2005 SUMMARY REPORT
of
Third Lake

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Third Lake is a natural glacial lake, encompassing approximately 155.5 acres and a shoreline length of 1.98 miles. It is the deepest lake in the county at 70 feet. Third Lake is part of the Mill Creek drainage of the Des Plaines River watershed. Water clarity, as measured by Secchi disk transparency readings, averaged 7.83 feet for the season, which is above the county median (where 50% of the lakes are above and below this value) of 3.17 feet. The 2005 average is an increase from the 2000 average of 4.17 feet, however, the clarity has remained relatively stable over the past 15 years.

Total phosphorus (TP) concentrations have remained relatively stable, with the 2005 average concentration (0.019 mg/L), 46% lower than the 2000 average (0.035 mg/L), but equal to the 1999 average (0.019 mg/L). In all years, TP was lowest early in the season (May) and highest in mid-summer (July-September).

Third Lake continues to have high concentrations of nitrate-nitrogen from May through July, in some cases more than ten times higher than the county epliminetic median of 0.116 mg/L. The 2005 average concentration was (0.820 mg/L), down slightly from the 2000 average (1.233 mg/L). The majority of the nitrate-nitrogen is entering the lake from the Avon-Fremont Drainage ditch during spring and early summer runoff.

Conductivity readings in Third Lake continue to increase. The 2005 epilimnetic average for conductivity was 1.4877 milliSiemens/cm, which is 92% higher than the county median of 0.7748 milliSiemens/cm, and a 116% increase from 1993. The seasonal average for chlorides in Third Lake in 2005 was 318 mg/L in the epilimnion and 302 mg/L in the hypolimnion. The current concentrations of chlorides in Third Lake may be adversely affecting aquatic life in the lake.

In 2005, LMU reassessed the 2000 shoreline erosion survey and found some eroded areas had been remediated, but identified new areas of erosion around the lake. These eroded areas should be remediated to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation instead of riprap or seawalls

The layered aeration system has been an asset to the lake, increasing the oxic volume of the lake, but needs occasional modifications such as adjusting the air flow and position of the ports on the aerators. The DO concentrations are also influenced by climatic conditions such as precipitation in the watershed that leads to more inputs of nutrients, solids, and pollutants entering the lake.

LAKE FACTS

Lake Name:	Third Lake
Historical Name:	Chittenden Lake
Nearest Municipality:	Village of Third Lake
Location:	T45N, R10E, Section 13 and 24
Elevation:	766.2 feet above mean sea level
Major Tributaries:	Mill Creek
Watershed:	Des Plaines River
Sub-watershed:	Mill Creek
Receiving Waterbody:	Grandwood Park Lake
Surface Area:	155.45 acres
Shoreline Length:	1.98 miles
Maximum Depth:	70 feet
Average Depth:	20.5 feet
Lake Volume:	3187.5 acre-feet
Lake Type:	Glacial, dammed spillway c.1980
Watershed Area:	8,567 acres
Major Watershed Land Uses:	Single Family and Agricultural
Bottom Ownership:	Private, Public (Village of Third Lake, Lake County Forest Preserve)
Management Entities:	Village of Third Lake
Current and Historical Uses:	Swimming, fishing, motorized and non-motorized boating.
Description of Access:	All access locations are private, open to the public (with a fee).

SUMMARY OF WATER QUALITY

Third Lake is the deepest lake in Lake County and has been previously studied by the Lakes Management Unit (LMU) in 1993, 1998, 1999 and 2000. A thorough review of these studies and the history of the lake were given in the 2001 Diagnostic/Feasibility and Phase II Monitoring Summary Report (available from LMU or on the web site: http://www.co.lake.il.us/health/ehs/lmureports.asp). In 2005, Third Lake was chosen to be one of seven "sentinel" lakes in the county, which LMU will be monitoring annually for five years, beginning with the 2005 season.

Water quality data was collected at the deep hole location from May through September in (Figure 1, See Appendix A for water sampling methods). In 2005, samples were collected from April through October. In all years, samples were collected at a depth of 3 feet and approximately 60 feet. See Table 1 for the Third Lake water quality data from 2000 and 2005. Appendix C explains the various water quality parameters measured, how these parameters relate to each other, and why the measurement of each parameter is important.

In 2005, water clarity, measured by Secchi disk transparency readings, averaged 7.83 feet for the season, which is above the county median (where 50% of the lakes are above and below this value) of 3.17 feet. Water clarity was best early (April, May) and late (September, October) in the season, with poor readings during June through August. The poor clarity was attributed to algae blooms occurring at the time of sampling. The 2005 average is an 88% improvement from 2000. The results of the Volunteer Lake Monitoring Program (VLMP) and LMU data can be seen in Figure 2 below. Overall the water clarity appears to be improving. The average water clarity reading, including both VLMP and LMU data, from 1991-2005 was 6.27 feet.

Correlated with the improved clarity readings from 2000 to 2005 was a decline in total suspended solids (TSS) concentration. The 2005 average (3.6 mg/L) was less than two times the 2000 average (7.9 mg/L; this is also the county median). Historically, the TSS concentrations fluctuated slightly, but have remained relatively stable (Figure 3). TSS concentrations in 2005 were highest during July and August, corresponding to the poor clarity months.

Total phosphorus (TP) concentrations have remained relatively stable (Figure 4), with the 2005 average concentration (0.019 mg/L), 46% lower than the 2000 average (0.035 mg/L), but equal to the 1999 average (0.019 mg/L). The average TP concentration in Third Lake, including both VLMP and LMU data, from 1991-2005 was 0.025 mg/L. In all years, TP was lowest early in the season (May) and highest in mid-summer (July-September). Phosphorus drives algae blooms in Third Lake and reducing the inputs of this nutrient into the lake from the surrounding watershed will benefit the lake. It is recommended that all homeowners in the watershed use no-phosphorus fertilizers on their properties unless it is determined through a soil test that additional phosphorus is needed.

Third Lake continues to have high concentrations of nitrate-nitrogen from May through July, in some cases more than ten times higher than the county epilimnetic (near surface) median of 0.116 mg/L. The 2005 average concentration was (0.820 mg/L), down slightly from the 2000 average (1.233 mg/L). The majority of the nitrate-nitrogen is likely entering the lake from the Avon-Fremont Drainage ditch during spring and early summer runoff.

High nutrient concentrations are usually indicative of water quality problems. Algae need light and nutrients, most importantly carbon, nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply (limiting). This means that nutrients (N&P) are usually the limiting factors in algal growth. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.) that are more difficult to control than sources of phosphorus. To compare the availability of these nutrients, a ratio of total nitrogen to total phosphorus is used (TN: TP). Ratios < 10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate that there is enough of both nutrients for excessive algal growth. The average ratio between total nitrogen and total phosphorus for Third Lake in 2005 was 96:1, indicating a strongly phosphorus-limited system. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon.

Based on data collected in 2005, standard classification indices compiled by the Illinois Environmental Protection Agency (IEPA) were used to determine the current condition of Third Lake. A general overall index that is commonly used is called a trophic state index or TSI. The TSI index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich productive). This index can be calculated using total phosphorus values obtained at or near the surface. The TSIp for Third Lake in 2005 classified it as a mesotrophic lake (TSIp = 46.6). This is an improvement from the 2000 TSIp of 55.4. Eutrophic lakes are the most common types of lakes throughout the lower Midwest, and they are particularly common among manmade lakes. See Table 2 in Appendix A for a ranking of average TSIp values for Lake County lakes (Third Lake is currently #8 of 162 lakes based on average TP concentrations). This ranking is only a relative assessment of the lakes in the county. The current rank of a lake is dependent upon many factors including lake origin, water source, nutrient loads, and morphometric features (volume, depth, substrate, etc.).

In Third Lake, the IEPA aquatic life impairment index was low, indicating a full degree of support for all aquatic organisms in the lake. Similarly, the good water clarity in the lake helped classify the swimming and recreation indices as a full degree of support. The overall use index was classified as full use.

Third Lake also has above average conductivity readings. The 2005 epilimnetic average for conductivity was 1.4877 milliSiemens/cm, which is 92% higher than the county median of 0.7748 milliSiemens/cm. The historical data also indicated a steady increase in conductivity readings (Figure 5), summarized by a 116% increase from 1993.
The most likely cause for these increases in conductivity readings is input from dissolved solids washed into the lake from storm events. One of the most common dissolved solids is road salt used in winter road maintenance. Because of the high conductivity readings, one additional parameter, chlorides, was collected beginning in 2005. Chloride concentrations help determine if road salt is the primary chloride source as most road salt is sodium chloride, calcium chloride,

potassium chloride, magnesium chloride or ferrocyanide salts. The seasonal average for chlorides in Third Lake in 2005 was 318 mg/L in the epilimnion and 302 mg/L in the hypolimnion. The IEPA standard for chloride is 500 mg/L. Once values exceed this standard the water body is deemed to be impaired, thus impacting aquatic life. It appears that the road salt is compounding in Third Lake and other lakes in the county. Some lakes in the county have seen a doubling of conductivity readings in the past 5-10 years. In a study by Environment Canada (equivalent to our USEPA), it was estimated that 5% of aquatic species such as fish, zooplankton and benthic invertebrates would be affected at chloride concentrations of about 210 mg/L. Additionally, shifts in algae populations in lakes were associated with chloride concentrations as low as 12 mg/L. The current concentrations of chlorides in Third Lake may be adversely affecting aquatic life in the lake.

Third Lake water quality is directly linked to precipitation events and the quality of the resulting runoff. This is due to the very large watershed (8,567 acres; Figures 6 and 7, Table 3) that drains into Third Lake. This is very evident when you compare 1999 and 2005 Third Lake water quality data (dry years with minimal runoff) to 1993 and 2000 (very wet years with excessive runoff). The main difference between the years was the quantity of precipitation and runoff. Lakes such as Third Lake, that have a high watershed to lake area ratio (>40:1) are very difficult to manage. The two predominant land uses in the watershed are single family (23.4%) and agricultural (20.5%). Transportation, although accounting for 10.4% of the land use in the watershed, accounts for approximately 31% of the total runoff. This likely explains the high conductivity readings in Third Lake.

Water quality has improved in the mid-depth (metalimnion) layer of the lake due to the operation of the layered aeration system. A very strong temperature gradient separated the epilimnion and the metalimnion. Dissolved oxygen (DO) concentrations that were previously anoxic below a depth of 12 feet (<1 mg/L) in 1993 and 1998 have been well above 2 mg/L recently in the mid-depth layer. Since 1999 the anoxic zone has fluctuated, but has ranged from below approximately 14-36 feet during the peak of the summer (August). Climatic conditions and equipment maintenance issues are the two probable causes for the fluctuations.

Plankton are microscopic plants and animals that are free-floating within the water column. Samples were collected during water quality testing and analyzed for species content (See Appendix A for methods). Diatoms (*Asterionella, Fragilaria*, and *Tabellaria*) were the dominant plankton in April (Figure 8), however green and blue-green algae dominated the remainder of the season. A bloom of the blue-green algae *Aphanizonenon* was occurring in June and again in August and September. In July, the green algae were predominant. LMU will continue to monitor the plankton in Third Lake to ascertain any changes in the communities and if changes are correlated with water quality changes.

Figure 1. Water quality sampling site (blue) and access locations (green) on Third Lake, 2005.

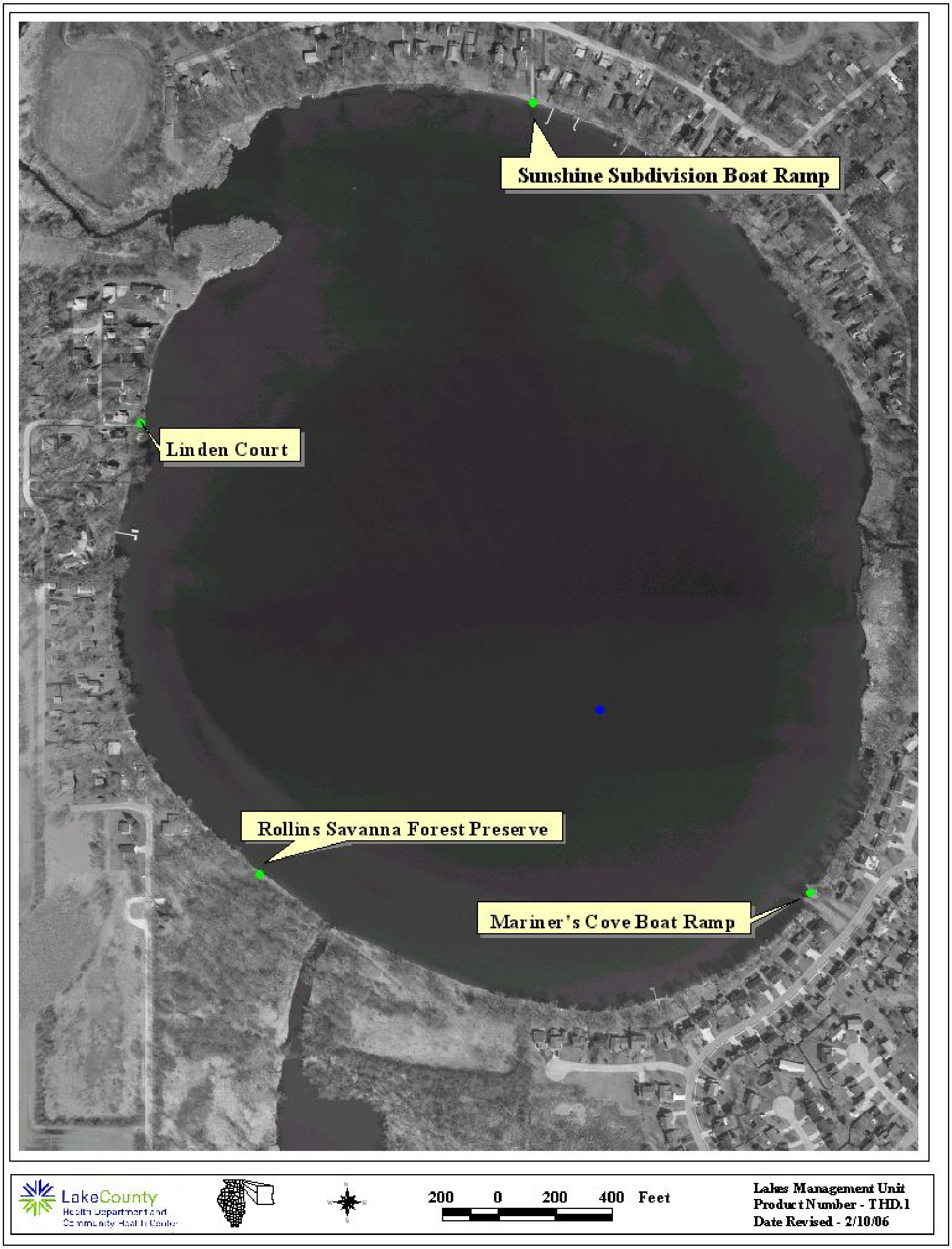


Table 1. Water quality data for Third Lake, 2000 and 2005.

2005	Epilimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
12-Apr	3	175	1.08	<0.10	1.710	0.015	<0.005	NA	303	3.9	875	150	8.56	1.4680	7.91	10.31
18-May	3	178	1.11	<0.10	1.290	0.021	<0.005	NA	308	2.7	897	158	10.47	1.5090	7.55	9.56
22-Jun	3	168	1.09	<0.10	0.697	0.019	<0.005	NA	319	3.9	918	185	5.28	1.5140	8.00	8.40
20-Jul	3	136	1.04	<0.10	0.123	0.015	<0.005	NA	331	5.5	904	168	5.18	1.5080	8.11	8.58
17-Aug	3	118	0.98	<0.10	<0.05	0.024	<0.005	NA	328	4.3	867	168	5.28	1.4730	8.78	8.51
21-Sep	3	116	0.82	<0.10	<0.05	0.021	<0.005	NA	323	3.1	846	171	8.40	1.4440	8.73	8.14
19-Oct	3	146	0.85	<0.10	0.304	0.018	<0.005	NA	314	2.0	818	122	11.65	1.4980	7.60	8.00
	Average	148	1.00	<0.10	0.820[k]	0.019	<0.005	NA	318	3.6	875	160	7.83	1.4877	8.10	8.79

2000	Epilimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
10-May	3	160	0.86	<0.10	2.07	0.012	<0.005	696	NA	2.2	611	120	7.71	0.9971	8.60	7.97
14-Jun	3	162	1.20	0.130	2.08	0.041	0.008	542	NA	2.4	551	167	5.18	0.8091	7.97	7.15
11-Jul	3	164	1.16	<0.10	1.41	0.045	0.010	474	NA	10.0	494	148	2.07	0.7187	7.93	7.47
16-Aug	3	158	1.30	<0.10	0.41	0.038	0.007	450	NA	13.0	504	157	2.76	0.7417	8.73	7.98
13-Sep	3	157	1.48	<0.10	0.20	0.041	0.012	498	NA	12.0	524	163	3.12	0.7935	8.70	8.13
	Average	160	1.20	0.130[k]	1.233	0.035	0.009[k]	532	NA	7.9	537	151	4.17	0.8120	8.39	7.74

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_3-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl^- = Chloride, mg/L
TDS = Total dissolved solids, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

k = Denotes that the actual value is known to be less than the value presented.

NA= Not applicable

Table 1. Continued.

2005	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
12-Apr	61	175	1.25	0.37	1.630	0.016	0.013	NA	302	2.1	874	148	NA	1.4590	7.36	7.18
18-May	62	189	1.76	0.97	0.991	0.124	0.091	NA	303	1.7	870	135	NA	1.4800	6.79	0.66
22-Jun	59	209	2.89	2.02	<0.05	0.525	0.461	NA	303	2.9	916	192	NA	1.4670	6.61	0.00
20-Jul	60	215	3.10	2.00	0.082	0.471	0.413	NA	303	7.9	897	164	NA	1.4740	6.58	0.04
17-Aug	59	234	4.00	3.14	<0.05	0.762	0.689	NA	301	5.1	913	194	NA	1.4870	6.62	0.01
21-Sep	60	256	5.00	4.03	<0.05	1.140	1.080	NA	300	4.0	875	138	NA	1.4980	5.80	0.06
19-Oct	59	235	3.73	3.08	<0.05	0.641	0.564	NA	299	15.0	863	112	NA	1.5325	6.43	0.15
	Average	216	3.10	2.23	0.901[k]	0.526	0.473	NA	302	5.5	887	155	NA	1.4854	6.60	1.16

2000	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
10-May	60	183	1.20	1.02	1.080	0.111	0.078	588	NA	1.9	687	141	NA	1.1380	7.77	1.56
14-Jun	60	197	2.54	1.77	0.490	0.314	0.312	726	NA	4.2	781	208	NA	1.1630	7.29	0.00
11-Jul	61	225	4.07	3.13	0.080	0.833	0.743	684	NA	4.3	755	187	NA	1.1690	6.90	0.00
16-Aug	60	259	5.80	5.15	0.060	1.380	1.330	677	NA	3.6	725	179	NA	1.1780	7.08	0.00
13-Sep	60	250	5.46	4.48	<0.05	1.110	0.982	704	NA	2.8	735	188	NA	1.1860	7.04	0.00
	Average	223	3.81	3.11	0.430[k]	0.750	0.689	676	NA	3.4	737	181	NA	1.1668	7.22	0.31

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_3-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl^- = Chloride, mg/L
TDS = Total dissolved solids, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

k = Denotes that the actual value is known to be less than the value presented.

NA= Not applicable

Figure 2. Average Secchi disk transparency depths, by year, for Third Lake.

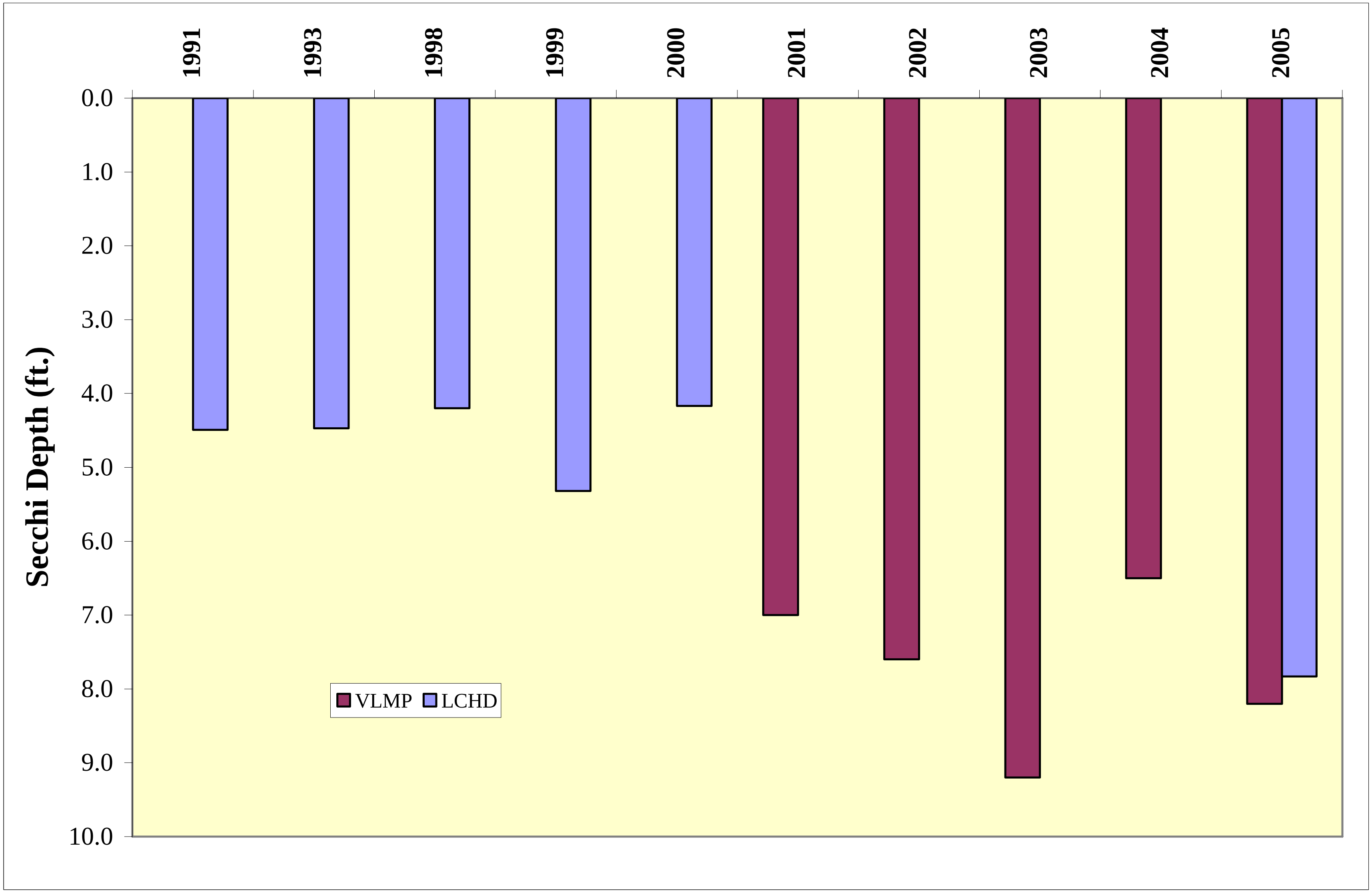


Figure 3. Average total suspended solid (TSS) concentrations, by year, for Third Lake.

Figure 4. Average total phosphorous (TP) concentrations, by year, for Third Lake.

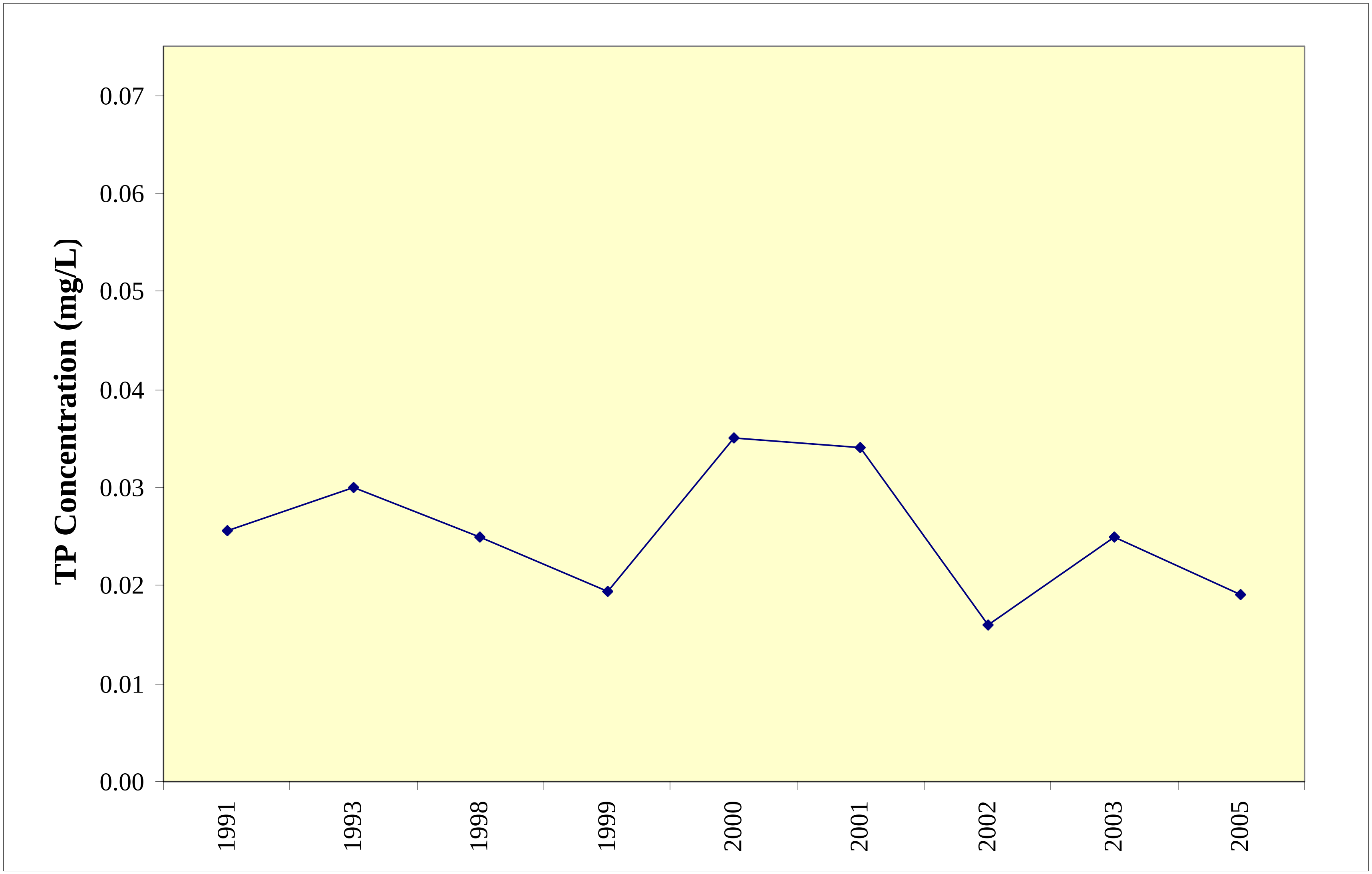


Figure 5. Average conductivity, by year, for Third Lake.

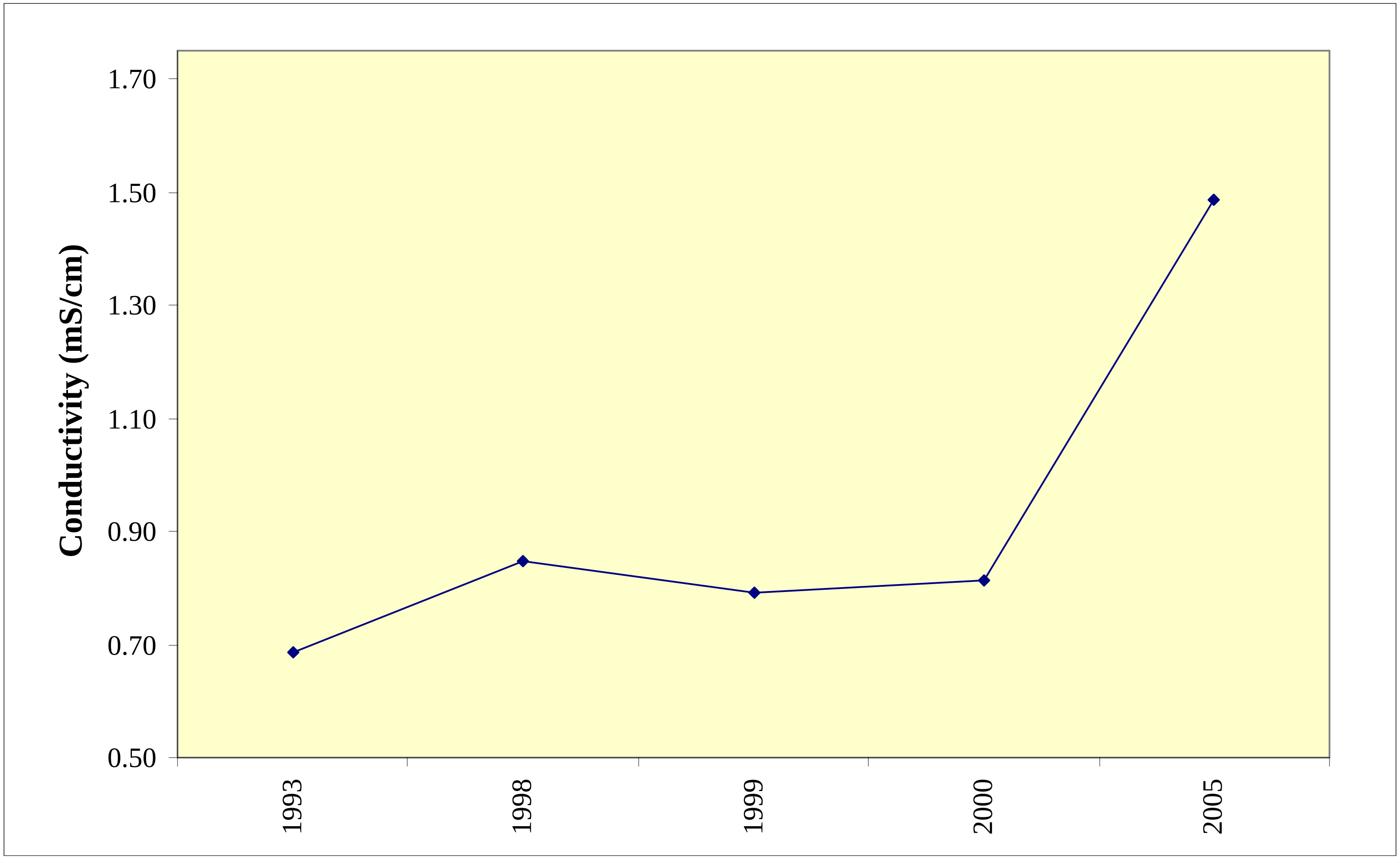


Figure 6. Approximate watershed delineation for Third Lake, 2005.

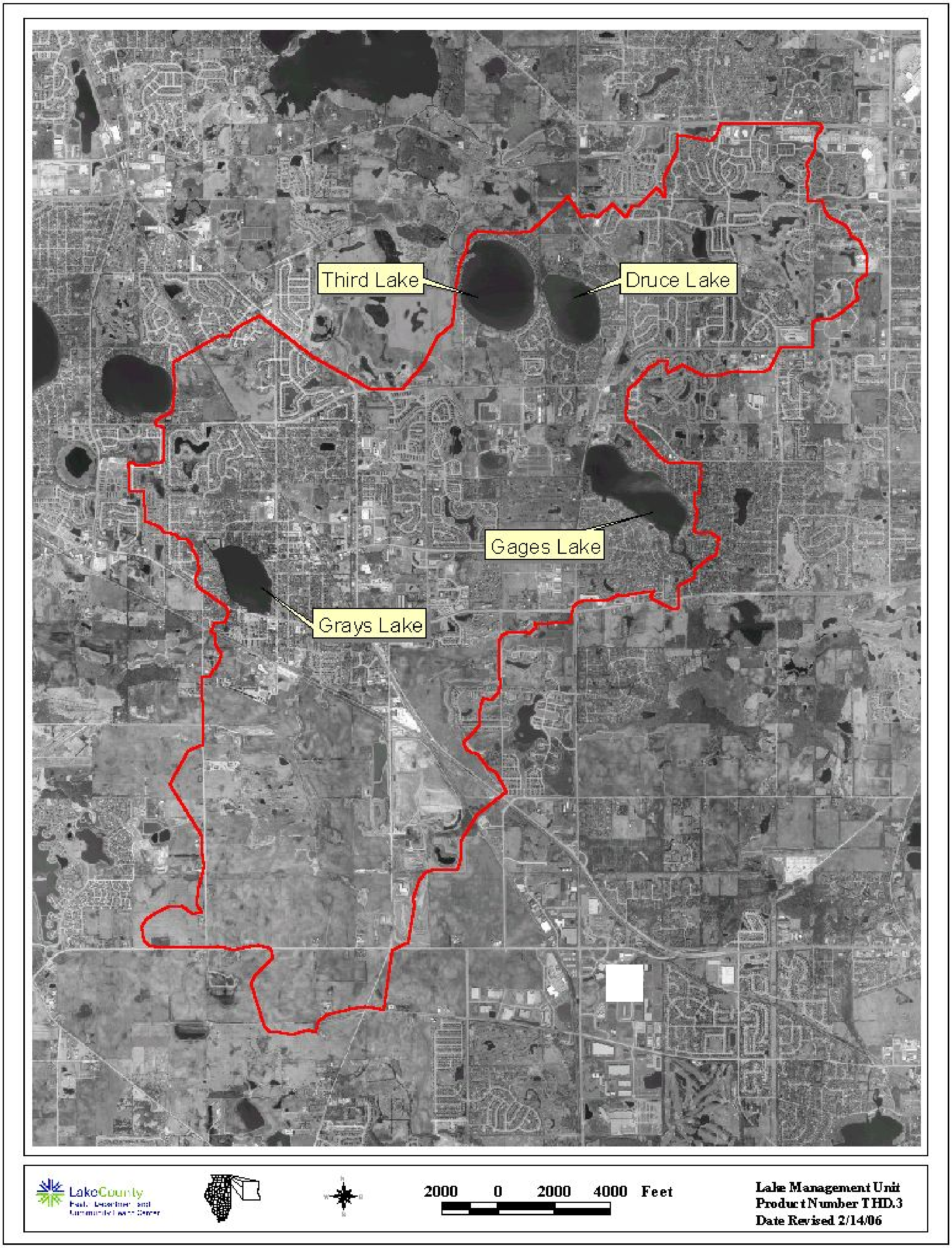


Figure 7. Approximate land use within the Third Lake watershed, 2005.

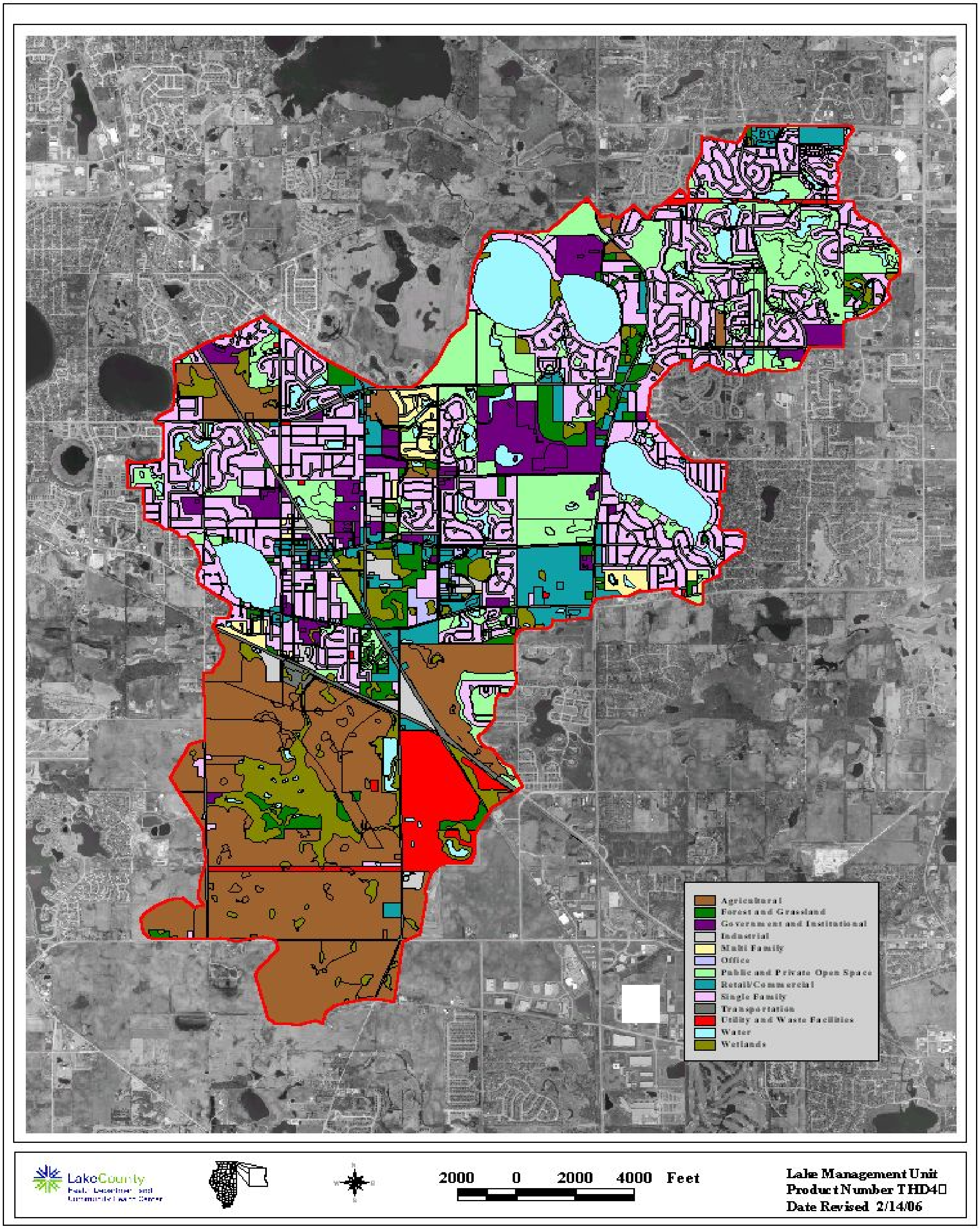


Figure 8. Plankton counts for Third Lake, 2005.

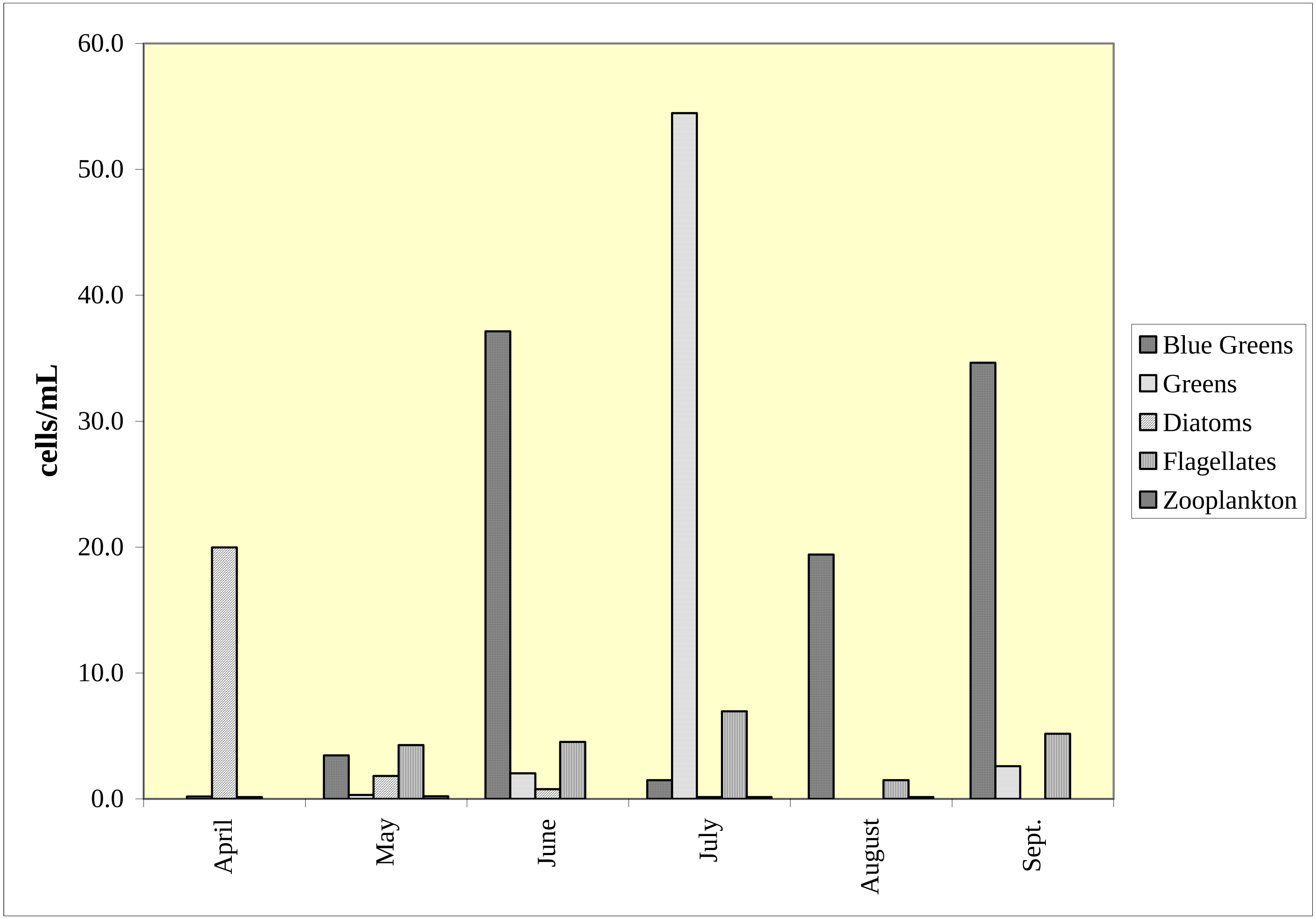


Table 2. Lake County average TSI phosphorous (TSIp) ranking 2000-2005.

RANK	LAKE NAME	TP AVE	TSIp
1	Windward Lake	0.0158	43.9
2	Sterling Lake	0.0162	44.3
3	Lake Minear	0.0165	44.6
4	Pulaski Pond	0.0180	45.8
5	Fourth Lake	0.0182	46.0
6	West Loon Lake	0.0182	46.0
7	Cedar Lake	0.0183	46.1
8	**Third Lake**	**0.0190**	**46.6**
9	Lake Carina	0.0193	46.9
10	Independence Grove	0.0194	46.9
11	Lake Kathyrn	0.0200	47.3
12	Lake of the Hollow	0.0200	47.3
13	Banana Pond	0.0202	47.5
14	Cross Lake	0.0220	48.7
15	Dog Pond	0.0222	48.9
16	Sand Pond	0.0230	49.4
17	Stone Quarry Lake	0.0230	49.4
18	Bangs Lake	0.0233	49.6
19	Cranberry Lake	0.0236	49.7
20	Deep Lake	0.0240	50.0
21	Druce Lake	0.0244	50.2
22	Little Silver Lake	0.0246	50.3
23	Round Lake	0.0254	50.8
24	Lake Leo	0.0256	50.9
25	Timber Lake	0.0270	51.7
26	Dugdale Lake	0.0274	51.9
27	Peterson Pond	0.0274	51.9
28	Lake Miltmore	0.0276	52.0
29	Ames Pit	0.0278	52.1
30	East Loon Lake	0.0280	52.2
31	Lake Zurich	0.0282	52.3
32	Lake Fairfield	0.0296	53.0
33	Gray's Lake	0.0302	53.3
34	Highland Lake	0.0302	53.3
35	Hook Lake	0.0302	53.3
36	Lake Catherine (Site 1)	0.0308	53.6
37	Lambs Farm Lake	0.0312	53.8
38	Old School Lake	0.0312	53.8
39	Sand Lake	0.0316	53.9
40	Waterford Lake	0.0318	54.0
41	Potomac Lake	0.0318	54.0
42	Sullivan Lake	0.0320	54.1
43	Wooster Lake	0.0324	54.3

Table 2. Continued.

RANK	LAKE NAME	TP AVE	TSIp
44	Gages Lake	0.0338	54.9
45	Hendrick Lake	0.0356	55.7
46	Diamond Lake	0.0372	56.3
47	Channel Lake (Site 1)	0.0380	56.6
48	Sun Lake	0.0410	57.7
49	Lake Linden	0.0420	58.0
50	Old Oak Lake	0.0428	58.3
51	Schreiber Lake	0.0434	58.5
52	Nielsen Pond	0.0448	59.0
53	Turner Lake	0.0458	59.3
54	Seven Acre Lake	0.0460	59.4
55	Willow Lake	0.0464	59.5
56	Lucky Lake	0.0476	59.9
57	Davis Lake	0.0476	59.9
58	East Meadow Lake	0.0478	59.9
59	College Trail Lake	0.0496	60.4
60	Countryside Lake	0.0512	60.9
61	Lake Lakeland Estates	0.0524	61.2
62	Butler Lake	0.0528	61.3
63	Lake Christa	0.0530	61.4
64	West Meadow Lake	0.0530	61.4
65	Deer Lake	0.0542	61.7
66	Heron Pond	0.0545	61.8
67	Little Bear Lake	0.0550	61.9
68	Lucy Lake	0.0552	62.0
69	Lake Charles	0.0580	62.7
70	White Lake	0.0588	62.9
71	Lake Naomi	0.0616	63.6
72	Lake Tranquility S1	0.0618	63.6
73	Werhane Lake	0.0630	63.9
74	Liberty Lake	0.0632	63.9
75	Countryside Glen Lake	0.0642	64.2
76	Leisure Lake	0.0648	64.3
77	Hastings Lake	0.0664	64.7
78	St. Mary's Lake	0.0666	64.7
79	Mary Lee Lake	0.0682	65.0
80	Honey Lake	0.0690	65.2
81	Redwing Slough, Site II, Outflow	0.0718	65.8
82	North Tower Lake	0.0718	65.8
83	Lake Fairview	0.0724	65.9
84	Spring Lake	0.0726	65.9
85	ADID 203	0.0730	66.0
86	Bluff Lake	0.0734	66.1
87	Long Lake	0.0761	66.6
88	Harvey Lake	0.0766	66.7

Table 2. Continued.

RANK	LAKE NAME	TP AVE	TSIp
89	Broberg Marsh	0.0782	67.0
90	Echo Lake	0.0792	67.2
91	Sylvan Lake	0.0794	67.2
92	Big Bear Lake	0.0806	67.4
93	Petite Lake	0.0834	67.9
94	Lake Marie (Site 1)	0.0850	68.2
95	North Churchill Lake	0.0872	68.6
96	Grandwood Park, Site II, Outflow	0.0876	68.6
97	South Churchill Lake	0.0896	69.0
98	Rivershire Pond 2	0.0900	69.0
99	McGreal Lake	0.0914	69.3
100	International Mine and Chemical Lake	0.0948	69.8
101	Eagle Lake (Site I)	0.0950	69.8
102	Dunns Lake	0.0952	69.8
103	Lake Barrington	0.0956	69.9
104	Lochanora Lake	0.0960	70.0
105	Owens Lake	0.0978	70.2
106	Woodland Lake	0.0986	70.4
107	Island Lake	0.0990	70.4
108	Duck Lake	0.0996	70.5
109	Tower Lake	0.1000	70.6
110	Crooked Lake	0.1014	70.8
111	Fish Lake	0.1022	70.9
112	Longview Meadow Lake	0.1024	70.9
113	Lake Forest Pond	0.1074	71.6
114	Bittersweet Golf Course #13	0.1096	71.9
115	Fox Lake (Site 1)	0.1098	71.9
116	Bresen Lake	0.1126	72.3
117	Round Lake Marsh North	0.1126	72.3
118	Timber Lake S	0.1128	72.3
119	Deer Lake Meadow Lake	0.1158	72.7
120	Taylor Lake	0.1184	73.0
121	Grand Avenue Marsh	0.1194	73.1
122	Columbus Park Lake	0.1226	73.5
123	Nippersink Lake (Site 1)	0.1240	73.7
124	Grass Lake (Site 1)	0.1288	74.2
125	Lake Holloway	0.1322	74.6
126	Lakewood Marsh	0.1330	74.7
127	Summerhill Estates Lake	0.1384	75.2
128	Redhead Lake	0.1412	75.5
129	Antioch Lake	0.1448	75.9
130	Forest Lake	0.1470	76.1
131	Valley Lake	0.1470	76.1
132	Slocum Lake	0.1496	76.4

Table 2. Continued.

RANK	LAKE NAME	TP AVE	TSIp
133	Drummond Lake	0.1510	76.5
134	Pond-a-Rudy	0.1514	76.5
135	Lake Matthews	0.1516	76.6
136	Buffalo Creek Reservoir	0.1550	76.9
137	Pistakee Lake (Site 1)	0.1592	77.3
138	Salem Lake	0.1650	77.8
139	Half Day Pit	0.1690	78.1
140	McDonald Lake 1	0.1722	78.4
141	Lake Eleanor Site II, Outflow	0.1812	79.1
142	Lake Farmington	0.1848	79.4
143	ADID 127	0.1886	79.7
144	Lake Louise Inlet	0.1938	80.1
145	Grassy Lake	0.1952	80.2
146	Fischer Lake	0.1978	80.4
147	Dog Bone Lake	0.1990	80.5
148	Redwing Marsh	0.2072	81.1
149	Stockholm Lake	0.2082	81.1
150	Bishop Lake	0.2156	81.6
151	Hidden Lake	0.2236	82.2
152	Lake Napa Suwe (Outlet)	0.2304	82.6
153	Patski Pond (outlet)	0.2512	83.8
154	Slough Lake	0.2634	84.5
155	McDonald Lake 2	0.2706	84.9
156	Oak Hills Lake	0.2792	85.4
157	Loch Lomond	0.2954	86.2
158	Fairfield Marsh	0.3264	87.6
159	ADID 182	0.3280	87.7
160	Flint Lake Outlet	0.4996	93.8
161	Rasmussen Lake	0.5025	93.8
162	Albert Lake, Site II, outflow	1.1894	106.3

Table 3. Approximate land uses and retention time for the Third Lake watershed, 2005.

Land Use	Acreage	% of Total
Agricultural	1757.6	20.5%
Forest and Grassland	317.2	3.7%
Government and Institutional	427.9	5.0%
Industrial	108.2	1.3%
Multi Family	104.8	1.2%
Office	30.6	0.4%
Public and Private Open Space	1072.1	12.5%
Retail/Commercial	399.0	4.7%
Single Family	2001.4	23.4%
Transportation	888.2	10.4%
Utility and Waste Facilities	287.2	3.4%
Water	666.2	7.8%
Wetlands	506.5	5.9%
Total Acres	**8566.8**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	1757.6	0.05	241.7	3.6%
Forest and Grassland	317.2	0.05	43.6	0.7%
Government and Institutional	427.9	0.50	588.4	8.8%
Industrial	108.2	0.85	252.9	3.8%
Multi Family	104.8	0.30	86.4	1.3%
Office	30.6	0.85	71.6	1.1%
Public and Private Open Space	1072.1	0.15	442.2	6.6%
Retail/Commercial	399.0	0.85	932.6	13.9%
Single Family	2001.4	0.30	1651.1	24.7%
Transportation	888.2	0.85	2076.1	31.0%
Utility and Waste Facilities	287.2	0.30	236.9	3.5%
Water	666.2	0.00	0.0	0.0%
Wetlands	506.5	0.05	69.6	1.0%
TOTAL	**8566.8**		**6693.4**	**100.0%**

Lake volume	**3187.5**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.48**	**years**
	173.82	**days**

SUMMARY OF AQUATIC MACROPHYTES

Aquatic plant species presence and distribution in Third Lake were assessed in June and August 2005 (see Appendix A for methods). Twelve aquatic submersed and floating plant species were found (see Table 4, below).

Third Lake has a good diversity of aquatic plants. In June, Sago Pondweed was the most common species, being found in 41.7% of the sample sites (Table 5a, 5b). Eurasian Watermilfoil (EWM), an invasive exotic species, *Chara*, and Slender Naiad were the next most common species, all being found in 17.5% of the sites. In August, EWM was the most common species (37.4%), followed by Sago Pondweed (12.1%) and Spiny Naiad (7.1%), and Chara (5.1%). The approximate plant densities (total density, including all species) are shown in Figures 9 (June) and 10 (August). The 2005 survey was similar to the 2000 study, however, EWM appeared to be less common in 2005. In 2000, a "ring of milfoil" was apparent approximately 100 feet of shore in approximately 8-10 feet of water. In 2005, the ring was not as prominent.

To maintain a healthy sunfish/bass fishery, the optimal aquatic plant (macrophyte) coverage is 30% to 40% across the lake bottom. Third Lake has approximately 35% coverage, although some of the plant beds were scattered. At this time the overall density of aquatic plants in Third Lake is adequate. However, the presence of EWM is a concern and its growth should be monitored since this exotic can quickly spread and shade out other beneficial native plants. No intensive aquatic plant management plans are recommended at this time.

Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. Aquatic plants will not photosynthesize at water depths with less than 1% of the available sunlight at the surface. During 2005, the depth of the 1% light level ranged from 12 feet (May) to17 feet (October). Based on the 1993 bathymetric map, approximately between 60-68% of the lake received adequate light penetration to grow rooted aquatic plants. However, the maximum depth at which plants were found in 2005 was 9.5 feet.

The Floristic Quality Index (FQI) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts (Nichols, 1999). Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. Third Lake had a FQI of 19.6 in 2005, which is a slight decline from 2000 (FQI of 21.6). The median FQI for 2000-2005 Lake County lakes is 13.1.

Table 4: Aquatic plant species found in Third Lake in 2005.

Coontail	*Ceratophyllum demersum*
Chara	*Chara* spp.
Curlyleaf Pondweed^	*Potamogeton crispus*
Flatstem Pondweed	*Potamogeton zosteriformis*
Illinois Pondweed	*Potamogeton illinoensis*
Largeleaf Pondweed	*Potamogeton amplifolius*
Sago Pondweed	*Potamogeton pectinatus*
Small Pondweed	*Potamogeton pusillus*
Eurasian Water Milfoil^	*Myriophyllum spicatum*
Slender Naiad	*Najas flexilis*
Spiny Naiad	*Najas marina*
White Water Lily	*Nymphaea tuberosa*
Horned Pondweed	*Zannichellia palustris*

^ Exotic plant

SUMMARY OF SHORELINE CONDITION

In 2000, an assessment was conducted to determine the condition of the shoreline at the water/land interface. Sixty percent (60%) of the undeveloped shoreline was primarily wetland vegetation (i.e., cattails). Developed shoreline had either mowed lawn to the edge (26% or 1750 feet), some form of unmowed buffer strip (24% or 1630 feet), concrete or metal seawalls (24% or 1632 feet) or rip rap (rock) (22% or 1443 feet). Interestingly, only 3% of the developed shoreline had a sand beach. The lack of beaches may be due to the algal accumulations that inhibited swimming prior to dredging.

Shoreline erosion on undeveloped shorelines was either none (60%) or slight (40%) as of May 2000. Developed shoreline had 53% with no erosion, 43% with slight erosion and 4% with moderate erosion. All sites with moderate erosion had mowed lawns directly to the edge.

The shoreline was reassessed for shoreline erosion in August 2005. Several locations classified as slight or moderate erosion in 2000 where reclassified as none or slight, as some form of shoreline restoration was completed. No severe erosion was noted. There were only three small parcels classified as moderately eroding (Figure 11).

Table 5a. Aquatic vegetation species found at the 103 (June) and 99 (August) sampling sites on Third Lake, 2005. Maximum depth plants were found was 9.5 feet.

June

Plant Density	Chara	Coontail	Curlyleaf Pondweed	Eurasian Water Milfoil	Flatstem Pondweed	Horned Pondweed	Illinois Pondweed	Largeleaf Pondweed	Sago Pondweed	Slender Naiad	Small Pondweed	Spiny Naiad
Present	11	5	2	17	2	2	8	1	25	12	5	15
Common	7	0	2	1	0	0	4	1	11	6	0	5
Abundant	0	0	0	0	0	0	0	0	6	0	0	0
Dominant	0	0	0	0	0	0	0	0	1	0	0	0
% Plant Occurrence	17.5	4.9	3.9	17.5	1.9	1.9	11.7	1.9	41.7	17.5	4.9	19.4

August

Plant Density	Chara	Coontail	Curlyleaf Pondweed	Eurasian Water Milfoil	Illinois Pondweed	Sago Pondweed	Slender Naiad	Small Pondweed	Spiny Naiad	White Water Lilly
Present	5	1	0	22	1	5	4	0	7	0
Common	0	0	0	13	1	6	0	0	0	0
Abundant	0	0	0	2	0	1	0	0	0	0
Dominant	0	0	0	0	0	0	0	0	0	0
% Plant Occurrence	5.1	1.0	0.0	37.4	2.0	12.1	4.0	0.0	7.1	0.0

Table 5b. Distribution of rake density across all sampling sites.

June

Rake Density (coverage)	# of Sites	% of Sites
No Plants	32	31.1
>0-10%	38	36.9
10-40%	22	21.4
40-60%	10	9.7
60-90%	1	1.0
>90%	0	0.0
Total Sites with Plants	71	68.9
Total # of Sites	103	100.0

August

Rake Density (coverage)	# of Sites	% of Sites
No Plants	53	53.5
>0-10%	26	26.3
10-40%	12	12.1
40-60%	7	7.1
60-90%	0	0.0
>90%	0	0.0
Total Sites with Plants	45	45.5
Total # of Sites	98	99.0

Figure 9. Aquatic plant grid illustrating plant on Third Lake, June 2005.

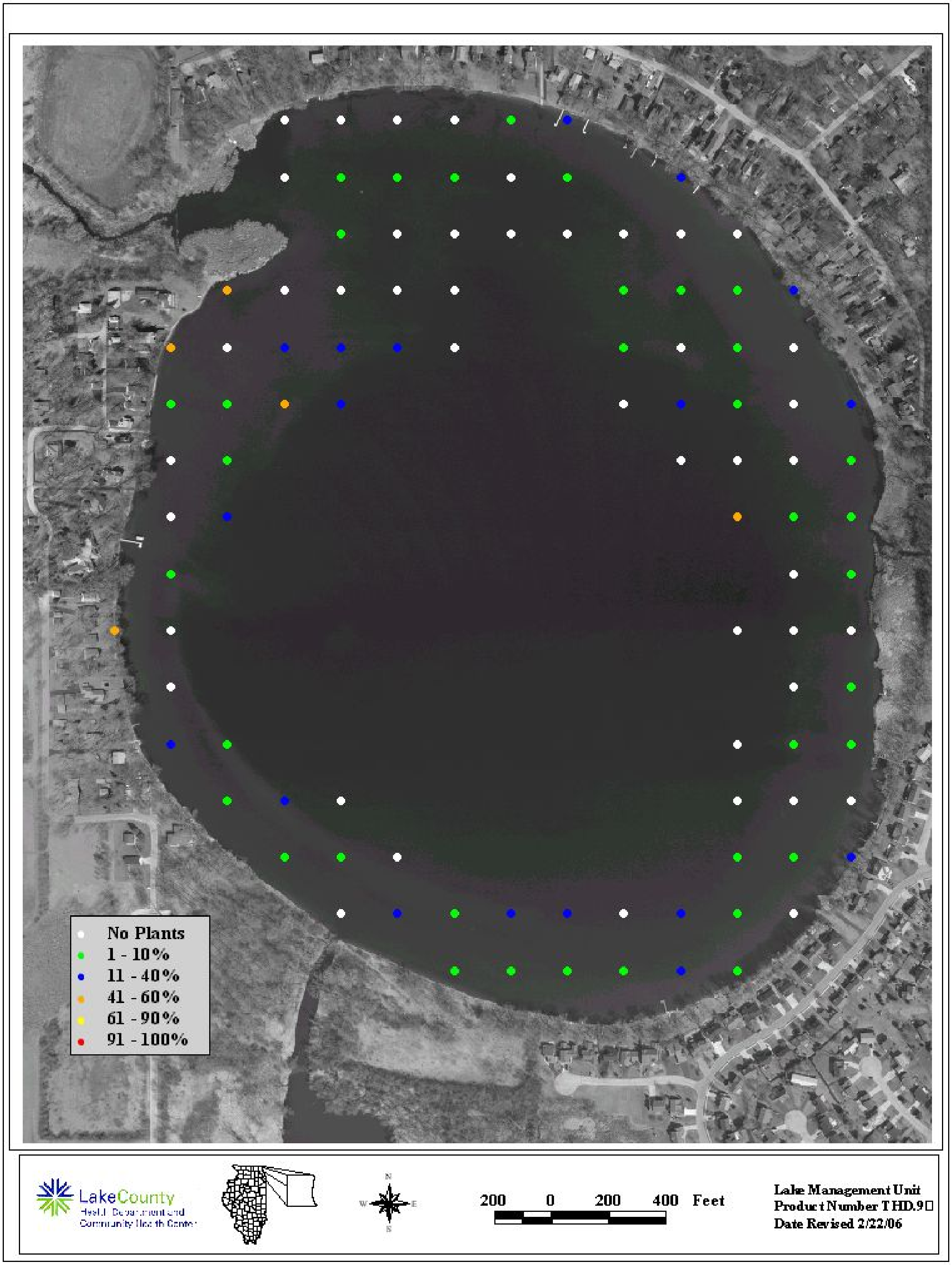


Figure 10. Aquatic plant sampling grid illustrating plant density on Third Lake, August 2005.

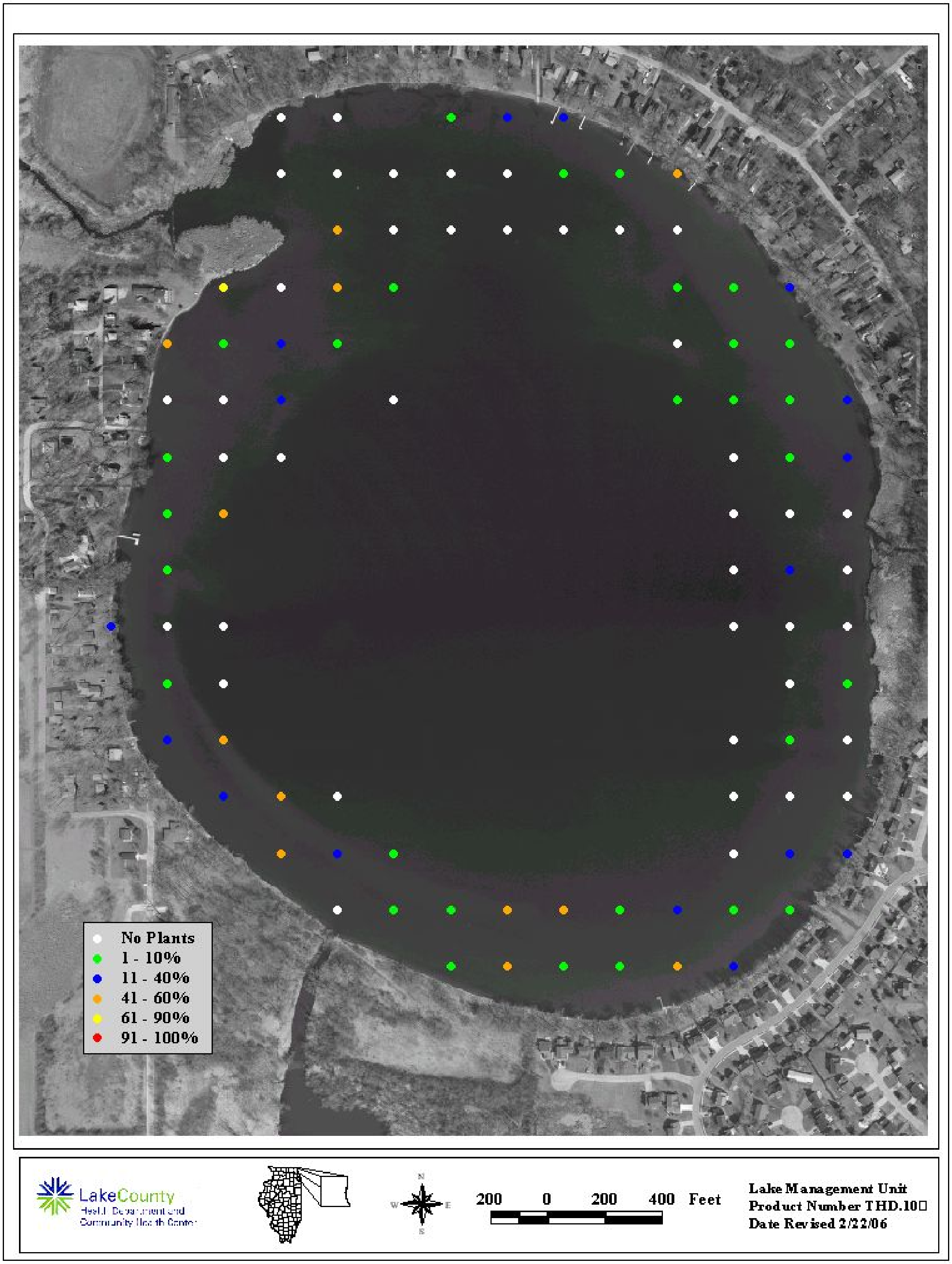
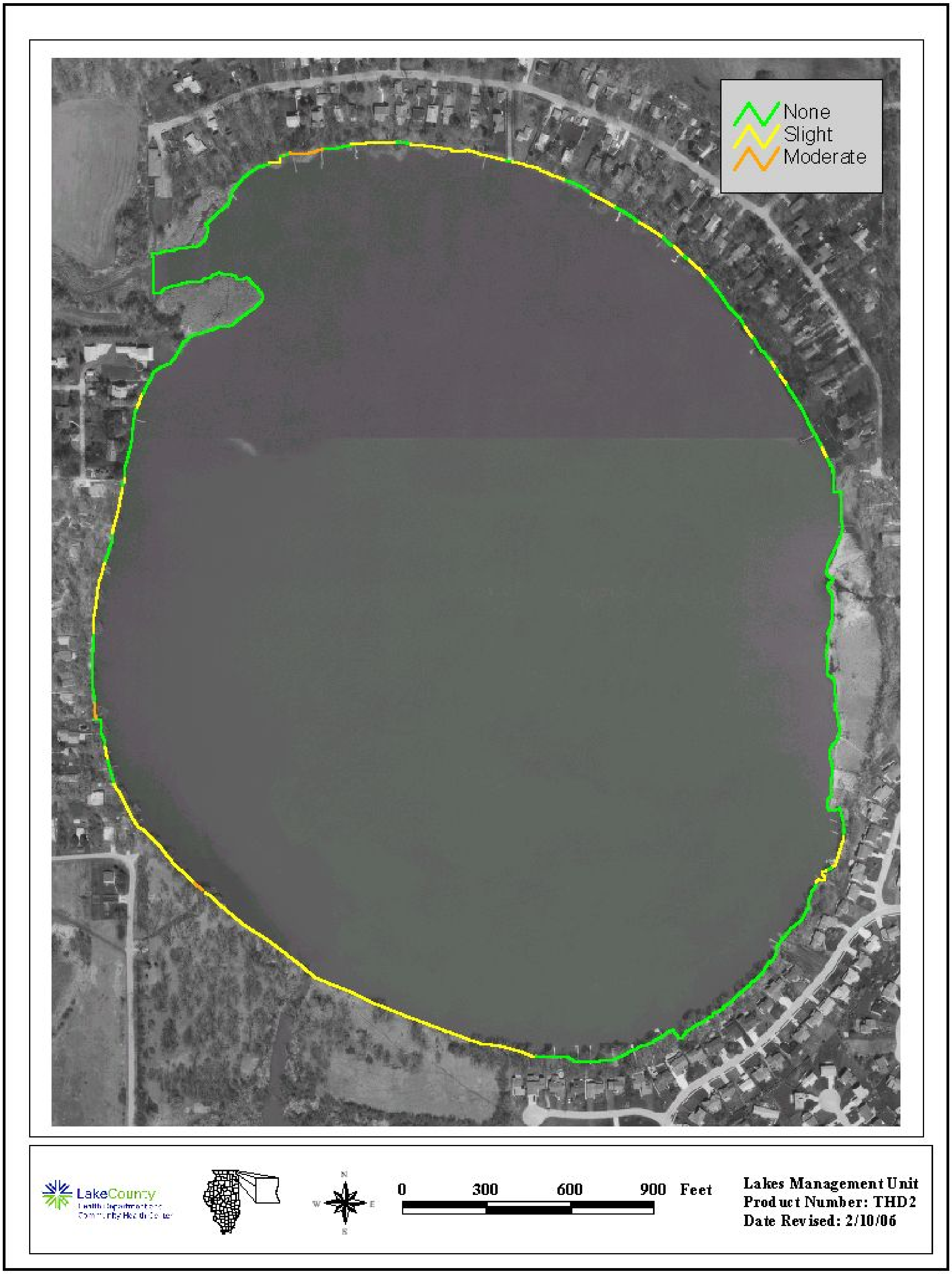


Figure 11. Shoreline erosion on Third Lake, 2005.



SUMMARY OF WILDLIFE AND HABITAT

Wildlife habitat around Third Lake was variable. Good habitat was found on the undeveloped sections of the eastern and southwestern shorelines, and along the northwest section of the lake near the spillway. While the manicured lawns on the lake do not provide good habitat, many of the lots had a mature tree canopy at the shoreline, which harbored numerous wildlife species. Improvements to the wildlife habitat on Third Lake may include the placement of artificial nesting structures (i.e., bird and bat boxes), leaving deadfall and creating buffer strips along shorelines, and boating restrictions.

The Illinois Department of Natural Resources (IDNR) conducted a survey in 2002 and reported overall a quality fishery. The IDNR recommended: (1) stocking Walleye fingerlings every other year if a population is desired, (2) remove all Common Carp and Yellow Bass caught, (3) treat aquatic vegetation when lake coverage exceeds 75% of the lake's shoreline surface, (4) establish a 15-inch minimum length limit and 1 per day catch limit on Largemouth Bass and a 24-inch minimum length limit and 1 per day catch limit on Northern Pike.

Since 2003, the Village Third Lake has been stocking Largemouth Bass, Smallmouth Bass, Northern Pike, and Channel Catfish. Additional regulations on Third Lake include "catch and release" only during April 15-June 15 on bass.

LAKE MANAGEMENT RECOMMENDATIONS

Overall Third Lake's water clarity has remained stable in recent years. Dissolved oxygen concentrations have improved and nuisance algae blooms have declined since the installation of the layered aeration system. The state of the lake's fishery appears well balanced. However, there are several of recommendations that will aid in improving the overall quality of Third Lake.

Shoreline erosion

There are still some areas around the lake with erosion. These eroded areas should be remediated to prevent additional loss of shoreline and continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation instead of riprap or seawalls (Appendix D1).

Continue monitoring dissolved oxygen concentrations and make modifications to the aeration system as needed

The layered aeration system has been an asset to the lake, but needs occasionally modifications such as adjusting the air flow and position of the ports on the aerators. The DO concentrations are influenced by climatic conditions such as precipitation in the watershed that leads to more inputs of nutrients, solids, and pollutants.

High conductivity readings and chloride concentrations

Conductivity readings in Third Lake continue to increase. The 2005 epilimnetic average for conductivity was 1.4877 milliSiemens/cm, which is 92% higher than the county median of 0.7748 milliSiemens/cm, and a 116% increase from 1993. The seasonal average for chlorides in Third Lake in 2005 was 318 mg/L in the epilimnion and 302 mg/L in the hypolimnion. The current concentrations of chlorides in Third Lake may be adversely affecting aquatic life in the lake.

The watershed of Third Lake is large and primarily urbanized. It is recommended that residents be mindful of practices occurring in the watershed that may negatively affect water quality. For example, road salt use for winter road maintenance should be addressed. Wise use and storage of salt, driver education, and assessing alternatives are goals that can be achieved (Appendix D2 and D3).

Wildlife habitat

With the lake being in a residential setting with the majority of the shoreline as riprap, seawall, or lawn, wildlife habitat is limited. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones, which were noted on some lots, and are recommended as one aspect of shoreline protection (Appendix D4). Most of the birds observed were those common to residential settings.

APPENDIX A. METHODS FOR FIELD DATA COLLECTION AND LABORATORY ANALYSES

Water Sampling and Laboratory Analyses

Two water samples were collected once a month from May through September. Sample locations were at the deepest point in the lake (see sample site map), three feet below the surface, and 3 feet above the bottom. Samples were collected with a horizontal Van Dorn water sampler. Approximately three liters of water were collected for each sample for all lab analyses. After collection, all samples were placed in a cooler with ice until delivered to the Lake County Health Department lab, where they were refrigerated. Analytical methods for the parameters are listed in Table A1. Except nitrate nitrogen, all methods are from the Eighteenth Edition of Standard Methods, (eds. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1992). Methodology for nitrate nitrogen was taken from the 14th edition of Standard Methods. Dissolved oxygen, temperature, conductivity and pH were measured at the deep hole with a Hydrolab DataSonde® 4a. Photosynthetic Active Radiation (PAR) was recorded using a LI-COR® 192 Spherical Sensor attached to the Hydrolab DataSonde® 4a. Readings were taken at the surface and then every two feet until reaching the bottom.

Plant Sampling

In order to randomly sample each lake, mapping software (ArcGIS 3.2) overlaid a grid pattern onto a 2004 aerial photo of Lake County and placed points 60 meters apart. Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At designated sampling sites, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, plant coverage was assessed for overall abundance. Then plants were individually identified and placed in categories based on coverage. Plants that were not found on the rake but were seen in the immediate vicinity of the boat at the time of sampling were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation.

Plankton Sampling

Plankton was sampled at the same location as water quality samples. Using the Hydrolab DataSonde® 4a 1% light level depth (depth where the water light is 1% of the surface irradiance) was determined. A plankton net/tow, with 80μm mesh, was then lowered to the pre-determined 1% light level depth and retrieved vertically. On the way up the water column, plankton are collected within a small cup on the bottom of the tow. The collected sample was then emptied into a pre-labeled brown plastic bottle. The net was rinsed with deionized water into the bottle in order to ensure all the plankton were collected. The sample was then transferred to a graduated cylinder to measure the amount of milliliters (mL) that the sample was. The sample was then returned to the bottle and preserved with Lugol's iodine solution (5 drops/mL). The sample bottle was then closed and stored in a cooler until returning to the lab, where it was transferred to the refrigerator until enumeration. Enumeration was performed within three months, but ideally within one month, under a microscope. Sample bottle was inverted several times to ensure proper homogenization. An automated pipette was used to retrieve 1 mL of sample, which was then placed on a Sedgewick Rafter slide. This is a microscope slide on which a rectangular chamber has been constructed, measuring 50 mm x 20 mm in area and with a depth of 1 mm. The slide was then placed under the microscope and counted at a 20X magnification. Twenty fields of view were randomly counted with all species within each field counted. Through calculations, it was determined how many of each species were in 1 mL of lake water.

Shoreline Assessment

In previous years a complete assessment of the shoreline was done. However, this year we did a visual estimate to determine changes in the shoreline. The degree of shoreline erosion was categorically defined as none, slight, moderate, or severe. Below are brief descriptions of each category.

None – Includes man-made erosion control such as beach, rip-rap and sea wall.

Slight – Minimal or no observable erosion; generally considered stable; no erosion control practices will be recommended with the possible exception of small problem areas noted within an area otherwise designated as “slight”.

Moderate – Recession is characterized by past or recently eroded banks; area may exhibit some exposed roots, fallen vegetation or minor slumping of soil material; erosion control practices may be recommended although the section is not deemed to warrant immediate remedial action.

Severe – Recession is characterized by eroding of exposed soil on nearly vertical banks, exposed roots, fallen vegetation or extensive slumping of bank material, undercutting, washouts or fence posts exhibiting realignment; erosion control practices are recommended and immediate remedial action may be warranted.

Wildlife Assessment

Species of wildlife were noted during visits to each lake. When possible, wildlife was identified to species by sight or sound. However, due to time constraints, collection of quantitative information was not possible. Thus, all data should be considered anecdotal.
Some of the species on the list may have only been seen once, or were spotted during their migration through the area.

Table A1. Analytical methods used for water quality parameters.

Parameter	***Method***
Temperature	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Dissolved oxygen	Hydrolab DataSonde ®4a or YSI 6600 Sonde®
Nitrate nitrogen	Brucine method Standard Methods (SM) 14th ed 419D Detection Limit = 0.05 mg/L
Ammonia nitrogen	SM 18th ed. Electrode method, #4500 NH_3-F Detection Limit = 0.1 mg/L
Total Kjeldahl nitrogen	SM 18th ed, 4500-N_{org} C Semi-Micro Kjeldahl, plus 4500 NH_3-F Detection Limit = 0.5 mg/L
pH	Hydrolab DataSonde® 4a, or YSI 6600 Sonde® Electrometric method
Total solids	SM 18th ed, Method #2540B
Total suspended solids	SM 18th ed, Method #2540D Detection Limit = 0.5 mg/L
Chloride	SM 18th ed, Method #4500C1-D
Total volatile solids	SM 18th ed, Method #2540E, from total solids
Alkalinity	SM 18th ed, Method #2320B, patentiometric titration curve method
Conductivity	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Total phosphorus	SM 18th ed, Methods #4500-P B 5 and #4500-P E Detection Limit = 0.01 mg/L
Soluble reactive phosphorus	SM 18th ed, Methods #4500-P B 1 and #4500-P E Detection Limit = 0.005 mg/L
Clarity	Secchi disk
Color	Illinois EPA Volunteer Lake Monitoring Color Chart
Photosynthetic Active Radiation (PAR)	Hydrolab DataSonde® 4a or YSI 6600 Sonde®, LI-COR® 192 Spherical Sensor

APPENDIX B. MULTI-PARAMETER DATA FOR BANGS LAKE IN 2005

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Ext Co
41205	111031	0.25	0.25	11.25	10.45	99.0	1.462	7.89	547	Surface		
41205	111111	1	1.03	11.34	10.38	98.5	1.468	7.9	443	Surface	100%	
41205	111202	2	2.00	11.34	10.28	97.5	1.468	7.92	142	0.25	32%	
41205	111249	3	3.05	11.33	10.31	97.8	1.468	7.91	95	1.3	21%	
41205	111341	4	4.00	11.34	10.25	97.3	1.468	7.91	66	2.25	15%	
41205	111430	6	6.03	11.34	10.33	98.0	1.468	7.9	35	4.28	7.9%	
41205	111517	8	8.08	11.30	10.20	96.7	1.466	7.9	22	6.33	5.0%	
41205	111604	10	10.05	11.22	10.16	96.2	1.465	7.89	14	8.3	3.2%	
41205	111659	12	11.98	11.14	10.13	95.6	1.466	7.88	9	10.23	2.0%	
41205	111808	14	14.07	10.80	9.99	93.7	1.461	7.84	4	12.32	0.9%	
41205	111919	16	15.89	10.19	9.90	91.5	1.459	7.8	1	14.14	0.2%	
41205	112029	18	18.08	9.22	9.86	89.0	1.457	7.75	0			
41205	112152	20	20.02	8.48	9.74	86.4	1.454	7.7	0			
41205	112320	22	21.94	8.06	9.83	86.3	1.455	7.67	0			
41205	112427	24	24.04	6.44	9.83	82.9	1.443	7.6	0			
41205	112554	26	26.04	6.02	9.62	80.3	1.443	7.55	0			
41205	112645	28	28.03	5.69	9.76	80.8	1.443	7.53	0			
41205	112728	30	29.98	5.58	9.70	80.0	1.444	7.52	0			
41205	112812	32	32.02	5.47	9.54	78.5	1.445	7.5	0			
41205	112857	34	34.01	5.37	9.34	76.7	1.447	7.48	0			
41205	112929	36	35.98	5.31	9.28	76.1	1.447	7.53	0			
41205	113011	38	38.03	5.21	9.26	75.7	1.449	7.52	0			
41205	113103	40	39.98	5.13	9.07	74.0	1.449	7.5	0			
41205	113137	42	42.04	5.03	8.83	71.9	1.451	7.49	0			
41205	113214	44	44.03	4.99	8.63	70.2	1.452	7.47	0			
41205	113301	46	46.08	4.95	8.53	70.8	1.452	7.47	0			
41205	113406	48	48.05	4.87	8.38	67.9	1.454	7.45	0			
41205	113455	50	49.98	4.84	8.29	67.1	1.454	7.43	0			
41205	113554	52	51.99	4.75	7.99	64.5	1.457	7.42	0			
41205	113644	54	54.04	4.64	7.94	64.0	1.458	7.41	0			
41205	113731	56	56.03	4.59	7.76	62.5	1.457	7.4	0			
41205	113828	58	58.02	4.55	7.53	60.6	1.458	7.38	0			
41205	114000	60	60.07	4.54	7.25	58.3	1.458	7.37	0			
41205	114049	62	62.03	4.51	7.02	56.4	1.459	7.36	0			
41205	114139	64	64.00	4.41	5.76	46.1	1.466	7.33	0			

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Ext Co
51805	111446	0	0.34	14.80	9.73	99.1	1.508	7.08	2196	Surface		
51805	111607	1	1.00	14.83	9.53	97.1	1.509	7.38	1914	Surface	100%	
51805	111711	2	1.98	14.79	9.56	97.3	1.508	7.46	662	0.23	35%	
51805	111926	3	3.05	14.76	9.56	97.3	1.509	7.55	450	1.3	24%	
51805	111959	4	4.05	14.70	9.51	96.6	1.506	7.57	486	2.3	25%	
51805	112102	6	6.00	14.65	9.56	97.1	1.508	7.59	297	4.25	16%	
51805	112156	8	7.99	14.52	9.44	95.5	1.509	7.61	188	6.24	10%	
51805	112304	10	10.03	13.40	9.31	92.0	1.505	7.60	140	8.28	7%	
51805	112410	12	11.98	13.37	9.20	90.8	1.505	7.60	86	10.23	4%	
51805	112508	14	14.01	13.30	9.19	90.6	1.505	7.60	48	12.26	3%	
51805	112600	16	16.01	13.21	9.15	90.0	1.505	7.60	32	14.26	1.7%	
51805	112714	18	17.99	12.85	8.82	86.1	1.505	7.57	20	16.24	1.0%	
51805	112827	20	19.99	12.23	8.51	81.9	1.507	7.54	11	18.24	0.6%	
51805	113039	22	22.01	11.27	8.42	79.4	1.499	7.48	6	20.26	0.3%	
51805	113153	24	24.00	10.29	8.36	76.9	1.505	7.41	3	22.25	0.2%	
51805	113246	26	25.99	9.73	8.53	77.4	1.515	7.40	1	24.24	0.1%	
51805	113400	28	28.01	9.30	8.56	76.9	1.506	7.36	0	26.26		
51805	113531	30	30.01	8.87	8.04	71.5	1.504	7.29	0	28.26		
51805	113814	32	31.97	8.40	7.62	67.0	1.497	7.21	0	30.22		
51805	114008	34	33.98	7.90	7.12	61.9	1.493	7.15	0	32.23		
51805	114128	36	35.95	7.28	6.45	55.2	1.483	7.09	0	34.2		
51805	114227	38	38.00	6.84	6.27	53.1	1.482	7.06	0	36.25		
51805	114347	40	39.99	6.36	5.73	47.9	1.485	7.02	0	38.24		
51805	114456	42	41.99	5.97	4.95	41.0	1.476	6.99	0	40.24		
51805	114556	44	44.01	5.79	4.86	40.0	1.475	6.98	0	42.26		
51805	114702	46	46.01	5.74	4.74	39.0	1.475	6.96	0	44.26		
51805	114816	48	48.00	5.63	4.33	35.5	1.475	6.94	0	46.25		
51805	114952	50	50.01	5.48	4.26	34.9	1.476	6.92	0	48.26		
51805	115058	52	52.03	5.18	4.06	33.0	1.475	6.90	0	50.28		
51805	115158	54	54.01	5.05	3.56	28.8	1.475	6.88	0	52.26		
51805	115318	56	56.00	4.96	2.65	21.4	1.477	6.85	0	54.25		
51805	115437	58	58.02	4.91	1.76	14.2	1.479	6.83	0	56.27		
51805	115557	60	60.04	4.90	1.20	9.7	1.479	6.80	0	58.29		
51805	115709	62	62.02	4.88	0.66	5.3	1.480	6.79	0	60.27		
51805	115809	64	64.00	4.84	0.40	3.2	1.481	6.77	0	62.25		

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Ext Co
6/22/05	82854	0.25	0.48	24.46	8.28	101.9	1.514	7.86	3163	Surface		
6/22/05	82956	1	0.92	24.5	8.46	104.2	1.514	7.93	3681	Surface	100%	
6/22/05	83110	2	1.99	24.49	8.48	104.4	1.51	7.98	1380	0.24	37%	
6/22/05	83221	3	3.02	24.5	8.4	103.5	1.512	7.99	920	1.27	25%	
6/22/05	83331	4	4	24.5	8.35	102.8	1.51	8	794	2.25	22%	
6/22/05	83420	6	6	24.47	8.35	102.8	1.51	8.01	443	4.25	12%	
6/22/05	83513	8	8.01	24.28	8.19	100.5	1.508	8	260	6.26	7%	
6/22/05	83631	10	10	23.82	8.09	98.4	1.508	7.97	134	8.25	4%	
6/22/05	83806	12	12	22.04	7.5	88.2	1.504	7.9	78	10.25	2%	
6/22/05	83925	14	13.95	20.55	6.54	74.7	1.5	7.8	46	12.2	1.2%	
6/22/05	84048	16	16.02	18.65	5.59	61.4	1.49	7.64	29	14.27	0.8%	
6/22/05	84209	18	18.01	12.94	4.82	46.9	1.485	7.39	13	16.26	0.4%	
6/22/05	84332	20	20.01	10.25	4.69	42.9	1.473	7.2	8	18.26	0.2%	
6/22/05	84456	22	21.98	9.56	4.63	41.7	1.474	7.07	4	20.23	0.1%	
6/22/05	84612	24	24.04	9.41	4.58	41.1	1.474	7	1	22.29	0.03%	
6/22/05	84725	26	25.99	9.33	4.56	40.8	1.475	6.96	0	24.24		
6/22/05	84820	28	27.99	9.29	4.56	40.8	1.475	6.93	0	26.24		
6/22/05	85002	30	30.03	9.26	4.55	40.7	1.475	6.81	0	28.28		
6/22/05	85134	32	32	9.22	4.53	40.5	1.476	6.81	0	30.25		
6/22/05	85321	34	33.96	9.07	4.4	39.1	1.475	6.79	0	32.21		
6/22/05	85419	36	35.98	8.95	4.32	38.3	1.474	6.79	0	34.23		
6/22/05	85548	38	37.99	8.88	4.22	37.4	1.474	6.81	0	36.24		
6/22/05	85656	40	40.01	8.78	4.13	36.5	1.473	6.83	0	38.26		
6/22/05	85802	42	42.01	8.7	4.03	35.6	1.474	6.85	0	40.26		
6/22/05	85912	44	43.99	8.44	3.59	31.5	1.472	6.86	0	42.24		
6/22/05	90020	46	46.02	7.88	2.72	23.5	1.468	6.84	0	44.27		
6/22/05	90154	48	48.01	6.61	0.94	7.9	1.457	6.78	0	46.26		
6/22/05	90342	50	49.97	5.77	0.05	0.4	1.459	6.72	0	48.22		
6/22/05	90456	52	51.98	5.5	0	0	1.458	6.69	0	50.23		
6/22/05	90605	54	53.99	5.32	0	0	1.459	6.67	0	52.24		
6/22/05	90718	56	56.03	5.17	0	0	1.461	6.65	0	54.28		
6/22/05	90817	58	57.98	5.11	0	0	1.465	6.62	0	56.23		
6/22/05	90928	60	59.99	5.08	0	0	1.469	6.59	0	58.24		
6/22/05	91001	62	62.03	5.08	0	0	1.47	6.58	0	60.28		

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Ext Co
72005	80807	0.25	0.28	24.47	9.79	121	0.0008	8.03	1073	Surface		
72005	80920	1	0.99	27.27	8.55	111.4	1.506	8.07	618	Surface	100%	
72005	81013	2	1.99	27.27	8.53	111.1	1.508	8.1	191	0.24	31%	
72005	81103	3	3	27.26	8.58	111.7	1.508	8.11	169	1.25	27%	
72005	81155	4	4.02	27.28	8.39	109.3	1.506	8.12	116	2.27	19%	
72005	81349	6	6.04	27.28	8.53	111.1	1.506	8.13	74	4.29	12%	
72005	81502	8	7.98	27.26	8.41	109.5	1.507	8.13	51	6.23	8%	
72005	81607	10	10.05	26.84	7.86	101.7	1.509	8.07	30	8.3	5%	
72005	81715	12	12.03	26.47	7.46	95.7	1.506	8.04	18	10.28	3%	
72005	81910	14	13.98	24.03	5.72	70.2	1.506	7.77	10	12.23	1.6%	
72005	82022	16	16.02	19.81	3.59	40.7	1.495	7.5	5	14.27	0.8%	
72005	82121	18	17.98	12.75	3.44	33.5	1.485	7.33	2	16.23	0.3%	
72005	82221	20	20.02	12	3.56	34.1	1.481	7.19	0	18.27		
72005	82327	22	22	11.38	3.69	34.9	1.481	7.09	0	20.25		
72005	82432	24	23.99	11.2	3.66	34.4	1.481	7.02	0	22.24		
72005	82541	26	25.98	11.15	3.59	33.7	1.48	6.96	0	24.23		
72005	82713	28	28.06	11.13	3.49	32.8	1.48	6.83	0	26.31		
72005	83658	30	30.01	11.06	3.5	32.8	1.479	6.73	0	28.26		
72005	83809	32	31.99	11.03	3.49	32.7	1.48	6.72	0	30.24		
72005	83928	34	34.01	11.01	3.39	31.8	1.48	6.73	0	32.26		
72005	84052	36	36.09	10.91	3.42	32	1.479	6.75	0	34.34		
72005	84208	38	38.08	10.82	3.31	30.8	1.479	6.77	0	36.33		
72005	84302	40	40	10.74	3.08	28.7	1.479	6.77	0	38.25		
72005	84422	42	41.93	10.67	3.1	28.7	1.479	6.78	0	40.18		
72005	84535	44	43.95	10.5	2.64	24.4	1.479	6.78	0	42.2		
72005	84706	46	46.02	9.74	1.2	10.9	1.476	6.76	0	44.27		
72005	84805	48	48	7.88	0.25	2.2	1.469	6.74	0	46.25		
72005	84904	50	50	6.97	0.11	1	1.461	6.71	0	48.25		
72005	84959	52	51.96	6.04	0.07	0.6	1.46	6.69	0	50.21		
72005	85045	54	54.01	5.61	0.06	0.5	1.465	6.66	0	52.26		
72005	85123	56	56.01	5.41	0.06	0.5	1.468	6.64	0	54.26		
72005	85203	58	57.98	5.3	0.05	0.4	1.471	6.61	0	56.23		
72005	85240	60	59.97	5.25	0.04	0.3	1.474	6.58	0	58.22		
72005	85328	62	62.06	5.18	0.04	0.3	1.481	6.53	0	60.31		
72005	85411	64	63.98	5.14	0.03	0.2	1.467	6.48	0	62.23		

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81705	81525	0.25	0.27	24.95	8.32	103.5	1.475	8.66	3249	Surface		
81705	81645	1	1	24.95	8.45	105.2	1.474	8.69	3579	Surface	100%	
81705	81804	2	2.03	24.95	8.5	105.8	1.473	8.73	1134	0.28	32%	
81705	82007	3	3.01	24.94	8.51	105.8	1.473	8.78	837	1.26	23%	
81705	82224	4	4	24.94	8.54	106.3	1.473	8.84	618	2.25	17%	
81705	82416	6	6	24.84	8.54	106	1.474	8.89	282	4.25	8%	
81705	82635	8	8.01	24.68	8.33	103.2	1.474	8.88	170	6.26	5%	
81705	82818	10	10.02	24.62	8.34	103.2	1.474	8.88	100	8.27	3%	
81705	83023	12	12.02	24.44	7.98	98.3	1.475	8.86	59	10.27	1.6%	
81705	83222	14	14.04	23.94	7.49	91.5	1.474	8.78	34	12.29	0.9%	
81705	83449	16	16.02	19.95	2.69	30.5	1.49	7.84	20	14.27	0.6%	
81705	83634	18	18.02	14.4	2.81	28.3	1.491	7.29	12	16.27	0.3%	
81705	83847	20	20	13.1	3.11	30.4	1.493	7.18	7	18.25	0.2%	
81705	83954	22	22.01	12.99	3.11	30.4	1.495	7.15	4	20.26	0.1%	
81705	84120	24	24.01	12.93	3.07	29.9	1.491	7.09	2	22.26	0.1%	
81705	84240	26	26	12.89	3.03	29.6	1.494	7.06	1	24.25	0.03%	
81705	84347	28	28	12.85	2.97	28.9	1.494	7.06	0	26.25		
81705	84445	30	30.04	12.81	2.96	28.8	1.491	7.04	0	28.29		
81705	84556	32	32.09	12.8	2.93	28.5	1.491	7.03	0	30.34		
81705	84709	34	34.01	12.75	2.82	27.4	1.497	7.02	0	32.26		
81705	84831	36	35.99	12.65	2.75	26.7	1.489	7.01	0	34.24		
81705	85008	38	38.04	12.53	2.63	25.4	1.493	7	0	36.29		
81705	85142	40	40.01	12.45	2.42	23.4	1.491	6.99	0	38.26		
81705	85335	42	42.01	12.35	2.32	22.3	1.493	7	0	40.26		
81705	85603	44	44.07	11.9	1.81	17.2	1.496	7	0	42.32		
81705	85903	46	46.01	11.44	1.07	10	1.488	6.97	0	44.26		
81705	90032	48	47.99	9.21	0.14	1.3	1.484	6.95	0	46.24		
81705	90137	50	49.99	7.62	0	0	1.474	6.91	0	48.24		
81705	90252	52	52.02	6.75	0	0	1.474	6.86	0	50.27		
81705	90404	54	53.97	6.03	0.01	0.1	1.474	6.77	0	52.22		
81705	90500	56	56	5.63	0.02	0.1	1.479	6.73	0	54.25		
81705	90553	58	58.03	5.38	0	0	1.483	6.65	0	56.28		
81705	90652	60	60.02	5.26	0.01	0.1	1.49	6.59	0	58.27		
81705	90833	62	62.06	5.23	0.13	1.1	1.496	6.51	0	60.31		

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92105	75750	0.25	0.38	22.05	8.32	98	1.445	8.7	2664	Surface		
92105	75850	1	1.04	22.06	8.15	96	1.445	8.71	2919	Surface	100%	
92105	80001	2	2.02	22.06	8.35	98.4	1.444	8.72	526	0.27	18%	
92105	80054	3	3.05	22.07	8.14	95.9	1.444	8.73	499	1.3	17%	
92105	80141	4	4.01	22.07	8.21	96.8	1.444	8.74	370	2.26	13%	
92105	80255	6	6.01	22.06	8.19	96.5	1.444	8.77	184	4.26	6%	
92105	80353	8	8.02	22.06	8.21	96.7	1.445	8.79	109	6.27	4%	
92105	80512	10	10.04	22.06	8.22	96.8	1.445	8.81	67	8.29	2%	
92105	80619	12	11.98	21.95	7.92	93.1	1.444	8.82	43	10.23	1.5%	
92105	80721	14	14.04	21.66	7.48	87.4	1.446	8.75	27	12.29	0.9%	
92105	80836	16	15.95	21.14	6.96	80.5	1.448	8.66	18	14.2	0.6%	
92105	80951	18	18.03	16.65	2.38	25.2	1.484	7.34	11	16.28	0.4%	
92105	81047	20	19.95	15.13	2.45	25.1	1.487	7.19	6	18.2	0.2%	
92105	81131	22	22.01	14.97	2.41	24.6	1.488	7.16	4	20.26	0.1%	
92105	81214	24	24.04	14.94	2.28	23.2	1.489	7.14	3	22.29	0.1%	
92105	81308	26	26.01	14.92	2.3	23.4	1.489	7.12	1	24.26	0.03%	
92105	81402	28	27.98	14.87	2.35	23.7	1.49	7.09	0	26.23		
92105	81455	30	29.97	14.83	2.2	22.3	1.49	7.08	0	28.22		
92105	81550	32	31.99	14.8	2.16	21.9	1.49	7.05	0	30.24		
92105	81639	34	34.03	14.79	2.12	21.5	1.49	7.03	0	32.28		
92105	81732	36	36	14.76	2.08	21.2	1.49	7	0	34.25		
92105	81817	38	38	14.7	1.96	19.9	1.49	6.97	0	36.25		
92105	81921	40	39.94	14.61	1.88	19	1.49	6.93	0	38.19		
92105	82007	42	42.03	14.43	1.5	15.1	1.49	6.89	0	40.28		
92105	82102	44	44	14.33	1.16	11.6	1.491	6.86	0	42.25		
92105	82158	46	46.02	13.57	0.51	5	1.491	6.77	0	44.27		
92105	82253	48	47.98	11.46	0.14	1.4	1.491	6.63	0	46.23		
92105	82351	50	49.97	10.09	0.13	1.2	1.482	6.47	0	48.22		
92105	82438	52	52.01	8.02	0.07	0.6	1.473	6.27	0	50.26		
92105	82534	54	53.99	7	0.05	0.5	1.477	6.1	0	52.24		
92105	82617	56	55.97	6.36	0.06	0.5	1.481	6	0	54.22		
92105	82656	58	57.99	5.91	0.06	0.5	1.49	5.87	0	56.24		
92105	82733	60	60.05	5.66	0.06	0.5	1.498	5.8	0	58.3		
92105	82819	62	61.97	5.51	0.13	1.1	1.519	5.7	0	60.22		

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101905	84718	0.5	0.4	14.97	8.1	83.2	1.501	7.66	711	Surface		
101905	84804	1	1.08	14.99	7.96	81.8	1.501	7.64	713	Surface	100%	
101905	84845	2	2.06	14.98	7.99	82.1	1.497	7.62	285	0.31	40%	
101905	84937	3	3.1	14.99	8	82.1	1.498	7.6	231	1.35	32%	
101905	85029	4	4.06	14.99	7.87	80.8	1.497	7.59	148	2.31	21%	
101905	85122	6	5.95	14.99	7.77	79.8	1.498	7.58	112	4.2	16%	
101905	85214	8	8.05	15	7.95	81.7	1.497	7.59	71	6.3	10%	
101905	85303	10	9.99	14.99	7.84	80.6	1.498	7.6	69	8.24	10%	
101905	85357	12	12.01	14.99	7.95	81.7	1.5	7.59	32	10.26	4%	
101905	85451	14	14.02	14.99	7.8	80.2	1.498	7.6	35	12.27	5%	
101905	85552	16	16.02	14.99	7.83	80.4	1.497	7.6	25	14.27	4%	
101905	85638	18	18.13	14.99	7.67	78.8	1.498	7.61	13	16.38	1.8%	
101905	85728	20	20.01	14.99	7.52	77.3	1.496	7.62	5	18.26	0.7%	
101905	85816	22	21.97	14.98	7.61	78.1	1.502	7.63	4	20.22	0.6%	
101905	85908	24	24.04	14.96	7.6	78	1.5	7.63	3	22.29	0%	
101905	85951	26	26.04	14.97	7.47	76.7	1.5	7.64	3	24.29	0%	
101905	90042	28	27.99	14.98	7.54	77.4	1.498	7.65	1	26.24	0%	
101905	90138	30	30.03	14.99	7.49	76.9	1.498	7.66	1	28.28	0%	
101905	90243	32	31.98	14.98	7.5	77	1.498	7.67	1	30.23	0%	
101905	90335	34	34.04	14.95	7.47	76.7	1.505	7.68	0	32.29	0%	
101905	90413	36	36.04	14.96	7.5	77	1.5	7.68	0	34.29	0%	
101905	90524	38	38.09	14.93	7.54	77.3	1.498	7.69	0	36.34	0%	
101905	90620	40	40.09	14.8	7.71	78.9	1.498	7.72	0	38.34	0%	
101905	90652	42	42	14.52	7.38	75.1	1.498	7.68	0	40.25	0%	
101905	90812	44	44.04	13.91	5.06	50.8	1.507	7.4	0	42.29	0%	
101905	90906	46	46.31	13.41	3.32	32.9	1.51	7.26	1	44.56	0%	
101905	91002	48	48.06	13.26	4.06	40.2	1.505	7.25	1	46.31	0%	
101905	91102	50	50	11.5	0.26	2.5	1.52	6.98	0	48.25	0%	
101905	91200	52	52	9.84	0.16	1.5	1.51	6.83	0	50.25	0%	
101905	91249	54	54.24	7.52	0.16	1.4	1.525	6.6	1	52.49	0%	
101905	91334	56	56.02	7.08	0.14	1.2	1.531	6.5	1	54.27	0%	
101905	91417	58	57.99	6.8	0.15	1.3	1.531	6.45	0	56.24	0%	
101905	91450	60	60.16	6.52	0.14	1.2	1.534	6.41	1	58.41	0%	
101905	91524	62	62.1	6.34	0.15	1.2	1.539	6.37	1	60.35	0%	

APPENDIX C. INTERPRETING YOUR LAKES WATER QUALITY DATA

Lakes possess a unique set of physical and chemical characteristics that will change over time. These in-lake water quality characteristics, or parameters, are used to describe and measure the quality of lakes, and they relate to one another in very distinct ways. As a result, it is virtually impossible to change any one component in or around a lake without affecting several other components, and it is important to understand how these components are linked.

The following pages will discuss the different water quality parameters measured by Lake County Health Department staff, how these parameters relate to each other, and why the measurement of each parameter is important. The median values (the middle number of the data set, where half of the numbers have greater values, and half have lesser values) of data collected from Lake County lakes from 2000-2005 will be used in the following discussion.

Temperature and Dissolved Oxygen:

Water temperature fluctuations will occur in response to changes in air temperatures, and can have dramatic impacts on several parameters in the lake. In the spring and fall, lakes tend to have uniform, well-mixed conditions throughout the water column (surface to the lake bottom). However, during the summer, deeper lakes will separate into distinct water layers. As surface water temperatures increase with increasing air temperatures, a large density difference will form between the heated surface water and colder bottom water. Once this difference is large enough, these two water layers will separate and generally will not mix again until the fall. At this time the lake is thermally stratified. The warm upper water layer is called the ***epilimnion***, while the cold bottom water layer is called the ***hypolimnion***. In some shallow lakes, stratification and destratification can occur several times during the summer. If this occurs the lake is described as polymictic. Thermal stratification also occurs to a lesser extent during the winter, when warmer bottom water becomes separated from ice-forming water at the surface until mixing occurs during spring ice-out.

Monthly temperature profiles were established on each lake by measuring water temperature every foot (lakes $\leq$ 15 feet deep) or every two feet (lakes > 15 feet deep) from the lake surface to the lake bottom. These profiles are important in understanding the distribution of chemical/biological characteristics and because increasing water temperature and the establishment of thermal stratification have a direct impact on dissolved oxygen (DO) concentrations in the water column. If a lake is shallow and easily mixed by wind, the DO concentration is usually consistent throughout the water column. However, shallow lakes are typically dominated by either plants or algae, and increasing water temperatures during the summer speeds up the rates of photosynthesis and decomposition in surface waters. When many of the plants or algae die at the end of the growing season, their decomposition results in heavy oxygen consumption and can lead to an oxygen crash. In deeper, thermally stratified lakes, oxygen production is greatest in the top portion of the lake, where sunlight drives photosynthesis, and oxygen consumption is greatest near the bottom of a lake, where sunken organic matter accumulates and decomposes. The oxygen difference between the top and bottom water layers can be dramatic, with plenty of oxygen near the surface, but practically none near the bottom. The oxygen profiles measured during the water quality study can illustrate if this is occurring. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters. Low oxygen conditions in the upper water of a lake can also be problematic since all aquatic organisms need oxygen to live. Some oxygen may be present in the water, but at too low a concentration to sustain aquatic life. Oxygen is needed by all plants, virtually all algae and for many chemical reactions that are important in lake functioning. Most adult sport-fish such as largemouth bass and bluegill require at least 3 mg/L of DO in the water to survive. However, their offspring require at least 5 mg/L DO as they are more sensitive to DO stress. When DO concentrations drop below 3 mg/L, rough fish such as carp and green sunfish are favored and over time will become the dominant fish species.

External pollution in the form of oxygen-demanding organic matter (i.e., sewage, lawn clippings, soil from shoreline erosion, and agricultural runoff) or nutrients that stimulate the growth of excessive organic matter (i.e., algae and plants) can reduce average DO concentrations in the lake by increasing oxygen consumption. This can have a detrimental impact on the fish community, which may be squeezed into a very small volume of water as a result of high temperatures in the epilimnion and low DO levels in the hypolimnion.

Nutrients:

Phosphorus:
For most Lake County lakes, phosphorus is the nutrient that limits plant and algae growth. This means that any addition of phosphorus to a lake will typically result in algae blooms or high plant densities during the summer. The source of phosphorus to a lake can be external or internal (or both). External sources of phosphorus enter a lake through point (i.e., storm pipes and wastewater discharge) and non-point runoff (i.e., overland water flow). This runoff can pick up large amounts of phosphorus from agricultural fields, septic systems or impervious surfaces before it empties into the lake.

Internal sources of phosphorus originate within the lake and are typically linked to the lake sediment. In lakes with high oxygen levels (oxic), phosphorus can be released from the sediment through plants or sediment resuspension. Plants take up sediment-bound phosphorus through their roots, releasing it in small amounts to the water column throughout their life cycles, and in large amounts once they die and begin to decompose. Sediment resuspension can occur through biological or mechanical means. Bottom-feeding fish, such as common carp and black bullhead can release phosphorus by stirring up bottom sediment during feeding activities and can add phosphorus to a lake through their fecal matter. Sediment resuspension, and subsequent phosphorus release, can also occur via wind/wave action or through the use of artificial aerators, especially in shallow lakes. In lakes that thermally stratify, internal phosphorus release can occur from the sediment through chemical means. Once oxygen is depleted (anoxia) in the hypolimnion, chemical reactions occur in which phosphorus bound to iron complexes in the sediment becomes soluble and is released into the water column. This phosphorus is trapped in the hypolimnion and is unavailable to algae until fall turnover, and can cause algae blooms once it moves into the sunlit surface water at that time. Accordingly, many of the lakes in Lake County are plagued by dense algae blooms and excessive, exotic plant coverage, which negatively affect DO levels, fish communities and water clarity.

Lakes with an average phosphorus concentration greater than 0.05 mg/L are considered nutrient rich. The median near surface total phosphorus (TP) concentration in Lake County lakes from 2000-2005 is 0.063 mg/L and ranged from a non-detectable minimum of <0.010 mg/L on five lakes to a maximum of 3.880 mg/L on Albert Lake. The median anoxic TP concentration in Lake County lakes from 2000-2005 was 0.174 mg/L and ranged from a minimum of 0.012 mg/L in West Loon Lake to a maximum of 3.880 mg/L in Taylor Lake.

The analysis of phosphorus also included soluble reactive phosphorus (SRP), a dissolved form of phosphorus that is readily available for plant and algae growth. SRP is not discussed in great detail in most of the water quality reports because SRP concentrations vary throughout the season depending on how plants and algae absorb and release it. It gives an indication of how much phosphorus is available for uptake, but, because it does not take all forms of phosphorus into account, it does not indicate how much phosphorus is truly present in the water column. TP is considered a better indicator of a lake's nutrient status because its concentrations remain more stable than soluble reactive phosphorus. However, elevated SRP levels are a strong indicator of nutrient problems in a lake.

Nitrogen:
Nitrogen is also an important nutrient for plant and algae growth. Sources of nitrogen to a lake vary widely, ranging from fertilizer and animal wastes, to human waste from sewage treatment plants or failing septic systems, to groundwater, air and rainfall. As a result, it is very difficult to control or reduce nitrogen inputs to a lake. Different forms of nitrogen are present in a lake under different oxic conditions. NH_4^+ (ammonium) is released from decomposing organic material under anoxic conditions and accumulates in the hypolimnion of thermally stratified lakes. If NH_4^+ comes into contact with oxygen, it is immediately converted to NO_2 (nitrite) which is then oxidized to NO_3^- (nitrate). Therefore, in a thermally stratified lake, levels of NH_4^+ would only be elevated in the hypolimnion and levels of NO_3^- would only be elevated in the epilimnion. Both NH_4^+ and NO_3^- can be used as a nitrogen source by aquatic plants and algae. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen plus ammonium. Adding the concentrations of TKN and nitrate together gives an indication of the amount of total nitrogen present in the water column. If inorganic nitrogen (NO_3^-, NO_2^-, NH_4^+) concentrations exceed 0.3 mg/L in spring, sufficient nitrogen is available to support summer algae blooms. However, low nitrogen levels do not guarantee limited algae growth the way low phosphorus levels do. Nitrogen gas in the air can dissolve in lake water and blue-green algae can "fix" atmospheric nitrogen, converting it into a usable form. Since other types of algae do not have the ability to do this, nuisance blue-green algae blooms are typically associated with lakes that are nitrogen limited (i.e., have low nitrogen levels).

The ratio of TKN plus nitrate nitrogen to total phosphorus (TN:TP) can indicate whether plant/algae growth in a lake is limited by nitrogen or phosphorus. Ratios of less than 10:1

suggest a system limited by nitrogen, while lakes with ratios greater than 20:1 are limited by phosphorus. It is important to know if a lake is limited by nitrogen or phosphorus because any addition of the limiting nutrient to the lake will, likely, result in algae blooms or an increase in plant density.

Solids:

Although several forms of solids (total solids, total suspended solids, total volatile solids, total dissolved solids) were measured each month by the Lakes Management Staff, total suspended solids (TSS) and total volatile solids (TVS) have the most impact on other variables and on the lake as a whole. TSS are particles of algae or sediment suspended in the water column. High TSS concentrations can result from algae blooms, sediment resuspension, and/or the inflow of turbid water, and are typically associated with low water clarity and high phosphorus concentrations in many lakes in Lake County. Low water clarity and high phosphorus concentrations, in turn, exacerbate the high TSS problem by leading to reduced plant density (which stabilize lake sediment) and increased occurrence of algae blooms. The median TSS value in epilimnetic waters in Lake County is 7.9 mg/L, ranging from below the 1 mg/L detection limit (10 lakes) to 165 mg/L in Fairfield Marsh.

TVS represents the fraction of total solids that are organic in nature, such as algae cells, tiny pieces of plant material, and/or tiny animals (zooplankton) in the water column. High TVS values indicate that a large portion of the suspended solids may be made up of algae cells. This is important in determining possible sources of phosphorus to a lake. If much of the suspended material in the water column is determined to be resuspended sediment that is releasing phosphorus, this problem would be addressed differently than if the suspended material was made up of algae cells that were releasing phosphorus. The median TVS value was 132 mg/L, ranging from 34 mg/L in Pulaski Pond to 298 mg/L in Fairfield Marsh.

Total dissolved solids (TDS) are the amount of dissolved substances, such as salts or minerals, remaining in water after evaporation.   These dissolved solids are discussed in further detail in the *Alkalinity* and *Conductivity* sections of this document. TDS concentrations were measured in Lake County lakes prior to 2004, but was discontinued due to the strong correlation of TDS to conductivity and chloride concentrations.

Water Clarity:

Water clarity (transparency) is not a chemical property of lake water, but is often an indicator of a lake's overall water quality. It is affected by a lake's water color, which is a reflection of the amount of total suspended solids and dissolved organic chemicals. Thus, transparency is a measure of particle concentration and is measured with a Secchi disk. Generally, the lower the clarity or Secchi depth, the poorer the water quality. A decrease in Secchi depth during the summer occurs as the result of an increase in suspended solids (algae or sediment) in the water column. Aquatic plants play an important role in the level of water clarity and can, in turn, be negatively affected by low clarity levels. Plants increase clarity by competing with algae for resources and by stabilizing sediments to prevent sediment resuspension. A lake with a healthy plant community will almost always have higher water clarity than a lake without plants. Additionally, if the plants in a lake are removed (through herbicide treatment or the stocking of grass carp), the lake will probably become dominated by algae and Secchi depth will decrease. This makes it very difficult for plants to become re-established due to the lack of available sunlight and the lake will, most likely, remain turbid. Turbidity will be accelerated if the lake is very shallow and/or common carp are present. Shallow lakes are more susceptible to sediment resuspension through wind/wave action and are more likely to experience clarity problems if plants are not present to stabilize bottom sediment.

Common Carp are prolific fish that feed on invertebrates in the sediment. Their feeding activities stir up bottom sediment and can dramatically decrease water clarity in shallow lakes. As mentioned above, lakes with low water clarity are, generally, considered to have poor water quality. This is because the causes and effects of low clarity negatively impact the plant and fish communities, as well as the levels of phosphorus in a lake. The detrimental impacts of low Secchi depth to plants has already been discussed. Fish populations will suffer as water clarity decreases due to a lack of food and decreased ability to successfully hunt for prey. Bluegills are planktivorous fish and feed on invertebrates that inhabit aquatic plants. If low clarity results in the disappearance of plants, this food source will disappear too. Largemouth Bass and Northern Pike are piscivorous fish that feed on other fish and hunt by sight. As the water clarity decreases, these fish species find it more difficult to see and ambush prey and may decline in size as a result. This could eventually lead to an imbalance in the fish community. Phosphorus release from resuspended sediment could increase as water clarity and plant density decrease. This would then result in increased algae blooms, further reducing Secchi depth and aggravating all problems just discussed. The average Secchi depth for Lake County lakes is 3.17 feet. From 2000-2005, Fairfield Marsh and Patski Pond had the lowest Secchi depths (0.33 feet) and Bangs Lake had the highest (29.23 feet). As an example of the difference in Secchi depth based on plant coverage, South Churchill Lake, which had no plant coverage and large numbers of Common Carp in 2003 had an average Secchi depth of 0.73 feet (over four times lower than the county average), while Deep Lake, which had a diverse plant community and few carp had an average 2003 Secchi depth of 12.48 feet (almost four times higher than the county average).

Another measure of clarity is the use of a light meter. The light meter measures the amount of light at the surface of the lake and the amount of light at each depth in the water column. The amount of attenuation and absorption (decreases) of light by the water column are major factors controlling temperature and potential photosynthesis. Light intensity at the lake surface varies seasonally and with cloud cover, and decreases with depth. The deeper into the water column light penetrates, the deeper potential plant growth. The maximum depth at which algae and plants can grow underwater is usually at the depth where the amount of light available is reduced to 0.5%-1% of the amount of light available at the lake surface. This is called the euphotic (sunlit) zone. A general rule of thumb in Lake County is that the 1% light level is about 1 to 3 times the Secchi disk depth.

Alkalinity, Conductivity, Chloride, pH:

Alkalinity:

Alkalinity is the measurement of the amount of acid necessary to neutralize carbonate ($CO_3^{=}$) and bicarbonate (HCO_3^-) ions in the water, and represents the buffering capacity of a body of water. The alkalinity of lake water depends on the types of minerals in the surrounding soils and in the bedrock. It also depends on how often the lake water comes in contact with these minerals. If a lake gets groundwater from aquifers containing limestone minerals such as calcium carbonate ($CaCO_3$) or dolomite ($CaMgCO_3$), alkalinity will be high. The median alkalinity in Lake County lakes (162 mg/L) is considered moderately hard according to the hardness classification scale of Brown, Skougstad and Fishman (1970). Because hard water (alkaline) lakes often have watersheds with fertile soils that add nutrients to the water, they usually produce more fish and aquatic plants than soft water lakes. Since the majority of Lake County lakes have a high alkalinity they are able to buffer the adverse effects of acid rain.

Conductivity and Chloride:

Conductivity is the inverse measure of the resistance of lake water to an electric flow. This means that the higher the conductivity, the more easily an electric current is able to flow through water. Since electric currents travel along ions in water, the more chemical ions or dissolved salts a body of water contains, the higher the conductivity will be. Accordingly, conductivity has been correlated to total dissolved solids and chloride ions. The amount of dissolved solids or conductivity of a lake is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, and evaporation and bacterial activity. Many Lake County lakes have elevated conductivity levels in May, but not during any other month. This was because chloride, in the form of road salt, was washing into the lakes with spring rains, increasing conductivity. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. Beginning in 2004, chloride concentrations are one of the parameters measured during the lake studies. Increased chloride concentrations may have a negative impact on aquatic organisms. Conductivity changes occur seasonally and with depth. For example, in stratified lakes the conductivity normally increases in the hypolimnion as bacterial decomposition converts organic materials to bicarbonate and carbonate ions depending on the pH of the water. These newly created ions increase the conductivity and total dissolved solids. Over the long term, conductivity is a good indicator of potential watershed or lake problems if an increasing trend is noted over a period of years. It is also important to know the conductivity of the water when fishery assessments are conducted, as electroshocking requires a high enough conductivity to properly stun the fish, but not too high as to cause injury or death.

pH:

pH is the measurement of hydrogen ion (H^+) activity in water. The pH of pure water is neutral at 7 and is considered acidic at levels below 7 and basic at levels above 7. Low pH levels of 4-5 are toxic to most aquatic life, while high pH levels (9-10) are not only toxic to aquatic life but may also result in the release of phosphorus from lake sediment. The presence of high plant densities can increase pH levels through photosynthesis, and lakes dominated by a large amount of plants or algae can experience large fluctuations in pH levels from day to night, depending on the rates of photosynthesis and respiration. Few, if any pH problems exist in Lake County lakes. Typically, the flooded gravel mines in the county are more acidic than the glacial lakes as they have less biological activity, but do not usually drop below pH levels of 7. The median near surface pH value of Lake County lakes is 8.30, with a minimum of 7.06 in Deer Lake and a maximum of 10.28 in Round Lake Marsh North.

Eutrophication and Trophic State Index:

The word *eutrophication* comes from a Greek word meaning "well nourished." This also describes the process in which a lake becomes enriched with nutrients. Over time, this is a lake's natural aging process, as it slowly fills in with eroded materials from the surrounding watershed and with decaying plants. If no human impacts disturb the watershed or the lake, natural eutrophication can take thousands of years. However, human activities on a lake or in the watershed accelerate this process by resulting in rapid soil erosion and heavy phosphorus inputs. This accelerated aging process on a lake is referred to as cultural eutrophication. The term trophic state refers to the amount of nutrient enrichment within a lake system. *Oligotrophic* lakes are usually deep and clear with low nutrient levels, little plant growth and a limited fishery. *Mesotrophic* lakes are more biologically productive than oligotrophic lakes and have moderate nutrient levels and more plant growth. A lake labeled as *eutrophic* is high in nutrients and can support high plant densities and large fish populations. Water clarity is typically poorer than oligotrophic or mesotrophic lakes and dissolved oxygen problems may be present. A *hypereutrophic* lake has excessive nutrients, resulting in nuisance plant or algae growth. These lakes are often pea-soup green, with poor water clarity. Low dissolved oxygen may also be a problem, with fish kills occurring in shallow, hypereutrophic lakes more often than less enriched lakes. As a result, rough fish (tolerant of low dissolved oxygen levels) dominate the fish community of many hypereutrophic lakes. The categorization of a lake into a certain trophic state should not be viewed as a "good to bad" categorization, as most lake residents rate their lake based on desired usage. For example, a fisherman would consider a plant-dominated, clear lake to be desirable, while a water-skier might prefer a turbid lake devoid of plants. Most lakes in Lake County are eutrophic or hypereutrophic. This is primarily as a result of cultural eutrophication. However, due to the fertile soil in this area, many lakes (especially man-made) may have started out under eutrophic conditions and will never attain even mesotrophic conditions, regardless of any amount of money put into the management options. This is not an excuse to allow a lake to continue to deteriorate, but may serve as a reality check for lake owners attempting to create unrealistic conditions in their lakes.

The Trophic State Index (TSI) is an index which attaches a score to a lake based on its average total phosphorus concentration, its average Secchi depth (water transparency) and/or its average chlorophyll *a* concentration (which represent algae biomass). It is based on the principle that as phosphorus levels increase, chlorophyll *a* concentrations increase and Secchi depth decreases. The higher the TSI score, the more nutrient-rich a lake is, and once a score is obtained, the lake can then be designated as oligotrophic, mesotrophic or eutrophic. Table 1 (below) illustrates the Trophic State Index using phosphorus concentration and Secchi depth.

Table 1. Trophic State Index (TSI).

Trophic State	TSI score	Total Phosphorus (mg/L)	Secchi Depth (feet)
Oligotrophic	<40	≤ 0.012	>13.12
Mesotrophic	≥40<50	>0.012 ≤ 0.024	≥6.56<13.12
Eutrophic	≥50<70	>0.024 ≤ 0.096	≥1.64<6.56
Hypereutrophic	≥70	>0.096	< 1.64

APPENDIX D. LAKE MANAGEMENT OPTIONS.

D1. Options for Lakes with Shoreline Erosion

Option 1: Install a Seawall

Seawalls are designed to prevent shoreline erosion on lakes in a similar manner they are used along coastlines to prevent beach erosion or harbor siltation. Today, seawalls are generally constructed of steel, although in the past seawalls were made of concrete or wood (frequently old railroad ties). A new type of construction material being used is vinyl or PVC. Vinyl seawalls will not rust over time.

If installed properly and in the appropriate areas (i.e., shorelines with severe erosion) seawalls provide effective erosion control. Seawalls are made to last many years and have relatively low maintenance. However, seawalls are disadvantageous for several reasons. One of the main disadvantages is that they are expensive, since a professional contractor and heavy equipment are needed for installation. Also, if any fill material is placed in the floodplain along the shoreline, compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling of another portion. Permits and surveys are needed whether replacing old seawall or installing a new one. Seawalls also provide little habitat for fish or wildlife. Because there is no structure for fish, wildlife, or their prey, few animals use shorelines with seawalls. In addition, poor water clarity that may be caused by resuspension of sediment from deflected wave action contributes to poor fish and wildlife habitat, since sight feeding fish and birds (i.e., bass, herons, and kingfishers) are less successful at catching prey. This may contribute to a lake's poor fishery (i.e., stunted fish populations).

Option 2: Install Rock Rip-Rap or Gabions

Rip-rap is the procedure of using rocks to stabilize shorelines. Size of the rock depends on the severity of the erosion, distance to rock source, and aesthetic preferences. Generally, four to eight inch diameter rocks are used. Gabions are wire cages or baskets filled with rock. They provide similar protection as rip-rap, but are less prone to displacement. They can be stacked, like blocks, to provide erosion control for extremely steep slopes.

Rip-rap and gabions can provide good shoreline erosion control. Rocks can absorb some of the wave energy while providing a more aesthetically pleasing appearance than seawalls. If installed properly, rip-rap and gabions will last for many years. Maintenance is relatively low, however, undercutting of the bank can cause sloughing of the rip-rap and subsequent shoreline. Fish and wildlife habitat can also be provided if large (not small) boulders are used. A major disadvantage of rip-rap is the initial expense of installation and associated permits. Installation is expensive since a licensed contractor and heavy equipment are generally needed to conduct the work. Permits are required if replacing existing or installing new rip-rap or gabions and must be acquired prior to work beginning.

Option 3: Create a Buffer Strip

Another effective, more natural method of controlling shoreline erosion is to create a buffer strip with existing or native vegetation. Native plants have deeper root systems than turfgrass and thus hold soil more effectively. Native plants also provide positive aesthetics and good wildlife habitat. Allowing vegetation to naturally propagate the shoreline would be the most cost effective, depending on the severity of erosion and the composition of the current vegetation. Stabilizing the shoreline with vegetation is most effective on slopes less than 2:1 to 3:1, horizontal to vertical, or flatter. Usually a buffer strip of at least 25 feet is recommended, however, wider strips (50 or even 100 feet) are recommended on steeper slopes or areas with severe erosion problems.

Buffer strips can be one of the least expensive means to stabilize shorelines. If no permits or heavy equipment are needed (i.e., no significant earthmoving or filling is planned), the property owner can complete the work without the need of professional contractors. Once established (typically within 3 years), a buffer strip of native vegetation will require little maintenance and may actually reduce the overall maintenance of the property, since the buffer strip will not have to be continuously mowed, watered, or fertilized. Buffer strips may slow the velocity of floodwaters, thus preventing shoreline erosion. Native plants also can withstand fluctuating water levels more effectively than commercial turfgrass. In addition, many wildlife species prefer the native shoreline vegetation habitat and various species are even dependent on native shoreline vegetation for their existence. In addition to the benefits of increased wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people, but also benefits wildlife and the overall health of the lake's ecosystem.

There are few disadvantages to native shoreline vegetation. Certain species (i.e., cattails) can be aggressive and may need to be controlled occasionally. If stands of shoreline vegetation become dense enough, access and visibility to the lake may be compromised to some degree. However, small paths could be cleared to provide lake access or smaller plants could be planted in these areas.

Option 4: Install Biolog, Fiber Roll, or Straw Blanket with Plantings

These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Biologs, fiber rolls, and straw blankets provide erosion control that secure the shoreline in the short-term and allow native plants to establish which will eventually provide long-term shoreline stabilization. They are most often made of bio-degradable materials, which break down by the time the natural vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from watershed sources. They are most effective in areas where plantings alone are not effective due to existing erosion.

Option 5: Install A-Jacks®

A-Jacks® are made of two pieces of pre-cast concrete when fitted together resemble a playing jacks. These structures are installed along the shoreline and covered with soil and/or an erosion control product. Native vegetation is then planted on the backfilled area. They can be used in areas where severe erosion does not justify a buffer strip alone. The advantage to A-Jacks® is that they are quite strong and require low maintenance once installed. In addition, once native vegetation becomes established the A-Jacks® cannot be seen. A disadvantage is that installation cost can be high since labor is intensive and requires some heavy equipment. A-Jacks® need to be pre-made and hauled in from the manufacturing site.

D2. Options for Watershed Nutrient Reduction

The two key nutrients for plant and algae growth are nitrogen and phosphorus. Fertilizers used for lawn and garden care have significant amounts of both. The three numbers on the fertilizer bag identify the percent of nitrogen, phosphorus and potash in the fertilizer mixture. For example, a fertilizer with the numbers 5-10-5 has 5% nitrogen, 10% phosphorus and 5% potash. Fertilizers considered low in phosphorus (the second number) have a number of 5 or lower. A lower concentration of phosphorus applied to a lawn will result in a smaller concentration of phosphorus in stormwater runoff. An established lawn will not be negatively affected by a lower phosphorus rate. However, for areas with new seeding or new sod, the homeowner would still want to use a fertilizer formulated for encouraging growth until the lawn is established. A simple soil test can determine the correct type and amount of fertilizer needed for the soil. Knowing this, homeowners can avoid applying the wrong type or amount of fertilizer.

Option 1. Buffer Strips

Buffer strips of unmowed native vegetation at least 25 feet wide along the shoreline can slow nutrient laden runoff from entering a lake. It can help prevent shoreline erosion and provide habitat beneficial for wildlife. Different plant mixes can be chosen to allow for more aesthetically pleasing buffer strips and tall species can be used to deter waterfowl from congregating along the shore. Initially the cost of plants can be expensive, however, over time less maintenance is required for the upkeep of a buffer strip.

Option 2. Lake Friendly Lawn and Garden Care Practices – Phosphorus Reduction

a. Compost yard waste instead of burning. Ashes from yard waste contain nutrients and are easily washed into a lake.

b. Avoid dumping yard waste along or into a ditch, pond, lake, or stream. As yard waste decomposes, the nutrients are released directly into the water, or flushed to the lake via the ditch.

c. Avoid applying fertilizer up to the water's edge. Leave a buffer strip of at least 25 feet of unfertilized yard before the shoreline.

d. Avoid applying fertilizers when heavy rains are expected, or over-watering the ground after applying fertilizer.
e. When landscaping, keep site disturbance to a minimum, especially the removal of vegetation and exposure of bare soil. Exposed soil can easily erode.
f. When landscaping, seed or plant exposed soil and cover it with mulch as soon as possible to minimize erosion and runoff.
g. Use lawn and garden chemicals sparingly, or do not use them at all.

Option 3. Street Sweeping

Street sweeping has been used in communities to help prevent debris from clogging stormsewer drains, but it also benefits lakes by removing excess phosphorus, sand, silt and other pollutants. Leftover sand and salt applied to streets has been found to contain higher concentrations of silt, phosphorus and trace metals than new sand and salt mixes. If a municipality does not manage the lake, the lake management entity may be able to offer the village or city extra payment for sweeping streets closest to the lake.

Option 4: Reduce Stormwater Volume from Impervious Surfaces

The quality and quantity of runoff directly affects the lake's water quality. With continued growth and development in Lake County, more impervious surfaces such as parking lots and buildings contribute to the volume of stormwater runoff. Runoff picks up pollutants such as nutrients and sediment as it moves over land or down gutters. A faster flow rate and higher volume can result in erosion and scouring, adding sediment and nutrients to the runoff.

Roof downspouts should be pointed away from driveways and foundations and toward lawns or planting beds where water can soak into the soil. A splash block directly below downspouts helps prevent soil erosion. If erosion still occurs, a flexible perforated plastic tubing attached to the downspout can dissipate the water flow.

Option 5: Required Practices for Construction

Follow the requirements in the Watershed Development Ordinance (WDO) concerning buffer strips. Buffer strips can slow the velocity of runoff and trap sediment and attached nutrients. Setbacks, buffer strips and erosion control features, when done properly, will help protect the lake from excessive runoff and associated pollutants. Information about the contents of the ordinance can be obtained through Lake County Planning and Development, (847) 360-6330.

Option 6. Organize a Local Watershed Organization

A watershed organization can be instrumental in circulating educational information about watersheds and how to care for them. Often a galvanized organization can be a stronger working unit and a stronger voice than a few individuals. Watershed residents are the first to notice problems in the area, such as a lack of erosion control at construction sites. This organization would be an advocate for the watershed, and members could voice their concerns about future development impacts to local officials. This organization could educate the community about how phosphorus (and other pollutants) affect lakes and can help people implement watershed controls. Several types of educational outreaches can be used together for best results. These include: community newsletters, newspaper articles, local cable and radio station announcements. In some cases fundraising may be utilized to secure more funding for a project.

Option 7. Motor Boat Restrictions for Shallow Lakes

To reduce resuspension of phosphorus from the sediment, communities that have a shallow lake or large shallow areas in their lake may want to restrict motorized boating. The action of a spinning prop in shallow areas can disturb the sediment. Flocculent sediment particles can release loosely attached phosphorus into the water. Restrictions could include a ban of motorized traffic in certain areas or ban the use of motors entirely, however this could be hard to enforce without hiring law enforcement personnel. This would work best for lakes with shallow areas that have a large phosphorus source in the sediment.

Option 8. Discourage Waterfowl from Congregating

Waterfowl droppings (feces) can be a source of phosphorus (and bacteria) to the water, especially if they are congregating in large numbers along beaches and/or other nearshore areas. The annual nutrient load from two Canada Geese can be greater than the annual nutrient load from residential areas (Gremlin and Malone, 1986). These birds prefer habitat with short plants or no plants, such as lawns mowed to the water's edge and beaches. Waterfowl avoid areas with tall, dense vegetation through which they are unable to see predators. Tactics to discourage waterfowl from congregating in large groups include scare devices, a buffer strip of tall plants along the shoreline, and discouraging people from feeding geese and ducks. Signage could be erected at public parks/beaches discouraging people from feeding waterfowl. A template is available from Lakes Management Unit.

D3. Options for Watershed Sediment Reduction

Continued sediment inflow can fill areas of the lake and cause the water to become turbid. Incoming sediment can smother fish eggs or cover young aquatic plants. Increased turbidity reduces sunlight penetration limiting aquatic plant growth. Damage to native aquatic plants from multiple sediment inputs can lead to the loss of these plant species and the animals that depend on them. Sight-feeding fish have a difficult time finding food in turbid water. Often nutrients, such as phosphorus, are attached to sediment particles that reach the lake through stormwater runoff, which can contribute to plant and algae growth.

Option 1. Municipal Street Sweeping

Street sweeping has been used by communities to help prevent debris from clogging stormsewer drains, but it also benefits a lake by removing excess sand, silt, phosphorus, and other pollutants. Leftover sand and salt applied to streets has been found to contain higher concentrations of silt, phosphorus and trace metals than new sand and salt mixes.

Option 2. Lake Friendly Lawn, Garden and Home Building Practices – Sediment

Please refer to the Watershed Development Ordinance for requirements.

a. Seed and mulch bare soil as soon as possible to minimize erosion and runoff.
b. During home building projects, disturb as little vegetation as possible to minimize erosion and runoff.
c. Incorporate a buffer strip of native vegetation next to the shoreline to improve the area for wildlife, enhance the aesthetics, and possibly increase the property value.
d. Minimize impervious surfaces when considering installing pathways or even driveways. Gravel can be a suitable and less expensive option than asphalt or concrete. This will allow water to infiltrate into the ground rather than flow across impervious surfaces.

Option 3. Agricultural Practices

Soil conservation practices such as leaving crop residue on agricultural fields helps protect the soil from erosion and potential delivery to lakes and streams by runoff. The soils and their nutrients stay where the crops can use them. In turn, less money is spent on fertilizers. Crop rotation can help rejuvenate soil that has been stripped of nutrients due to years of one crop being grown. Soil conservation practices can help protect soil from eroding and aid in maintaining the integrity of the soil.

D4. Options to Enhance Wildlife Habitat Conditions on a Lake

Option 1: Increase Habitat Cover

One of the best ways to increase habitat cover is to leave a minimum 25-foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes. This will provide cover from predators and provide nesting structure for many wildlife species and their prey.

Brush piles also make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They should be place at least 10 feet away from the shoreline to prevent any debris from washing into the lake. Trees that have fallen on the ground or into the water are beneficial by harboring food and providing cover for many wildlife species. In a lake, fallen trees provide excellent cover for fish, basking sites for turtles, and perches for herons and egrets. Increasing habitat cover should not be limited to the terrestrial environment. Native aquatic vegetation, particularly along the shoreline, can provide cover for fish and other wildlife. Finally, by increasing habitat, wildlife is attracted to and uses the area as a place to raise their young. However, if vegetation is allowed to grow, lake access and visibility may be limited. If this occurs, a small path can be made to the shoreline.

Option 2: Increase Natural Food Supply

This can be accomplished in conjunction with Option 1. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Beneficial aquatic plants are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration. Supplying natural foods artificially (i.e., birdfeeders, nectar feeders, corn cobs, etc.) will attract wildlife and in most cases does not harm the animals. However, “people food” such as bread should be avoided. Care should be given to maintain clean feeders and birdbaths to minimize disease outbreaks. Providing food for wildlife will increase the likelihood they will use the area. Migrating wildlife can be attracted with a natural food supply, primarily from seeds, but also from insects, aquatic plants or small fish.

Option 3: Limit Disturbance

Since most species of wildlife are susceptible to human disturbance, any action to curtail disturbances is beneficial. Limiting disturbance can include posting signs in areas of the lake where wildlife may live (e.g., nesting waterfowl), establish a “no wake” area, boat horsepower or speed limits, or establish restricted boating hours. These are examples of time and space zoning for lake usage. Enforcement and public education are needed if this option is to be successful. In some areas, off-duty law enforcement officers can be hired to patrol the lake.
Limiting disturbance will increase the chance that wildlife will use the lake, particularly for raising their young. Many wildlife species have suffered population declines due to loss of habitat and poor breeding success. This is due in part to their sensitivity to disturbance. Recreation activities such as canoeing and paddleboating may be enhanced by the limited disturbance.

One of the strongest opponents to this option would probably be the powerboat users and water skiers. However, this problem may be solved if a significant portion of the daylight hours and the use of the middle part of the lake (assuming the lake is deep enough) are allowed for powerboating. For example, powerboating could be allowed between 9 AM and 6 PM within the boundaries established by “no wake” restricted area buoys.

APPENDIX E. WATER QUALITY STATISTICS FOR ALL LAKE COUNTY LAKES

2000 - 2005 Water Quality Parameters, Statistics Summary

	ALK (oxic) <=3ft 2000-2005	
Average	**167.0**	
Median	**162.0**	
Minimum	**64.9**	**IMC**
Maximum	**330.0**	**Flint Lake**
STD	**42.2**	
n =	**803**	

	ALK (anoxic) 2000-2005	
Average	**205**	
Median	**194**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**53**	
n =	**265**	

	Cond (oxic) <=3ft 2000-2005	
Average	**0.8536**	
Median	**0.7748**	
Minimum	**0.2305**	**White Lake**
Maximum	**6.8920**	**IMC**
STD	**0.5203**	
n =	**808**	

	Cond (anoxic) 2000-2005	
Average	**0.9606**	
Median	**0.8210**	
Minimum	**0.3031**	**White Lake**
Maximum	**7.4080**	**IMC**
STD	**0.7611**	
n =	**265**	

	NO3-N (oxic) <=3ft 2000-2005	
Average	**0.480**	
Median	**0.116**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.019**	
n =	**808**	

*ND = Many lakes had non-detects (69%)
Only compare lakes with detectable
concentrations to the statistics above

	NH3-N (anoxic) 2000-2005	
Average	**2.296**	
Median	**1.560**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.483**	
n =	**265**	

*ND = 21% Non-detects from 32 different lakes

	pH (oxic) <=3ft 2000-2005	
Average	**8.31**	
Median	**8.30**	
Minimum	**7.06**	**Deer Lake**
Maximum	**10.28**	**Round Lake Marsh North**
STD	**0.46**	
n =	**807**	

	pH (anoxic) 2000-2005	
Average	**7.11**	
Median	**7.13**	
Minimum	**5.80**	**Third Lake**
Maximum	**8.48**	**Heron Pond**
STD	**0.41**	
n =	**265**	

	All Secchi 2000-2005	
Average	**4.39**	
Median	**3.17**	
Minimum	**0.33**	**Fairfield Marsh, Patski Pond**
Maximum	**29.23**	**Bangs Lake**
STD	**3.65**	
n =	**740**	

81 of 161 lakes had anoxic conditions
Anoxic conditions are defined <=1 mg/l D.O.
pH Units are equal to the -Log of [H] ion activity
Conductivity units are in MilliSiemens/cm
Secchi Disk depth units are in feet
All others are in mg/L

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2000 - 2005 Water Quality Parameters, Statistics Summary continued

TKN (oxic)	<=3ft 2000-2005	
Average	**1.457**	
Median	**1.220**	
Minimum	**<0.5**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.831**	
n =	**808**	

*ND = 5% Non-detects from 19 different lakes

TKN (anoxic)	2000-2005	
Average	**3.067**	
Median	**2.270**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.467**	
n =	**265**	

*ND = 5% Non-detects from 7 different lakes

TP (oxic)	<=3ft 2000-2005	
Average	**0.098**	
Median	**0.063**	
Minimum	**<0.01**	**From 5 Lakes**
Maximum	**3.880**	**Albert Lake**
STD	**0.168**	
n =	**795**	

*ND = 0.1% Non-detects from 5 different lakes
(Bangs, Cedar, Carina, Minear,& Stone Quarry)

TP (anoxic)	2000-2005	
Average	**0.320**	
Median	**0.174**	
Minimum	**0.012**	**West Loon Lake**
Maximum	**3.800**	**Taylor Lake**
STD	**0.412**	
n =	**265**	

TSS (all)	<=3ft 2000-2005	
Average	**15.3**	
Median	**7.9**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**815**	

*ND = 2% Non-detects from 10 different lakes

TVS (oxic)	<=3ft 2000-2005	
Average	**136.0**	
Median	**132.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**40.4**	
n =	**758**	

No 2002 IEPA Chain Lakes

TDS (oxic)	<=3ft 2000-2004	
Average	**470**	
Median	**454**	
Minimum	**150**	**Lake Kathryn, White**
Maximum	**1340**	**IMC**
STD	**169**	
n =	**745**	

No 2002 IEPA Chain Lakes, Data from 00-04.

CL (anoxic)	2004-2005	
Average	**277**	
Median	**102**	
Minimum	**53**	**Banana Pond**
Maximum	**2390**	**IMC**
STD	**489**	
n =	**66**	

CL (oxic)	<=3ft 2004-2005	
Average	**243.8**	
Median	**183.0**	
Minimum	**51.7**	**Heron Pond**
Maximum	**2760.0**	**IMC**
STD	**339.4**	
n =	**197**	

LakeCounty
Health Department and
Community Health Center

APPENDIX F. GRANT PROGRAM OPPORTUNITIES

Grant Program Name	Funding Source	Funding Focus			Cost Share	Typical Award
		Water Quality	Flooding	Habitat		
Challenge Grant Program	USFWS			X	>50%	<$10,000
Chicago Wilderness Small Grants Program	CW			X	None	$15,000
Conservation 2000 (C2000)	IDNR			X	None	$10,000 to $500,000
Conservation Reserve Program	NRCS			X	Land	Variable
Five Star Challenge Grant	NFWF			X	None	$5,000 to $20,000
Flood Mitigation Assistance Program	IEMA		X		25%	$200,000
Habitat Restoration Program for the Fox Watershed	LCSWCD			X	25%	<$1,000K
Illinois Clean Lakes Program (ICLP)	IEPA	X			>50%	$5,000 to $30,000
Illinois Clean Energy Community Foundation	ICECF			X	None	Variable
Lakes Education Assistance Grant Program (LEAP)	IEPA	X			None	$500
Northeast Illinois Wetland Conservation Account	USFWS	X		X	>50%	$600 to $200,000
Partners for Fish and Wildlife Program	USFWS			X	>50%	$3,000
Section 206: Aquatic Ecosystem Restoration	USACE			X	35%	<$1,000,000
Section 319: Non-Point Source Management Program	IEPA	X		X	>40%	Variable
STAG Grants	LCSMC	X			None	Variable
Stream Cleanup And Lakeshore Enhancement (SCALE)	IEPA	X			None	$2,000
Streambank Stabilization and Restoration Program (SSRP)	LCSWCD	X		X	25%	Variable
Unincorporated Lake County Drainage Fund	LCPBD		X		>50%	$5,000 to $10,000
Wildlife Habitat Incentives Program	NRCS			X	Land	Variable
Watershed Management Board	LCSMC	X	X	X	>50%	$5K to $10K
Wetland Reserve Program	NRCS			X	Land	Variable

CW = Chicago Wilderness
ICECF = Illinois Clean Energy Community Foundation
IEMA = Illinois Emergency Management Agency
IEPA = Illinois Environmental Protection Agency
IDNR = Illinois Department of Natural Resources
LCPBD = Lake County Planning, Building,
and Development Department
LCSMC = Lake County Stormwater Management Commission
LCSWCD = Lake County Soil and Water Conservation District
NFWF = National Fish and Wildlife Foundation
NRCS = Natural Resources Conservation Service
USACE = United States Army Corps of Engineers
USFWS = United States Fish and Wildlife Service