2005 SUMMARY REPORT
of
Lake Lakeland Estates

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Lake Lakeland Estates is a natural slough pothole lake in the Slocum Lake drain of the Fox River watershed, and is located within the Village of Lake Barrington. There is one main inlet that drains stormwater from the surrounding neighborhood. Water flows out of the lake through a dropbox spillway in the west "arm" to a stormwater system. The lake receives runoff from a primarily residential watershed, with several homeowners owning portions of the lake bottom. The Lakeland Estates Property Owner's Association owns and manages a beach and park along the north shore. Members of the Association and their guests can use the picnic area, playground and swim raft at this park. Residents use the lake for fishing, non-motorized boating and aesthetics. The Association has been treating the lake with aquatic herbicides and algaecides to control Eurasian Watermilfoil and algae.

Water clarity (Secchi depth) in the lake averaged 6.3 feet, which was an improvement from the 2000 average of 4.4 feet. Related to water clarity is total suspended solids (TSS) concentration. The average TSS for Lake Lakeland Estates during the study was 4.4 mg/L. This value was well below the county median of 7.9 mg/L, and was nearly half the TSS concentration found in the 2000 study (8.2 mg/L). This decrease in TSS is directly related to the increase in water clarity. Average total phosphorus (TP) concentration in Lake Lakeland Estates (0.052 mg/L) was below the county median of 0.063 mg/L. This is an improvement from the 2000 survey when the average TP concentration (0.094 mg/L) was well above the county median. Lower TP concentrations were another contributing factor to the decrease in TSS in 2005. Total Kjeldahl Nitrogen (TKN) concentrations also saw a slight decrease from 2000 (1.46 mg/L in 2000; 1.14 mg/L in 2005). The average epilimnetic dissolved oxygen (DO) concentration was 9.95 mg/L, while the average hypolimnetic DO concentration was 4.31 mg/L.

A new plant sampling technique was employed in 2005 using a grid system with points 60 m apart. Plant sampling was conducted on the lake in July at 17 sites. Overall, five species comprised the plant community. This is an increase from the 2000 sampling, when only two species were found in July (*Chara* spp. and Small Pondweed). The most common species in 2005 was *Chara* spp. (found at 65% of the sites) followed closely by Coontail (found at 59% of the sites).

A reassessment in 2005 of the comprehensive shoreline survey performed in 2000 found that erosion problems have increased on the lake. Almost the entire shoreline (approximately 75%) is now considered to be eroding to some degree, where as in 2000, only 31% was categorized as eroding. It is strongly recommended that this erosion problem be remediated.

LAKE FACTS

Lake Name:	Lake Lakeland Estates
Historical Name:	None
Nearest Municipality:	Village of Lake Barrington
Location:	T43N, R9E, Sections 34,35
Elevation:	760.0 feet
Major Tributaries:	None
Watershed:	Fox River
Sub-watershed:	Slocum Lake Drain
Receiving Water body:	None
Surface Area:	14.3 acres
Shoreline Length:	0.9 miles
Maximum Depth:	12.0 feet
Average Depth (est.):	6.0 feet
Lake Volume (est.):	85.8 acre-feet
Lake Type:	Natural Slough Pothole
Watershed Area (est.):	125.9 acres
Major Watershed Land uses:	Single-family housing, Forest, Wetland
Bottom Ownership:	Multiple private
Management Entities:	Lakeland Estates Property Owner's Association
Current and Historical uses:	Fishing, non-motorized boating and aesthetic enjoyment.
Description of Access:	No public access

SUMMARY OF WATER QUALITY

Lake Lakeland Estates has a medium size watershed as related to other watersheds within Lake County (Figure 1). The lake receives runoff from a primarily residential watershed, with sections of forest/grassland and wetland (Figure 2). The large amount of impervious surfaces that are associated with residential areas (rooftops, driveways, and roads) increase the amount of direct stormwater runoff into a lake. Lakes that have watersheds with less development have land (wetland, grassland, etc.) that is able to filter out nutrients and solids from stormwater before it reaches the lake. The composition of Lake Lakeland Estates watershed correlates to the relatively high total phosphorus concentrations (see below).

Water samples were taken once a month at the deepest location in the lake, from May to September (Figure 3). Two samples were taken; one from the warm, upper water layer (epilimnion) and one from the cooler, lower water layer (hypolimnion). They were analyzed for nutrients, solid concentrations and other physical parameters (Appendix A). The epilimnion sample was taken from three feet deep each month, while the hypolimnion sample varied from 8-9 feet deep, as these samples are always taken three feet above the bottom, and the water level fluctuated throughout the season (overall decrease of 14'' according to LCHD measurements). Lake Lakeland Estates was divided into an epilimnion and a hypolimnion in June and July, with the strongest stratification occurring in June. Thermal stratification is measured in relative thermal resistance to mixing (RTRM). RTRM values that fall below 20 allow water within the entire waterbody to mix freely, while values of 20 and higher generally resist mixing. The size of this strongly stratified layer usually increases throughout the summer. In Lake Lakeland a weak stratification set up for a couple of months (June and July) and then broke down for the remainder of the open water season. Because of this pattern, the lake is most likely polymictic (a lake that mixes several times throughout the season).

The average dissolved oxygen (DO) concentration in the epilimnion was 9.95 mg/L, while the average hypolimnetic DO concentration was 4.31 mg/L (Table 1). There was adequate DO (defined as <5.0 mg/L for game fish) throughout the whole lake in May and June, but then as thermal stratification set up, there was a loss of DO to the hypolimnion starting with our July sampling. DO concentrations remained low (<5.0 mg/L) in the hypolimnion throughout the rest of the sampling season (until September). Because a bathymetric map does not exist for Lake Lakeland, there is no way of knowing the water volume that experienced these low DO conditions in July, August and September. Water that has less than 5.0 mg/L of DO is consider inadequate to support most aquatic life, and the point in the water column where DO falls below this level is the beginning of the hypoxic layer. This pattern of decreased oxygen content as the summer progresses is normal. As water heats up, it is able to hold less oxygen. Also, as organisms start to die and fall to the bottom to decay, more oxygen is used to breakdown the dead material. Anoxic conditions (< 1.0 mg/L of DO) occurred from July (below ~ 8 feet) to September (below ~ 8.5 feet). (Appendix B).

Figure 1. Approximate watershed delineation for Lake Lakeland Estates, 2005.

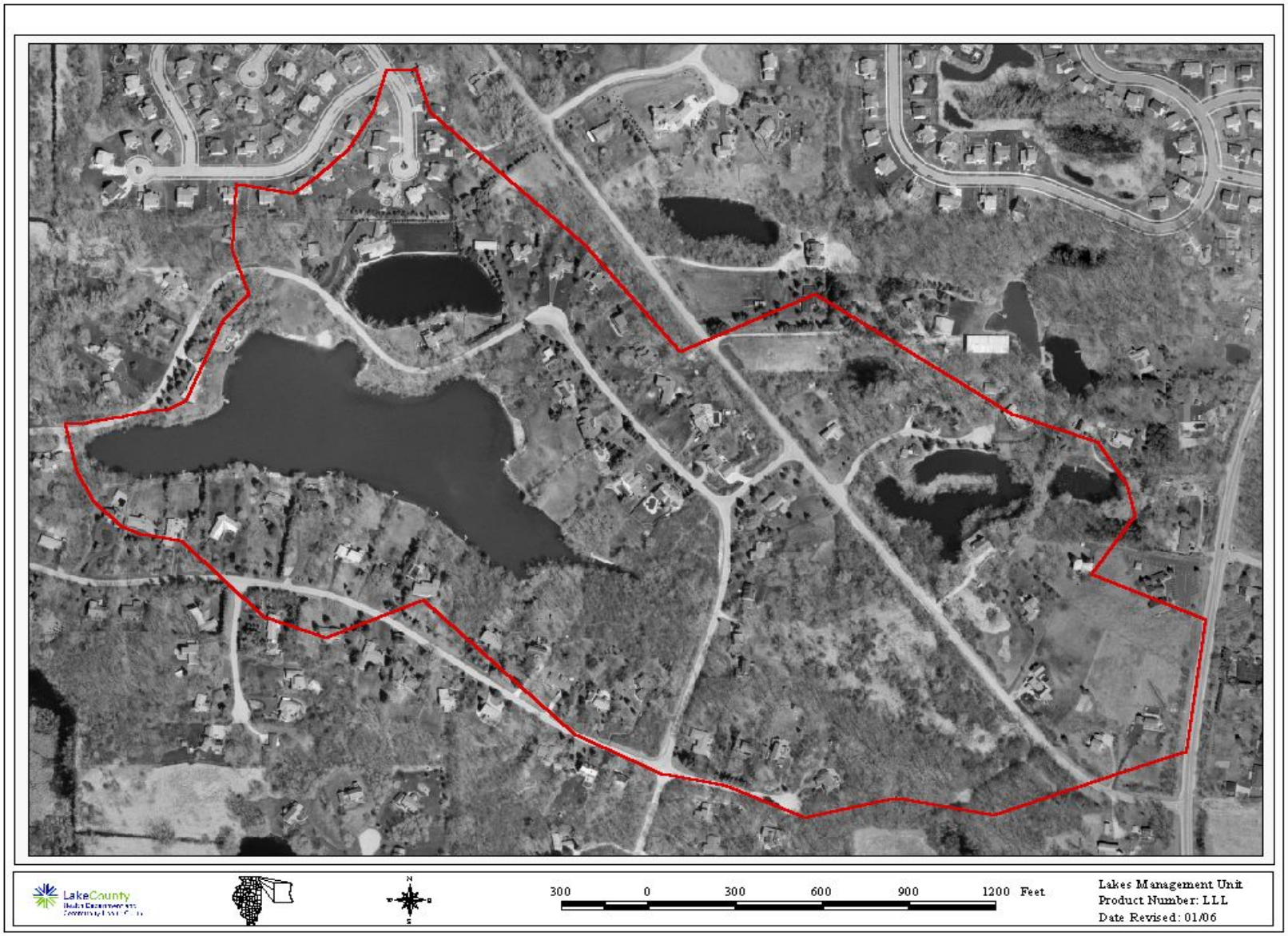

Figure 2. Approximate land use within the Lake Lakeland Estates watershed, 2005.

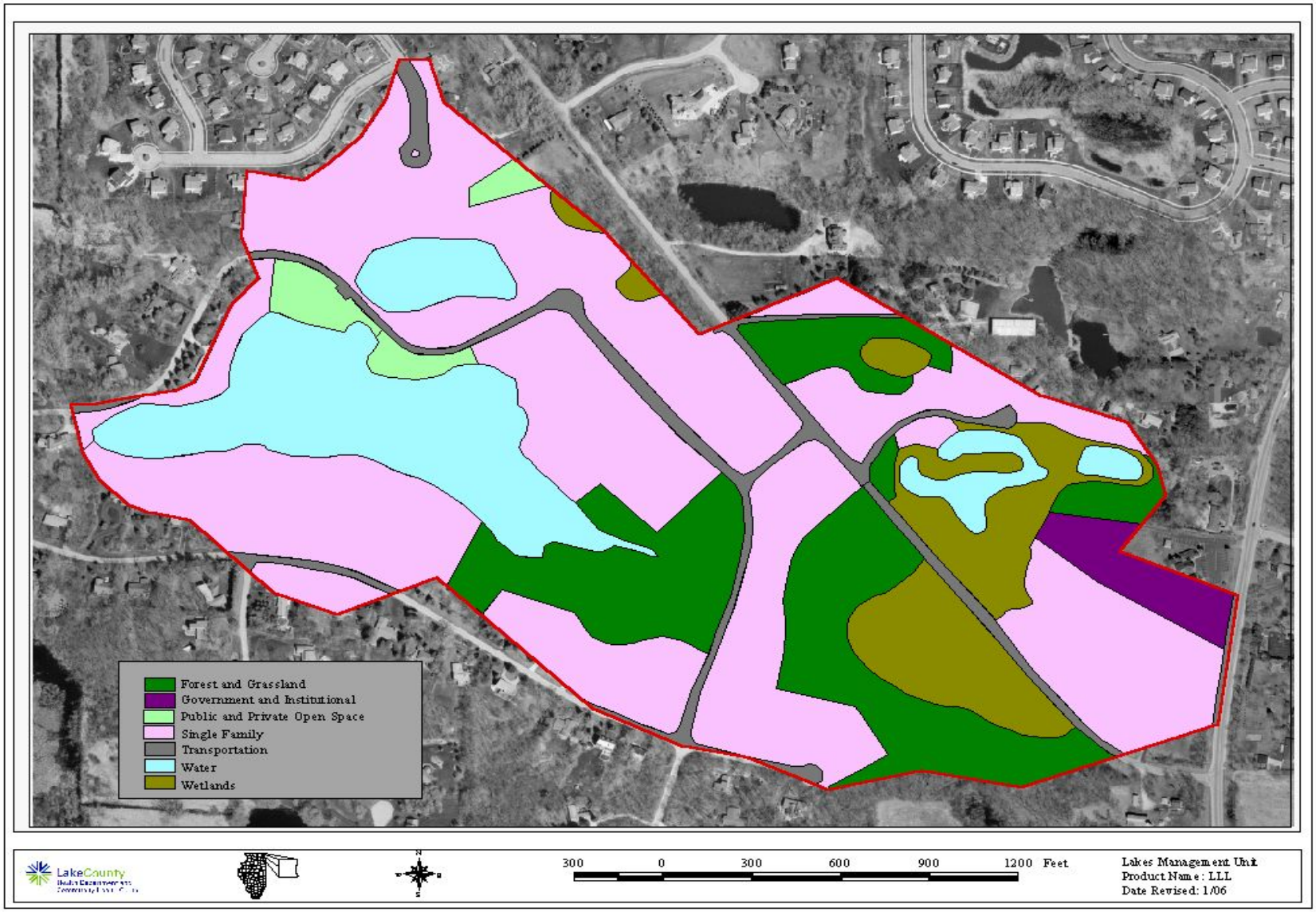

Figure 3. Water quality sampling site on Lake Lakeland Estates, 2005.

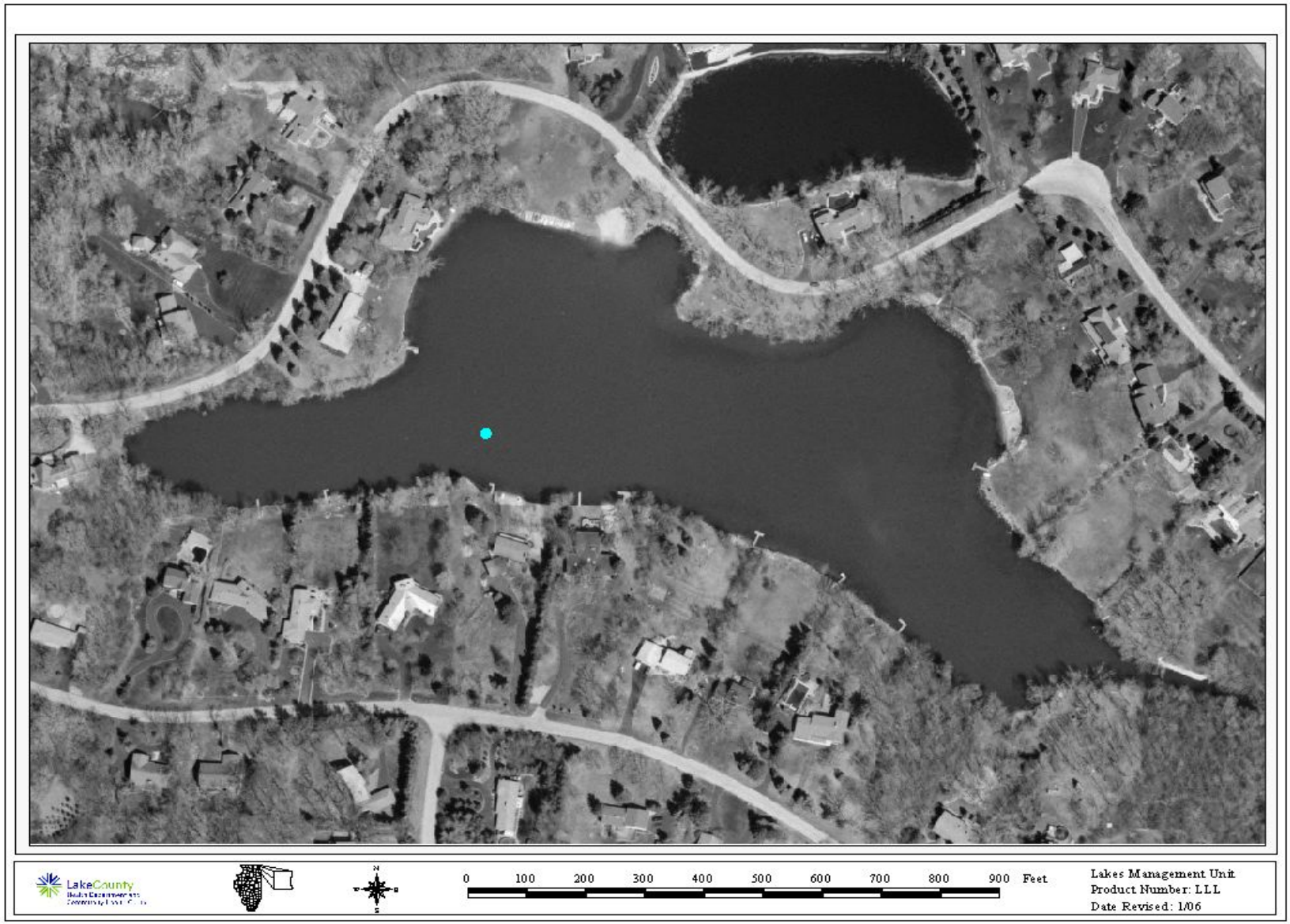

Table 1. Water quality data for Lake Lakeland Estates, 2000 and 2005.

2005	Epilimnion															
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
18-May	3	182	0.91	<0.1	<0.05	0.021	<0.005	NA	185	2.2	573	141	7.55	0.9820	8.28	12.82
22-Jun	3	158	0.92	<0.1	<0.05	0.045	0.014	NA	195	1.3	591	179	9.88	0.9820	8.63	11.53
20-Jul	3	152	1.13	<0.1	<0.05	0.048	0.006	NA	209	3.1	580	148	5.57	1.0310	8.46	7.88
17-Aug	3	163	1.35	<0.1	<0.05	0.074	0.007	NA	212	6.4	638	203	3.94	1.0480	8.10	7.88
21-Sep	3	169	1.38	<0.1	<0.05	0.074	0.007	NA	221	8.9	624	170	4.59	1.071	8.18	9.63
	Average	165	1.14	<0.1	<0.05	0.052	0.009[k]	NA	204	4.4	601	168	6.31	1.0228	8.33	9.95

2000	Epilimnion															
DATE	DEPTH	ALK	TKN	NH3	NO3	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
18-May	3	159	1.21	<0.1	<0.05	0.045	0.013	433	NA	1.4	438	164	6.89	0.6770	8.10	6.18
22-Jun	3	179	1.16	<0.1	0.058	0.074	0.028	382	NA	2.8	444	157	8.10	0.6967	7.79	5.94
20-Jul	3	192	<0.5	<0.1	0.069	0.149	0.012	410	NA	10.0	442	140	0.95	0.6800	7.56	3.41
24-Aug	3	204	1.40	<0.1	<0.05	0.112	0.014	466	NA	13.0	489	148	2.89	0.7226	8.36	7.69
21-Sep	3	213	2.06	0.192	<0.05	0.090	0.015	412	NA	14.0	456	156	3.12	0.7300	8.16	5.13
	Average	189	1.46[k]	0.192[k]	0.064[k]	0.094	0.016	421	NA	8.2	454	153	4.39	0.7013	7.99	5.67

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
TDS = Total Dissolved Solids, mg/L
Cl^- = ions of chloride, 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

Note: "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	NH3-N	NO3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
18-May	9	186	0.87	<0.1	<0.05	0.020	<0.005	NA	183	2.8	576	145	NA	0.9900	8.01	9.90
22-Jun	9	168	1.02	<0.1	<0.05	0.066	0.020	NA	195	3.1	594	185	NA	0.9960	8.01	7.92
20-Jul	8	161	2.14	<0.1	<0.05	0.306	0.101	NA	204	20.0	615	182	NA	1.0350	7.70	1.20
17-Aug	8	163	1.48	0.104	<0.05	0.092	0.008	NA	213	6.7	614	186	NA	1.0510	7.37	0.09
21-Sep	8	170	1.41	0.308	<0.05	0.121	0.019	NA	217	10.0	613	160	NA	1.0800	7.68	2.46
	Average	170	1.38	0.206[k]	<0.05	0.121	0.037[k]	NA	202	8.5	602	172	NA	1.0304	7.75	4.31

2000	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH3	NO3	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
18-May	9	176	1.20	<0.1	0.052	0.070	0.031	456	NA	2.9	471	159	NA	0.7084	7.57	0.02
22-Jun	10	189	1.24	<0.1	0.061	0.148	0.059	440	NA	6.9	493	167	NA	0.7173	7.20	0.06
20-Jul	10	208	<0.5	0.752	0.070	0.380	0.318	398	NA	9.1	451	144	NA	0.7299	6.99	0.20
24-Aug	10	227	3.10	1.690	<0.05	0.622	0.460	464	NA	14.0	497	157	NA	0.7808	6.97	0.09
21-Sep	9	212	1.97	0.139	<0.05	0.076	0.009	410	NA	19.0	456	155	NA	0.7289	8.22	5.78
	Average	202	1.88[k]	0.860[k]	0.061[k]	0.26	0.175	434	NA	10.4	474	156	NA	0.7331	7.39	1.23

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
TDS = Total Dissolved Solids, mg/L
Cl^- = ions of chloride, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
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SECCHI = Secchi Disk Depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

Note: "k" denotes that the actual value is known to be less than the value presented.
NA = Not Applicable

Suspended solids are made up of any type of solid particles in the water column, including algal cells and sediment. The average total suspended solids (TSS) concentration for Lake Lakeland Estates during the study was 4.4 mg/L. This value was well below the county median of 7.9 mg/L, and was nearly half the TSS concentration found in the 2000 study (8.2 mg/L). This decrease in TSS is directly related to the increase in water clarity (Secchi depth) (Figure 4). Secchi depth increased from an average of 4.4 feet in 2000, to an average of 6.3 feet in 2005. This level was above the county median Secchi depth of 3.2 feet (2005). The highest Secchi depth this season was 9.9 feet in June, while the lowest occurred in August (3.9 feet). The increase in Secchi depth and subsequent decrease in TSS may have been due to annual variation and the fact that 2005 saw drought-like conditions that reduced inflow of constituents into the lake.

Conductivity is the measure of ions within water. The higher the conductivity, the more ions there are and the better the water can conduct electricity. In Lake Lakeland, average epilimnetic conductivity in 2005 was 1.023 mS/cm. This is an increase since 2000, when the average epilimnetic value was 0.7013 mS/cm. This 46% increase is probably due to the accumulation of road salt in the lake from winter road management within the watershed. Many lakes throughout the county are experiencing the same trend. Also, the lake saw a water level decrease of 14'' over the season, and conductivity concentrations increased as the water dropped. This was because the ions were concentrated into a smaller volume of water. In relation to conductivity is the chloride ion (Cl^-) (Figure 5). The median Cl^- concentration in the county is 183.0 mg/L, and Lake Lakeland had a concentration that exceeded this (204.0 mg/L). According to an Environment Canada study on environmental effects of road salt, Cl^- levels above 220 mg/L can have effects on the aquatic community, while levels as low as 12 mg/L have been shown to affect the algal community. There is not an immediate remediation procedure to reverse the Cl^- levels in the lake. Road salt use within the watershed should be reviewed and alternatives considered (Appendix D1).

Another aspect of water quality is the nutrients within a water body, especially nitrogen (N) and phosphorus (P). These are the two nutrients that can limit plant and algal growth. Carbon and light are the other factors that control plant and algal growth, but these are not normally limiting. Average total phosphorus (TP) concentration (0.052 mg/L) in Lake Lakeland Estates for 2005 was below the county median of 0.063 mg/L. This was a major improvement from the 2000 survey when the average TP concentration (0.094 mg/L) was well above the county median. Total Kjeldahl Nitrogen (TKN) concentrations also decreased slightly from 2000, from 1.46 mg/L in 2000 to 1.14 mg/L in 2005. Possible reasons for the overall improvement in water quality from 2000 to 2005 were the drought-like conditions experienced in 2005 and therefore the lack of and/or decrease of inflows from the watershed. Also, there were more aquatic plants in 2005 than in 2000. These plants use phosphorus, which is most likely one of the causes for the decrease in TP between the two years (See more on plants below).

Figure 4. Total suspended solids (TSS) concentration vs. Secchi depth in Lake Lakeland Estates, 2005.

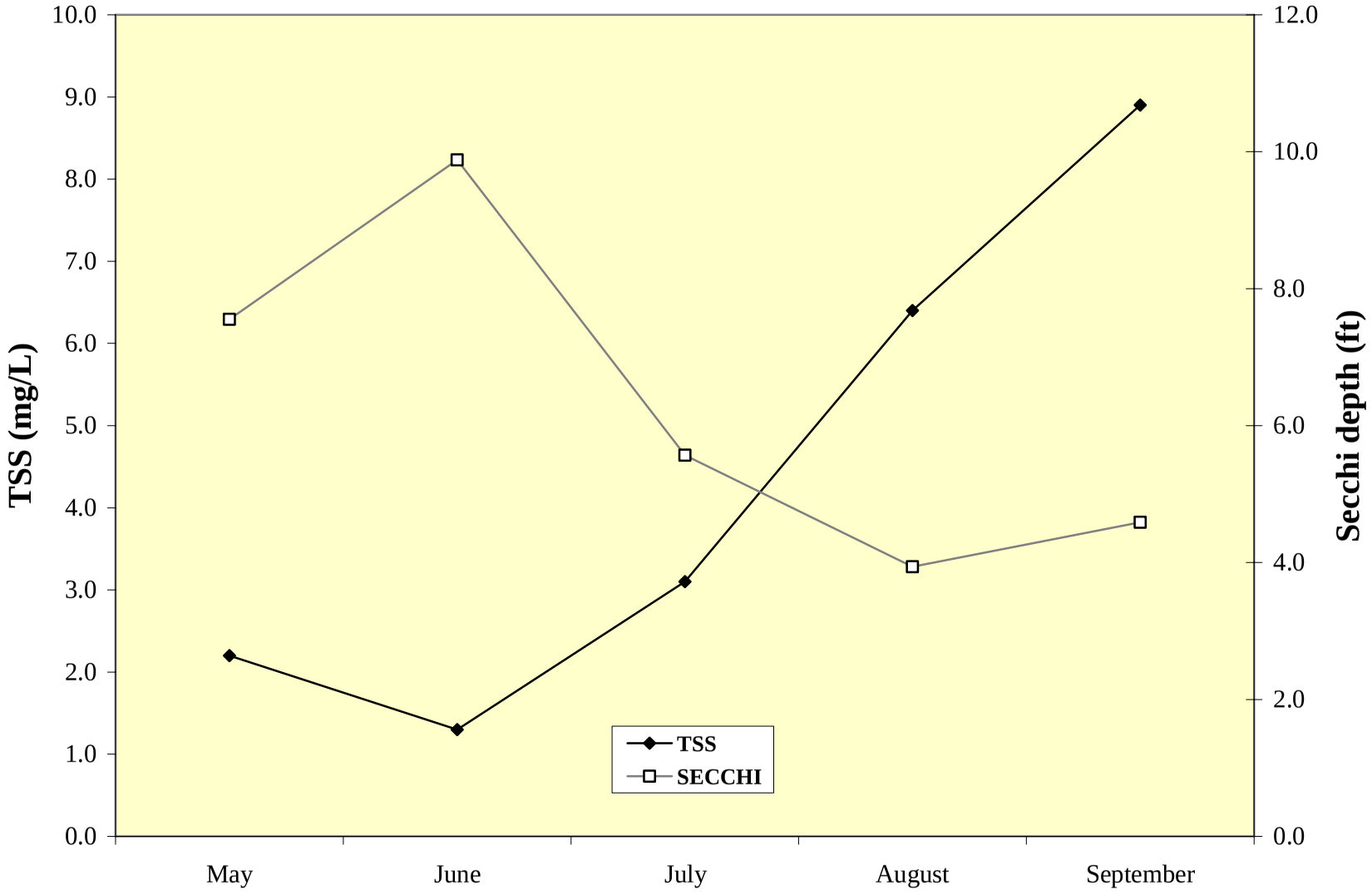
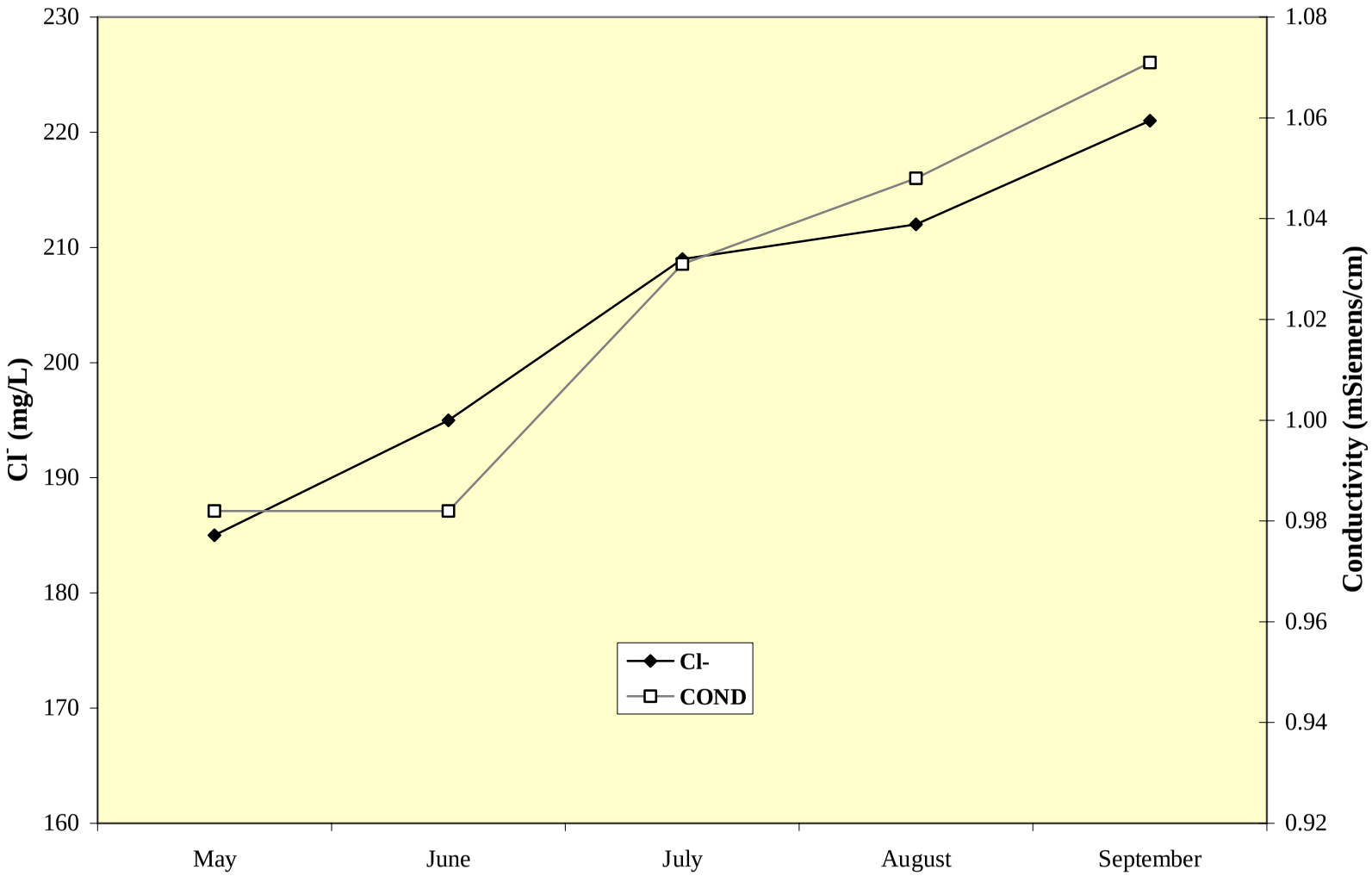


Figure 5. Chloride concentration (Cl^-) vs. conductivity in Lake Lakeland Estates, 2005.



In order to compare the availability of N and P, 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 there is enough of both nutrients for excessive plant and algal growth. Lake Lakeland Estates has a TN:TP ratio of 23:1, which indicates phosphorus limitation. This means any additions of phosphorus, even small influxes, could result in increases in plant and algal biomass. The use of no-phosphate lawn fertilizers is highly recommended (See Appendix C for more on understanding lake water quality results; Appendix D1).

Another way to look at phosphorus levels and how it affects productivity of the lake is to use a Trophic State Index (TSI) based on phosphorus (TSIp). TSIp values are commonly used to classify and compare lake productivity levels (trophic state). The higher the phosphorus levels the greater the amount of plant and/or algal biomass, which leads to a higher TSIp and corresponding trophic state. Based on a TSIp value of 59, Lake Lakeland Estates was classified as eutrophic. A eutrophic lake is defined as an over productive system that has above average nutrient levels and high plant and/or algal biomass (growth). The 2005 TSIp value was a major decrease from 2000 when the lake had a TSIp value of 70 and was classified as hypereutrophic. Based on the 2005 Secchi TSI, Lake Lakeland Estates is borderline eutrophic/mesotrophic with a value of 51. This is also a decrease from 2000, when the Secchi TSI was 56. Based on TSIp, the lake ranks 61st out of 162 lakes sampled in Lake County (Table 2). This is an improvement from 99th of 161 in 2000. Again, these improvements are probably due to the drought-like conditions present in 2005.

TSI values along with other water quality parameters can be used to make other analysis based on use impairment indexes established by the Illinois Environmental Protection Agency (IEPA). Most water quality standard impairment assessments were listed as *None*. However, aquatic vegetation was the source of impairments based on excessive plant growth (*Slight* use impairment), and exotic species (*Slight* use impairment). Furthermore, based on IEPA indices, Lake Lakeland Estates was listed as providing *Partial* support for Recreational Use and *Full* support of Swimming and Aquatic Life Use. Based on these indices, this lake was listed as providing *Full* Overall Use support.

SUMMARY OF AQUATIC MACROPHYTES

An aquatic plant (macrophyte) survey was conducted in July 2005. A new sampling method was initiated in 2005 where sampling sites were based on a grid system created by mapping software (ArcGIS), with each site located 60 meters (~200 feet) apart. On Lake Lakeland there were 17 sampling sites (Figure 6). Overall, there were a total of five species in the plant community. This is an increase from 2000 sampling, when only two species (*Chara* spp. and Small Pondweed) were found in July, and one was a different species altogether than those found in 2005 (Table 3). The most common species in 2005 was *Chara* spp. (found at 65% of the sites) followed closely by Coontail (found at 59% of the sites) (Table 4a). Plants need at least 1% of surface light levels in order to photosynthesize and survive. In July, the light level throughout the water column (10 feet) was adequate for plant photosynthesis. Plants were not found below

8.6 feet (only Coontail below 7.0 feet). The light level and plant growth depth correlates fairly well. Plants below 8.6 feet may not have been detected in our sampling method. While plants were found at nearly all of the sampling sites (Table 4b), only shallow, shoreline areas had topped out vegetation (plants reaching the surface). In order to sustain a high quality lake with a good quality fishery, the IDNR recommends there be 30-40% plant coverage in a lake. This lake had approximately 80% plant coverage, which is double the recommended coverage.

An algal bloom of *Cladophora* spp. (a green algae) was observed in June, and an algal bloom was also noted in September that only covered areas near shore. Plants and algae were treated from April to July, with exact dates not known. There were seven algaecide treatments (Cutrine®), one herbicide treatment (Reward®) and three instances when both Cutrine® and Reward® were used. A private consulting firm analyzed the lake weekly, and then determined what the lake needed to control plant growth. These treatments didn't seem to be successful in reducing plant biomass to the desired 30-40% coverage. It is possible that sampling was performed right before a treatment, and therefore did not detect the reduction results. In the future, it is recommended that treatments be better documented so the homeowners association knows exact amounts and dates of all treatments. These actions would aide in lake management and allow assessment of what treatments would be needed in the future.

FQI (Floristic Quality Index) 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. The average FQI for 2000-2005 Lake County lakes is 14.0. Lake Lakeland Estates had a FQI of 10.0 in 2005 (Table 5). This is a decrease since 2000 when the FQI was 13.8. This drop is mostly attributed to the emergence of the non-native, invasive species Eurasian Watermilfoil (EWM). There was also a plant community shift since surveying in 2000. This can be attributed to the change in plant sampling technique employed by the Lakes Management Unit and the fact that plant community composition can vary from year to year.

Table 2. Lake County average TSI phosphorus (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

Figure 6. Aquatic plant sampling grid that illustrates plant density on Lake Lakeland Estates, 2005.

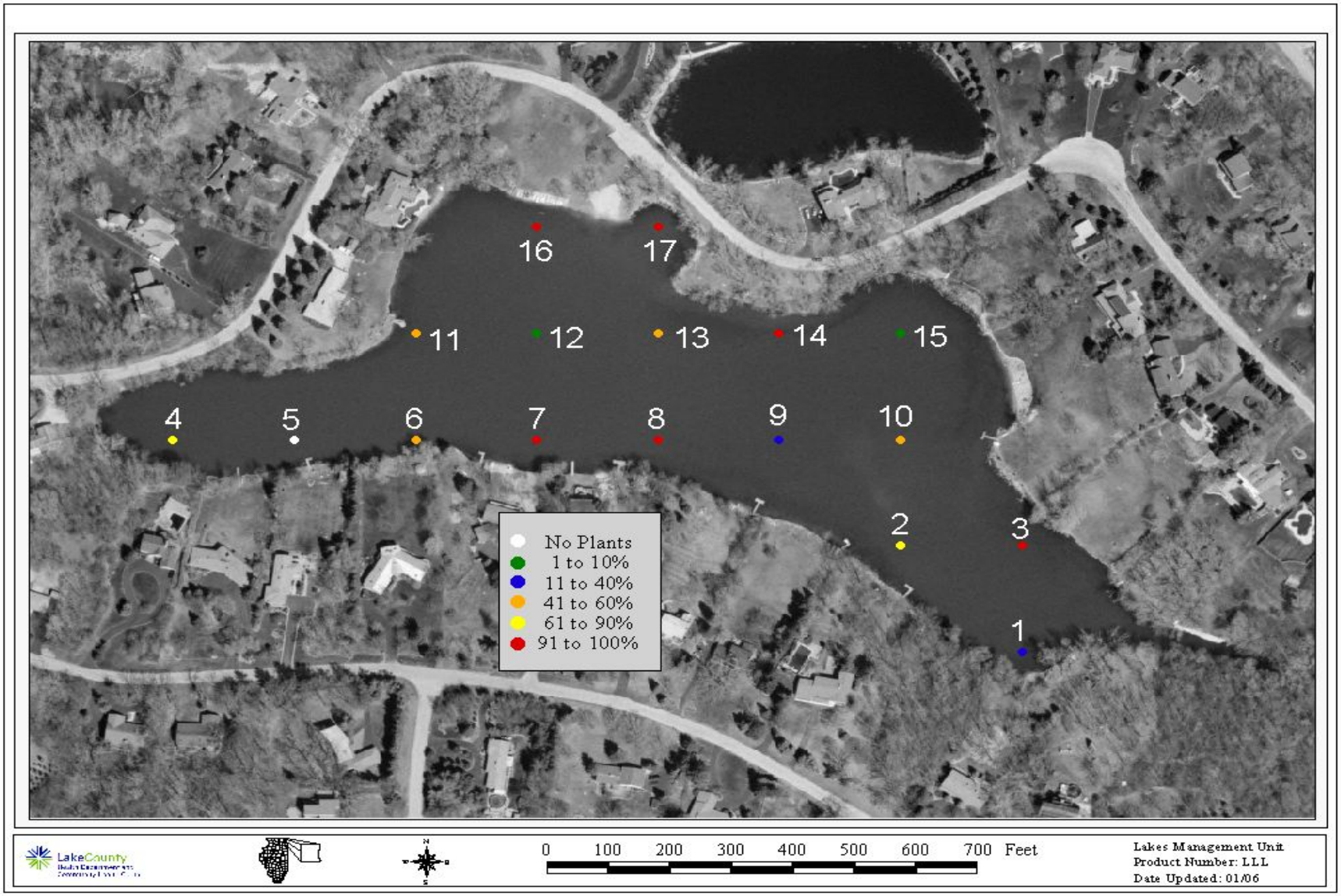


Table 3. Aquatic plant species found in Lake Lakeland Estates, 2005.

Coontail	*Ceratophyllum demersum*
Chara (Macro alga)	*Chara* spp.
Eurasian Watermilfoil^	*Myriophyllum spicatum*
Leafy Pondweed	*Potamogeton foliosus*
Southern Naiad	*Najas guadalupensis*

^**Exotic species**

SUMMARY OF SHORELINE CONDITIONS

A reassessment of the comprehensive shoreline survey performed in 2000 found erosion problems have increased on the lake. A large area that was considered moderately eroded was changed to the severely eroded category. There were five small sections changed from no erosion to slight erosion, and three sites changed from slight to moderate erosion. Almost the entire shoreline (approximately 75%) is now considered to be eroding to some degree, where as in 2000, only 31% was categorized as eroding. Approximately 25% of the shoreline is mowed grass with none or small buffer zones in between the lawn and the lake. Frequently, shorelines with mowed lawn to the water's edge are in some stage of erosion, since turfgrass has shallow roots. Some of the buffer areas were less than five feet wide, which could be one reason these buffer areas were eroding. In any case, eroding shorelines may continue to worsen as a result of wind induced wave action if protective measures are not taken. This can add sediment to the water and result in a loss of shoreline property, lower water clarity and increase nutrients. Erosion mitigation needs to be performed or conditions will continue to worsen (For more details, see Appendix D2).

SUMMARY OF WILDLIFE AND HABITAT CONDITION

Wildlife observations were made during May and June sampling. Several bird species were observed including Robins, Swallows, Sparrows, Orioles, Goldfinch, Canadian Geese and Blue Herons. No small mammals were noted. The undeveloped wooded shore provided good habitat for songbirds. Although residential areas usually do not offer good wildlife habitat, the mature trees in the lots surrounding the lake offer some songbird habitat. Downed trees (deadfall) in the water offer good habitat for fish, turtles and wading birds. Deadfall should be left in the water. There has not been any known follow up to the 1998 fishery assessment performed by a private consulting firm. When the fishery survey was conducted, they found good Bluegill and Largemouth Bass populations, although the Bluegill may have started to become stunted. Northern Pike were successfully reproducing in the lake. Because the company only visited the lake once, not all management issues could be accurately assessed. A more recent survey is recommended.

Table 4a. Aquatic plant species found at the 17 sampling sites on Lake Lakeland Estates, 2005. Maximum depth that plants were found was 8.6 feet.

Plant Density	Chara	Coontail	Eurasian Watermilfoil	Leafy Pondweed	Southern Naiad
Present	2	5	4	2	1
Common	2	2	2	1	0
Abundant	2	3	0	0	0
Dominant	5	0	0	0	0
% Plant Occurrence	64.7	58.8	35.3	17.6	5.9

Table 4b. Distribution of rake density across all sampling sites.

Rake Density (coverage)	# of Sites	% of Sites
No Plants	1	5.9
>0-10%	2	11.8
10-40%	2	11.8
40-60%	4	23.5
60-90%	2	11.8
>90%	6	35.3
Total Sites with Plants	16	94.1
Total # of Sites	17	100.0

Table 5. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native).

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	35.6	37.8
2	Deep Lake	33.9	35.4
3	Round Lake Marsh North	29.1	29.9
4	East Loon Lake	28.4	29.9
5	Cranberry Lake	28.3	28.3
6	Sullivan Lake	28.2	29.7
7	Deer Lake	27.9	30.2
8	Little Silver Lake	27.9	30.0
9	Schreiber Lake	26.8	27.6
10	Redwing Slough	26.0	26.9
11	West Loon Lake	26.0	27.6
12	Timber Lake (North)	25.5	27.1
13	Cross Lake	25.2	27.8
14	Wooster Lake	25.2	26.9
15	Lake Zurich	24.0	26.0
16	Lake of the Hollow	23.8	26.2
17	Lakewood Marsh	23.8	24.7
18	Round Lake	23.5	25.9
19	Fourth Lake	23.0	24.8
20	Druce Lake	22.8	25.2
21	Sun Lake	22.7	24.5
22	Countryside Glen Lake	21.9	22.8
23	Sterling Lake	21.8	24.1
24	Butler Lake	21.4	23.1
25	Bangs Lake	21.2	23.7
26	ADID 203	20.5	20.5
27	Broberg Marsh	20.5	21.4
28	Davis Lake	20.5	21.4
29	McGreal Lake	20.2	22.1
30	Lake Kathryn	19.6	20.7
31	Third Lake	19.6	21.7
32	Owens Lake	19.3	20.2
33	Redhead Lake	19.3	21.2
34	Lake Minear	18.8	20.6
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Fish Lake	18.1	20.0
39	McDonald Lake 1	17.7	18.7
40	Potomac Lake	17.3	18.5
41	Hendrick Lake	17.2	19.0
42	Duck Lake	17.1	19.1

Table 5. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
43	Summerhill Estates Lake	17.1	18.0
44	Ames Pit	17.0	18.0
45	Seven Acre Lake	17.0	15.5
46	Grand Avenue Marsh	16.9	18.7
47	Gray's Lake	16.9	19.8
48	White Lake	16.9	18.7
49	Bresen Lake	16.6	17.8
50	Waterford Lake	16.6	17.8
51	Diamond Lake	16.3	17.4
52	Lake Barrington	16.3	17.4
53	Lake Napa Suwe	16.3	17.4
54	Windward Lake	16.3	17.6
55	Fischer Lake	16.0	18.1
56	Dog Bone Lake	15.7	15.7
57	Independence Grove	15.5	16.7
58	Long Lake	15.5	17.3
59	Tower Lake	15.2	17.6
60	Heron Pond	15.1	15.1
61	Lake Linden	15.1	16.5
62	Lake Tranquility (S1)	15.0	17.0
63	North Churchill Lake	15.0	15.0
64	Dog Training Pond	14.7	15.9
65	Island Lake	14.7	16.6
66	Highland Lake	14.5	16.7
67	Lake Fairview	14.3	16.3
68	Taylor Lake	14.3	16.3
69	Dugdale Lake	14.0	15.1
70	Eagle Lake (S1)	14.0	15.1
71	Longview Meadow Lake	13.9	13.9
72	Bishop Lake	13.4	15.0
73	Hook Lake	13.4	15.5
74	Timber Lake (South)	13.4	15.5
75	Buffalo Creek Reservoir	13.1	14.3
76	Mary Lee Lake	13.1	15.1
77	Old School Lake	13.1	15.1
78	Dunn's Lake	12.7	13.9
79	Old Oak Lake	12.7	14.7
80	Echo Lake	12.5	14.8
81	Sand Lake	12.5	14.8
82	Stone Quarry Lake	12.5	12.5
83	Honey Lake	12.1	14.3

Table 5. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
84	Lake Leo	12.1	14.3
85	Lambs Farm Lake	12.1	14.3
86	Pond-A-Rudy	12.1	12.1
87	Stockholm Lake	12.1	13.5
88	Lake Matthews	12.0	12.0
89	McDonald Lake 2	12.0	12.0
90	Flint Lake	11.8	13.0
91	Harvey Lake	11.8	13.0
92	Rivershire Pond 2	11.5	13.3
93	Antioch Lake	11.3	13.4
94	Lake Charles	11.3	13.4
95	Lake Naomi	11.2	12.5
96	Pulaski Pond	11.2	12.5
97	Lake Christa	11.0	12.7
98	Redwing Marsh	11.0	11.0
99	West Meadow Lake	11.0	11.0
100	Nielsen Pond	10.7	12.0
101	Lake Holloway	10.6	10.6
102	Lake Carina	10.2	12.5
103	College Trail Lake	10.0	10.0
104	**Lake Lakeland Estates**	**10.0**	**11.5**
105	Crooked Lake	9.8	12.0
106	Hastings Lake	9.8	12.0
107	Werhane Lake	9.8	12.0
108	Big Bear Lake	9.5	11.0
109	Little Bear Lake	9.5	11.0
110	Loch Lomond	9.4	12.1
111	Sand Pond (IDNR)	9.4	12.1
112	Columbus Park Lake	9.2	9.2
113	Sylvan Lake	9.2	9.2
114	Grandwood Park Lake	9.0	11.0
115	Lake Fairfield	9.0	10.4
116	East Meadow Lake	8.5	8.5
117	Lake Farmington	8.5	9.8
118	Lucy Lake	8.5	9.8
119	South Churchill Lake	8.5	8.5
120	Bittersweet Golf Course #13	8.1	8.1
121	Woodland Lake	8.1	9.9
122	Albert Lake	7.5	8.7
123	Banana Pond	7.5	9.2
124	Fairfield Marsh	7.5	8.7
125	Lake Eleanor	7.5	8.7

Table 5. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
126	Lake Louise	7.5	8.7
127	Patski Pond	7.1	7.1
128	Rasmussen Lake	7.1	7.1
129	Lucky Lake	7.0	7.0
130	Lake Forest Pond	6.9	8.5
131	Leisure Lake	6.4	9.0
132	Peterson Pond	6.0	8.5
133	Countryside Lake	5.8	7.1
134	Gages Lake	5.8	10.0
135	Grassy Lake	5.8	7.1
136	Slocum Lake	5.8	7.1
137	Deer Lake Meadow Lake	5.2	6.4
138	ADID 127	5.0	5.0
139	Drummond Lake	5.0	7.1
140	IMC	5.0	7.1
141	Liberty Lake	5.0	5.0
142	Oak Hills Lake	5.0	5.0
143	Slough Lake	5.0	5.0
144	North Tower Lake	4.9	7.0
145	Forest Lake	3.5	5.0
146	Half Day Pit	2.9	5.0
147	Lochanora Lake	2.5	5.0
148	Hidden Lake	0.0	0.0
149	St. Mary's Lake	0.0	0.0
150	Valley Lake	0.0	0.0
151	Willow Lake	0.0	0.0
	Mean	**14.0**	**15.4**
	Median	**13.1**	**14.8**

LAKE MANAGEMENT RECOMMENDATIONS

Lake Lakeland Estates has seen an improvement in plant diversity since the last survey conducted in 2000. This is encouraging, and hopefully will persist in the future. Plant treatments should continue to be performed, but monitored at a closer level. Water clarity has also improved, with the Secchi depth average increasing by two feet since 2000. Closely related was the decrease in TSS concentrations, which have decreased by almost half. However, it is unknown why there was such an increase in water quality parameters. Drought conditions may have helped the water quality by reducing the inflow of runoff to the lake. With less runoff, there are less nutrients and solids being washed into the lake.

Watershed nutrient reduction

Road salt inputs from the watershed have increased the conductivity in the lake and resulted in high Cl^- concentrations, which could have negative impacts on aquatic life. It is assumed that road salt is needed for winter road management, but there are ways to reduce lake inputs, e.g. the use of no-phosphate lawn fertilizers (See Appendix D1 for more details).

Shoreline erosion

Erosion is a potentially serious problem to lake shorelines and occurs as a result of wind, wave, or ice action or from overland rainwater runoff. While some erosion to shorelines is natural, human alteration of the environment can accelerate and exacerbate the problem. Erosion not only results in loss of shoreline, but also negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. This effect is felt throughout the food chain since poor water quality negatively affects everything from microbial life to sight feeding fish and birds to people who want to use the lake for recreational purposes. The resulting increased amount of sediment will over time begin to fill in the lake, decreasing overall lake depth and volume and potentially impairing various recreational uses. It is strongly recommended that the moderate and severe erosion be remediated as soon as possible, and buffer strips be installed around the lake, including the Association property near the beach (See Appendix D2 for more details).

Creating a bathymetric map

The creation of a current bathymetric (depth contour) map would aide in lake management practices. For example, when low DO concentrations are observed, it would be possible to determine the volume of water affected, and therefore the amount of stress fish and other aquatic life is receiving. The old map created in 1975 by the IDNR is outdated and most likely inaccurate (See Appendix D3 for more details).

Aquatic plant management

Plant management is important to a lake ecosystem. An ideal situation is to have a diverse native plant community that covers 30-40% of the lake bottom. Of course, this situation does

not occur in all lakes, but management practices should have this as their goal. In most cases, only the exotic nuisance plants such as Eurasian Watermilfoil (EWM) should be targeted for herbicide treatment. Diquat (Reward®), a liquid, broad-spectrum contact herbicide, is non-selective and can adversely affect native pondweeds. In order to target EWM, granular 2,4-D should be considered, a systemic herbicide. 2,4-D is better at selecting dicot plants like EWM than Reward®, and in granular form, would be better for spot treatments. Also, the introduction of beneficial native plants could offer important habitat and once established, would help improve the water clarity by stabilizing the sediment and competing with algae for sunlight and nutrients. Unlike EWM, native plants do not normally grow to nuisance proportions (See Appendix D4 for more details).

- **Eliminate or control exotic species**

According to the 2000 Lakes Management Unit report, there were exotic shoreline plant species on the lake's shoreline. A management plan should be instated that controls or eliminates these species. If controlled, many exotic species can perform many of the original functions they were brought here for. For example, Reed Canary Grass was imported for its erosion control properties. It still contributes to this objective (offering better erosion control than commercial turfgrass), but needs to be isolated and kept in control (See Appendix D5 for more details).

- **Participate in the Volunteer Lake Monitoring Program**

Information is vital to understanding the workings of a lake. The more data collected, the better a lake can be understood. Data can be used to create and implement a conservation and/or restoration plan. While the LCHD does collect a lot of data during the years a lake is studied, gaps can be filled with data collected by volunteers. The Volunteer Lake Management Program (VLMP) is a program that relies on volunteers to gather a variety of information on their chosen lake. Installing a staff water gauge and performing weekly monitoring is one example of data a volunteer could collect. (See Appendix D6 for more details)

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
Total dissolved solids	SM 18th ed, Method #2540C
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 LAKE LAKELAND ESTATES 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	Extinction Coefficient 0.81
5/18/2005	10:21:52	0.25	0.489	16.84	12.77	132.0	1.014	8.27	2256.7	Surface		
5/18/2005	10:23:37	1	1.011	16.87	12.64	130.9	0.982	8.26	1360.1	Surface		
5/18/2005	10:25:16	2	2.018	16.76	12.80	132.2	1.013	8.27	249.8	0.268	100%	6.32
5/18/2005	10:26:44	3	2.992	16.76	12.82	132.4	0.981	8.27	333.9	1.242	134%	-0.30
5/18/2005	10:28:48	4	3.99	15.88	12.83	130.0	1.017	8.24	300.4	2.24	120%	0.11
5/18/2005	10:29:58	5	5.001	15.56	13.40	134.9	0.982	8.23	261.6	3.251	105%	0.14
5/18/2005	10:31:01	6	5.993	14.94	12.43	123.5	0.985	8.15	218.9	4.243	88%	0.18
5/18/2005	10:32:15	7	7.001	14.61	11.89	117.3	0.985	8.13	154.6	5.251	62%	0.35
5/18/2005	10:33:22	8	7.994	14.39	11.04	108.3	0.987	8.08	122.1	6.244	49%	0.24
5/18/2005	10:34:56	9	8.991	14.17	9.90	96.7	1.016	8.01	90.7	7.241	36%	0.30
5/18/2005	10:36:18	10	9.995	13.84	8.24	79.9	0.994	7.86	59.5	8.245	24%	0.42
5/18/2005	10:38:13	11	11.005	13.27	5.18	49.6	1.003	7.61	39.9	9.255	16%	0.40

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	Extinction Coefficient -0.03
6/22/2005		0.25	0.558	25.28	11.60	141.4	0.982	8.63	2102.2	Surface		
6/22/2005		1	1.018	25.31	11.56	141.0	0.983	8.64	550.9	Surface		
6/22/2005		2	1.939	25.32	11.58	141.4	0.982	8.63	866.2	0.189	100%	-2.39
6/22/2005		3	3.070	25.32	11.53	140.7	0.981	8.63	167.2	1.32	19%	1.45
6/22/2005		4	4.014	25.29	11.43	139.4	0.983	8.59	583.0	2.264	67%	-1.32
6/22/2005		5	5.130	25.13	11.26	137.0	0.984	8.54	385.8	3.38	45%	0.37
6/22/2005		6	6.133	24.10	11.78	140.6	0.982	8.46	280.2	4.383	32%	0.32
6/22/2005		7	6.995	23.33	11.11	130.7	0.987	8.37	226.3	5.245	26%	0.25
6/22/2005		8	8.063	22.44	9.80	113.3	0.990	8.22	175.4	6.313	20%	0.24
6/22/2005		9	9.042	21.77	7.92	90.4	0.996	8.01	131.8	7.292	15%	0.29
6/22/2005		10	9.988	20.44	4.91	54.6	1.010	7.71	77.8	8.238	9%	0.56
6/22/2005		11	11.012	18.99	0.76	9.8	1.024	7.49	53.7	9.262	6%	0.36

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	Extinction Coefficient 0.85
7/20/2005		0.25	0.497	28.29	8.12	104.6	1.029	8.41	2841.6	Surface		
7/20/2005		1	0.905	28.29	8.05	103.6	1.030	8.44	1820.5	Surface		
7/20/2005		2	1.998	28.28	7.97	102.6	1.031	8.46	739.7	0.248	100%	3.63
7/20/2005		3	2.966	28.26	7.88	101.4	1.031	8.46	194.8	1.216	26%	1.38
7/20/2005		4	4.011	28.23	7.86	101.1	1.031	8.47	148.6	2.261	20%	0.26
7/20/2005		5	5.037	28.15	7.15	91.9	1.032	8.41	177.4	3.287	24%	-0.17
7/20/2005		6	6.014	27.94	5.56	71.1	1.033	8.23	39.5	4.264	5%	1.54
7/20/2005		7	7.058	27.72	3.77	48.1	1.034	8.01	31.9	5.308	4%	0.20
7/20/2005		8	8.055	27.10	1.20	15.1	1.035	7.70	23.8	6.305	3%	0.29
7/20/2005		9	9.090	25.81	0.30	3.6	1.038	7.50	34.5	7.34	5%	-0.36
7/20/2005		10	10.214	24.18	0.18	2.2	1.041	7.30	21.6	8.464	3%	0.42

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	Extinction Coefficient 0.81
8/17/2005		0.25	0.507	26.19	7.94	98.4	1.047	8.08	3021.9	Surface		
8/17/2005		1	1.067	25.81	7.77	95.7	1.048	8.05	1469.0	Surface		
8/17/2005		2	2.010	25.67	7.72	94.9	1.048	8.07	745.0	0.26	100%	2.61
8/17/2005		3	3.045	25.50	7.88	96.5	1.048	8.10	392.2	1.295	53%	0.62
8/17/2005		4	4.012	25.42	6.71	82.1	1.049	8.01	96.8	2.262	13%	1.45
8/17/2005		5	5.029	25.10	4.53	55.1	1.051	7.77	65.3	3.279	9%	0.39
8/17/2005		6	6.044	24.97	1.39	16.9	1.050	7.50	51.3	4.294	7%	0.24
8/17/2005		7	7.004	24.65	0.25	3.0	1.050	7.42	32.2	5.254	4%	0.49
8/17/2005		8	7.954	24.31	0.09	1.1	1.051	7.37	22.7	6.204	3%	0.37
8/17/2005		9	9.005	23.89	0.03	0.4	1.054	7.30	16.3	7.255	2%	0.32
8/17/2005		10	10.034	23.35	0.04	0.5	1.061	7.17	11.5	8.284	2%	0.34
8/17/2005		11	10.941	23.01	0.01	0.2	1.068	7.07	6.0	9.191	1%	0.72

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	Extinction Coefficient
											Average	0.65
9/21/2005		0.5	0.507	22.71	9.69	112.6	1.069	8.15	2892.9	Surface		
9/21/2005		1	0.983	22.67	9.72	112.9	1.070	8.16	1367.1	Surface		
9/21/2005		2	2.210	22.47	9.67	112.0	1.071	8.17	564.3	0.46	100%	1.92
9/21/2005		3	3.053	22.38	9.63	111.3	1.071	8.18	387.4	1.303	69%	0.45
9/21/2005		4	4.071	22.34	9.58	110.6	1.071	8.19	221.8	2.321	39%	0.55
9/21/2005		5	5.078	22.17	7.22	83.1	1.074	8.05	125.2	3.328	22%	0.57
9/21/2005		6	6.063	22.06	4.62	53.1	1.077	7.84	81.1	4.313	14%	0.44
9/21/2005		7	7.021	21.92	3.17	36.3	1.078	7.74	51.0	5.271	9%	0.48
9/21/2005		8	7.964	21.77	2.46	28.1	1.081	7.67	34.1	6.214	6%	0.43
9/21/2005		9	8.970	21.45	0.45	5.2	1.084	7.57	23.4	7.22	4%	0.37
9/21/2005		10	10.019	21.11	0.34	3.9	1.089	7.50	14.4	8.269	3%	0.46

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 Watershed Nutrient Reduction

The two key ingredients (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 from that area. 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 strip and tall species can be used to deter waterfowl from congregating along the shore. Initially the cost of new plants can be expensive, however over time less maintenance is required for upkeep of a buffer strip.

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

a. Compost yard waste instead of burning yard waste. 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 within are released directly into the water, or are flushed to a 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 phosphorus, silt and trace metals than sand and salt mixes before they're applied to the street. If

a municipality does not manage the lake, the lake management entity may be able to offer the village of 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 surface 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 rushes 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 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) affects lakes and can help people implement watershed controls. Several types of educational outreach 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 get more money for a project.

D2. 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, as steel will.

If installed properly and in the appropriate areas (i.e., shorelines with severe erosion) seawalls provide effective erosion control. Seawalls are made to last numerous 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 in of another portion of the floodplain. Permits and surveys are needed whether replacing and old seawall or installing a new one. Seawalls also provide no 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 term for 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. Prior to the initiation of work permits and/or surveys from the appropriate government agencies need to be obtained.

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 no 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. Also, many fish and wildlife species prefer the native shoreline vegetation habitat. Various wildlife species are even dependent upon shoreline vegetation for their existence. In addition to the benefits of increased fish and wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of various 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 terrestrial sources. They are most effective in areas where plantings alone are not effective due to already severe erosion.

Option 5: Install A-Jacks®

A-Jacks® are made of two pieces of pre-cast concrete when fitted together resemble a child's 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. The 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.

D3. Option for Creating a Bathymetric Map

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. Maps can be created by the Lake County Health Department - Lakes Management Unit (LMU). LMU recently purchased a BioSonics DT-X^{TM} Echosounder. With this equipment the creation of an accurate bathymetric map of almost any size lake in the county is possible. Costs vary, but can range from $2,000-5,000 depending on lake size.

D4. Options for Aquatic Plant Management

Option 1: Aquatic Herbicides

Aquatic herbicides are the most common method to control nuisance vegetation/algae. When used properly, they can provide selective and reliable control. Products cannot be licensed for use in aquatic situations unless there is less than a 1 in 1,000,000 chance of any negative effects on human health, wildlife, and the environment. Prior to herbicide application, licensed applicators should evaluate the lake's vegetation and, along with the lake's management plan, choose the appropriate herbicide and treatment areas, and apply the herbicides during appropriate conditions (i.e., low wind speed, DO concentration, temperature).

When used properly, aquatic herbicides can be a powerful tool in management of excessive vegetation. Often, aquatic herbicide treatments can be more cost effective in the long run compared to other management techniques. The fisheries and waterfowl populations of the lake would benefit greatly due to an increase in quality habitat and food supply. Dense stands of plants would be thinned out and improve spawning habitat and food source availability for fish. By implementing a good management plan with aquatic herbicides, usage opportunities of the lake would increase.

The most obvious drawback of using aquatic herbicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error can make them unsafe and bring about undesired outcomes. If not properly used, aquatic herbicides can remove too much vegetation from the lake. Another problem associated with removing too much vegetation is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. After the initial removal, there is a possibility for regrowth of vegetation. Upon regrowth, weedy plants such as Eurasian Watermilfoil and coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiversity. Over-removal, and possible regrowth of nuisance vegetation that may follow will drastically impair recreational use of the lake.

Option 2: Mechanical Harvesting

Mechanical harvesting involves the cutting and removal of nuisance aquatic vegetation by large specialized boats with underwater cutting bars. The total removal or over removal (neither of which should never be the plan of any management entity) of plants by mechanical harvesting should never be attempted. To avoid complete or over removal, the management entity should have a harvesting plan that determines where and how much vegetation is to be removed.

Mechanical harvesting can be a selective means to reduce stands of nuisance vegetation in a lake. Typically, plants cut low enough to restore recreational use and limit or prevent regrowth. This practice normally improves habitat for fish and other aquatic organisms.
High initial investment, extensive maintenance, and high operational costs have led to decreased use. Mechanical harvesters cannot be used in less than 2-4 feet of water (depending on draft of the harvester) and cannot maneuver well in tight places. The harvested plant material must be disposed of properly to a place that can accommodate large quantities of plants and prevent any from washing back into the lake. Fish, mussels, turtles and other aquatic organisms are commonly caught in the harvester and injured or even removed from the lake in the harvesting process. After the initial removal, there is a possibility for vegetation regrowth. If complete/over removal does occur several problems can result. One problem is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. Another problem with mechanical harvesting, even if properly done, is that it can be a nonselective process.

Option 3: Hand Removal

Hand removal of excessive aquatic vegetation is a commonly used management technique. Hand removal is normally used in small ponds/lakes and limited areas for selective vegetation removal. Areas surrounding piers and beaches are commonly targeted areas. Typically tools such as rakes and cutting bars are used to remove vegetation. Hand removal is a quick, inexpensive, and selective way to remove nuisance vegetation. There are few negative attributes to hand removal. One negative implication is labor. Depending on the extent of infestation, removal of large amount, of vegetation can be quite tiresome. Another drawback can be disposal. Finding a site for numerous residents to dispose of large quantities of harvested vegetation can sometimes be problematic.

Option 4: Water Milfoil Weevil

Euhrychiopsis lecontei (*E. lecontei*) is a biological control organism used to control Eurasian Watermilfoil (EWM). *E. lecontei* is a native weevil, which feeds exclusively on milfoil species. It is stocked as a biocontrol and is commonly referred to as the Eurasian Watermilfoil weevil. Currently, the LCHD-Lakes Management Unit has documented weevils in 35 Lake County lakes. Many of these lakes have seen declines in EWM densities in recent years. Weevils are stocked in known quantities to achieve a density of 1-4 weevils per stem. As weevil populations expand, EWM populations may decline. After EWM declines, weevil populations decline and do not feed on any other aquatic plants. Currently only one company, EnviroScience Inc., has a

stocking program (called the MiddFoil® process). The program includes evaluation of EWM densities, of current weevil populations (if any), stocking, monitoring, and restocking as needed.

If control with milfoil weevils were successful, the quality of the lake would be improved. Native plants could start to recolonize, and fisheries of the lake would improve due to more balanced predation and higher quality habitat. Waterfowl would benefit due to increased food sources and availability of prey. Use of milfoil weevils does have some drawbacks. Control using the weevil has been inconsistent in many cases. Also, Milfoil control using weevils may not work well on plants in deep water. Furthermore, weevils do not work well in areas where plants are continuously disturbed by activities such as powerboats and swimming, harvesting or herbicide use. One of the most prohibitive aspects to weevil use is price. Typically weevils are stocked to achieve a density of 1-4 weevils per stem. This translates to 500-3000 weevils per acre.

Option 5: Reestablishing Native Aquatic Vegetation

Revegetation should only be done when existing nuisance vegetation, such as Eurasian Watermilfoil, are under control using one of the above management options. If the lake has poor clarity due to excessive algal growth or turbidity, these problems must be addressed before a revegetation plan is undertaken. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. There are few negative impacts to revegetating a lake. One possible drawback is the possibility of new vegetation expanding to nuisance levels and needing control. However, this is an unlikely outcome. Another drawback could be high costs if extensive revegetation is needed using imported plants.

D5. Options to Eliminate or Control Exotic Species

Option 1: Biological Control

Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase.
Control of exotics by a natural mechanism is preferable to chemical treatments, however there are few exotics that can be controlled by biological means. Insects, being part of the same ecological system as the exotic plant (i.e., the beetles and weevils and the Purple Loosestrife) are more likely to provide long-term control. Chemical treatments are usually non-selective while

bio-control measures target specific plant species. Bio-control can also be expensive and labor intensive.

Option 2: Control by Hand

Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Some exotics, such as purple loosestrife and reed canary grass, can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is removed. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored since regrowth is common. This can be labor intensive however, costs are low. Many exotic species, such as Purple Loosestrife, Buckthorn, and Garlic Mustard are proficient at colonizing disturbed sites.

Option 3: Herbicide Treatment

Chemical treatments can be effective at controlling exotic plant species. However, chemical treatment works best on individual plants or small areas already infested with the plant. In some areas where individual spot treatments are prohibitive or impractical (i.e., large expanses of a wetland or woodland), chemical treatments may not be an option because in order to chemically treat the area, a broadcast application would be needed. Because many of the herbicides are not selective, meaning they kill all plants they contact, this may be unacceptable if native plants are found in the proposed treatment area.

Herbicides are commonly used to control nuisance shoreline vegetation by applying it to green foliage or cut stems. They provide a fast and effective way to control or eliminate nuisance vegetation by killing the root of the plant, preventing regrowth. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. It is best to apply herbicides when plants are actively growing, such as in the late spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

D6. Participate in the Volunteer Lake Monitoring Program

In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection Agency (Illinois EPA) to gather fundamental information on Illinois' inland lakes, and to provide an educational program for citizens. Annually, approximately 165 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 300 citizen volunteers. The volunteers are primarily lake shore residents, lake owners/managers, members of environmental groups, public water supply personnel, and citizens with interest in a particular lake.

The VLMP relies on volunteers to gather a variety of information on their chosen lake. The primary measurement is Secchi disk transparency or Secchi depth. Analysis of the Secchi disk measurement provides an indication of the general water quality condition of the lake, as well as the amount of usable habitat available for fish and other aquatic life.

Microscopic plants and animals, water color, and suspended sediments are factors that interfere with light penetration through the water column and lessen the Secchi disk depth. As a rule, one to three times the Secchi depth is considered the lighted or euphotic zone of the lake. In this region of the lake there is enough light to allow plants to survive and produce oxygen. Water below the lighted zone can be expected to have little or no dissolved oxygen. Other observations such as water color, suspended algae and sediment, aquatic plants, and odor are also recorded. The sampling season is May through October with volunteer measurements taken twice a month. After volunteers have completed one year of the basic monitoring program, they are qualified to participate in the Expanded Monitoring Program. In the expanded program, selected volunteers are trained to collect water samples that are shipped to the Illinois EPA laboratory for analysis of total and volatile suspended solids, total phosphorus, nitrate-nitrite nitrogen and ammonia nitrogen. Other parameters that are part of the expanded program include dissolved oxygen, temperature, and zebra mussel monitoring. Additionally, chlorophyll *a* monitoring has been added to the regiment for selected lakes.

For information, please contact:

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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