

**2007 SUMMARY REPORT  
of  
North Tower Lake  
Lake County, Illinois**

*Prepared by the*

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# TABLE OF CONTENTS

EXECUTIVE SUMMARY .....	1
LAKE FACTS .....	2
SUMMARY OF WATER QUALITY .....	3
SUMMARY OF AQUATIC MACROPHYTES .....	12
SUMMARY OF SHORELINE CONDITION .....	12
SUMMARY OF WILDLIFE AND HABITAT .....	16
LAKE MANAGEMENT RECOMMENDATIONS .....	18
TABLES	
Table 1. Summary of water quality data for North Tower Lake, 2007 .....	5
Table 2. Lake County average TSI phosphorus (TSIp) rankings 2000-2007 .....	7
FIGURES	
Figure 1. Water quality sampling site on North Tower Lake, 2007 .....	4
Figure 2. Secchi depth vs. total suspended solid (TSS) concentrations in North Tower Lake, 2007 .....	11
Figure 3. Approximate watershed delineation of North Tower Lake, 2007 .....	13
Figure 4. Approximate land use within the North Tower Lake watershed, 2007 .....	14
Figure 5. Aquatic plant sampling grid illustrating plant density on North Tower Lake, 2007 .....	15
Figure 6. Shoreline erosion on North Tower Lake, 2007 .....	17
APPENDICES	
Appendix A. Methods for field data collection and laboratory analyses.	
Appendix B. Multi-parameter data for North Tower Lake in 2007.	
Appendix C. Interpreting your lake's water quality data.	
Appendix D. Lake management options.	
D1. Options for Creating a Bathymetric Map	
D2. Aquatic Plant Management	
D3. Options to Assess Your Lake's Fishery	
D4. Options to Reduce Conductivity and Chloride Concentrations	
D5. Participation in Volunteer Lake Management Program	
D6. Options for Lakes with Shoreline Erosion	
D7. Options to Enhance Wildlife Habitat Conditions on Lake	
D8. Options for Lakes with High Canada Geese Populations	

D9. Options for Watershed Nutrient Reduction  
Appendix E. Water quality statistics for all Lake County lakes.  
Appendix F. Grant program opportunities.

## EXECUTIVE SUMMARY

North Tower Lake was created in 1939 by damming a small tributary of the Timber Lake Drain. Residential housing started to appear on the lake by the early 1940s. Since its creation, the Tower Lakes Improvement Association (TLIA) has overseen the management of North Tower Lake. The lake has a surface area of approximately 7.4 acres, a maximum depth of 9.4 feet and an estimated average depth of 4.7 feet. It is available to subdivision residents for aesthetics, non-motorized boating, swimming, and fishing.

Water levels in North Tower Lake (taken at a pipe next to the outlet) decreased approximately one inch throughout the season. North Tower Lake weakly stratified at 3 and 6 feet in June and July, respectively. This type of weak stratification followed by complete mixing is normal for a shallow, small lake like North Tower. Dissolved oxygen (DO) levels were adequate to support aquatic life ( $> 5$  mg/L) for most of the summer, however in July there were anoxic conditions ( $< 1$  mg/L) below 7 feet.

Overall, water quality in North Tower declined slightly from 2001, when the lake was last sampled by the Lakes Management Unit. Phosphorus and nitrogen are two important nutrients for plant and algal growth. The average total phosphorus for North Tower Lake was 0.088 mg/L compared to the county median of 0.063 mg/L, and higher than 2001 (0.072 mg/L). Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average TKN for North Tower Lake in 2007 was unchanged from 2001 (0.98 mg/L), which was slightly lower than the county median of 1.22 mg/L.

Total suspended solid concentrations (TSS) fluctuated throughout the season with a maximum concentration of 10.0 mg/L in September and 8.8 mg/L in August. The average TSS concentration for the season was 5.7 mg/L, which was below the county median of 8.0 mg/L. However, the TSS increased by 103% since 2001 when the average was 2.8 mg/L. This was most likely due to the storm events that occurred in late summer. High TSS values are typically correlated with poor water clarity and can be detrimental to many aspects of the lake ecosystem, including the plant and fish communities. Water clarity was measured by Secchi disk depth with the lowest reading in August (2.85 feet) corresponding to a high TSS value. The average Secchi depth for the season was 4.61 feet, which is greater than the county median (3.28 feet), but a decline from 2001. The average conductivity concentration for North Tower Lake was 1.1988 mS/cm, which was well above the county median (0.8038 mS/cm), but a 21% increase from the 2001 average (0.9876 mg/L). The average chloride concentration (255 mg/L) was also greater than the county median (158 mg/L).

The only aquatic plant found in Tower Lake was *Chara* spp., a macro-algae, which was found at 61% of the sites sampled. This was a decrease in abundance and plant diversity from 2001 when Curlyleaf Pondweed and Small Pondweed were also found.

Although the LMU found no erosion in 2001, they noted that much of the rip rap was deteriorating and could be at risk for erosion in the future. In 2007 the shoreline erosion was reassessed and the entire shoreline was found to be slightly eroding.

## LAKE FACTS

<b>Lake Name:</b>	North Tower Lake
<b>Historical Name:</b>	None
<b>Nearest Municipality:</b>	Tower Lakes
<b>Location:</b>	T43N, R9E, Section 2
<b>Elevation:</b>	754.0 feet
<b>Major Tributaries:</b>	None
<b>Watershed:</b>	Fox River
<b>Sub-watershed:</b>	Tower Lake Drain
<b>Receiving Water body:</b>	Davlin's Pond, Tower Lake
<b>Surface Area:</b>	7.4 acres
<b>Shoreline Length:</b>	0.6 miles
<b>Maximum Depth:</b>	9.4 feet
<b>Average Depth (est.):</b>	4.7 feet
<b>Lake Volume (est.):</b>	37.7 acre-feet
<b>Lake Type:</b>	Impoundment
<b>Watershed Area:</b>	55.0 acres
<b>Major Watershed Land uses:</b>	Single Family, Transportation, and Forest and grassland
<b>Bottom Ownership:</b>	Private
<b>Management Entities:</b>	Tower Lake Improvement Association
<b>Current and Historical uses:</b>	Boating (no motor), fishing, swimming, and aesthetics.
<b>Description of Access:</b>	No public access, Association members only

## SUMMARY OF WATER QUALITY

Water samples were collected from May to September in North Tower Lake at the deepest point (Figure 1), three feet below the surface (Appendix A). Water levels in North Tower Lake (taken at a pipe next to the outlet) decreased approximately 1 inch throughout the season. Initially, the water level went down 4 inches and then increased in August by 6 inches, due to heavy rainfall. In order to accurately monitor water levels it is recommended that a permanent staff gauge be installed and water levels are monitored and recorded frequently (i.e., daily or weekly).

Thermal stratification is measured in relative thermal resistance to mixing (RTRM). RTRM values that fall below 20 allow water within the entire water body to mix freely, while values of 20 and higher generally do not allow mixing. In most lakes, the size of this strongly stratified layer increases throughout the summer. North Tower Lake weakly stratified at 3 and 6 feet in May and June, respectively, and again slightly in August at 4 feet. The lake exhibits polymictic tendencies, meaning stratification and turnover occur repeatedly over the year. This may be the result of climatic factors (i.e., wind and wave action, temperature) and the shallow nature of the lake. Lakes that do not stratify or stratify only weakly may have fewer problems with low dissolved oxygen (DO) problems or the build up and release of excessive nutrients. This type of weak stratification followed by complete mixing is normal for a small, shallow lake like North Tower.

A dissolved oxygen (DO) concentration  $>5.0$  mg/L is considered adequate to support a sunfish/bass fishery, since many fish suffer from oxygen stress below this amount. In North Tower, DO levels were adequate to support aquatic life for most of the summer, however in July there were anoxic conditions ( $<1$  mg/L) below 7 feet (Appendix B). Since a bathymetric map with volumetric calculations of North Tower Lake does not exist, an accurate assessment of the DO conditions cannot be made. It is recommended that a bathymetric map be created.

Phosphorus is a nutrient that limits plant and algal growth, therefore any addition of phosphorus to the lake may produce algal blooms (Appendix C). The average total phosphorus (TP) concentration for North Tower Lake was 0.088 mg/L (Table 1) and the county median was 0.063 mg/L (Appendix E). This phosphorus concentration was an increase from 2001 when it was 0.072 mg/L. Nitrogen is the other nutrient critical for algal growth. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average TKN concentration for North Tower Lake was 0.98 mg/L, which was lower than the county median of 1.22 mg/L but equal to the concentration in 2001. The TN:TP (total nitrogen to total phosphorus) ratio looks at which nutrient was limiting plant and algal growth in a lake. Ratios of  $< 10:1$  indicate nitrogen was limiting. Ratios of  $>15:1$  indicate phosphorus was limiting. Ratios  $>10:1$ ,  $<15:1$  indicate there was enough of both nutrients for excessive algal growth. North Tower Lake had a TN:TP ratio of 12:1 which indicated phosphorus and nitrogen could both contribute to algal blooms. Nitrogen is difficult to control because it can come from a variety of external sources including being transformed by blue-green algae from an atmospheric form to an organic form. When the TN:TP ratios are calculated monthly it shows some months were phosphorous limited and other months were nitrogen limited. In May the lake was limited by phosphorus with TN:TP ratios of 16:1 and TP concentrations were low at this time, 0.059 mg/L. During July and August the TN:TP ratio was 12:1 and 13:1, respectively, indicating neither nutrient was limiting. However, in June and September, the lake was nitrogen limiting,

**Figure 1. Water quality sampling site on North Tower Lake, 2007.**



**Table 1. Summary of water quality data for North Tower Lake, 2007.**

2007	Epilimnion															
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>2</sub> +NO <sub>3</sub> -N	TP	SRP	TDS	Cl <sup>-</sup>	TSS	TS	TVS	SECCHI	COND	pH	DO
09-May	3	169	0.93	<0.1	<0.05	0.059	<0.005	NA	261	2.8	611	100	6.40	1.1960	8.50	7.41
13-Jun	3	192	0.82	<0.1	<0.05	0.098	0.044	NA	266	3.1	721	166	6.56	1.2410	7.98	6.89
11-Jul	3	193	1.08	<0.1	<0.05	0.087	0.021	NA	272	3.9	727	166	4.29	1.3090	8.14	4.72
08-Aug	3	166	0.97	<0.1	<0.05	0.072	0.006	NA	248	8.8	626	140	2.85	1.1500	8.72	13.36
12-Sep	3	180	1.08	<0.1	<0.05	0.123	0.015	NA	230	10.0	626	141	2.95	1.0980	8.59	11.58
<b>Average</b>		180	0.98	<0.1	<0.05	0.088	<0.005	NA	255	6.0	662	143	4.61	1.1988	8.39	8.79

2001	Epilimnion															
DATE	DEPTH	ALK	TKN	NH <sub>3</sub>	NO <sub>3</sub> -N <sup>*</sup>	TP	SRP	TDS	Cl <sup>-</sup>	TSS	TS	TVS	SECCHI	COND	pH	DO
23-May	3	161	0.53	<0.1	<0.05	0.082	0.027	534	NA	1.9	567	167	0 <sup>a</sup>	0.9605	8.11	5.21
27-Jun	3	162	0.85	<0.1	<0.05	0.056	0.017	520	NA	0.7	573	142	8.86	0.9834	8.35	9.92
1-Aug	3	153	1.37	<0.1	<0.05	0.085	0.015	598	NA	6.1	613	185	3.25	0.9996	8.17	6.64
29-Aug	3	169	1.22	<0.1	<0.05	0.090	0.011	546	NA	4.0	628	127	4.00	1.0290	7.92	6.35
25-Sep	3	154	0.95	<0.1	<0.05	0.046	0.005	526	NA	1.2	545	137	0 <sup>a</sup>	0.9656	8.36	9.91
<b>Average</b>		160	0.98	<0.1	<0.05	0.072	0.015	545	NA	2.8	585	152	5.37 <sup>b</sup>	0.9876	8.18	7.61

5

Glossary
ALK = Alkalinity, mg/L CaCO <sub>3</sub>
TKN = Total Kjeldahl nitrogen, mg/L
NH <sub>3</sub> -N = Ammonia nitrogen, mg/L
NO <sub>2</sub> +NO <sub>3</sub> -N = Nitrate + Nitrite nitrogen, mg/L
NO <sub>3</sub> -N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl <sup>-</sup> = Chloride, mg/L
TDS = Total dissolved solids, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

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

NA= Not applicable

\* = Prior to 2006 only Nitrate - nitrogen was analyzed

a = Secchi depth was obstructed by the bottom

b = Secchi disk depth average does not include data from May because Secchi disk was on the bottom and therefore the reading could have been deeper

both with a ration of 8:1. When nitrogen is limited, aquatic organisms are unable to utilize the available phosphorus and the concentrations increase. Phosphorus can also be released from sediment through biological or mechanical processes or from plant or algal cells as they die. This typically occurs in lakes like North Tower Lake that do not stratify, therefore phosphorus attached to bottom sediment or released from dying algae/plant cells can be easily distributed throughout the water column. Phosphorus is easier to control due to the sources. Phosphorus comes from fertilizers used with the watershed, as well as geese feces. Buffer strips around the lake can filter some of the nutrients from runoff before it enters the lake. Buffer strips will also deter geese from congregating along the shoreline of the lake.

Another way to look at phosphorus levels and how they affect 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 TSIp index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich, productive). In 2007, North Tower Lake was eutrophic with a TSIp value of 68.7, which placed it 99<sup>th</sup> out of 163 lakes in the county (Table 2). In 2001 North Tower Lake had a TSIp of 65.8.

TSI values along with other water quality parameters can be used to make other analyses based on use impairment indexes established by the Illinois Environmental Protection Agency (IEPA). Based on IEPA indices, North Tower Lake has *Partial* support for recreational use and *Full* support of aquatic life use. Based on these indices, this lake was listed as providing *Partial* overall use support.

Total suspended solids (TSS) are composed of nonvolatile suspended solids such as non-organic clay or sediment materials, and volatile suspended solids such as algae and other organic matter. The 2007 average TSS concentration for North Tower Lake was 5.7 mg/L, which was below the county median of 8.0 mg/L. However, the TSS has increased by 103% since 2001 when the average was 2.8 mg/L. TSS increased as the season progressed with maximum concentrations in August and September. This was most likely due to the storm events that occurred in late summer. Water clarity is a direct result of the amount of TSS in the water column, and is usually the first thing people notice about a lake, as it typifies the overall lake quality. High TSS values are typically correlated with poor water clarity and can be detrimental to many aspects of the lake ecosystem, including the plant and fish communities. Water clarity was measured by Secchi depth, with the lowest reading in August (2.85 feet) corresponding to a high TSS value (Figure 2). The average Secchi depth for the season was 4.6 feet, which was greater than the county median (3.28 feet). The Secchi depths for August and September were much lower due to the heavy rain events during that time. This may explain the decrease in Secchi depth since 2001 when the average was 5.37 feet.

Conductivity concentrations, which are correlated with chloride concentrations, have been increasing throughout the past few years in the county. It is believed that road salt is probably the reason for the increase because chloride concentrations detect sodium chloride and calcium chloride which are what most road salt consists of. The average conductivity concentration for North Tower Lake was 1.1988 mS/cm, which was well above the county median (0.8038 mS/cm), but a 21% increase from the 2001 average (0.9876 mg/L). The average chloride

**Table 2. Lake County average TSI phosphorous (TSIp) ranking 2000-2007.**

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Independence Grove	0.0114	39.24
4	Sand Pond (IDNR)	0.0132	41.36
5	Cedar Lake	0.0157	41.60
6	Windward Lake	0.0158	43.95
7	Pulaski Pond	0.0180	45.83
8	Timber Lake (North)	0.0180	45.83
9	Fourth Lake	0.0182	45.99
10	West Loon Lake	0.0182	45.99
11	Lake Kathym	0.0200	47.35
12	Lake of the Hollow	0.0200	47.35
13	Banana Pond	0.0202	47.49
14	Lake Minear	0.0204	47.63
15	Bangs Lake	0.0212	48.17
16	Cross Lake	0.0220	48.72
17	Dog Pond	0.0222	48.85
18	Stone Quarry Lake	0.0230	49.36
19	Cranberry Lake	0.0234	49.61
20	Deep Lake	0.0240	49.98
21	Druce Lake	0.0244	50.22
22	Little Silver Lake	0.0246	50.33
23	Round Lake	0.0254	50.80
24	Lake Leo	0.0256	50.91
25	Dugdale Lake	0.0274	51.89
26	Peterson Pond	0.0274	51.89
27	Lake Miltmore	0.0276	51.99
28	East Loon Lake	0.0280	52.20
29	Lake Zurich	0.0282	52.30
30	Lake Fairfield	0.0296	53.00
31	Gray's Lake	0.0302	53.29
32	Highland Lake	0.0302	53.29
33	Hook Lake	0.0302	53.29
34	Lake Catherine (Site 1)	0.0308	53.57
35	Lambs Farm Lake	0.0312	53.76
36	Old School Lake	0.0312	53.76
37	Sand Lake	0.0316	53.94
38	Sullivan Lake	0.0320	54.13
39	Lake Linden	0.0326	54.39
40	Countryside Lake	0.0332	54.66
41	Gages Lake	0.0338	54.92
42	Hendrick Lake	0.0344	55.17
43	Third Lake	0.0346	55.24
44	Diamond Lake	0.0372	56.30
45	Channel Lake (Site 1)	0.0380	56.60
46	Ames Pit	0.0390	56.98

**Table 2. Continued.**

<b>RANK</b>	<b>LAKE NAME</b>	<b>TP AVE</b>	<b>TSIp</b>
47	White Lake	0.0408	57.63
48	Sun Lake	0.0410	57.70
49	Potomac Lake	0.0424	58.18
50	Duck Lake	0.0426	58.25
51	Old Oak Lake	0.0428	58.32
52	Deer Lake	0.0434	58.52
53	Schreiber Lake	0.0434	58.52
54	Nielsen Pond	0.0448	58.98
55	Turner Lake	0.0458	59.30
56	Seven Acre Lake	0.0460	59.36
57	Willow Lake	0.0464	59.48
58	Lucky Lake	0.0476	59.85
59	Davis Lake	0.0476	59.85
60	East Meadow Lake	0.0478	59.91
61	College Trail Lake	0.0496	60.45
62	Lake Lakeland Estates	0.0524	61.24
63	Butler Lake	0.0528	61.35
64	West Meadow Lake	0.0530	61.40
65	Heron Pond	0.0545	61.80
66	Little Bear Lake	0.0550	61.94
67	Lucy Lake	0.0552	61.99
68	Lake Christa	0.0576	62.60
69	Lake Charles	0.0580	62.70
70	Crooked Lake	0.0608	63.38
71	Waterford Lake	0.0610	63.43
72	Lake Naomi	0.0616	63.57
73	Lake Tranquility S1	0.0618	63.62
74	Werhane Lake	0.0630	63.89
75	Liberty Lake	0.0632	63.94
76	Countryside Glen Lake	0.0642	64.17
77	Lake Fairview	0.0648	64.30
78	Leisure Lake	0.0648	64.30
79	Tower Lake	0.0662	64.61
80	Wooster Lake	0.0663	64.63
81	St. Mary's Lake	0.0666	64.70
82	Mary Lee Lake	0.0682	65.04
83	Hastings Lake	0.0684	65.08
84	Honey Lake	0.0690	65.21
85	Spring Lake	0.0726	65.94
86	ADID 203	0.0730	66.02
87	Bluff Lake	0.0734	66.10
88	Harvey Lake	0.0766	66.71
89	Broberg Marsh	0.0782	67.01
90	Echo Lake	0.0792	67.19
91	Sylvan Lake	0.0794	67.23
92	Big Bear Lake	0.0806	67.45

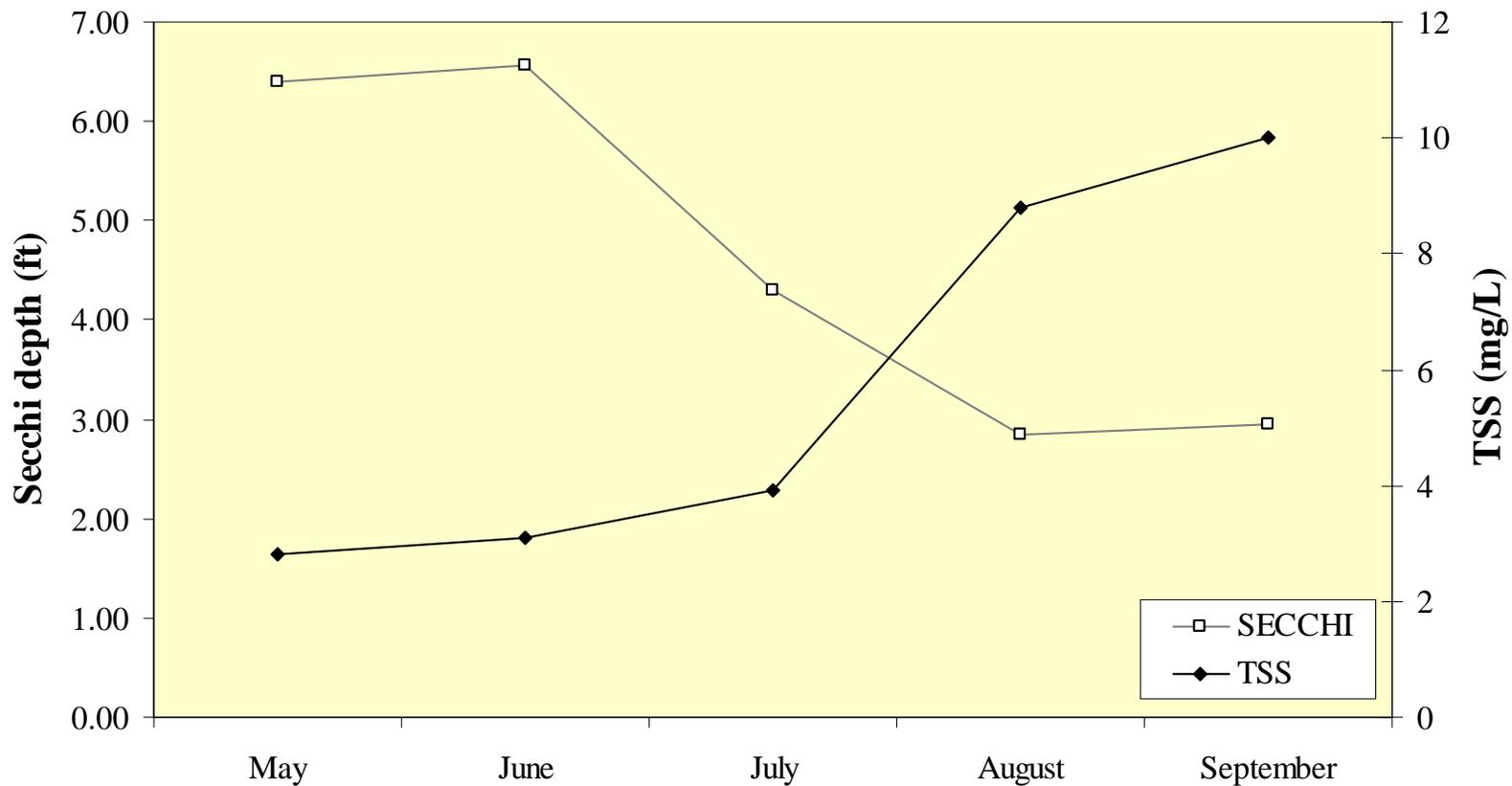
**Table 2. Continued.**

<b>RANK</b>	<b>LAKE NAME</b>	<b>TP AVE</b>	<b>TSIp</b>
93	Petite Lake	0.0834	67.94
94	Timber Lake (South)	0.0848	68.18
95	Lake Marie (Site 1)	0.0850	68.21
96	North Churchill Lake	0.0872	68.58
97	Grand Avenue Marsh	0.0874	68.61
98	Grandwood Park, Site II, Outflow	0.0876	68.65
<b>99</b>	<b>North Tower Lake</b>	<b>0.0878</b>	<b>68.68</b>
100	South Churchill Lake	0.0896	68.97
101	Rivershire Pond 2	0.0900	69.04
102	McGreal Lake	0.0914	69.26
103	International Mine and Chemical Lake	0.0948	69.79
104	Eagle Lake (Site I)	0.0950	69.82
105	Valley Lake	0.0950	69.82
106	Dunns Lake	0.0952	69.85
107	Fish Lake	0.0956	69.91
108	Lochanora Lake	0.0960	69.97
109	Owens Lake	0.0978	70.23
110	Woodland Lake	0.0986	70.35
111	Island Lake	0.0990	70.41
112	McDonald Lake 1	0.0996	70.50
113	Longview Meadow Lake	0.1024	70.90
114	Long Lake	0.1029	70.96
115	Lake Barrington	0.1053	71.31
116	Redwing Slough, Site II, Outflow	0.1072	71.56
117	Lake Forest Pond	0.1074	71.59
118	Bittersweet Golf Course #13	0.1096	71.88
119	Fox Lake (Site 1)	0.1098	71.90
120	Osprey Lake	0.1108	72.04
121	Bresen Lake	0.1126	72.27
122	Round Lake Marsh North	0.1126	72.27
123	Deer Lake Meadow Lake	0.1158	72.67
124	Taylor Lake	0.1184	72.99
125	Columbus Park Lake	0.1226	73.49
126	Nippersink Lake (Site 1)	0.1240	73.66
127	Grass Lake (Site 1)	0.1288	74.21
128	Lake Holloway	0.1322	74.58
129	Lakewood Marsh	0.1330	74.67
130	Summerhill Estates Lake	0.1384	75.24
131	Redhead Lake	0.1412	75.53
132	Forest Lake	0.1422	75.63
133	Antioch Lake	0.1448	75.89
134	Slocum Lake	0.1496	76.36
135	Drummond Lake	0.1510	76.50
136	Pond-a-Rudy	0.1514	76.54
137	Lake Matthews	0.1516	76.56
138	Buffalo Creek Reservoir	0.1550	76.88

**Table 2. Continued.**

<b>RANK</b>	<b>LAKE NAME</b>	<b>TP AVE</b>	<b>TSIp</b>
139	Pistakee Lake (Site 1)	0.1592	77.26
140	Salem Lake	0.1650	77.78
141	Half Day Pit	0.1690	78.12
142	Lake Eleanor Site II, Outflow	0.1812	79.13
143	Lake Farmington	0.1848	79.41
144	ADID 127	0.1886	79.71
145	Lake Louise Inlet	0.1938	80.10
146	Grassy Lake	0.1952	80.20
147	Dog Bone Lake	0.1990	80.48
148	Redwing Marsh	0.2072	81.06
149	Stockholm Lake	0.2082	81.13
150	Bishop Lake	0.2156	81.63
151	Hidden Lake	0.2236	82.16
152	Fischer Lake	0.2278	82.43
153	Lake Napa Suwe (Outlet)	0.2304	82.59
154	Patski Pond (outlet)	0.2512	83.84
155	Oak Hills Lake	0.2792	85.36
156	Loch Lomond	0.2954	86.18
157	McDonald Lake 2	0.3254	87.57
158	Fairfield Marsh	0.3264	87.61
159	ADID 182	0.3280	87.69
160	Slough Lake	0.4134	91.02
161	Flint Lake Outlet	0.4996	93.75
162	Rasmussen Lake	0.5025	93.84
163	Albert Lake, Site II, outflow	1.1894	106.3

**Figure 2. Secchi depth vs. total suspended solid (TSS) concentrations in North Tower Lake, 2007.**



concentration was 255 mg/L, which was greater than the county median (158 mg/L). A study done in Canada reported 10% of aquatic species were harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with chloride concentrations as low as 12 mg/l. At the current levels in North Tower Lake, chloride concentrations may negatively impact aquatic life. It is recommended that the winter road maintenance in the watershed be evaluated as many alternatives to road salt are currently available and being used by several entities in Lake and surrounding counties.

The North Tower Lake watershed (Figure 3) is approximately 55 acres and includes Rose's Pond to the west. The area immediately adjacent to the lake is mostly single family homes making up 55% of the watershed (Figure 4), which contributes 63% of the estimated runoff in the watershed (Table 3). Thirty-five percent of runoff comes from transportation (roads), which is about 10 acres of the watershed. The retention time of the lake was calculated to be 343 days. This is a long retention time compared to Tower Lake which was estimated to be 45 days. This would account for the increase in water quality of Tower Lake and the decrease in North Tower Lake.

### **SUMMARY OF AQUATIC MACROPHYTES**

Plant sampling was conducted on North Tower Lake in June. Thirty-one points were sampled based on a computer generated grid system using ArcGIS with points 30 meters apart (Figure 5). The only plant found was a macro-algae, *Chara* spp., which was found at 61% of the sites. This is a decrease in abundance from 2001 when Curlyleaf Pondweed and Small Pondweed were present. The decrease in species is most likely due to plant treatments performed in the spring, before sampling. A healthy aquatic plant population is critical to good lake health. Aquatic vegetation provides important wildlife habitat and food sources. Additionally, aquatic plants provided many water quality benefits such as sediment stabilization and competition with algae for available resources. According to the IDNR, the optimal plant coverage for a healthy sunfish/bass fishery is 30% to 40% across the lake bottom.

Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a lake. When the light level in the water column falls below 1% of the surface light level, plants can no longer photosynthesize. Plants in North Tower Lake were found at a maximum depth of 5.9 feet, however the 1% light level was to the bottom (8 feet). Due to the sampling method used however, some plants may have been missed.

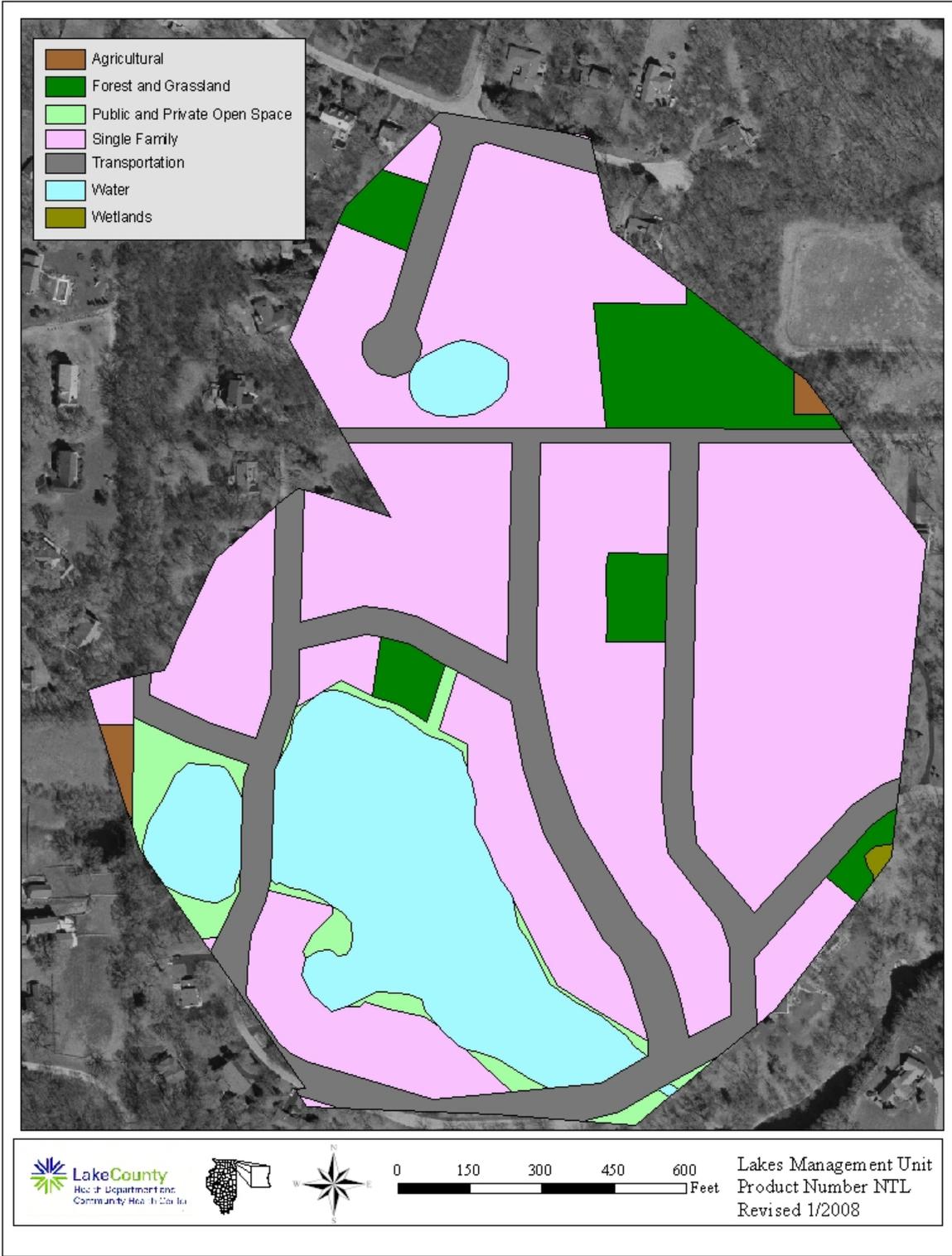
### **SUMMARY OF SHORELINE CONDITION**

In 2001, a complete shoreline assessment was performed in May and June. This assessment found 100% of North Tower Lake's shoreline developed. The majority of developed shoreline consisted of rock rip rap (53%) and manicured lawn (40%). Both of these shoreline types are considered undesirable. Rip rap can be prone to erosion if not installed properly. Several rip rap areas on North Tower Lake were in disrepair. Lawn at the land-water interface can create problems due to the poor root structure of turf grasses, which are unable to stabilize soils and may lead to erosion. Additionally, both rip rap and manicured lawns offer very poor wildlife habitat and offer low/no buffering of runoff into the lake.

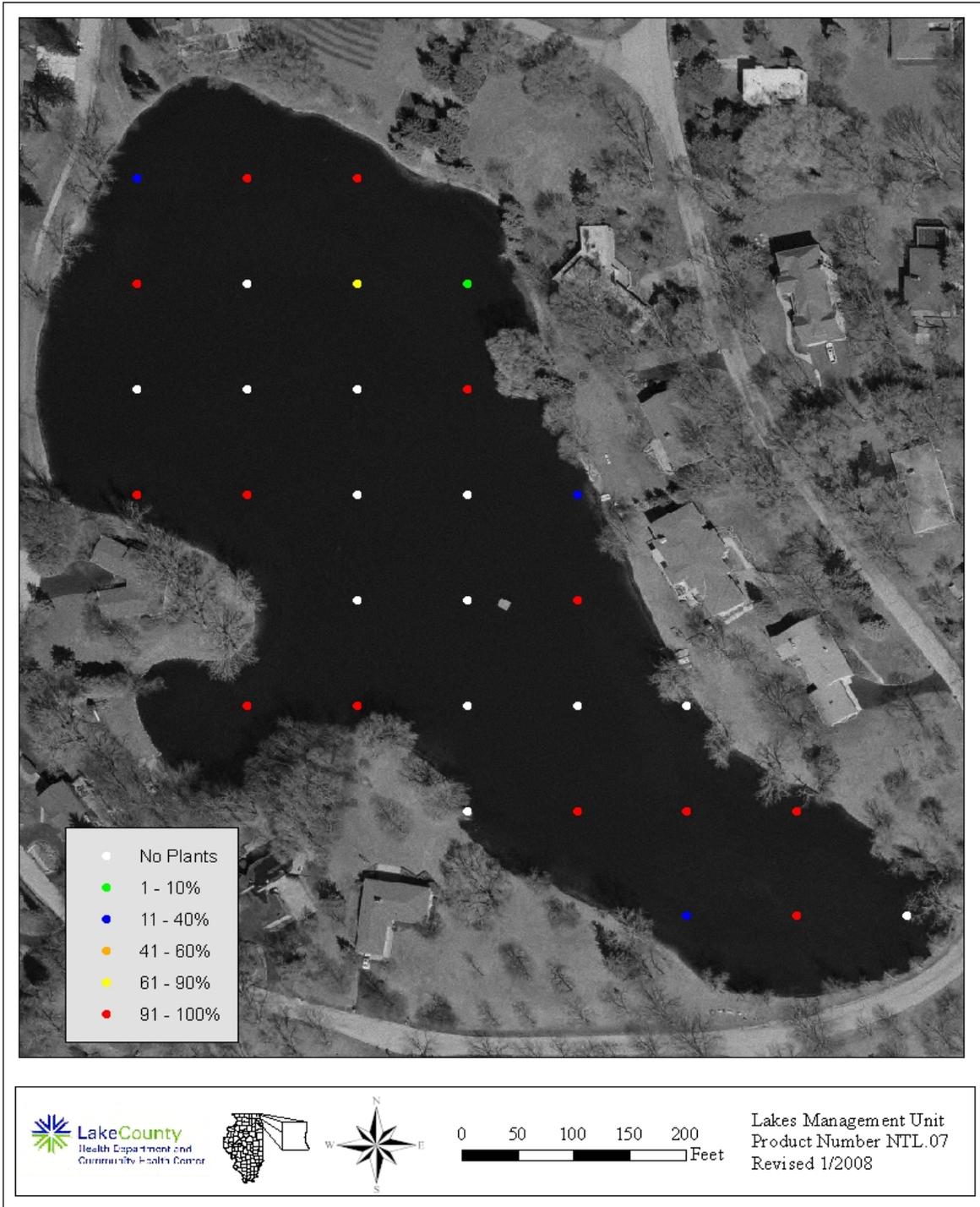
**Figure 3. Approximate watershed delineation of North Tower Lake, 2007.**



**Figure 4. Approximate land use within the North Tower Lake watershed, 2007.**



**Figure 5. Aquatic plant sampling grid illustrating *Chara* spp. density on North Tower Lake, June 2007.**

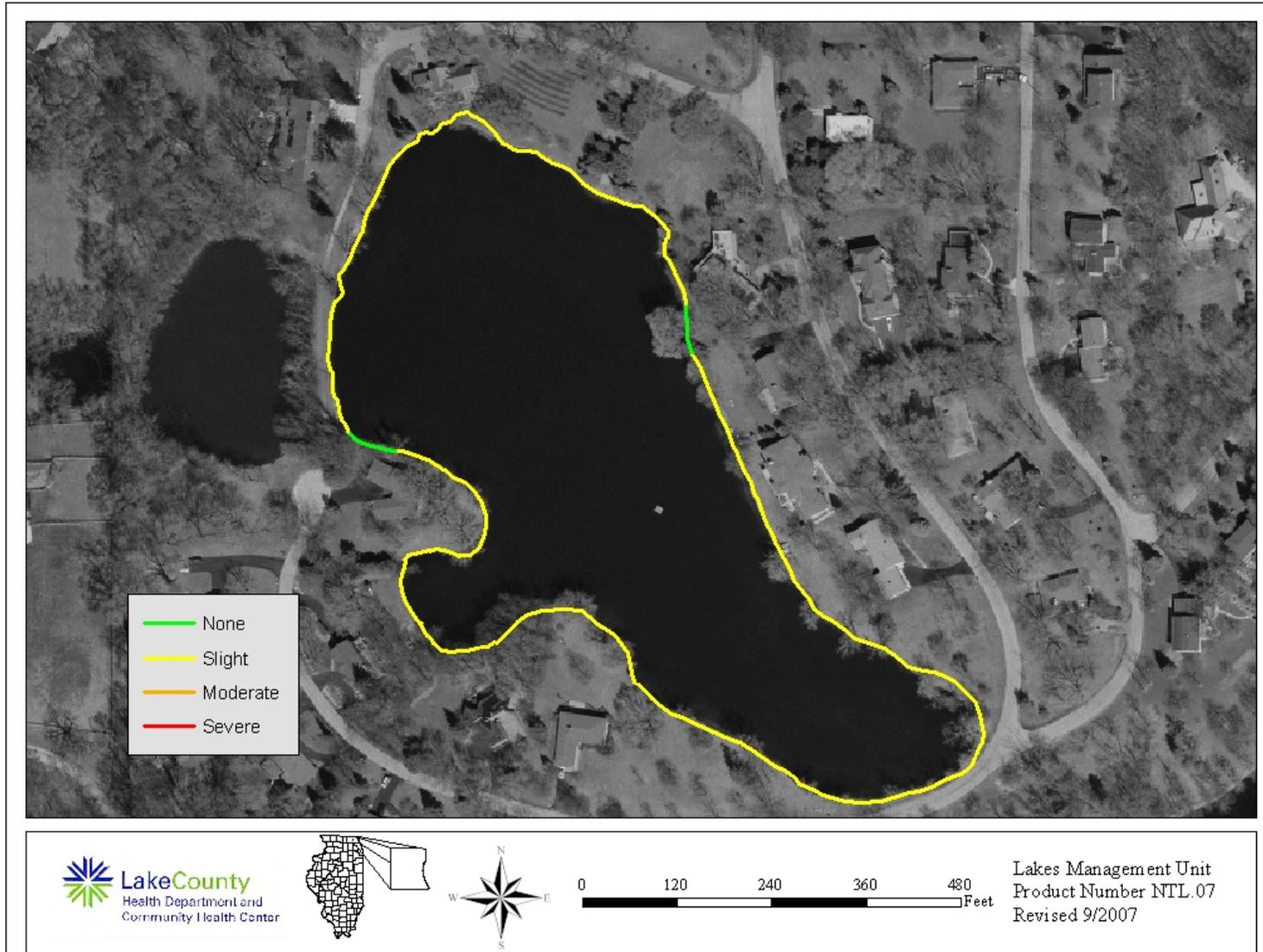


Shorelines were also assessed for the presence of erosion. Based on the 2001 LMU assessment, there was no erosion on North Tower Lake. This is largely due to the overwhelming dominance of rip rap, which can be effective at preventing erosion if installed properly. Additionally, the slope leading up to the lake is very flat, which helps to reduce the chance of erosion. Low water level fluctuations also helped keep erosion to a minimum at North Tower Lake. Although the LMU in 2001 found no erosion, they noted that much of the rip rap was deteriorating and could be at risk for erosion in the future. In 2007 the shoreline erosion was reassessed and changes were noted. The LMU found almost the entire shoreline to be slightly eroding (Figure 6). Eroding shorelines may contribute sediment and nutrients to the lake. It is recommended these areas are taken care of before the erosion problem becomes more difficult to control or fix.

## **SUMMARY OF WILDLIFE AND HABITAT CONDITIONS**

Habitat conditions around North Tower Lake are below average. This is due to the dominance of the shoreline types such as rip rap and manicured lawn, which offer poor habitat, and the low occurrence of desirable types of shoreline such as shrub, woodland, and buffer areas. During the 2007 study several types of common waterfowl were observed during the course of the study including Great Blue Heron, White Egret, and Canada Geese. The presence of geese can contribute to the nutrients in the lake. Methods should be taken to control and discourage the geese from congregating around the lake. Lawn to the edge of the lake allows easy access for the geese to the lake, while buffer strips deter geese from congregating. There was a nice habitat area at the northwest end of the lake (Rose's Park). Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones and are recommended as one aspect of shoreline protection. Erecting birdhouses and allowing brush or trees that have fallen into the water to remain creates additional habitat for birds, fish, reptiles, and amphibians.

Figure 6. Shoreline erosion on North Tower Lake, 2007.



## LAKE MANAGEMENT RECOMMENDATIONS

North Tower Lake has an active lake association (TLIA) which can work to make improvements to the lake. It had a small, developed watershed, little wildlife habitat, and no aquatic macrophytes. To improve the quality of North Tower Lake, the LMU has the following recommendations.

### **Creating a Bathymetric Map**

Creating an updated bathymetric map can help with improvements to North Tower Lake. A bathymetric 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 (Appendix D1).

### **Aquatic Plant Management**

A key to a healthy lake is a well-balanced aquatic plant population. Aquatic plants compete with algae for nutrients and stabilize bottom substrate, which in turn improves water clarity. Putting together a good aquatic plant management plan should not be rushed. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. Follow up is critical for an aquatic plant management plan to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake (Appendix D2).

### **Assess Your Lake's Fishery**

If one of the goals for the lake is to have recreational fishing for users, a formal fisheries assessment should be conducted to determine the diversity and health of the fish community (Appendix D3).

### **Reduce Conductivity and Chloride Concentrations**

Conductivity concentrations in North Tower Lake have increased 21% since the 2001 average (0.9876 mg/L). The average chloride concentration was 255 mg/L, which was greater than the county median (158 mg/L), and is potentially harmful to aquatic life in the lake. The use of road salts for winter road management is a major contributor to chloride concentrations and conductivity. Proper application procedures and alternative methods can be used to keep these concentrations under control (Appendix D4).

### **Participate in the Volunteer Lake Monitoring Program (VLMP)**

To track future water quality trends, it is recommended that the lake become enrolled in the Volunteer Lake Monitoring Program (VMLP), which trains a volunteer to measure the

Secchi disk readings on a bimonthly basis from April to October (Appendix D5). In addition to the VMLP, a staff gauge should be installed to monitor the lake level each month.

#### **Lakes with Shoreline Erosion**

The entire shoreline of the lake is showing signs of erosion. These eroded areas should be remediated to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation instead of riprap or seawalls (Appendix D6).

#### **Enhance Wildlife Habitat Conditions on a Lake**

With the lake being in a residential setting and a majority of the shoreline as riprap or lawn, wildlife habitat was limited. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones, which was recommended as one aspect of shoreline protection. Erecting birdhouses and allowing brush or trees that have fallen into the water to remain creates additional habitat for birds, fish, reptiles, and amphibians (Appendix D7).

#### **Lakes with High Canada Geese Populations**

The presence of geese can contribute to the nutrients in the lake. Methods should be taken to control and discourage the geese from congregating around the lake. Lawn to the edge of the lake allows easy access for the geese to the lake. Buffer strips should be installed along the water's edge to deter geese. Also, people feeding the geese can keep them congregating. It is recommended that signs stating "No Feeding Waterfowl" be installed (Appendix D8).

#### **Watershed Nutrient Reduction**

The water quality in North Tower Lake has declined since 2001 due to the high retention time, runoff from the surrounding watershed, and the shallow nature of the lake. Lakes that do not stratify or stratify only weakly may have fewer problems with low dissolved oxygen (DO) problems or the build up and release of excessive nutrients. The large amount of single family homes in the watershed allows for more runoff, which carries nutrients from fertilizers and geese feces into the lake (Appendix D9).

**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 (ArcMap 9.1) overlaid a grid pattern onto a 2006 aerial photo of Lake County and placed points 60 or 30 meters apart, depending on lake size. 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.

## **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.**

<i>Parameter</i>	<i>Method</i>
Temperature	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Dissolved oxygen	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Nitrate and Nitrite nitrogen	USEPA 353.2 rev. 2.0 EPA-600/R-93/100 Detection Limit = 0.05 mg/L
Ammonia nitrogen	SM 18 <sup>th</sup> ed. Electrode method, #4500 NH <sub>3</sub> -F Detection Limit = 0.1 mg/L
Total Kjeldahl nitrogen	SM 18 <sup>th</sup> ed, 4500-N <sub>org</sub> C Semi-Micro Kjeldahl, plus 4500 NH <sub>3</sub> -F Detection Limit = 0.5 mg/L
pH	Hydrolab DataSonde® 4a, or YSI 6600 Sonde® Electrometric method
Total solids	SM 18 <sup>th</sup> ed, Method #2540B
Total suspended solids	SM 18 <sup>th</sup> ed, Method #2540D Detection Limit = 0.5 mg/L
Chloride	SM 18 <sup>th</sup> ed, Method #4500C1-D
Total volatile solids	SM 18 <sup>th</sup> ed, Method #2540E, from total solids
Alkalinity	SM 18 <sup>th</sup> ed, Method #2320B, potentiometric titration curve method
Conductivity	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Total phosphorus	SM 18 <sup>th</sup> ed, Methods #4500-P B 5 and #4500-P E Detection Limit = 0.01 mg/L
Soluble reactive phosphorus	SM 18 <sup>th</sup> 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 NORTH TOWER  
LAKE IN 2007**

North Tower Lake 2007 Multiparameter data

Text											
Date	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light Meter	% Light Transmission Average	Extinction Coefficient
MMDDYY	feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet		0.59
05/09/2007	0.5	0.505	21.25	8.02	90.7	1.199	8.53	3572.7	Surface		
05/09/2007	1	0.991	21.09	7.86	88.6	1.165	8.52	3403.2	Surface	100%	
05/09/2007	2	2.029	20.76	7.22	80.9	1.199	8.46	1024.4	0.359	30%	3.34
05/09/2007	3	2.993	19.31	7.41	80.7	1.196	8.50	713.9	1.323	21%	0.27
05/09/2007	4	3.994	17.89	8.14	86.1	1.194	8.57	485.0	2.324	14%	0.17
05/09/2007	5	4.948	16.91	8.60	89.1	1.190	8.61	335.5	3.278	10%	0.11
05/09/2007	6	5.997	16.34	8.82	90.4	1.184	8.63	243.0	4.327	7%	0.07
05/09/2007	7	7.014	15.98	10.45	106.2	1.182	8.70	169.0	5.344	5.0%	0.07
05/09/2007	8	7.997	15.81	11.05	111.9	1.180	8.73	98.3	6.327	2.9%	0.09

Text											
Date	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light Meter	% Light Transmission Average	Extinction Coefficient
MMDDYY	feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet		0.60
06/13/2007	0.5	0.544	26.00	7.07	87.4	1.242	8.04	3388.5	Surface		
06/13/2007	1	1.033	25.60	7.02	86.2	1.242	8.00	3310.5	Surface	100%	
06/13/2007	2	2.008	25.25	7.04	85.8	1.242	8.00	1065.7	0.338	32%	3.35
06/13/2007	3	3.000	25.16	6.89	83.9	1.241	7.98	775.2	1.330	23%	0.24
06/13/2007	4	4.029	25.05	6.39	77.7	1.242	7.94	558.7	2.359	17%	0.14
06/13/2007	5	5.031	24.52	4.78	57.5	1.243	7.83	396.9	3.361	12%	0.10
06/13/2007	6	6.014	23.79	3.34	39.7	1.242	7.69	272.0	4.344	8%	0.09
06/13/2007	7	6.993	21.91	2.70	31.0	1.262	7.53	191.2	5.323	6%	0.07
06/13/2007	8	7.974	20.49	2.31	25.7	1.286	7.30	56.3	6.304	2%	0.19

Text											
Date	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light	% Light	Extinction
MMDDYY	feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	Meter	Transmission	Coefficient
									feet	Average	0.72
07/11/2007	0.5	0.528	26.66	4.68	58.6	1.310	8.25	3392.5	Surface		
07/11/2007	1	1.071	26.66	4.70	58.9	1.310	8.16	3310.0	Surface	100%	
07/11/2007	2	2.012	26.65	4.76	59.6	1.309	8.16	1015.9	0.342	31%	3.45
07/11/2007	3	3.087	26.60	4.72	59.0	1.309	8.14	689.0	1.417	21%	0.27
07/11/2007	4	3.978	26.53	4.75	59.3	1.309	8.13	277.3	2.308	8%	0.39
07/11/2007	5	5.083	26.30	4.72	58.7	1.310	8.12	288.4	3.413	9%	-0.01
07/11/2007	6	5.997	26.08	3.85	47.7	1.310	8.06	140.3	4.327	4%	0.17
07/11/2007	7	7.085	25.77	3.37	41.5	1.309	8.01	125.5	5.415	4%	0.02

Text											
Date	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light	% Light	Extinction
MMDDYY	feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	Meter	Transmission	Coefficient
									feet	Average	0.85
08/08/2007	0.5	0.600	28.76	13.73	178.3	1.156	8.80	1890.6	Surface		
08/08/2007	1	1.000	28.74	13.77	178.8	1.156	8.78	1493.0	Surface	100%	
08/08/2007	2	2.000	28.48	14.07	182.2	1.150	8.78	256.0	0.330	17%	5.34
08/08/2007	3	3.000	28.40	13.36	172.5	1.150	8.72	254.0	1.330	17%	0.01
08/08/2007	4	4.087	27.27	8.88	112.3	1.129	8.43	174.3	2.417	12%	0.16
08/08/2007	5	5.091	26.70	5.08	63.6	1.158	8.22	92.9	3.421	6%	0.18
08/08/2007	6	6.092	26.26	1.33	16.5	1.230	8.03	54.6	4.422	4%	0.12
08/08/2007	7	7.055	25.76	0.32	3.9	1.245	7.84	35.0	5.385	2%	0.08
08/08/2007	8	8.000	25.30	0.27	4.0	1.262	7.65	22.9	6.330	2%	0.07

Date MMDDYY	Text								Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.82
	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý			
09/12/2007	0.5	0.564	21.13	11.88	134.0	1.098	8.45	3351.3	Surface		
09/12/2007	1	1.064	20.98	11.85	133.2	1.100	8.53	3120.9	Surface	100%	
09/12/2007	2	2.042	20.66	11.91	133.1	1.100	8.57	684.3	0.372	22%	4.08
09/12/2007	3	3.062	20.58	11.58	129.2	1.098	8.59	98.9	1.392	3%	1.39
09/12/2007	4	4.064	20.46	10.63	118.3	1.098	8.57	221.9	2.394	7%	-0.34
09/12/2007	5	5.082	20.39	10.26	114.1	1.099	8.56	109.5	3.412	4%	0.21
09/12/2007	6	6.069	20.31	9.89	109.8	1.100	8.55	65.7	4.399	2.1%	0.12
09/12/2007	7	7.068	19.99	9.59	105.8	1.100	8.53	25.7	5.398	0.8%	0.17
09/12/2007	8	8.036	19.93	9.16	100.9	1.100	8.52	13.9	6.366	0.4%	0.10

**APPENDIX C. INTERPRETING YOUR LAKE'S 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.  $\text{NH}_4^+$  (ammonium) is released from decomposing organic material under anoxic conditions and accumulates in the hypolimnion of thermally stratified lakes. If  $\text{NH}_4^+$  comes into contact with oxygen, it is immediately converted to  $\text{NO}_2^-$  (nitrite) which is then oxidized to  $\text{NO}_3^-$  (nitrate). Therefore, in a thermally stratified lake, levels of  $\text{NH}_4^+$  would only be elevated in the hypolimnion and levels of  $\text{NO}_3^-$  would only be elevated in the epilimnion. Both  $\text{NH}_4^+$  and  $\text{NO}_3^-$  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 ( $\text{NO}_3^-$ ,  $\text{NO}_2^-$ ,  $\text{NH}_4^+$ ) 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 ( $\text{CO}_3^-$ ) and bicarbonate ( $\text{HCO}_3^-$ ) 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 ( $\text{CaCO}_3$ ) or dolomite ( $\text{CaMgCO}_3$ ), 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	$\leq 0.012$	>13.12
Mesotrophic	$\geq 40 < 50$	$> 0.012 \leq 0.024$	$\geq 6.56 < 13.12$
Eutrophic	$\geq 50 < 70$	$> 0.024 \leq 0.096$	$\geq 1.64 < 6.56$
Hypereutrophic	$\geq 70$	$> 0.096$	< 1.64

## **APPENDIX D. LAKE MANAGEMENT OPTIONS**

## ***D1. 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™ 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.

## ***D2. 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 a 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: Watermilfoil 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<sup>®</sup> 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 the fishery 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, 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 the high costs of extensive revegetation with imported plants.

### ***D3. Options to Assess Your Lake's Fishery***

Many lakes have a fish-stocking program in which fish are stocked every year or two to supplement fish species already occurring in the lake or to introduce additional fish species into the system. However, few lakes that participate in stocking check the progress or success of these programs with regular fish surveys. Lake managers should have information about whether or not funds delegated to fish stocking are being well spent, and it is difficult to determine how stocked fish species are surviving and reproducing or how they are affecting the rest of the fish community without a comprehensive fish assessment.

A simple, inexpensive way to collect information on the status of a fishery is to sample anglers actively involved in recreational fishing on the lake and evaluate the types, numbers and sizes of

fish caught. Such information provides insight on the status of fish populations in the lake, as well as a direct measure of the quality of fishing and the fishing experience. However, the numbers and types of fish sampled by anglers are limited, focusing on game and catchable-sized fish. Thus, in order to obtain a comprehensive assessment of the fish community, including non-game fish species, more quantitative methods such as gill netting, trap netting, seining, trawling, angling (hook and line fishing) and electroshocking must be employed. Each method has its advantages and limitations, and frequently multiple gears are employed. The best gear and sampling methods depend on the target species and life stage, the types of information desired, and the environment to be sampled.

It is best to monitor fish populations annually. The best time of year depends on the sampling method, the target fish species, and the types of data to be collected. In many lakes and regions, the best time to sample fish is during the fall turnover period after thermal stratification breaks down and the lake is completely mixed because: (1) young-of-year (YOY) and age 1+ (one year or older) fish of most target species should be present and vulnerable to most standard collection gear, including seines, trap nets and electroshockers; (2) species that dwell in the hypolimnion during the summer may be more vulnerable to capture during fall overturn; and (3) lower water temperatures in the fall can help reduce sampling-related mortality. Sampling locations are also species, life stage, and gear dependent. As with sampling methods and time, locations should be selected to maximize capture efficiency for the target species of interest and provide the greatest gain in information for the least amount of sampling effort.

The Illinois Department of Natural Resources (IDNR) will perform a fish survey at no charge on most public and some private water bodies. In order to determine if your lake is eligible for a survey by the IDNR, contact Frank Jakubecik, Fisheries Biologist, at (815) 675-2319. If a lake is not eligible for an IDNR fish survey or if a more comprehensive survey is desired, contact the Lakes Management Unit for a list of consultants.

#### ***D4. Options to Reduce Conductivity and Chloride Concentrations***

Road salt (sodium chloride) is the most commonly used winter road de-icer. While recent advances in the technology of salt spreaders have increased the efficiency to allow more even distribution, the effect to the surrounding environment has come into question. Whether it is used on highways for public safety or on your sidewalk and driveway to ensure your own safety, the main reason for road salt's popularity is that it is a low cost option. However, it could end up costing you more in the long run from the damages that result from its application.

Excess salt can effect soil and in turn plant growth. This can lead to the die-off of beneficial native plant species that cannot tolerate high salt levels, and lead to the increase of non-native, and/or invasive species that can.

Road salts end up in waterways either directly or through groundwater percolation. The problem is that animals do not use chloride and therefore it builds up in a system. This can lead to decreases in dissolved oxygen, which can lead to a loss of biodiversity.

The Lakes Management Unit monitors the levels of salts in surface waters in the county by measuring conductivity and chloride concentrations (which are correlated to each other). There has been an overall increase in salt levels that has been occurring over the past couple of decades. These increases could have detrimental effects on plants, fish and animals living and using the water.

What can you do to help maintain or reduce chloride levels?

#### Option 1. Proper Use on Your Property

Ultimately, the less you use of any product, the better. Physically removing as much snow and ice as possible before applying a de-icing agent is the most important step. Adding more products before removing what has already melted can result in over application, meaning unnecessary chemicals ending up in run-off to near by streams and lakes.

#### Option 2. Examples of Alternatives

While alternatives may contain chloride, they tend to work faster at lower temperatures and therefore require less application to achieve the same result that common road salt would.

##### Calcium, Magnesium or Potassium Chloride

- Aided by the intense heat evolved during its dissolution, these are used as ice-melting compounds.

##### Calcium Magnesium Acetate (CMA)

- Mixture of dolomitic lime and acetic acid; can also be made from cheese whey and may have even better ice penetration.
- Benefits: low corrosion rates, safe for concrete, low toxicity and biodegradable, stays on surfaces longer (fewer applications necessary).
- Multi-Purpose: use straight, mix with sodium chloride, sand or as a liquid
- Negatives: slow action at low temperatures, higher cost.

##### Agricultural Byproducts

- Usually mixed with calcium chloride to provide anti-corrosion properties.
- Lower the freezing point of the salt they are added to.
- as a pre-wetting (anti-ice) agent, it's like a Teflon treatment to which ice and snow will not stick.

Local hardware and home improvement stores should carry at least one salt alternative. Some names to look for: Zero Ice Melt Jug, Vaporizer, Ice Away, and many others. Check labels or ask a sales associate before you buy in order to ensure you are purchasing a salt alternative.

#### Option 3. Talk to Your Municipality About Using an Alternative

Many municipalities are testing or already using alternative products to keep the roads safe. Check with your municipality and encourage the use of these products.

### ***D5. 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. Approximately 165 lakes (of

3,041 lakes in Illinois) are sampled annually by approximately 300 volunteers. The volunteers are lakeshore residents, lake owners/managers, members of environmental groups, public water supply personnel, and/or 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 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 zone of the lake. In this region of the lake there is enough light to allow plants to grow 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, 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:

VLMP Regional Coordinator:  
Holly Hudson  
Chicago Metropolitan Agency for Planning  
233 S. Wacker Drive, Suite 880  
Chicago, IL 60606  
(312) 386-8700

## ***D6. Options for Lakes with Shoreline Erosion***

### **Option 1: Install a Seawall**

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

If installed properly and in the appropriate areas (i.e., shorelines with severe erosion) seawalls provide effective erosion control. Seawalls are made to last many years and have relatively low maintenance. However, seawalls are disadvantageous for several reasons. One of the main disadvantages is that they are expensive, since a professional contractor and heavy equipment are

needed for installation. Also, if any fill material is placed in the floodplain along the shoreline, compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling of another portion. Permits and surveys are needed whether replacing old seawall or installing a new one. Seawalls also provide little habitat for fish or wildlife. Because there is no structure for fish, wildlife, or their prey, few animals use shorelines with seawalls. In addition, poor water clarity that may be caused by resuspension of sediment from deflected wave action contributes to poor fish and wildlife habitat, since sight feeding fish and birds (i.e., bass, herons, and kingfishers) are less successful at catching prey. This may contribute to a lake's poor fishery (i.e., stunted fish populations).

### **Option 2: Install Rock Rip-Rap or Gabions**

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

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

### **Option 3: Create a Buffer Strip**

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

Buffer strips can be one of the least expensive means to stabilize shorelines. If no permits or heavy equipment are needed (i.e., no significant earthmoving or filling is planned), the property owner can complete the work without the need of professional contractors. Once established (typically within 3 years), a buffer strip of native vegetation will require little maintenance and may actually reduce the overall maintenance of the property, since the buffer strip will not have to be continuously mowed, watered, or fertilized. Buffer strips may slow the velocity of

floodwaters, thus preventing shoreline erosion. Native plants also can withstand fluctuating water levels more effectively than commercial turfgrass. In addition, many wildlife species prefer the native shoreline vegetation habitat and various species are even dependent on native shoreline vegetation for their existence. In addition to the benefits of increased wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people, but also benefits wildlife and the overall health of the lake's ecosystem.

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

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

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

#### **Option 5: Install A-Jacks®**

A-Jacks® are made of two pieces of pre-cast concrete when fitted together resemble a playing jacks. These structures are installed along the shoreline and covered with soil and/or an erosion control product. Native vegetation is then planted on the backfilled area. They can be used in areas where severe erosion does not justify a buffer strip alone.

The advantage to A-Jacks® is that they are quite strong and require low maintenance once installed. In addition, once native vegetation becomes established the A-Jacks® cannot be seen. A disadvantage is that installation cost can be high since labor is intensive and requires some heavy equipment. A-Jacks® need to be pre-made and hauled in from the manufacturing site.

#### **Option 6: Establish a “No Wake” Zone or No Motor Area**

Establishing a “no wake” zone or no motor area will not solve erosion problems by itself. However, since shoreline erosion is generally not caused by one specific factor, these techniques can be effective if used in combination with one or more of the techniques described above. Limiting boat activity, particularly near shorelines or in shallow areas, may also have an additional benefit by improving water quality since less sediment may be disturbed and resuspended in the water column. Less motorboat disturbance will also benefit wildlife and may encourage many species to use the lake both during spring and fall migration and for summer

residence. This may add to the lake's aesthetics and increasing recreational opportunities for some lake users.

Enforcement and public education are the primary obstacles with the "no wake" techniques. Public resistance to any regulation change may be strong, particularly if the lake is open to the public and has had no similar regulations in the past. Depending on the regulations implemented, there may be some loss of recreational use for some users, particularly powerboating. However, if the lake is large enough, certain parts of the lake (i.e., the middle or deepest) may be used for this activity without negatively influencing other uses.

## ***D7. Options to Enhance Wildlife Habitat Conditions on a Lake***

### **Option 1: Increase Habitat Cover**

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

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

### **Option 2: Increase Natural Food Supply**

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

### **Option 3: Limit Disturbance**

Since most species of wildlife are susceptible to human disturbance, any action to curtail disturbances is beneficial. Limiting disturbance can include posting signs in areas of the lake where wildlife may live (e.g., nesting waterfowl), establish a “no wake” area, boat horsepower or speed limits, or establish restricted boating hours. These are examples of time and space zoning for lake usage. Enforcement and public education are needed if this option is to be successful. In some areas, off-duty law enforcement officers can be hired to patrol the lake.

Limiting disturbance will increase the chance that wildlife will use the lake, particularly for raising their young. Many wildlife species have suffered population declines due to loss of habitat and poor breeding success. This is due in part to their sensitivity to disturbance. Recreation activities such as canoeing and paddleboating may be enhanced by the limited disturbance.

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

## ***D8. Options for Lakes with High Canada Geese Populations***

### **Option 1: Removal**

Since Canada Geese are considered migratory waterfowl, both state and federal laws restrict taking or harassing geese. Under the federal Migratory Bird Treaty Act, it is illegal to kill or capture geese outside a legal hunting season or to harass their nests without a permit. If removal of problematic geese is warranted or if nest and egg destruction becomes an option, permits need to be obtained from the Illinois Department of Natural Resources (217- 782-6384) and the U.S. Fish and Wildlife Service (217-241-6700). Removing a significant portion of a problem goose population can have a positive effect on the overall health of a lake. However, if the habitat conditions still exist, more geese will likely replace any that were removed. Thus, money and time used removing geese may not be well spent unless there is a change in habitat conditions.

### **Option 2: Dispersal/Repellent Techniques**

Several techniques and products are on the market that claim to disperse or deter geese from using an area. These techniques can be divided into two categories: harassment and chemical. With both types of techniques it is important to implement any action early in the season, before geese establish territories and begin nesting. Once established, the dispersal/repellant techniques may be less effective and geese more difficult to coerce into leaving. Harassment techniques include scaring off geese with noisemakers, or chasing them off using dogs or swans. Chemical repellents may also be used with some effectiveness. New products are continually coming out that claim to rid an area of nuisance geese.

With persistence, harassment and/or use of repellants can result reduced or minimal usage of an area by geese. Fewer geese may mean less feces and cleaner yards and parks, which may

increase recreational uses along shorelines. However, the effectiveness of harassment techniques is reduced over time since geese will adapt to the devices.

### **Option 3: Exclusion**

Erecting a barrier to exclude geese is another option. In addition to a traditional wood or wire fence, an effective exclusion control is to suspend netting over the area where geese are unwanted. Geese are reluctant to fly or walk into the area. A similar deterrent that is often used is a single string or wire suspended a foot or so above the ground along the length of the shoreline. This technique will not be effective if the geese are using a large area. The single string or wire method may be effective at first, but geese often learn to go around, over, or under the string after a short period of time. Excluding geese from one area will force them to another area on a different part of the same lake or another nearby lake. While this solves one property owner's problem, it creates one for another.

### **Option 4: Habitat Alteration**

One of the best methods to deter geese from using an area is through habitat alteration. Habitats that consist of mowed turfgrass to the edge of the shoreline are ideal for geese. Create a buffer strip (approximately 10-20 feet wide) between the shoreline and any mowed lawn by planting natural shoreline vegetation (i.e., bulrushes, cattails, rushes, grasses, shrubs, and trees, etc.) or allowing the vegetation to establish naturally. Aeration systems that run into the fall and winter prevent the lake from freezing, thus not forcing geese to migrate elsewhere. To alleviate this problem, turn aerators off during fall and early winter. Once the lake freezes over and the geese have left, wait a few weeks before turning the aerators on again if needed.

Altering the habitat in an area can not only make the habitat less desirable for geese, but may be more desirable for many other species of wildlife. A buffer strip has additional benefits by filtering run-off of nutrients, sediments, and pollutants and protecting the shoreline from erosion from wind, wave, or ice action. The more area that has natural vegetation, the less turfgrass needs to be constantly manicured and maintained.

### **Option 5: Do Not Feed Waterfowl!**

There are few "good things", if any, that come from feeding waterfowl. Birds become dependent on handouts, become semi-domesticated, and do not migrate. This causes populations to increase and concentrate, which may create additional problems such as diseases within waterfowl populations. The nutritional value in many of the "foods" (i.e., white bread) given to geese and other waterfowl are quite low. Since geese are physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese that are accustomed to hand feeding may become aggressive toward other geese or even the people feeding the geese.

## ***D9. Options for Watershed Nutrient Reduction***

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

### **Option 1. Buffer Strips**

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

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

- a. Compost yard waste instead of burning. Ashes from yard waste contain nutrients and are easily washed into a lake.
- b. Avoid dumping yard waste along or into a ditch, pond, lake, or stream. As yard waste decomposes, the nutrients are released directly into the water, or flushed to the lake via the ditch.
- c. Avoid applying fertilizer up to the water's edge. Leave a buffer strip of at least 25 feet of unfertilized yard before the shoreline.
- d. Avoid applying fertilizers when heavy rains are expected, or over-watering the ground after applying fertilizer.
- e. When landscaping, keep site disturbance to a minimum, especially the removal of vegetation and exposure of bare soil. Exposed soil can easily erode.
- f. When landscaping, seed or plant exposed soil and cover it with mulch as soon as possible to minimize erosion and runoff.
- g. Use lawn and garden chemicals sparingly, or do not use them at all.
- e. Most lawns in Lake County do not need additional phosphorus for sufficient plant growth. Consider using a phosphorus-free fertilizer.

### **Option 3. Street Sweeping**

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

phosphorus and trace metals than new sand and salt mixes. If a municipality does not manage the lake, the lake management entity may be able to offer the village or city extra payment for sweeping streets closest to the lake.

#### **Option 4: Reduce Stormwater Volume from Impervious Surfaces**

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

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

#### **Option 5: Required Practices for Construction**

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

#### **Option 6. Organize a Local Watershed Organization**

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

#### **Option 7. Motor Boat Restrictions for Shallow Lakes**

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

### **Option 8. Discourage Waterfowl from Congregating**

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

**APPENDIX E. WATER QUALITY STATISTICS FOR ALL LAKE  
COUNTY LAKES.**

## 2000 - 2007 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2007		ALKanoxic 2000-2007	
Average	<b>167.3</b>		<b>200</b>	
Median	<b>162.0</b>		<b>193</b>	
Minimum	<b>64.9</b>	<b>IMC</b>	<b>103</b>	<b>Heron Pond</b>
Maximum	<b>330.0</b>	<b>Flint Lake</b>	<b>470</b>	<b>Lake Marie</b>
STD	<b>42.0</b>		<b>48</b>	
n =	<b>803</b>		<b>253</b>	

	Condoxic <=3ft00-2007		Condanoxic 2000-2007	
Average	<b>0.8856</b>		<b>1.0035</b>	
Median	<b>0.8038</b>		<b>0.8340</b>	
Minimum	<b>0.2542</b>	<b>Broberg Marsh</b>	<b>0.3210</b>	<b>Lake Kathryn</b>
Maximum	<b>6.8920</b>	<b>IMC</b>	<b>7.4080</b>	<b>IMC</b>
STD	<b>0.5243</b>		<b>0.7787</b>	
n =	<b>802</b>		<b>252</b>	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2007		NH3-Nanoxic 2000-2007	
Average	<b>0.515</b>		<b>2.070</b>	
Median	<b>0.150</b>		<b>1.340</b>	
Minimum	<b>&lt;0.05</b>	<b>*ND</b>	<b>&lt;0.1</b>	<b>*ND</b>
Maximum	<b>9.670</b>	<b>South Churchill Lake</b>	<b>18.400</b>	<b>Taylor Lake</b>
STD	<b>1.082</b>		<b>2.296</b>	
n =	<b>808</b>		<b>252</b>	

\*ND = Many lakes had non-detects (74.5%)

\*ND = 19.8% Non-detects from 28 different lakes

Only compare lakes with detectable concentrations to the statistics above  
Beginning in 2006, Nitrate+Nitrite was measured.

	pHoxic <=3ft00-2007		pHanoxic 2000-2007	
Average	<b>8.31</b>		<b>7.22</b>	
Median	<b>8.31</b>		<b>7.21</b>	
Minimum	<b>7.07</b>	<b>Bittersweet #13</b>	<b>6.24</b>	<b>Banana Pond</b>
Maximum	<b>10.28</b>	<b>Round Lake Marsh</b>	<b>8.48</b>	<b>Heron Pond</b>
STD	<b>0.44</b>	<b>North</b>	<b>0.41</b>	
n =	<b>797</b>		<b>252</b>	

	All Secchi 2000-2007	
Average	<b>4.57</b>	
Median	<b>3.28</b>	
Minimum	<b>0.33</b>	<b>Fairfield Marsh, Patski Pond</b>
Maximum	<b>21.33</b>	<b>Bangs Lake</b>
STD	<b>3.81</b>	
n =	<b>750</b>	



## 2000 - 2007 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2007	
Average	<b>1.457</b>	
Median	<b>1.220</b>	
Minimum	<b>&lt;0.1</b>	<b>*ND</b>
Maximum	<b>10.300</b>	<b>Fairfield Marsh</b>
STD	<b>0.830</b>	
n =	<b>808</b>	

\*ND = 4.5% Non-detects from 16 different lakes

	TPoxic <=3ft00-2007	
Average	<b>0.100</b>	
Median	<b>0.063</b>	
Minimum	<b>&lt;0.01</b>	<b>*ND</b>
Maximum	<b>3.880</b>	<b>Albert Lake</b>
STD	<b>0.171</b>	
n =	<b>808</b>	

\*ND = 2.4% Non-detects from 7 different lakes  
(Carina, Minear, & Stone Quarry)

	TSSall <=3ft00-2007	
Average	<b>15.5</b>	
Median	<b>8.0</b>	
Minimum	<b>&lt;0.1</b>	<b>*ND</b>
Maximum	<b>165.0</b>	<b>Fairfield Marsh</b>
STD	<b>20.3</b>	
n =	<b>814</b>	

\*ND = 1.8% Non-detects from 11 different lakes

	TDSoxic <=3ft00-2004	
Average	<b>470</b>	
Median	<b>454</b>	
Minimum	<b>150</b>	<b>Lake Kathryn, White</b>
Maximum	<b>1340</b>	<b>IMC</b>
STD	<b>169</b>	
n =	<b>745</b>	

No 2002 IEPA Chain Lakes.

	CLoxic <=3ft00-2007	
Average	<b>211</b>	
Median	<b>158</b>	
Minimum	<b>30</b>	<b>White Lake</b>
Maximum	<b>2760</b>	<b>IMC</b>
STD	<b>247</b>	
n =	<b>411</b>	

	TKNanoxic 2000-2007	
Average	<b>2.910</b>	
Median	<b>2.320</b>	
Minimum	<b>&lt;0.5</b>	<b>*ND</b>
Maximum	<b>21.000</b>	<b>Taylor Lake</b>
STD	<b>2.272</b>	
n =	<b>252</b>	

\*ND = 2.8% Non-detects from 4 different lakes

	TPanoxic 2000-2007	
Average	<b>0.294</b>	
Median	<b>0.177</b>	
Minimum	<b>0.012</b>	<b>Indep. Grove and W. Loon Lake</b>
Maximum	<b>3.800</b>	<b>Taylor Lake</b>
STD	<b>0.380</b>	
n =	<b>252</b>	

	TVSoxic <=3ft00-2007	
Average	<b>135.3</b>	
Median	<b>132.0</b>	
Minimum	<b>34.0</b>	<b>Pulaski Pond Fairfield Marsh</b>
Maximum	<b>298.0</b>	
STD	<b>39.9</b>	
n =	<b>758</b>	

No 2002 IEPA Chain Lakes

	CLanoxic <=3ft00-2007	
Average	<b>232</b>	
Median	<b>119</b>	
Minimum	<b>41</b>	<b>Timber Lake (N)</b>
Maximum	<b>2390</b>	<b>IMC</b>
STD	<b>400</b>	
n =	<b>102</b>	

77 of 163 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

Minimums and maximums are based on data from all lakes from 2000-2007 (n=1363).

Average, median and STD are based on data from the most recent water quality sampling year for each lake.

LCHD Lakes Management Unit ~ 12/17/2007

## **APPENDIX F. GRANT PROGRAM OPPORTUNITES**

**Table F1. Potential Grant Opportunities**

Grant Program Name	Funding Source	Contact Information	Funding Focus				Cost Share
			Water Quality/ Wetland	Habitat	Erosion	Flooding	
Challenge Grant Program	USFWS	847-381-2253 or 309-793-5800		X	X		
Chicago Wilderness Small Grants	CW	312-346-8166 ext. 30					None
Partners in Conservation (formerly C2000)	IDNR	<a href="http://dnr.state.il.us/orep/c2000/">http://dnr.state.il.us/orep/c2000/</a>		X			None
Conservation Reserve Program	NRCS	<a href="http://www.nrcs.usda.gov/programs/crp/">http://www.nrcs.usda.gov/programs/crp/</a>		X			Land
Ecosystems Program	IDNR	<a href="http://dnr.state.il.us/orep/c2000/ecosystem/">http://dnr.state.il.us/orep/c2000/ecosystem/</a>		X			None
Emergency Watershed Protection	NRCS	<a href="http://www.nrcs.usda.gov/programs/ewp/">http://www.nrcs.usda.gov/programs/ewp/</a>			X	X	None
Five Star Challenge	NFWF	<a href="http://www.nfwf.org/AM/Template.cfm">http://www.nfwf.org/AM/Template.cfm</a>		X			None
Illinois Flood Mitigation Assistance Program	IEMA	<a href="http://www.state.il.us/iema/construction.htm">http://www.state.il.us/iema/construction.htm</a>				X	None
Great Lakes Basin Program	GLBP	<a href="http://www.glc.org/basin/stateproj.html?st=il">http://www.glc.org/basin/stateproj.html?st=il</a>	X		X		None
Illinois Clean Energy Community Foundation	ICECF	<a href="http://www.illinoiscleanenergy.org/">http://www.illinoiscleanenergy.org/</a>		X			
Illinois Clean Lakes Program	IEPA	<a href="http://www.epa.state.il.us/water/financial-assistance/index.html">http://www.epa.state.il.us/water/financial-assistance/index.html</a>					None
Lake Education Assistance Program (LEAP)	IEPA	<a href="http://www.epa.state.il.us/water/conservation-2000/leap/index.html">http://www.epa.state.il.us/water/conservation-2000/leap/index.html</a>	X				\$500

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  
 IDOA = Illinois Department of Agriculture  
 LCSCMC = 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

**Table F1. Continued**

Grant Program Name	Funding Source	Contact Information	Funding Focus				Cost Share
			Water Quality/ Wetland	Habitat	Erosion	Flooding	
Northeast Illinois Wetland Conservation Account	USFWF	847-381-2253	X				
Partners for Fish and Wildlife	USFWS	<a href="http://ecos.fws.gov/partners/">http://ecos.fws.gov/partners/</a>		X			> 50%
River Network's Watershed Assistance Grants Program	River Network	<a href="http://www.rivernetwork.org">http://www.rivernetwork.org</a>	X	X	X		na
Section 206: Aquatic Ecosystems Restoration	USACE	312-353-6400, 309-794-5590 or 314-331-8404		X			35%
Section 319: Non-Point Source Management Program	IEPA	<a href="http://www.epa.state.il.us/water/financial-assistance/non-point.html">http://www.epa.state.il.us/water/financial-assistance/non-point.html</a>	X	X			>40%
Section 1135: Project Modifications for the Improvement of the Environment	USACE	312-353-6400, 309-794-5590 or 314-331-8404		X			25%
Stream Cleanup And Lakeshore Enhancement (SCALE)	IEPA	<a href="http://www.epa.state.il.us/water/watershed/scale.html">http://www.epa.state.il.us/water/watershed/scale.html</a>	X	X			None
Streambank Stabilization & Restoration (SSRP)	IDOA/ LCSWCD	<a href="http://www.agr.state.il.us/Environment/conserv/">http://www.agr.state.il.us/Environment/conserv/</a> or call LCSWCD at (847) 223-1056		X	X		25%
Watershed Management Boards	LCSMC	<a href="http://www.co.lake.il.us/smc/projects/wmb/default.asp">http://www.co.lake.il.us/smc/projects/wmb/default.asp</a>	X		X	X	50%
Wetlands Reserve Program	NRCS	<a href="http://www.nrcs.usda.gov/programs/wrp/">http://www.nrcs.usda.gov/programs/wrp/</a>	X	X			Land
Wildlife Habitat Incentive Program	NRCS	<a href="http://www.nrcs.usda.gov/programs/whip/">http://www.nrcs.usda.gov/programs/whip/</a>		X			Land

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  
 IDOA = Illinois Department of Agriculture  
 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