erosion; bank heights greater than 3 feet and less than 8 feet were classified as having moderate erosion; and bank heights greater than 8 feet were classified as having severe erosion.

An estimated 65,310 meters (214,271 feet) of the 132,058 meters (433,260 feet) of shoreline was classified as eroded during the 2003 survey. The largest classification of eroded shoreline was 35,759 meters (117,321 feet) of slight shoreline erosion, which represented 54.8% of the total eroded shoreline length. Moderate shoreline erosion accounted for 25,033 meters (82,128 feet) or 38.3% of the total eroded shoreline and severe erosion made up 6.9% of the total eroded shoreline with 4,518 meters (14,822 feet).

An estimated 410,772 cubic yards of soil has eroded from the shoreline of Kinkaid Lake. This estimated loading was calculated by extending the eroded bank into the lake at a projected slope of 3:1 (3 foot horizontal to 1 foot vertical) to form a typical triangular end area. Then, the length of the eroded shoreline in linear feet was multiplied by the projected end area for each degree of classification of erosion. The eroded shoreline length totaled approximately 554,542.9 tons (503,072,811 kg) of delivered soil to Kinkaid Lake. The total tons of delivered soil were calculated using a dry unit weight of 100 pounds per cubic-ft.

From 1996-2001, riprap has been placed along the shoreline in several locations in an attempt to stabilize the shoreline and reduce erosion (see Figures 25A and 25B). Most of these locations were considered to be successful stabilization measures. In addition to the general observations and measurements, areas in greatest need of remediation were documented and photographed (Appendix D). Shoreline erosion is most commonly attributed to wave action from boats and strong winds.

5. Hydrologic Budget

A hydrologic budget was developed in order to account for the total inflow and outflow of water for the Kinkaid Lake system during the Phase 1 (2003-04) monitoring period. The budget accounts for the inflows from the tributaries entering the lake, total precipitation to the watershed, direct precipitation to the lake, as well as outflows consisting of evaporation, water withdrawals for the public water supply, and flow over the spillway. The hydrologic budget is a critical component and the basis for developing subsequent sediment and nutrient budgets. In general, the lake hydrologic budget for the Kinkaid Lake system was calculated assuming the following formula:

Change in Storage Capacity = Inflows – Outflows *

* Unaccounted flows are assumed to be caused from fluctuations in the groundwater inflows and outflows.

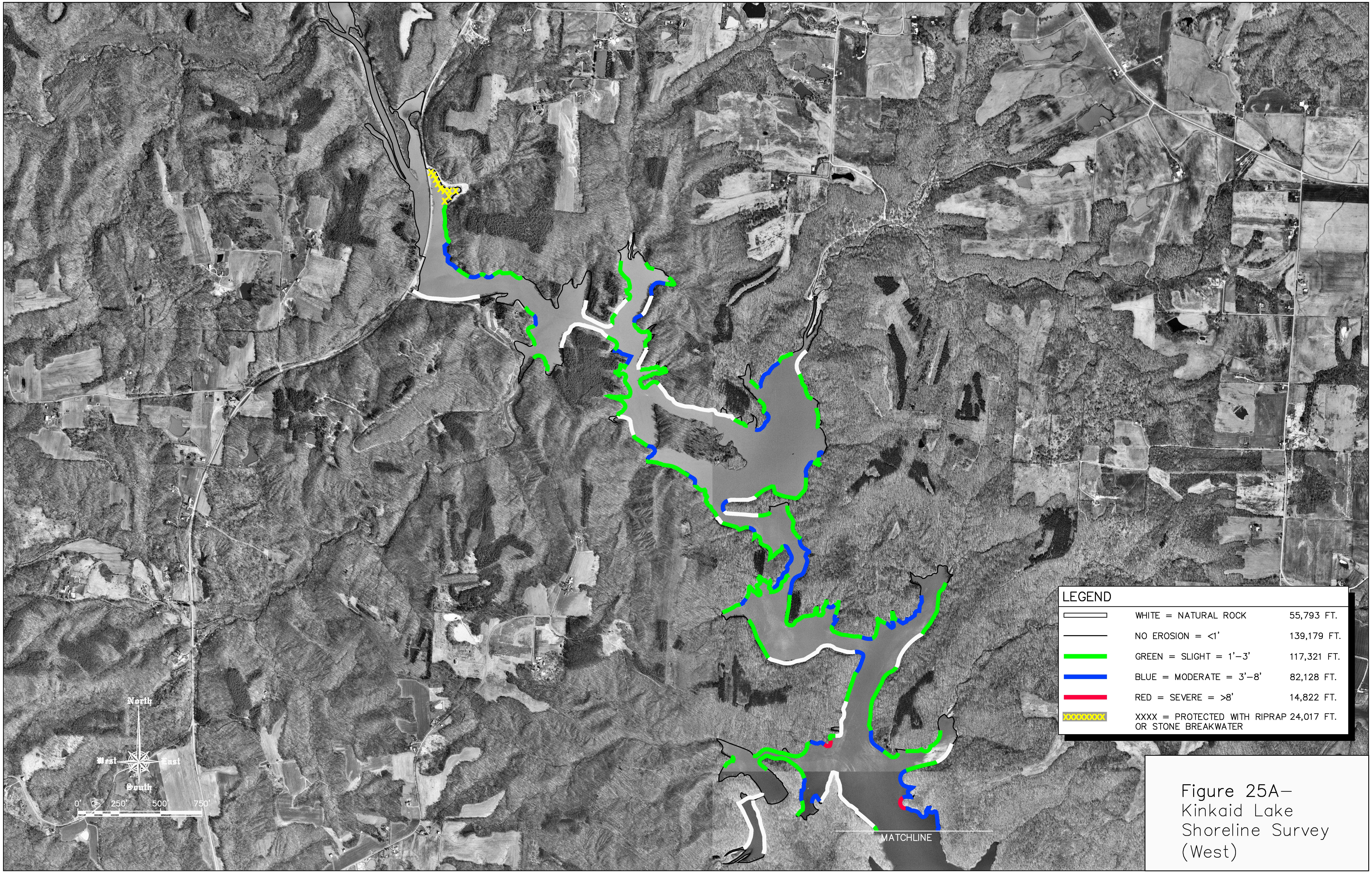


Figure 25A—
Kinkaid Lake
Shoreline Survey
(West)

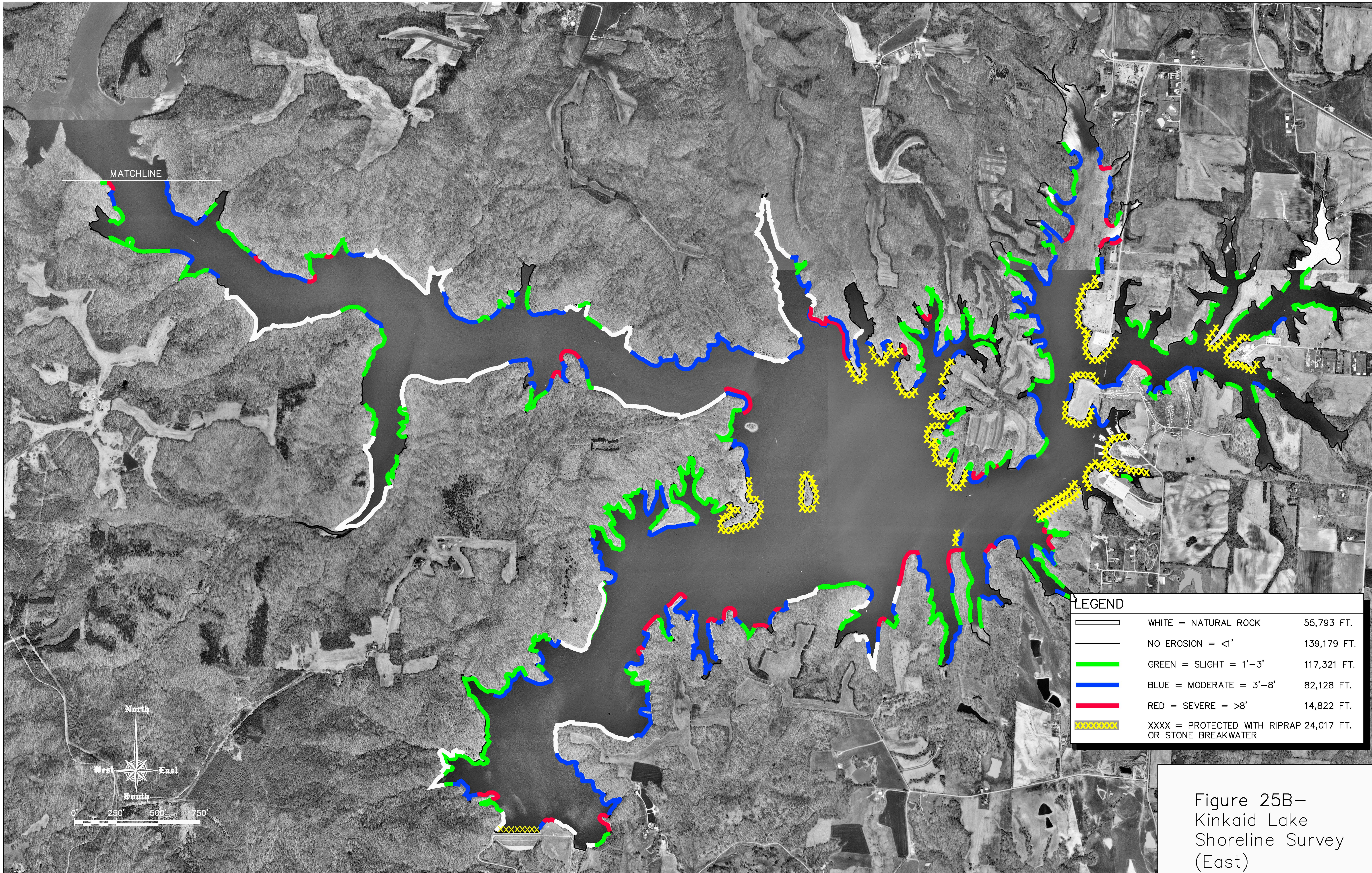


Figure 25B—
Kinkaid Lake
Shoreline Survey
(East)

The hydrologic budget was developed by using daily precipitation readings collected at the water plant and the daily water level (discharge) readings collected over the weir at the spillway located near the dam. The daily spillway outfall readings were used with the dam's spillway-rating curve to develop daily lake discharges. The daily spillway discharges and daily precipitation readings were found to occur at more regular intervals and to be more reliable and accurate in developing the hydrologic budget than the dozen or less flow measurements collected during the Phase 1 (2003-04) monitoring period.

Daily and monthly precipitation (rainfall) readings were applied to the lake and to the entire watershed, and runoff coefficients and sediment delivery ratios were used to model and predict the potential watershed inflows to the lake. Monthly evaporation rates and average monthly pumping rates at the water plant were also used to calculate outflows from the lake. Evaporation was determined using the methods described in "Lake Evaporation in Illinois" (Roberts and Stall, 1967).

Historical precipitation data was obtained from the Illinois Environmental Protection Agency (IEPA) Total Maximum Daily Load (TMDL) Report for the Big Muddy River (January 2004). Average total precipitation for the Kinkaid Lake and Murphysboro area from 1985 to 2000 was 113.54 cm (44.7 inches). The annual average precipitation for the area was approximately three and a third-inches more than the 104.98 cm (41.33 inches) of precipitation observed in the Phase 1 monitoring period.

The total calculated inputs for the Phase 1 monitoring year were 115,406,994.4 cubic-meters (93,598.5 acre-ft). An average inflow of 2.54% of the total hydrologic budget was unaccounted for and could be potentially attributed to groundwater inflows and outflows. Approximately 103,985,718.1 cubic-meters (84,335.5 acre-ft) of water left the lake and were delivered as outputs. The volume of water estimated to either enter or exit the Kinkaid Lake system as a result of each of the above components was compiled monthly during the monitoring year that occurred from May 2003 to April 2004 (see Table 15).

Table 15. Phase 1 (2003-04) Hydrologic Budget for Kinkaid Lake

Month	Avg. Pool Level	Avg. Surface Area	Inputs: Precip. from Watershed	Inputs: Direct Lake Precip.	Inputs: Net Inputs	Outputs: Evapor. from Lake	Outputs: Public Water Supply	Outputs: Spillway Outflow	Outputs: Net Outputs	Unaccounted Inflow
	Ft-ASL	Ac	Ac-Ft	Ac-Ft	Ac-Ft	Ac-Ft	Ac-Ft	Ac-Ft	Act-Ft	Ac-Ft
May-03	420.36	2,683	4,945.8	1,133.9	6,079.6	1,042.0	9.2	8482.5	9,533.7	-3,454.1
Jun-03	420.01	2,654	5,680.4	1,302.3	6,982.7	1,322.3	10.0	235.8	1,568.1	5,414.6
Jul-03	419.66	2,672	2,391.7	548.3	2,940.1	1,466.7	10.0	0	1,476.7	1,463.4
Aug-03	419.65	2,672	1,836.5	421.0	2,257.6	1,322.3	10.0	0	1,332.3	925.3
Sep-03	419.65	2,672	2,306.3	528.8	2,835.1	869.3	9.2	0	878.5	1,956.6
Oct-03	419.3	2,669	1,409.4	323.1	1,732.5	450.2	9.2	0	459.4	1,273.1
Nov-03	419.46	2,670	4,313.7	989.0	5,302.6	243.5	9.2	0	252.7	5,049.9
Dec-03	419.91	2,673	1,623.0	372.1	1,995.0	147.2	9.2	0	156.4	1,838.6
Jan-04	420.22	2,672	2,092.8	479.8	2,572.6	121.8	9.2	5183.55	5,314.5	-2,742.0
Feb-04	420.2	2,670	1,623.0	372.1	1,995.0	277.5	9.2	4712.4	4,999.1	-3,004.0
Mar-04	420.37	2,684	4,458.9	1,022.3	5,481.1	331.3	9.2	8675.1	9,015.6	-3,534.5
Apr-04	420.29	2,677	2,622.4	601.2	3,223.6	812.6	9.2	6827.85	7,649.7	-4,426.1
Sum		**acre-feet**	**35,303.8**	**8,093.8**	**43,397.6**	**8,406.7**	**112.8**	**34,117.2**	**42,636.7**	**760.8**
		cubic meters	43,529,556	9,979,645	53,509,201	10,365,480	139,110	42,066,508	52,571,098	938,103
Avg.		acre-feet	2,942.0	674.5	3,616.5	700.6	9.4	2,843.1	3,553.1	63.4
		cubic meters	3,627,463	831,637	4,459,100	863,790	11,593	3,505,542	4,380,925	78,175
			81.35%	**18.65%**	**100.00%**	**19.72%**	**0.26%**	**80.02%**	**100.00%**	**1.75%**

6. Phosphorus and Nitrogen Budgets

Nitrogen and phosphorus are generally considered to be the two main nutrients involved in algal growth and the lake eutrophication process. The inputs of phosphorus and nitrogen were calculated on a monthly basis for the Phase 1 monitoring period using tributary samples collected from May 2003 through April 2004 (see Appendix A). The methodologies for the collection and calculation of nutrient inputs and outputs were similar to those used in the hydraulic budget with the exception of internal regeneration calculation, which was calculated as an additional input.

Data was collected during the monitoring year and then concentrations were estimated using a flow weighted average method. The total amount of a specific nutrient transported over a given period of time was calculated using the following equation (along with conversion factors):

$$T_i = (Q_i \times C_i)$$

where:

T_i = Total amount of nutrient transported during a particular period.

Q_i = Total flow of water entering or leaving the lake during a period.

C_i = Concentration of nutrients for the period being calculated.

The calculated numbers were correlated with the hydrologic budget estimates for water movement and then converted to kilograms in order to estimate the total amount of nutrients flowing into and out of the lake during the sampling period. The estimated releases of ammonia-nitrogen and phosphorus from sediment were based on rates determined by Keeney (1973) and Nurnberg (1984), respectively. A rate of 120.0 $mg/m^2/day$ (1.07 lbs/acre/day) for ammonia-nitrogen and 12.0 $mg/m^2/day$ (0.107 lbs/acre/day) for phosphorus was used to calculate an approximate internal nutrient loads for the period of time that dissolved oxygen levels were less than 1.0 mg/l.

The regeneration values for anaerobic conditions were multiplied by the approximate area of the lake bottom that had summertime dissolved oxygen levels below 1.0 mg/l in order to arrive at a daily loading rate. This rate was used to determine nutrient loadings during the time the lake was anoxic. Nutrient loadings for aerobic conditions were calculated in a similar manner, except that the entire lake area was used when sufficient dissolved oxygen levels were present. Atmospheric inputs were derived from regional concentrations obtained through the National Atmospheric Deposition Program (NADP) and applied to precipitation totals.

Tables 16 and 17 display the monthly estimates for the phosphorus and nitrogen budgets, respectively. The total gross loading to the lake from all sources was estimated to be 33,736.5 kg (37.2 tons) of phosphorus and 407,132.1 kg (449 tons) of nitrogen. Internal regeneration accounted for approximately 12.5 percent of the total phosphorus load and 10.5 percent of the total nitrogen load. A net load of 25,690 kg (28.3 tons) of phosphorus and 270,085 kg (297.7 tons) of nitrogen entered Kinkaid Lake during the Phase 1 sampling period.

As is typical for Midwestern lakes, the net nitrogen load was greater than the phosphorus load on a monthly basis. This loading estimate supports the prior determination that phosphorus is the limiting nutrient throughout the year in Kinkaid Lake.

Table 16 – Phase 1 (2003-04) Phosphorus Budget for Kinkaid Lake

Month	Atmos. Inflow		Watershed & Site 2 & 3 Inflows		Internal Regeneration		Watershed & Site 1 Outflows		Net Phosphorus Load	
Units	kg	tons	kg	tons	kg	tons	kg	tons	kg	tons
May-03	23.7	0.026	2,043.8	2.3	0.0	0.0	1,092.8	1.2	974.6	1.1
Jun-03	30.9	0.034	1,451.1	1.6	805.6	0.9	22.9	0.0	2,264.6	2.5
Jul-03	5.5	0.006	1,675.8	1.8	784.4	0.9	0.0	0.0	2,465.7	2.7
Aug-03	3.2	0.004	928.8	1.0	931.5	1.0	0.0	0.0	1,863.6	2.1
Sep-03	5.1	0.006	1,911.8	2.1	894.4	1.0	0.0	0.0	2,811.3	3.1
Oct-03	1.9	0.002	714.5	0.8	799.5	0.9	0.0	0.0	1,516.0	1.7
Nov-03	17.9	0.020	7,315.9	8.1	0.0	0.0	0.0	0.0	7,333.8	8.1
Dec-03	2.5	0.003	1,365.3	1.5	0.0	0.0	0.0	0.0	1,367.9	1.5
Jan-04	4.2	0.005	1,427.6	1.6	0.0	0.0	198.9	0.2	1,232.9	1.4
Feb-04	2.5	0.003	946.9	1.0	0.0	0.0	64.6	0.1	884.9	1.0
Mar-04	19.2	0.021	7,144.7	7.9	0.0	0.0	4,589.5	5.1	2,574.4	2.8
Apr-04	6.6	0.007	2,471.4	2.7	0.0	0.0	2,077.5	2.3	400.5	0.4
Sum	**123.4**	**0.136**	**29,397.7**	**32.4**	**4,215.4**	**4.6**	**8,046.4**	**8.9**	**25,690.1**	**28.3**

Annual Totals	Total KG	Total Tons	Percent of Total
Atmospheric Inflow	123.4	0.1	0.4%
Watershed & Site 2&3 Inflows	29,397.7	32.4	87.1%
Internal Regeneration	4,215.4	4.6	12.5%
Total Inflow	**33,736.5**	**37.2**	100.0%
Watershed & Site 1 Outflows	8,046.4	8.9	100.0%
Total Outflow	**8,046.4**	**8.9**	100.0%
Net Phosphorus Load	**25,690.1**	**28.3**	

Table 17 – Phase 1 (2003-04) Nitrogen Budget for Kinkaid Lake

Month	Atmos. Inflow		Watershed & Site 2 & 3 Inflows		Internal Regeneration		Watershed & Site 1 Outflows		Net Nitrogen Load	
Units	kg	tons	kg	tons	kg	tons	kg	tons	kg	tons
May-03	1,005.9	1.1	108,734.0	119.9	0.0	0.0	13,709.4	15.1	96,030.5	105.9
Jun-03	1,142.8	1.3	102,896.7	113.4	8,055.8	8.9	670.0	0.7	111,425.3	122.8
Jul-03	484.4	0.5	8,821.4	9.7	7,844.4	8.6	0.0	0.0	17,150.2	18.9
Aug-03	372.0	0.4	6,864.2	7.6	9,315.1	10.3	0.0	0.0	16,551.3	18.2
Sep-03	467.1	0.5	15,021.2	16.6	8,944.0	9.9	0.0	0.0	24,432.3	26.9
Oct-03	285.2	0.3	5,598.2	6.2	7,995.0	8.8	0.0	0.0	13,878.4	15.3
Nov-03	873.1	1.0	13,632.5	15.0	0.0	0.0	0.0	0.0	14,505.6	16.0
Dec-03	328.9	0.4	6,972.9	7.7	0.0	0.0	0.0	0.0	7,301.7	8.0
Jan-04	423.9	0.5	6,347.9	7.0	0.0	0.0	18,912.2	20.8	-12,140.4	-13.4
Feb-04	328.5	0.4	7,427.3	8.2	0.0	0.0	11,496.6	12.7	-3,740.8	-4.1
Mar-04	907.2	1.0	56,101.8	61.8	0.0	0.0	57,072.0	62.9	-63.1	-0.1
Apr-04	532.2	0.6	19,408.7	21.4	0.0	0.0	35,186.8	38.8	-15,246.0	-16.8
Sum	**7,151.1**	**7.9**	**357,826.7**	**394.4**	**42,154.3**	**46.5**	**137,047.1**	**151.1**	**270,085.1**	**297.7**

Annual Totals	Total KG	Total Tons	Percent of Total
Atmospheric Inflow	7,151.1	7.9	1.8%
Watershed & Site 2&3 Inflows	357,826.7	394.4	88.8%
Internal Regeneration	42,154.3	46.5	10.5%
Total Inflow	**407,132.1**	**448.8**	100.0%
Watershed & Site 1 Outflows	137,047.1	151.1	100.0%
Total Outflow	**137,047.1**	**151.1**	100.0%
Net Nitrogen Load	**270,085.1**	**297.7**	

7. Sediment Budget

The system flow data calculated in the hydrologic budget were used to develop a sediment budget (see Table 18), which indicates the amount of sediment entering the lake system. The flow values in the hydrologic budget and the corresponding tributary sample total suspended solids (TSS) concentrations were used to calculate sediment inputs and outputs for the lake. An estimate of 10 percent was added (i.e., bed load transport was estimated to be 90 percent) (Fitzpatrick and Harbison, 1986) to the monitored tributary inputs. Tributary samples collected typically do not account for nutrients and sediment transported along the bottom of the tributary, which cannot be accurately monitored.

Out of the 32,909,096 kg (36,276 tons) of sediment estimated to have entered Kinkaid Lake during the Phase 1 monitoring year, 30,948,277 kg (34,115 tons) were deposited in the lake. This resulted in an overall trap efficiency of 94.0 percent. It was estimated that shoreline erosion has contributed a total of 18,400 tons of sediment annually, or 50.7 percent of the total annual sediment load for the Phase 1 monitoring period.

The sedimentation survey completed by Cochran & Wilken, Inc. determined that 1,160,025 cubic-yards were deposited in the lake from 1971 to 2004. The average dry-bulk density of lake sediment is estimated to be 50.0 lbs/cu ft, or 1,350 pounds per cubic yard. Based on this estimation, there has been approximately 783,017 tons of sediment deposited within the upper end of the lake over its history. Therefore, the average annual rate of deposition (for those areas surveyed) during the 33-year period was approximately 23,728 tons per year.

The net sediment load of 34,115 tons in the Sediment Budget Summary during the Phase 1 monitoring year appeared to be a 30.4 percent overestimate compared to the select areas of the lake that were contained with the sedimentation survey, which indicated an average annual sediment loading of 23,728 tons per year.

Table 18 – Phase 1 (2003-04) Sediment Budget Summary for Kinkaid Lake

Month	Watershed & Site 2 & 3 Inflows		Shoreline Erosion		Watershed & Site 1 Outflows		Net Sediment Load	
Units	**kg**	**tons**	**kg**	**tons**	**kg**	**tons**	**kg**	**tons**
May-03	6,997,581.7	7,713.5			255,772.8	281.9	6,741,809.0	7,431.6
Jun-03	3,377,339.2	3,722.9			26,501.2	29.2	3,350,838.0	3,693.7
Jul-03	144,564.0	159.4			0.0	0.0	144,564.0	159.4
Aug-03	147,250.9	162.3	Annual Estimates		0.0	0.0	147,250.9	162.3
Sep-03	440,962.3	486.1	Only For		0.0	0.0	440,962.3	486.1
Oct-03	165,163.3	182.1	Shoreline Erosion		0.0	0.0	165,163.3	182.1
Nov-03	2,032,641.3	2,240.6			0.0	0.0	2,032,641.3	2,240.6
Dec-03	238,235.5	262.6			0.0	0.0	238,235.5	262.6
Jan-04	232,335.0	256.1			42,627.1	47.0	189,707.8	209.1
Feb-04	218,215.8	240.5			206,680.7	227.8	11,535.1	12.7
Mar-04	1,650,052.5	1,818.9			998,760.9	1,100.9	651,291.6	717.9
Apr-04	572,555.6	631.1			430,476.6	474.5	142,079.0	156.6
Sum	**16,216,897.0**	**17,876.1**	**16,692,199.0**	**18,400.0**	**1,960,819.2**	**2,161.4**	**30,948,276.8**	**34,114.6**

Annual Totals	Total KG	Total Tons	Percent of Total
Watershed & Site 2&3 Inflows	16,216,897.0	17,876.1	49.3%
Shoreline Erosion	16,692,199.0	18,400.0	50.7%
Total Inflow	**32,909,096.0**	**36,276.1**	100.0%
Watershed & Site 1 Outflows	1,960,819.2	2,161.4	100.0%
Total Outflow	**1,960,819.2**	**2,161.4**	100.0%

L. Biological Resources and Ecological Relationships

1. Phytoplankton

Phytoplankton analyses were completed for Kinkaid Lake by Dr. Larry O'Flaherty of Western Illinois University (WIU) in order to qualify and quantify the species present in the water column (see Appendix B). Selected historical phytoplankton analyses were conducted on available sample data from Site 1 in 1977, 1979, and 2003 and from Sites 4, and 9 in 2003. During the 2003-Phase 1 monitoring period, samples were collected from Sites 1, 4, and 9 on the following dates: May 13, June 25 (Site 9 only), July 30, August 28, and October 23 (Table 19). The 1979 samples were analyzed using the Membrane Filter Method and all other samples from 1987 until present were analyzed using the Sweep Method (Sedgewick-Rafter counting cell). The Sweep Method allows for a more accurate identification of individual algal taxa than the Membrane Filter Method.

Table 19. Kinkaid Lake - Phase 1 (2003) - Site 1 Phytoplankton Summary

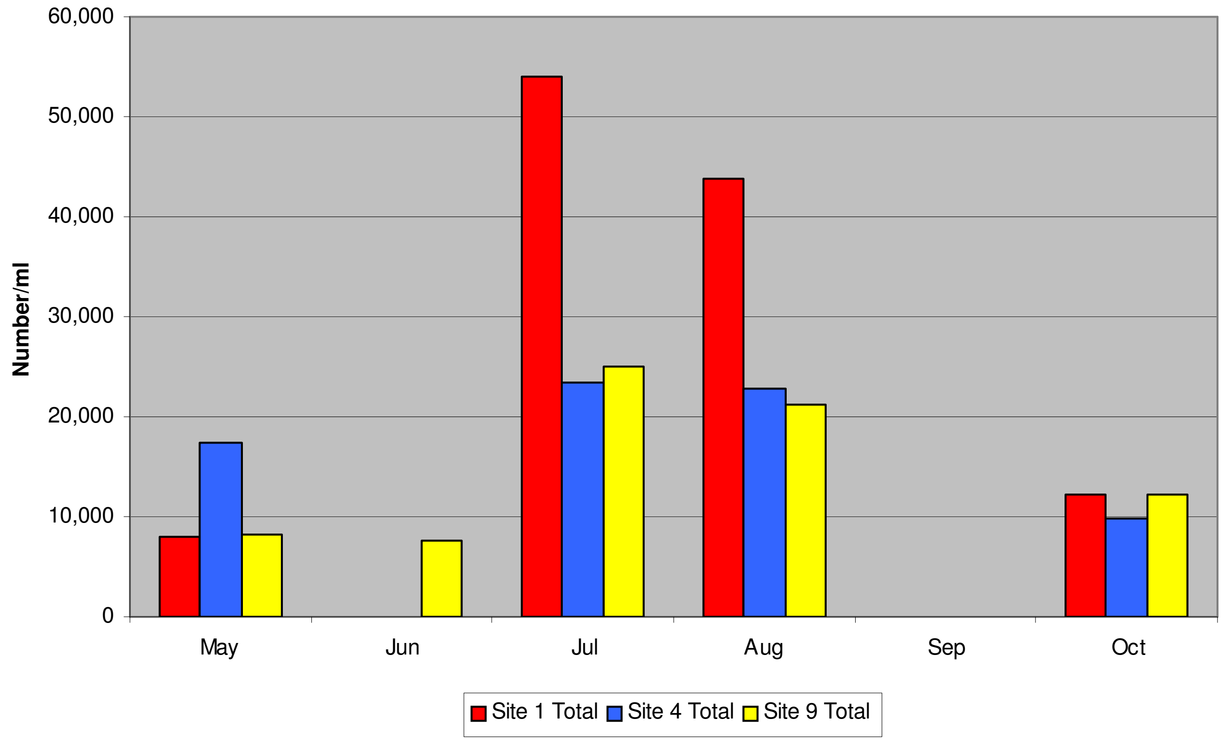
Phylum	May	Jun	Jul	Aug	Sep	Oct
Bacillariophyta	41	na	306	581	na	591
Chlorophyta	204	na	265	693	na	510
Chrysophyta	0	na	0	41	na	163
Cryptophyta	1,091	na	82	20	na	153
Cyanophyta	6,737	na	53,345	42,470	na	10,701
Euglenophyta	20	na	20	10	na	112
Pyrrhophyta	0	na	0	0	na	0
Total	**8,093**	**0**	**54,018**	**43,815**	**0**	**12,230**

Source: O'Flaherty, 2003

Note: All values represent the number of algal units per milliliter.

Phytoplankton analyses at Site 1 during the Phase 1 monitoring period showed that the total algal population ranged from a low of 8,093 (number of units/ml) in May to a high of 53,018 (number of units/ml) in July. Sites 4 and 9 were also similar in terms of total number of algal units and distribution of individual taxa with the dominant algal division being Cyanophyta (blue-greens). Figure 26 below shows the similarity of total phytoplankton concentrations for Sites 1, 4, and 9 for the Phase 1 (2003) samples.

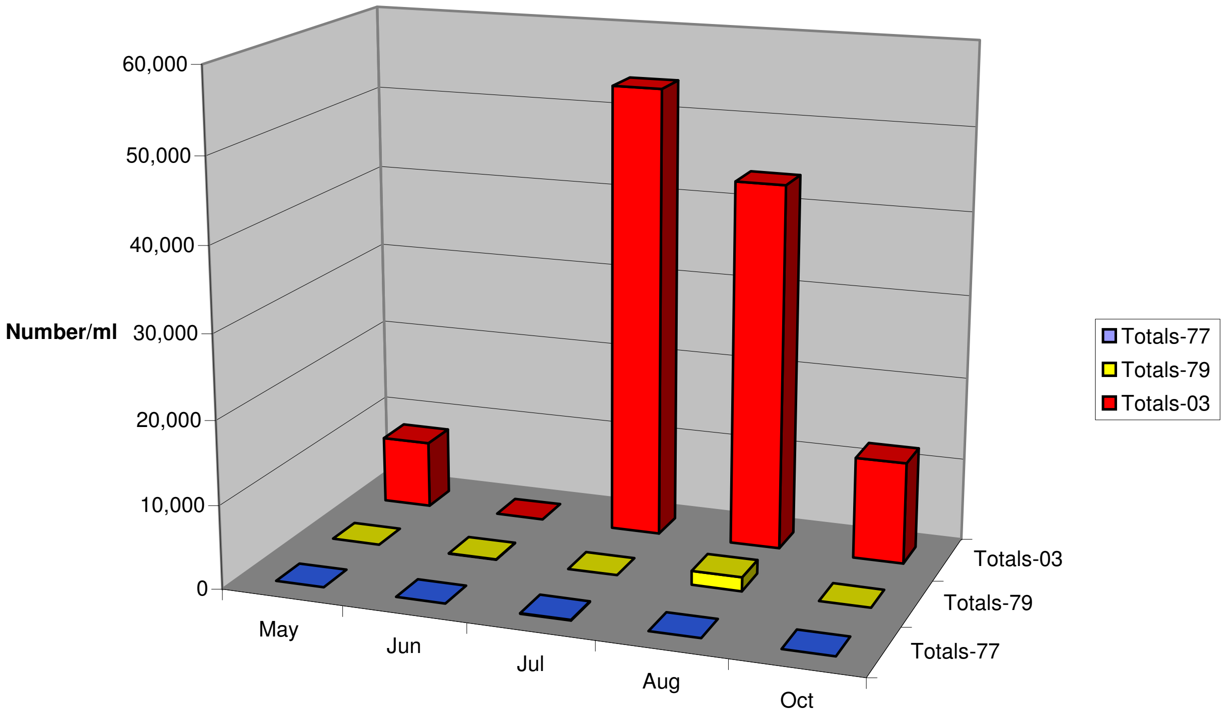
Figure 26.   Kinkaid Lake - Phytoplankton Concentration Comparison for Phase 1 (2003) Period



Source: O'Flaherty, 2003

A comparison of the Phase 1 (2003) Site 1 sample data with historical 1977 and 1979 data shows that there has been a significant increase in total algal productivity in Kinkaid Lake (see Figure 27 below). As mentioned, variances in the analytical methods used to determine algal taxa and concentrations may have skewed the results.

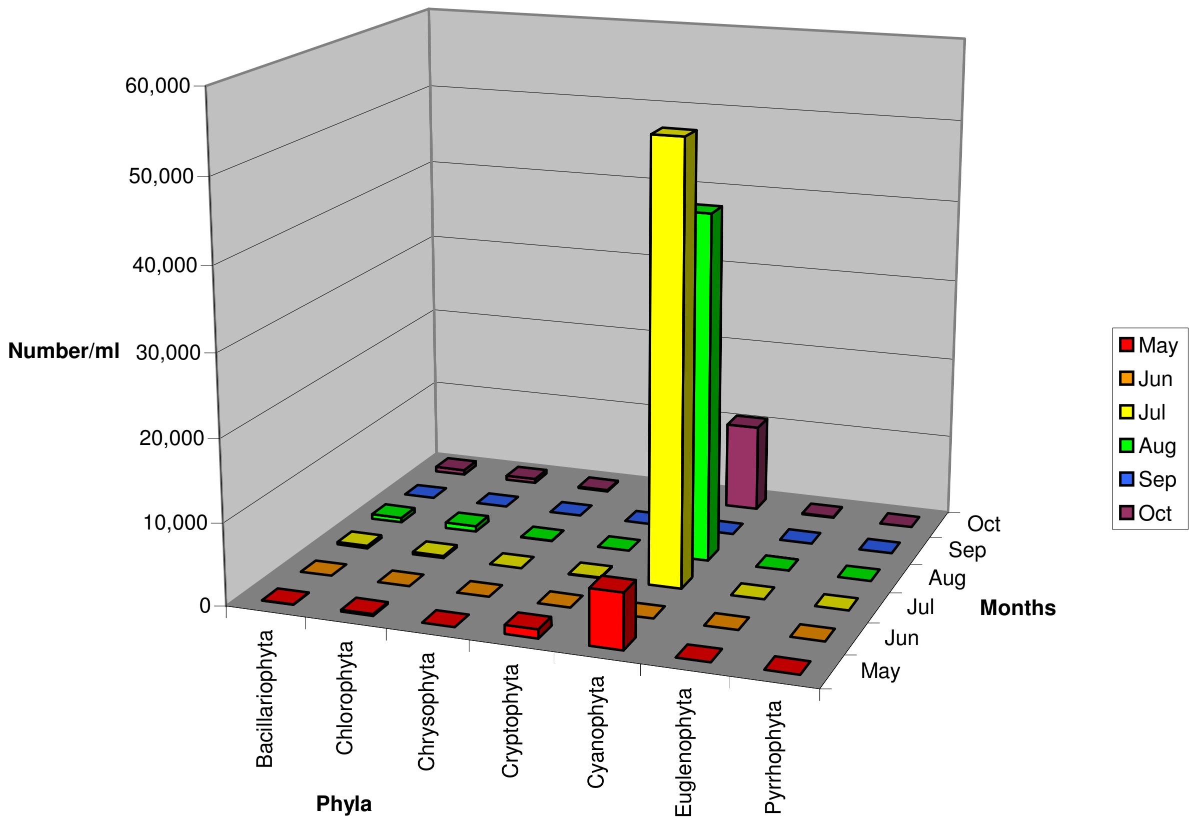
Figure 27. Kinkaid Lake – Historical (1977, 1979, and 2003) Site 1
Total Phytoplankton Concentration Comparison



Source: O'Flaherty, 2003

In addition to the increased algal productivity and blue-green dominance found in the Phase 1 (2003) samples (see Figure 28), it is apparent that the phylum Cyanophyta (blue-green algae) has become abundant in Kinkaid Lake during the summer months. This algal order represents nuisance blue-green algae that is generally indicative of highly eutrophic conditions.

Figure 28. Kinkaid Lake - Site 1 Dominant Phytoplankton Comparison for the Phase 1 (2003) Period



Source: O'Flaherty, 2003

2. Fisheries Population

a. History

Kinkaid Lake has a diverse fish population and IDNR has documented twenty-nine (29) species occurring in Kinkaid Lake (see Table 20). These species support and include multiple sport fish: black crappie, white crappie, bluegill sunfish, channel catfish, largemouth bass, longear sunfish, muskellunge, redear sunfish, walleye, and white bass. Kinkaid Lake is renown for its muskellunge (MUE) fishing. The lower portion of the lake with its increased water clarity, water depths, irregular shorelines, and presence of sufficient forage have sustained and supported the growth of the Kinkaid Lake MUE population. IDNR indicates that the populations of most sport fish are generally healthy. However, siltation and turbidity in the upper portions of the lake have significantly diminished the quality and availability of fish habitat.

b. Population Survey

Fish population surveys for Kinkaid Lake have typically been completed in the spring of each year by the regional Illinois DNR fisheries biologist. Table 20 lists the major fish species known to occur in Kinkaid Lake.

Table 20 - Common Fish Species of Kinkaid Lake

Species	ID Code	Scientific Name
Bigmouth Buffalo	BGB	*Ictobus cyprinellus*
Brown Bullhead	BRB	*Ameiurus natalis*
Black Bullhead Catfish	BLB	*Ameiurus melas*
Black Crappie	BLC	*Pomoxis nigomaculatus*
Bluegill Sunfish	BLG	*Lepomis macrochirus*
Brook Silverside	BRS	*Labbidessthes sicculus*
Common Carp	CAP	*Cyprinus carpio*
Channel Catfish	CCF	*Ictalurus punctatus*
Flathead Catfish	FLC	*Pylodictis oliivaris*
Freshwater Drum	FRD	*Aplodinotus grunniens*
Golden Redhouse	GOR	*Moxostoma erthrurum*
Golden Shinner	GOS	*Notemigonus crysoleucas*
Green Sunfish	GSF	*Lepomis cyanellus*
Gizzard Shad	GZS	*Dorosoma cepedianum*
Largemouth Bass	LMB	*Micropterus salmoides*
Logperch	LOP	*Percina caprodes*
Longear Sunfish	LOS	*Lepomis mehalotis*
Muskellunge	MUE	*Esox masquinongy*
Orange Spotted Sunfish	ORS	*Lepomis humilis*
Redear Sunfish	RSF	*Lepomis microlophus*
Smallmouth Buffalo	SAB	*Ictobus bubalus*
Spotted Sucker	SOS	*Minytrema melanops*
Threadfin Shad	THS	*Dorosoma petenense*
Walleye	WAE	*Stizostedion vitreum*
Warmouth	WAM	*Lepomis gulosus*
White Bass	WHB	*Morone chrysops*
White Crappie	WHC	*Pomoxis annularis*
White Sucker	WHS	*Catostomus commersonnii*
Yellow Bullhead Catfish	YEB	*Ameiurus natalis*

Source: IDNR, 2005

The fish population surveys have typically utilized methods including electrofishing, gill nets, and trap nets. The fish population survey data presented in Table 21 only includes the results from 4 hours or 240 minutes of daylight electrofishing. The species collected were enumerated, weighed, and measured in length. Species were then categorized into groups by length and weight. Table 21 lists the results of the electrofishing population surveys for 2001, 2002, and 2003. The results presented in Table 21 are discussed under Fisheries Management.

Table 21 – Kinkaid Lake Fish Population Survey Summary

	Spring 2001				Spring 2002				Spring 2003			
			Length (In)				Length (In)				Length (In)	
Species	No.	% of Total	Min.	Max.	No.	% of Total	Min.	Max.	No.	% of Total	Min.	Max.
CCF	28	2.1%	9.1	24	49	1.3%	12.6	28.3	19	0.9%	9.1	26.8
BGB	2	0.1%	18.1	19.3	2	0.1%	22	22.4	3	0.1%	16.9	24
BRB	0	0.0%	0	0	3	0.1%	8.7	10.3	3	0.1%	9.8	14.2
BLC	1	0.1%	11.6	11.6	0	0.0%	0	0	0	0.0%	0	0
LMB	302	22.6%	3.1	20.1	401	10.9%	3.9	20.9	252	11.3%	3.9	20.5
CAP	40	3.0%	14.6	27.2	32	0.9%	16.5	24	43	1.9%	16.1	24.8
WAE	3	0.2%	16.9	21.7	6	0.2%	11.8	21.7	2	0.1%	15.4	18.9
FCF	0	0.0%	0	0	1	0.0%	8.8	8.8	0	0.0%	0	0
FRD	1	0.1%	17	17	1	0.0%	15.2	15.2	1	0.0%	14.3	14.3
GSF	9	0.7%	3.5	6.3	14	0.4%	3.9	7.1	0	0.0%	0	0
GOR	1	0.1%	13.2	13.2	0	0.0%	0	0	1	0.0%	16.7	16.7
GOS	0	0.0%	0	0	0	0.0%	0	0	1	0.0%	6.1	6.1
GZS	158	11.8%	3.9	9.8	1,731	47.1%	4.7	11	757	34.0%	1.6	8.7
LOP	0	0.0%	0	0	0	0.0%	0	0	1	0.0%	3.7	3.7
LOS	41	3.1%	2.8	5.9	92	2.5%	2.8	5.9	41	1.8%	2.4	5.5
MUE	2	0.1%	18.5	28.3	11	0.3%	13	39.4	9	0.4%	14.6	42.5
ORS	0	0.0%	0	0	0	0.0%	0	0	3	0.1%	3.1	3.5
BLG	301	22.6%	2	7.1	620	16.9%	2.8	7.1	668	30.0%	2.8	7.1
RSF	9	0.7%	5.5	6.7	32	0.9%	4.7	9.1	50	2.2%	6.3	6.7
SAB	0	0.0%	0	0	1	0.0%	17.5	17.5	0	0.0%	0	0
SDS	157	11.8%	7.1	15.4	32	0.9%	10.6	17.7	143	6.4%	5.5	15.4
THS	30	2.2%	2.8	3.5	368	10.0%	2.8	5.1	0	0.0%	0	0
WAM	31	2.3%	3.9	7.1	8	0.2%	4.3	7.5	9	0.4%	3.5	5.5
WHB	1	0.1%	14.3	14.3	4	0.1%	11	16.9	8	0.4%	12.6	15.7
YEB	58	4.3%	6.3	11.8	1	0.0%	10.4	10.4	7	0.3%	7.1	11.4
WHC	159	11.9%	6.7	12.2	264	7.2%	5.1	13.8	205	9.2%	3.5	13.4
Total	1,334	100.0%			3,673	100.0%			2,226	100.0%		

Source: IDNR, 2003

c. Fish Contaminant Monitoring

In recent years, fish flesh analyses have identified elevated mercury levels in largemouth bass and white crappie that were found in Kinkaid Lake. Mercury is found in the environment because of natural and human activities. It is transferred up the food chain to predator species and can accumulate in people that consume contamination fish. Mercury is extremely toxic to humans and causes many adverse health effects. Table 22 lists the restrictive consumption related to special mercury advisory for Kinkaid Lake.

Table 22 – Special Mercury Advisory for Kinkaid Lake

Species	Sizes	Women Beyond Childbearing Age & Males >15 Years	Pregnant or Nursing Women, Women of Childbearing Age, & Children <15 Years
LMB	All Sizes	1 meal / week	1 meal / month
WAE	All Sizes	1 meal / week	1 meal / month
WHC	All Sizes	unlimited	1 meal / week

Source: IDNR, 2004.

Fish flesh analyses were completed during the Phase 1 sampling period (2003-04) on samples of largemouth bass, white bass, walleye, carp, channel catfish, and white crappie to determine the level of toxicity present in Kinkaid Lake fishes. The 2003 fillet analyses revealed acceptable U.S. Food and Drug Administration (USFDA) levels of contaminants. The USFDA action concentrations are listed in Table 23, while the recorded concentrations of fish contaminants are listed in Table 24.

Table 23 - USFDA Action Level for Fish Flesh Analysis

Parameter	Actio Level (ppm)
Chlordane	0.3
Dieldrin	0.3
Heptachlor Epoxide	0.3
PCB's	2.0
Mercury	1.0
Total DDT	5.0

Source: USFDA

Table 24 - Fish Flesh Analyses for Kinkaid Lake for the Phase 1 (2003) Period

Species	Units	Detection Level	LMB 05/15/03	WHB 03/21/03	WAE 03/21/03	CAP 03/03/03	CCF 03/21/03	WHC 03/18/03
Aldrin	ug/g	0.01	ND	ND	ND	ND	ND	ND
Chlordane	ug/g	0.02	ND	ND	ND	ND	ND	ND
Total DDT	ug/g	0.01	ND	ND	ND	ND	ND	ND
Dieldrin	ug/g	0.01	ND	ND	ND	ND	ND	ND
Total PCBs	ug/g	0.1	ND	ND	ND	ND	ND	ND
Heptachlor	ug/g	0.01	ND	ND	ND	ND	ND	ND
Heptachlor Epoxide	ug/g	0.01	ND	ND	ND	ND	ND	ND
Toxaphene	ug/g	1	ND	ND	ND	ND	ND	ND
Methoxychlor	ug/g	0.05	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ug/g	0.01	ND	ND	ND	ND	ND	ND
Gamma-BHC (Lindane)	ug/g	0.01	ND	ND	ND	ND	ND	ND
Alpha-BHC	ug/g	0.01	ND	ND	ND	ND	ND	ND
Mirex	ug/g	0.01	ND	ND	ND	ND	ND	ND
Endrin	ug/g	0.01	ND	ND	ND	ND	ND	ND
Lipid Content	Percent	%	0.35	0.66	0.9	1.2	1.6	0.67

d. Fisheries Management

A lake management status report was compiled by the District IDNR Fisheries Biologist in 2003. General summaries of the major species sampled in the 2003-status report are as follows:

Largemouth Bass (LMB) – A total of 252 (11.3% of the total) LMB were collected by electrofishing during the 2003 survey. The 2003 LMB catch per unit effort (CPUE) averaged 63 fish per hour (1.05 fish per minute). The LMB sample for 2003 was down when compared to the all-time record that was observed in 2002. However, the 2003 LMB sample was reported to be in line with historical records. Seventeen percent of the LMB collected in 2003 were legal fish (larger than 16-inches). The LMB population for Kinkaid Lake is ranked as good.

Bluegill (BLG) – A total of 668 (30 percent of the total) BLG were collected in the 2003 survey. The CPUE for BLG in 2003 averaged 167 fish per hour (2.8 fish/minute). BLG numbers of the last few years have been higher than the historical average. Due to the larger size of the lake and the high competition for food resources amongst smaller fishes, the BLG and RSF in the lake exhibit slower growth rates.

White Crappie (WHC) – Crappie populations are cyclic as they produce a good spawn every three to five years. In 2003, the 205 WHC collected represented approximately nine percent of the total fish sampled. The surveys in 2002 and 2003 contained more WHC than in recent years. The WHC CPUE in 2003 averaged 27 fish per hour (0.45 fish/minute). Kinkaid Lake Crappie regulations (see Table 26) attempt to limit harvesting, which should improve the WHC population.

Walleye (WAE) – Walleye sampling was slightly down in 2003 compared to other years. This result was most likely due to sampling methodology and timing. In 2003, only 2 fish were collected via electrofishing; however, gill and trap netting in 2003 collected 23 fish. While samples were down, local anglers report fair to good WAE populations in the lake.

Channel Catfish (CCF) - DNR reports that the lake has an unusually high population of CCF that is under harvested. While 2003 electrofishing only collected 19 fish, numerous CCF were collected in gill and trap nets in the upper portion of the lake.

Muskellunge (MUE) – As mentioned, Kinkaid Lake is famous for its MUE fishing. The 2003 trap netting sampling collected 214 fish, which was the highest on record. Excellent habitat, stocking efforts, and the addition of the spillway barrier have all been attributed to excellent MUE fishing at Kinkaid Lake.

The fisheries management report evaluated 2003 survey data and compared that data to the historical averages for the lake. Generally, considering observed fluctuations in certain fish populations, the 2003 survey data did not vary from the historical averages. The overall fisheries management objective for Kinkaid Lake has been to achieve a quality, diversified sport fishery. A record of supplemental fish stocking from 1996-2003 for Kinkaid Lake was reported along with a listing of the current Sport Fish Regulations that are in effect. The fish-stocking summary is provided in Table 25 below.

Table 25. Historical Fish Stocking Data for Kinkaid Lake

Year	Species	Number & Size	Year	Species	Number & Size
1996	MUE	507 / 8.5" Fingerlings	2001	MUE	2,825 / 10" Fingerlings
1997	MUE	342 / 12.5" Fingerlings	2001	THS	1,000 / 2.5" Fingerlings
1997	THS	3,500 / 3" Fingerlings	2001	WAE	56,000 / 1.5" Fingerlings
1997	WAE	38,314 / 1.3" Fingerlings	2001	LMB	1,000 / 5" Fingerlings
1997	WAE	72,868 / 1.6" Fingerlings	2002	THS	650 / 2.5" Fingerlings
1997	MUE	1,169 / 13" Fingerlings	2002	THS	1,300 / 3" Fingerlings
1997	MUE	365 / 12" Fingerlings	2002	THS	1,000 / 4" Fingerlings
1997	MUE	368 / 11" Fingerlings	2002	WAE	55,000 / 1.5" Fingerlings
1997	MUE	1,444 / 10" Fingerlings	2002	MUE	2,750 / 10.5" Fingerlings
1998	WAE	55,000 / 1.4" Fingerlings	2003	THS	1,500 / 3" Fingerlings
1998	MUE	3,970 / 10" Fingerlings	2003	CCF	4,500 / 7.5" Fingerlings
1998	MUE	14 / 13" Fingerlings	2003	RSF	90,000 / 0.75" Fingerlings
1999	MUE	61 / 15" Fingerlings	2003	WAE	55,000 / 1.5" Fingerlings
1999	WAE	55,000 / 1.5" Fingerlings	2003	MUE	1,960 / 11" Fingerlings
1999	MUE	18,809 / 4" Fingerlings	2003	LMB	1,505 / 7.5" Fingerlings
1999	MUE	2,794 / 11.3" Fingerlings	2003	WAE	612 / 9" Fingerlings
1999	MUE	1,000 / 13" Fingerlings	2003	CCF	4,300 / 5" Fingerlings
2000	THS	4,000 / 2.5" Fingerlings	2003	CCF	5,073 / 7" Fingerlings
2000	THS	1,500 / 4.5" Fingerlings	2003	MUE	840 / 10" Fingerlings
2000	WAE	70,704 / 2" Fingerlings			
2000	LMB	65,162 / 1.5" Fingerlings			
2000	MUE	2,210 / 11" Fingerlings			
2000	MUE	540 / 10" Fingerlings			

Source: Illinois DNR, 2003

The current sport fish regulations in effect for Kinkaid Lake continue to be maintained in order to assist in achieving IDNR management goals and to ensure a more balanced fishery. Table 26 provides a listing of the current regulations.

Table 26 - Current Sport Fishing Regulations in Effect for Kinkaid Lake

Fish Species	Regulation
Recreational Use Restrictions	All live bait in excess of 8 inches must be rigged with a quick set rig
Large or Small Mouth Bass	16-inch minimum length with a 3 fish per day creel limit
White, Black, or Hybrid Crappie	9-inch minimum length with a 25 fish per day creel limit
Pure Muskellunge	48-inch minimum length

Source: IDNR, 2003

The 2003 status report for Kinkaid Lake discussed the current sport fishing regulations listed in Table 26. The 16-inch size limit for LMB and SMB was established in 1998. It has been recognized that the LMB and SMB growth rates are slow and it takes more time to establish good LMB and SMB populations. The size-restrictions on bass should improve populations. A 9-inch limit on WHB and BLC was set in 2001 in an attempt improve the crappie population by spreading out the harvest. Currently 10 to 11-inch MUE are stocked annually into the lake at a rate of 1 fish per acre.

In 1996, trophy-sized MUE were escaping over the spillway during periods of heavy rain and high flows. As a result, in 1998, a barrier was added to the spillway to prevent fish from escaping. No fish escapees have been documented since the barrier was installed and the regional IDNR fisheries biologist has reported that the MUE and WAE populations have benefited since its installation.

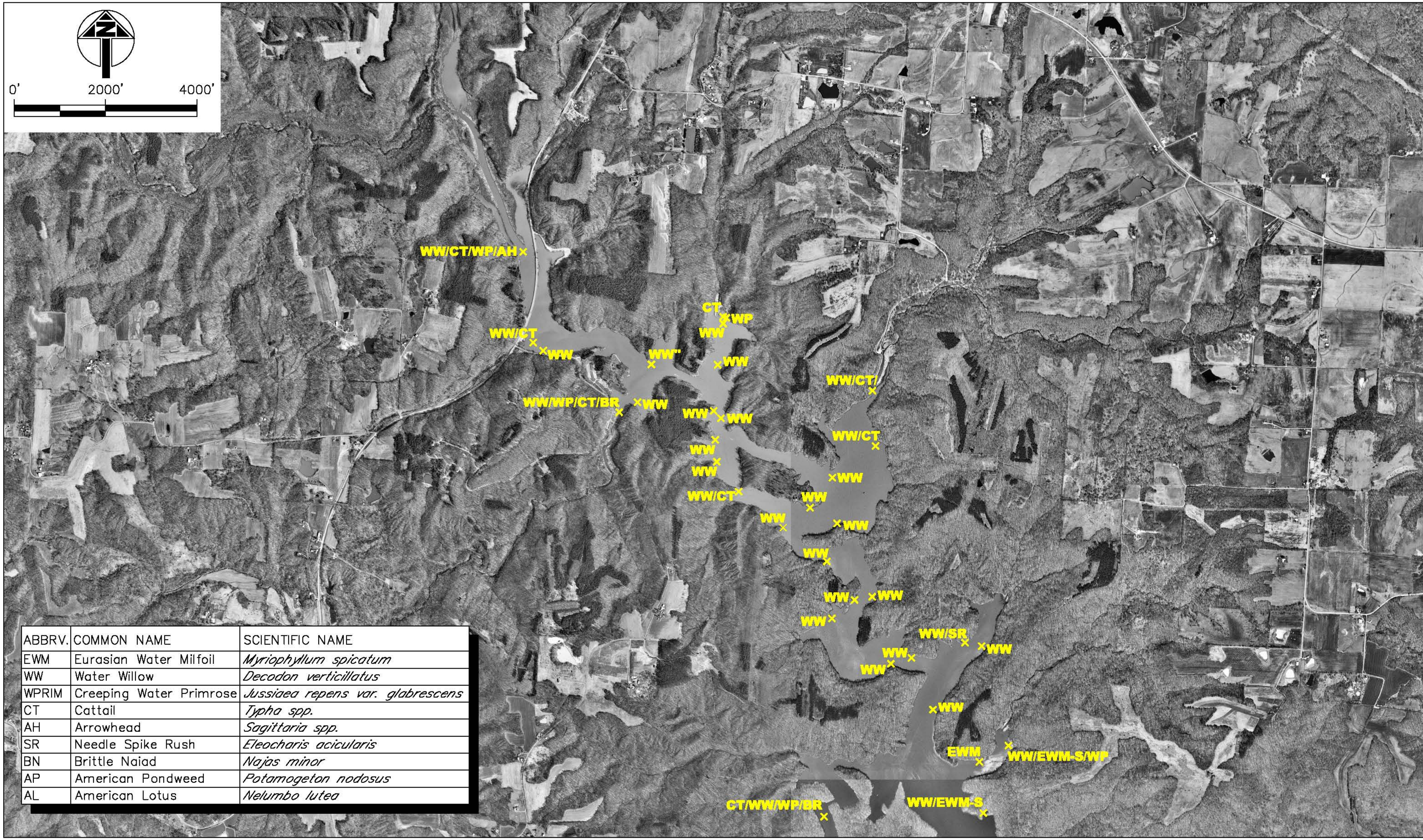
3. Aquatic Vegetation

In August 2003, Cochran & Wilken, Inc. conducted aquatic macrophyte mapping on Kinkaid Lake with the assistance from the KRCCD. Ninety-one (91) random sites along the Kinkaid Lake shoreline were sampled. Plant species were identified and site coordinates were recorded with global positioning system (GPS) and delineated on an aerial photograph map. Sampling locations were plotted utilizing AutoCAD Map software (see Figures 29A and 29B). A total of nine (9) aquatic macrophyte species (6 emergent and 2 submersed) were identified during the plant survey in Kinkaid Lake. Plant sample sites had water depth ranges from 0.5 to 12.5 feet. Results for the aquatic macrophyte survey for Kinkaid Lake were evaluated by the number of times a particular species was encountered over the total number of sample sites. Generally, water willow (*Decodon verticillatus*) and Eurasian water milfoil (*Myriophyllum spicatum)* were the most dominant species encountered in Kinkaid Lake.

Eurasian water milfoil is typically an invasive, exotic species, within most lakes. However, its presence in Kinkaid Lake has generally been beneficial, as it has been contained to localized strips along the shoreline and has provided habitat for invertebrates. This similar trend was observed for the other aquatic plant species that were encountered, as turbidity and the steep slope of the littoral zone in Kinkaid Lake limits light penetration and suitable habitat for most aquatic macrophytes. Table 27 lists the species encountered in Kinkaid Lake during the Phase 1 aquatic macrophyte survey.

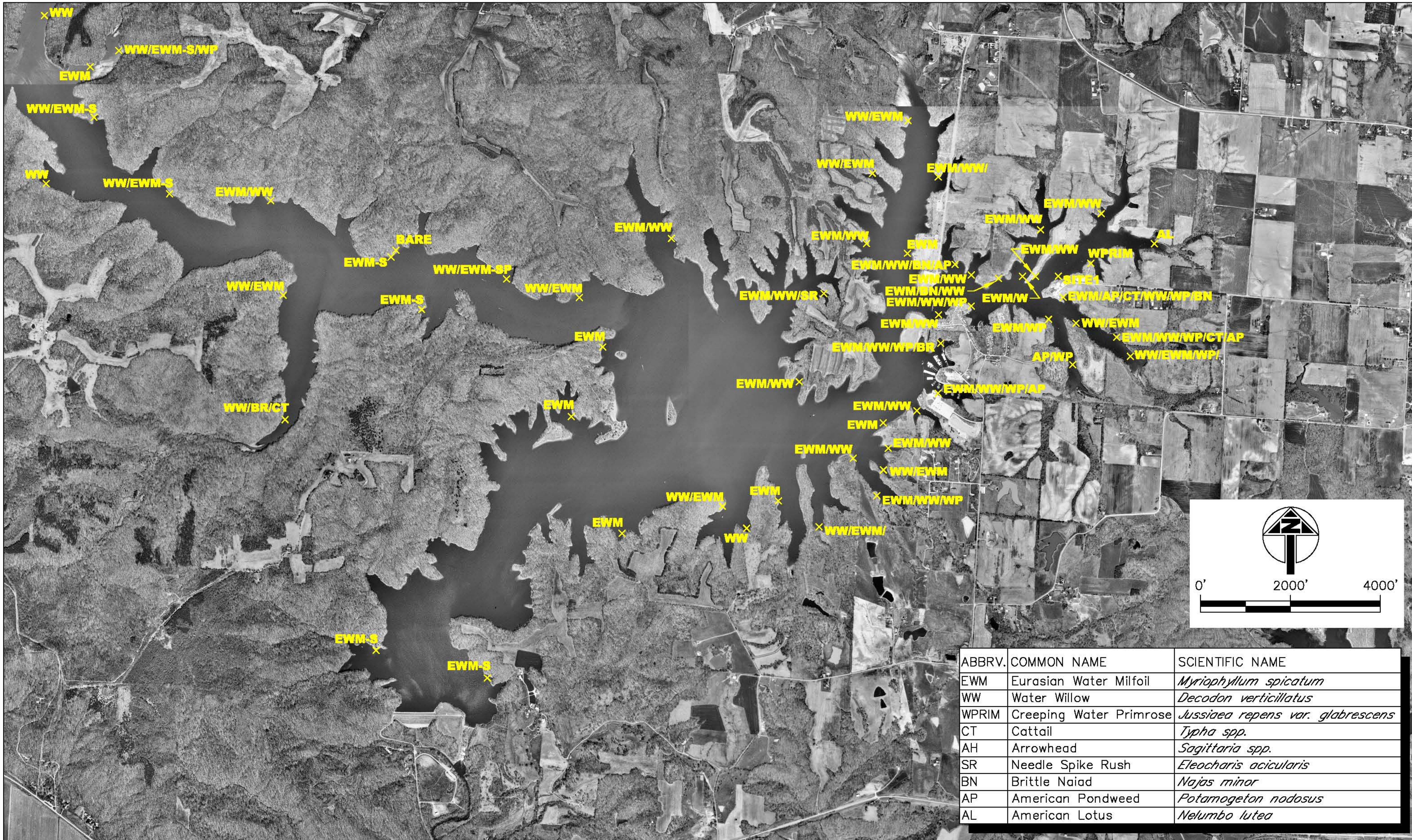
Table 27 – Aquatic Macrophyte Species Encountered in Kinkaid Lake in the Phase 1 (2003) Period

Common Name	Scientific Name	Type	Status
Eurasian Water Milfoil	*Myriophyllum spicatum*	Submersed	Exotic
Water Willow	*Decodon verticillatus*	Emergent	Native
Creeping Water Primrose	*Jussiaea repens var. glabrescens*	Emergent	Native
Cattail	*Typha spp.*	Emergent	Native
Arrowhead	*Sagittaria spp.*	Emergent	Native
Needle Spike Rush	*Eleocharis acicularis*	Emergent	Native
Brittle Naiad	*Najas minor*	Submersed	Native
American Pondweed	*Potamogeton nodosus*	Submersed	Native
American Lotus	*Nelumbo lutea*	Emergent	Native



ABBRV.	COMMON NAME	SCIENTIFIC NAME
EWM	Eurasian Water Milfoil	*Myriophyllum spicatum*
WW	Water Willow	*Decodon verticillatus*
WPRIM	Creeping Water Primrose	*Jussiaea repens var. glabrescens*
CT	Cattail	*Typha spp.*
AH	Arrowhead	*Sagittaria spp.*
SR	Needle Spike Rush	*Eleocharis acicularis*
BN	Brittle Naiad	*Najas minor*
AP	American Pondweed	*Potamogeton nodosus*
AL	American Lotus	*Nelumbo lutea*

FIGURE 29A- MACROPHYTE DISTRIBUTION FOR KINKAID LAKE (WEST)



ABBRV.	COMMON NAME	SCIENTIFIC NAME
EWM	Eurasian Water Milfoil	*Myriophyllum spicatum*
WW	Water Willow	*Decodon verticillatus*
WPRIM	Creeping Water Primrose	*Jussiaea repens var. glabrescens*
CT	Cattail	*Typha spp.*
AH	Arrowhead	*Sagittaria spp.*
SR	Needle Spike Rush	*Eleocharis acicularis*
BN	Brittle Naiad	*Najas minor*
AP	American Pondweed	*Potamogeton nodosus*
AL	American Lotus	*Nelumbo lutea*

FIGURE 29B- MACROPHYTE DISTRIBUTION FOR KINKAID LAKE (EAST)