2007 SUMMARY REPORT
of
Tower Lake

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Tower Lake was constructed in 1923 and then enlarged by dredging the southeastern bay in the 1940s. Tower Lake has a large watershed of approximately 3217 acres. A spillway on the southwest side of the lake controls the flow out of the lake. Water leaving Tower Lake eventually flows into the Fox River. It is a private lake available for aesthetics, boating (no motors), swimming, and fishing. Overall, the 2007 lake water quality has improved slightly since 2001 with parameters measured in 2007 below 2001 measurements.

The water levels in Tower Lake (taken from a stake placed in the lake by the Lakes Management Unit (LMU) remained unchanged for 2007. Tower Lake remained mixed as a result of its shallow morphometry and the effects of wind and wave action across the lake. Dissolved oxygen levels were adequate to support aquatic life (> 5 mg/L) for the entire summer.

Phosphorus and nitrogen are two nutrients important for plant and algal growth. The average total phosphorus for Tower Lake was 0.066 mg/L compared to the county median of 0.063 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 Tower Lake was 1.26 mg/L, which was slightly higher than the county median of 1.22 mg/L.

Total suspended solid concentrations (TSS) fluctuated throughout the season with a maximum concentration of 12.0 mg/L in September. The average TSS concentration for the season was 7.1 mg/L, which was below the county median of 8.0 mg/L, and well below the 2001 average of 15.0 mg/L. 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 September (2.30 feet) corresponding to the high TSS value. The average Secchi depth for the season was 4.31 feet, which was greater than the county median (3.28 feet), and a significant improvement from the 2001 average of 2.31 feet. The average conductivity reading for Tower Lake was 1.0254 mS/cm, which was well above the county median (0.8038 mS/cm). This was a slight decrease from the 2001 average (1.0544 mg/L).

Aquatic plants were found at 27 of the 71 sites sampled with five species found, which was a decrease in plant diversity since 2001. Coontail was the most abundant species in 2007 found at 22% of the sites and White Water Lily was the second most abundant at 14% of the sites. The loss in species abundance may be due to the time of year the plants were sampled. In addition, Tower Lakes Improvement Association (TLIA) had the lake treated with fluridone (Sonar) to control the aquatic plants.

In 2007 the shoreline erosion was reassessed since the 2001 study and changes were noted. There were quite a few areas on the lake where the erosion has increased with 35% exhibiting slight erosion, 22% with moderate erosion, and 5% had severe erosion. The TLIA should promote the use of well-maintained, naturalized shoreline and minimize the use of rip rap, seawalls, and manicured lawns to the waters edge. Additionally, TLIA should promote the use of buffer strips of deep rooted native vegetation around the entire lake regardless of shoreline type.

LAKE FACTS

Lake Name:	Tower Lake
Historical Name:	None
Nearest Municipality:	Tower Lakes
Location:	T43N, R9E, Section 2
Elevation:	746.0 feet
Major Tributaries:	Davlin's pond
Watershed:	Fox River
Sub-watershed:	Tower Lake Drain
Receiving Water body:	None
Surface Area:	69.2 acres
Shoreline Length:	3.3 miles
Maximum Depth:	7.5 feet
Average Depth (est.):	4.5 feet
Lake Volume (est.):	233.5 acre-feet
Lake Type:	Impoundment
Watershed Area:	3217.0 acres
Major Watershed Land uses:	Single Family, Wetlands, Transportation, and Agriculture
Bottom Ownership:	Private
Management Entities:	Private
Current and Historical uses:	Boating (no motor), fishing, swimming, and aesthetics
Description of Access:	Association members only

SUMMARY OF WATER QUALITY

Water samples were collected from May to September in Tower Lake at the deepest point (Figure 1), three feet below the surface of the water (Appendix A). Water levels in Tower Lake (taken from a stake placed in the lake by the Lakes Management Unit (LMU)) fluctuated slightly throughout the summer, but the overall level remained unchanged. In order to accurately monitor water levels it is recommended that a staff gauge be installed and levels measured and recorded frequently (daily or weekly).

Tower Lake remained mixed as a result of its shallow morphometry and the effects of wind and wave action across the lake. Dissolved oxygen levels were adequate to support aquatic life for the entire summer (Appendix B). 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 August the lake went anoxic (<1.0 mg/L) below five feet. Using a bathymetric map produced by the LMU in 1988, that would be 5% of the lake. Five percent is an acceptable range of anoxic area in a lake, therefore the LMU has no concerns at this time. However, this map is over 10 years old and it is suggested an updated map be created.

Overall, water quality has improved since 2001. Most of the parameters measured in 2007 were below 2001 levels. This may be due to the wetter summer in 2007. Rain events may have caused an increase in lake volume, thus diluting the nutrient concentrations. Increase flow out of the lake may also have caused a “flushing” of the lake during normal low water level periods. The water level increased by seven inches in August due to heavy rains and then fell five inches in September. Zebra Mussels were found in 2001 in Tower Lake. They are filter feeders that feed on plankton and algae in the lake. Initially they appear to have a positive affect on the lake, however, long term affects can damage the life cycle of the lake.

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 Tower Lake in 2007 was 0.066 mg/L (Table 1) and the county median was 0.063 mg/L (Appendix E). This phosphorus concentration was a decrease from 2001 which was 0.100 mg/L. As in 2001, TP increased as the season progressed, due probably to the large rain fall washing fertilizers and geese feces into the lake. 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 Tower Lake was 1.26 mg/L, which was slightly higher than the county median of 1.22 mg/L and lower than the concentration in 2001 (1.62 mg/L). The TN:TP (total nitrogen to total phosphorus) ratio is used to determine which nutrient limits plant and algal growth in a lake. Ratios < 10:1 indicates 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. Tower Lake had a TN:TP ratio of 19:1 which indicated phosphorus was limiting. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.), which are more difficult to control than sources of phosphorus. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon. Sources of phosphorus include fertilizers and geese. The LMU encourages the use of phosphorus free fertilizers within the watershed to reduce the phosphorus running into the lake.

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

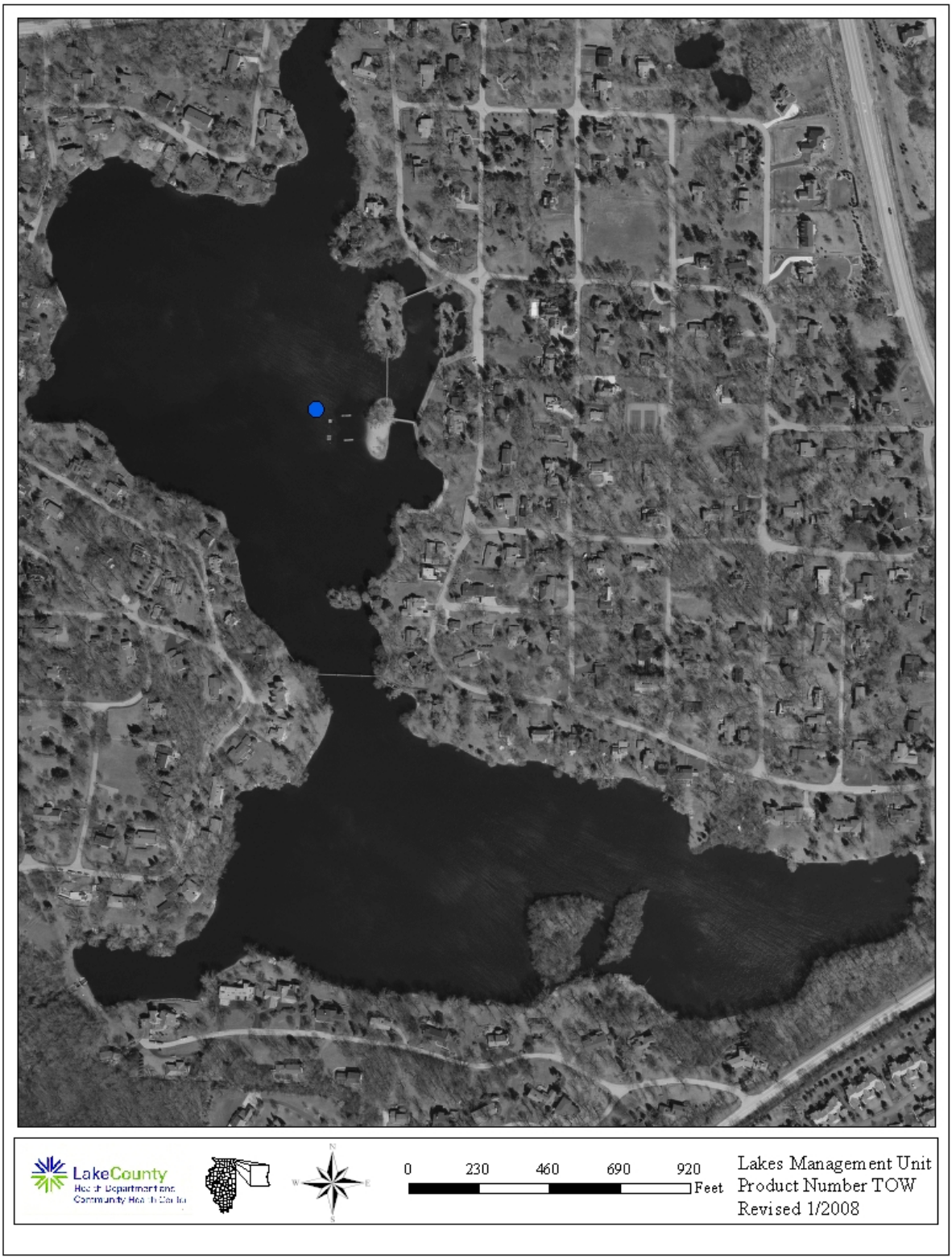


Table 1. Summary of water quality data for Tower Lake, 2007.

2007	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
09-May	3	243	0.94	<0.1	<0.05	0.028	<0.005	NA	182	3.1	620	103	6.56	1.1110	8.20	9.85
13-Jun	3	219	1.04	<0.1	<0.05	0.047	<0.005	NA	189	4.2	642	146	6.40	1.0720	8.36	8.72
11-Jul	3	220	1.41	<0.1	<0.05	0.068	<0.005	NA	196	9.3	642	150	3.94	1.1110	8.53	7.36
08-Aug	3	182	1.36	<0.1	<0.05	0.101	0.009	NA	179	6.8	560	124	2.36	0.9750	8.31	8.74
12-Sep	3	225	1.55	<0.1	<0.05	0.087	<0.005	NA	124	12.0	519	104	2.30	0.8580	8.10	8.90
	Average	218	1.26	<0.1	<0.05	0.066	0.009[k]	NA	225	7.1	597	125	4.31	1.0254	8.30	8.71

2001	Epilimnion															
DATE	DEPTH	ALK	TKN	NH3	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
23-May	3	252	0.80	0.233	<0.05	0.060	0.011	672	NA	14.6	688	180	2.26	1.1020	7.69	5.52
27-Jun	3	240	1.60	<0.1	<0.05	0.056	<0.005	672	NA	5.6	705	177	4.50	1.1070	8.13	8.70
1-Aug	3	199	1.71	<0.1	<0.05	0.101	0.011	620	NA	12.0	679	215	2.20	1.0490	8.30	9.05
29-Aug	3	184	2.16	<0.1	<0.05	0.162	0.005	583	NA	26.2	691	257	1.05	1.0160	8.43	9.50
25-Sep	3	177	1.83	<0.1	<0.05	0.121	0.019	570	NA	16.8	617	171	1.54	0.9981	7.93	7.77
	Average	210	1.62	0.233[k]	<0.05	0.100	0.009[k]	623	NA	15.0	676	200	2.31	1.0544	8.10	8.11

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_2+NO_3-N = Nitrate + Nitrite nitrogen, mg/L
NO_3-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl^- = Chloride, mg/L
TDS = Total dissolved solids, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed

Geese will congregate in areas with well mowed lawn to the lakes shoreline. Planting native vegetative buffer strips along the shoreline deters the geese, as it is not preferable habitat.

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, Tower Lake was eutrophic with a TSIp value of 64.6, which placed it 79th out of 163 lakes in the county (Table 2). In 2001 the TSIp value was 70.6 classifying the lake as hypereutrophic.

The Illinois EPA has a use index for assessing lakes for aquatic life and recreational use impairment. TSI values along with other water quality parameters are used to make the analyses. According to this index, Tower Lake provides *Full* support of aquatic life and *Partial* of recreational activity. The overall use was *Partial*.

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 TSS concentration was slightly below the Lake County median (8.0mg/L), with the average for the summer at 7.1 mg/L. This was a decrease of more than 50% since the 2001 average of 15.0 mg/L. 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 disk depth. Tower Lake had its lowest readings in August (2.36 feet) and September (2.30 feet) corresponding to the highest TSS concentrations (Figure 2). The average Secchi depth for the season was 4.31 feet, which was greater than the county median (3.28 feet) and a significant improvement from the 2001 average (2.31 feet).

Conductivity readings, which are correlated with chloride concentrations, have been increasing throughout the past few years in the county. The average conductivity reading for the lake in 2007 was 1.0254 mS/cm, just below the 2001 average (1.0544 mg/L). This was higher than the Lake County median conductivity of 0.8038 milliSiemens/cm. This slight decrease may be due to the large rainfall which occurred in 2007, increasing the lake volume in August. In August and September the average conductivity concentrations were the lowest of the season causing the decrease in the seasonal average. Chloride concentrations detect sodium chloride and calcium chloride which are what most road salt consists of. The average chloride concentration was 174 mg/L, which was higher 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. 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.

Tower Lake has a large watershed (3217 acres; Figure 3) which consists mainly of single family homes (46%). Wetlands made up 11% of the watershed and transportation was 10.5% of the

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 Kathyrn	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.

RANK	LAKE NAME	TP AVE	TSIp
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.

RANK	LAKE NAME	TP AVE	TSIp
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
99	North Tower Lake	0.0878	68.68
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.

RANK	LAKE NAME	TP AVE	TSIp
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 Tower Lake, 2007.

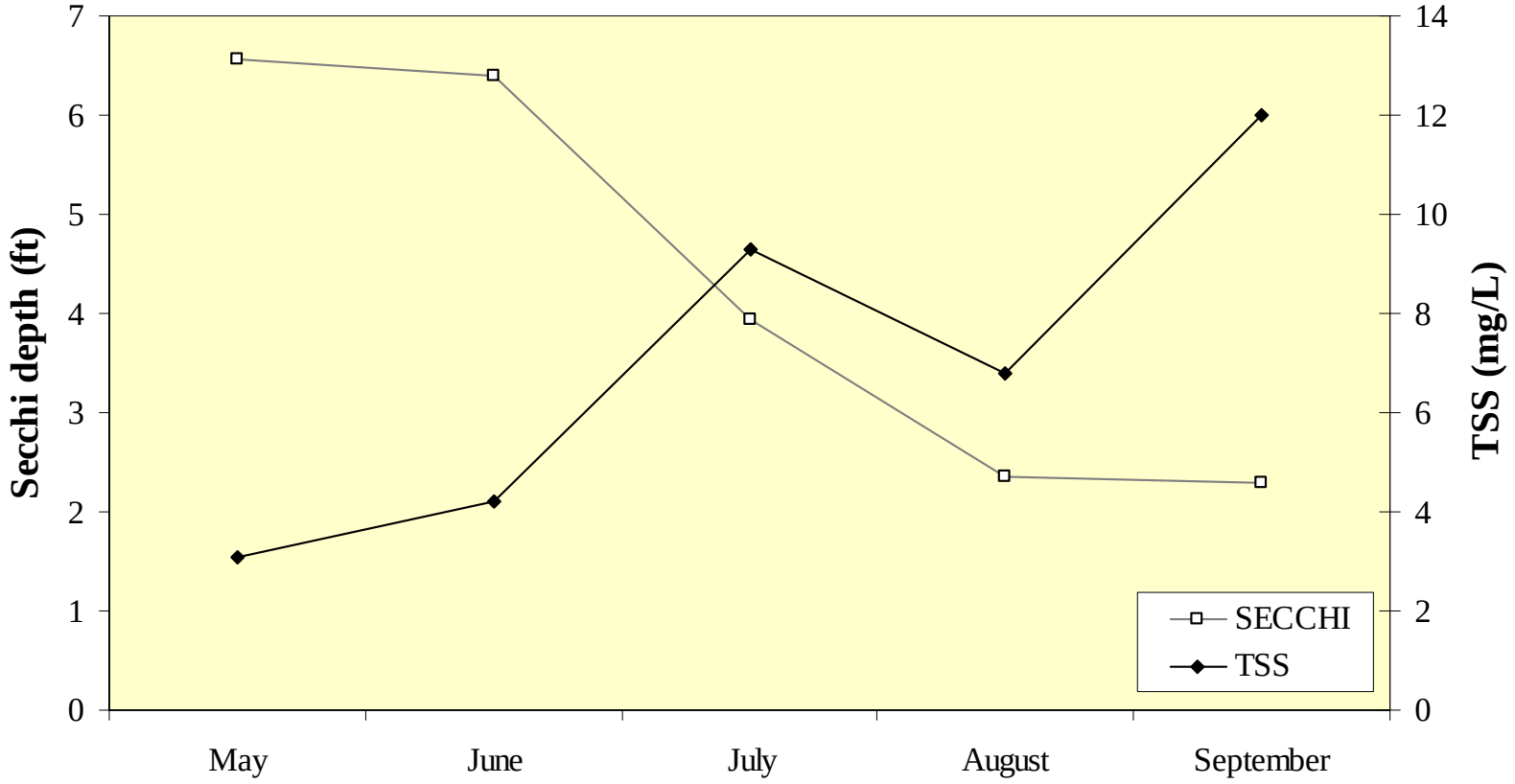
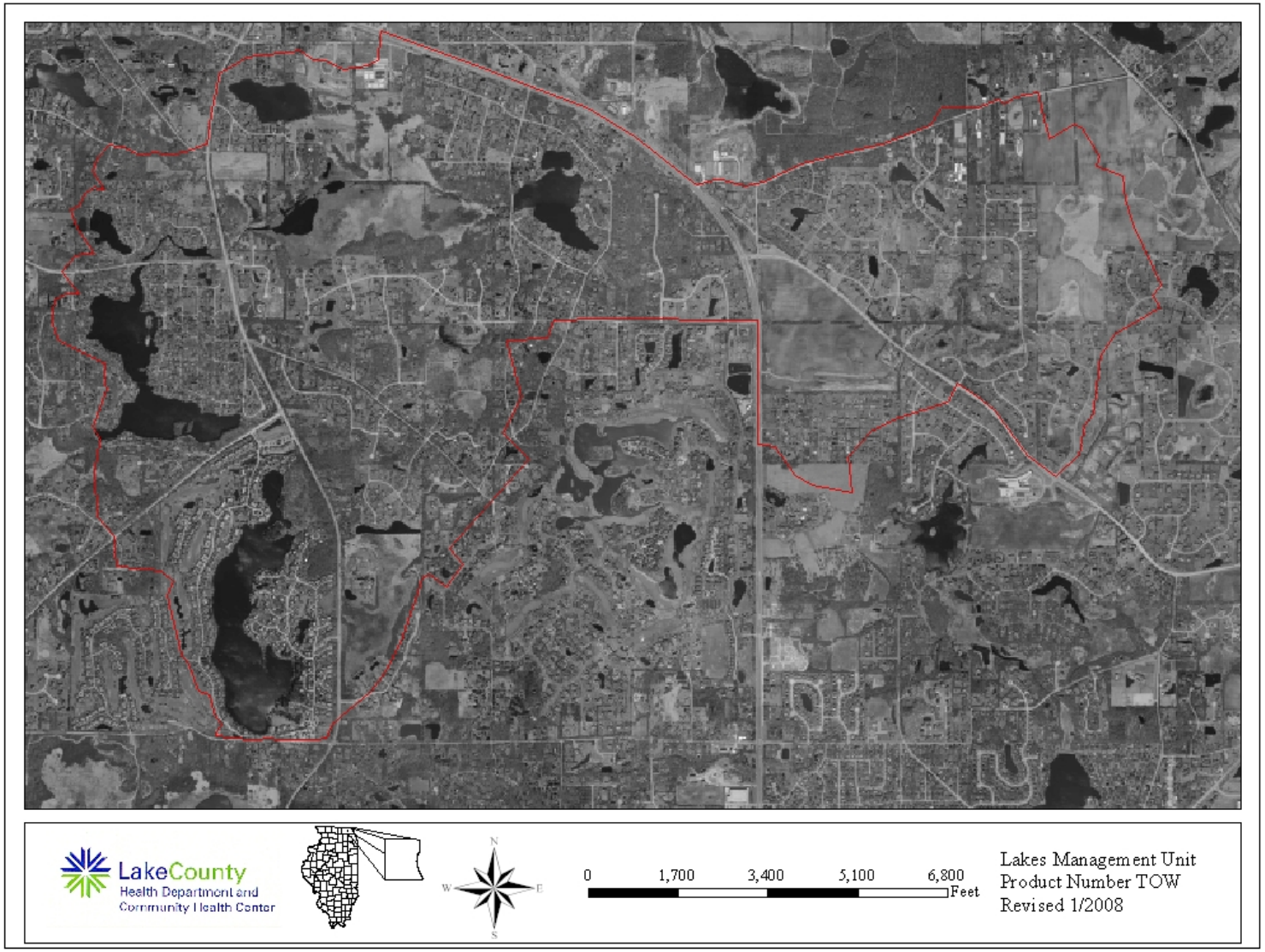


Figure 3. Approximate watershed delineation of Tower Lake, 2007.



watershed (Figure 4). There is a spillway on the west side of the southern side of the lake, which controls the flow out of the lake, which eventually flows into Fox River. Due to the large watershed with a large portion made of impervious surfaces, the retention time of the lake is very short at 46 days. North Tower Lake is within the Tower Lake watershed, but the differences in retention time between the lakes may be playing a part in water quality differences. North Tower Lake has a very long retention time of 343 days compared to the short retention time of 46 days in Tower Lake.

Tower Lake had one swimming beach (East swimming beach) the LMU monitors for *E. coli* bacteria levels. It was sampled from May to September in 2007 with two recommended closings. LMU recommend closing when E. coli levels are >235 colony forming unit per 100mL. The LMU has been sampling the beach since 1988, generally with minimal problems.

SUMMARY OF AQUATIC MACROPHYTES

Plant sampling was conducted on Tower Lake in July. There were 71 points sampled based on a computer generated grid system with points 60 meters apart (Figure 5). Aquatic plants existed at 27 of the sites (38%) with five species found (Table 3). This was a decrease in plant diversity since 2001 when nine species were found. Bladderwort, Curlyleaf Pondweed, Horned Pondweed, Small Pondweed, and Eurasian Watermilfoil were found in 2001 but not in 2007. Coontail was the most abundant species in 2007 found at 22% of the sites and White Water Lily was the second most abundant at 14% of the sites (Table 4). The loss in species abundance may be due to the sampling time. In 2001 plants were noted monthly (May through September) and in 2007 plants were sampled only in July, after herbicide treatments on the lake. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow. When the light level in the water column falls below 1% of the surface light level, plants can no longer grow. The 1% light level in Tower Lake was at the bottom May and June, just off the bottom in July and August, and at 5 feet in September. Plants were found at 6.6 feet, meaning plants were growing in all areas possible. 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. A Fluoridone (Sonar) treatment for plants was done on April 19, and followed up throughout the summer with Copper Sulfate treatments for algae. Lilies were also treated with liquid 2,4D in mid August. Due to the loss of plants to the treatment, algal blooms become more prominent in the lake. The plants were using up the phosphorus in the water and in their absence the algae takes over. LMU suggests reducing the Fluoridone treatment to only areas in which plants are impeding recreational activities.

Floristic quality index (FQI) is an assessment tool designed to evaluate the closeness the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submersed plant species found in the lake.

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

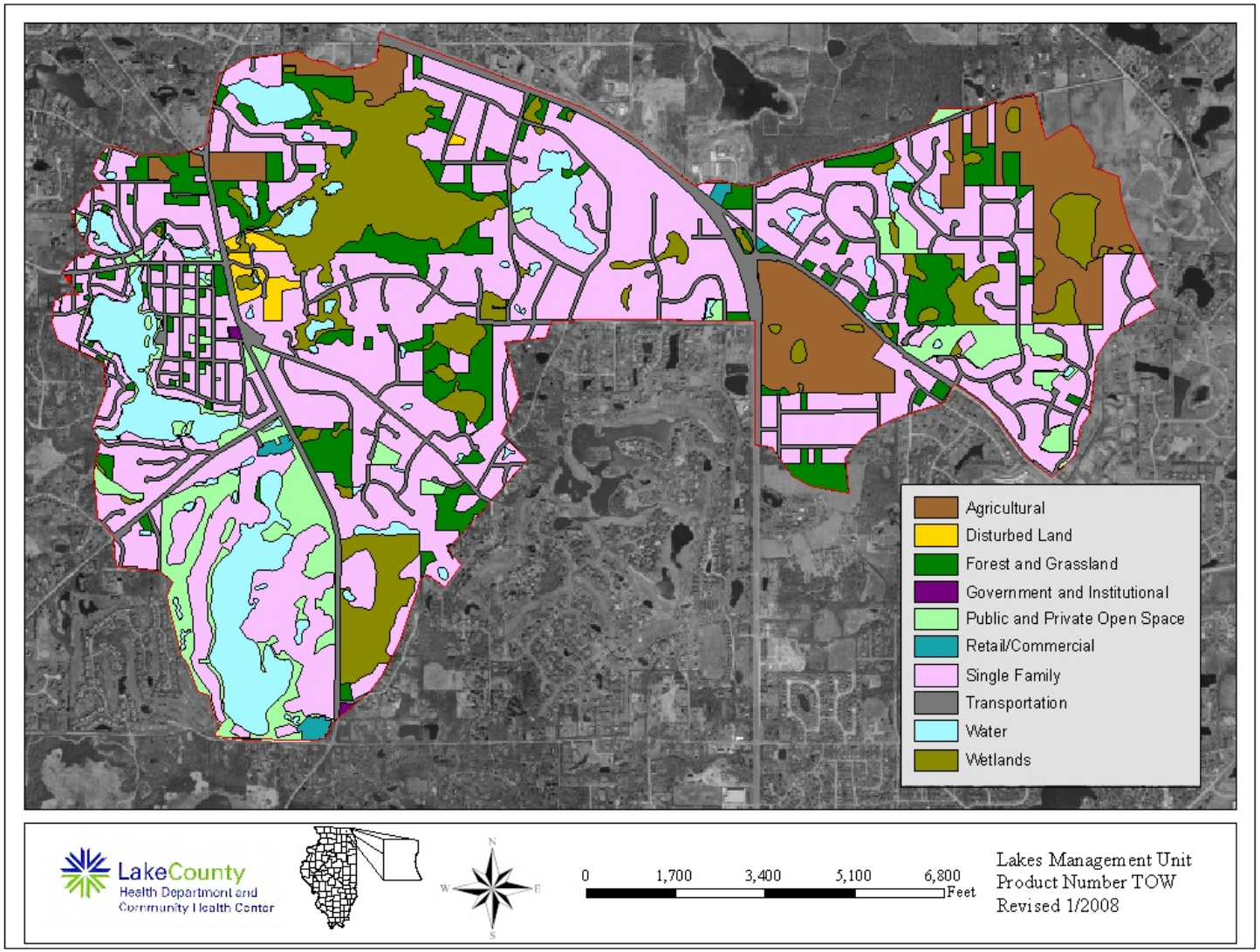


Figure 5. Aquatic plant sampling grid illustrating plant density on Tower Lake, July 2007.

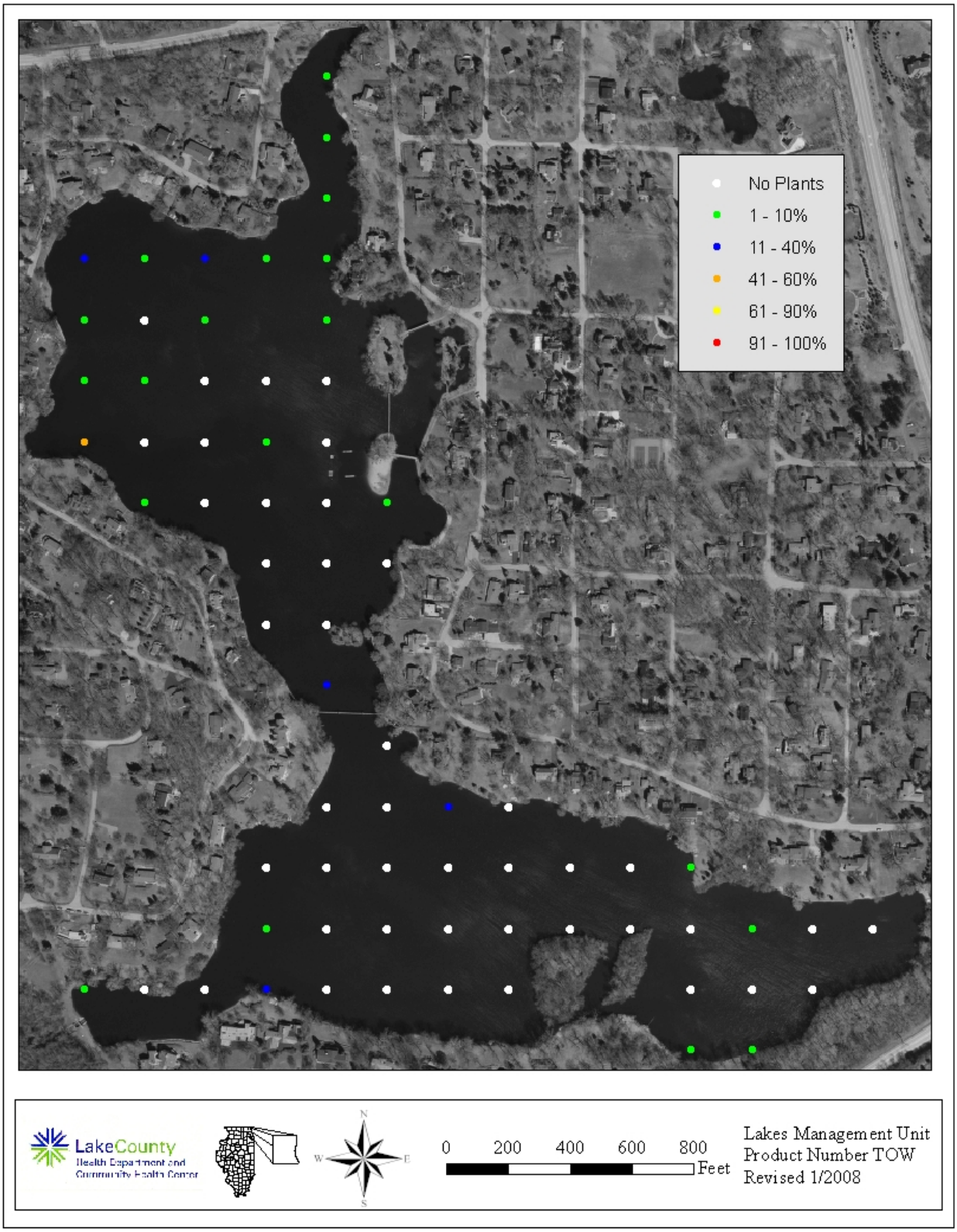


Table 3: Aquatic plant species found in Tower Lake, 2007.

Coontail	*Ceratophyllum demersum*
Chara (Macro algae)	*Chara* spp.
Duckweed	*Lemna* spp.
Sago Pondweed	*Potamogeton pectinatus*
White Water Lily	*Nymphaea tuberosa*

Table 4a. Aquatic plant species found at the 71 June sampling sites on Tower Lake. The maximum depth that plants were found was 6.6 feet.

Plant Density	Chara	Coontail	Duckweed	Sago Pondweed	White Water Lily
Present	5	11	1	1	8
Common	1	4	0	0	2
Abundant	0	1	0	0	0
Dominant	0	0	0	0	0
% Plant Occurrence	8.5	22.5	1.4	1.4	14.1

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

Rake Density (coverage)	# of Sites	% of Sites
No Plants	44	62.0
>0-10%	20	28.2
10-40%	6	8.5
40-60%	1	1.4
60-90%	0	0.0
>90%	0	0.0
Total Sites with Plants	27	38.0
Total # of Sites	71	100.0

These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates there is a large number of sensitive, high quality plant species present in the lake. Non-native species were counted in the FQI calculations for Lake County lakes. In 2007, Tower Lake had an FQI of 11.0 and ranked 96th of 152 lakes in the county (Table 5). In 2001 Tower Lake had an FQI of 15.2. The median FQI of lakes the LMU has studied from 2000-2007 was 12.5.

SUMMARY OF SHORELINE CONDITION

A comprehensive shoreline survey was performed in 2001 and several important observations were made. A majority of Tower Lake's shoreline was developed (87%). The portion of the shoreline that was undeveloped was made up of shrub, wetlands, and woodlands. The two main types of developed shoreline were rock rip rap (44%) and manicured lawn (20%). Both of these shoreline types are considered undesirable. Rip rap offers little habitat and can be prone to erosion and wave reflection if not installed properly. Several rip rap areas on the lake were in disrepair and were either eroding or were at risk of eroding. Manicured lawn is a poor shoreline stabilizer due to the shallow root structure of turf grasses, which are unable to stabilize soils, and may lead to erosion. Other types of developed shoreline included buffer strips (19%), seawall (9%), woodland (6%) and beach (3%). Shorelines were also assessed for the presence of erosion. The overall occurrence of erosion on Tower Lake was moderate. Based on the 2001 LMU assessment, 77% of the shoreline on Tower Lake was listed as having no form of erosion. This is largely due to the overwhelming dominance of rip rap shorelines. Of the total shoreline, only 5 % was assessed as having slight erosion. However, 18% of the shoreline was assessed as having moderate erosion. There were no shorelines assessed as having severe erosion. The eroded shorelines (slight and moderate) mainly consisted of rip rap areas that were poorly maintained/installed and woodland areas that were overgrown with the invasive shrub species, Common Buckthorn, which provides little sediment stabilization.

In 2007 the shoreline erosion was reassessed and changes were noted. There were several areas on the lake where the erosion had increased. In 2001 the shoreline had no severe erosion, but in 2007 one of the islands on the south side was exhibiting severe erosion (Figure 6). This area should be remediated immediately. It is recommended that the TLIA promote the use of well-maintained, naturalized shoreline and minimize the use of rip rap, seawalls, and manicured lawns to the waters edge. Additionally, TLIA should promote the use of buffer strips of deep rooted native vegetation around the entire lake regardless of shoreline type. This includes establishing buffer strips behind existing seawalls and rip rap, and when replacing any failing erosion control structures. Additionally, it would be beneficial to extend these buffers into the lake by planting emergent vegetation (Arrowhead, Pickerel Weed, etc), which will help to dissipate wave action.

SUMMARY OF WILDLIFE AND HABITAT

Wildlife habitat in the form of wetlands and forest areas are good wildlife habitat. Waterfowl such as Great Blue Heron, Green Heron, and White Egret were seen on the lake. It is very important to preserve the wetland, pine, and hardwood forest buffer areas around the lake to maintain the appropriate habitat for these bird species and others in the future.

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

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	35.1	37.3
2	Deep Lake	33.9	35.4
3	Cranberry Lake	30.1	31.0
4	Round Lake Marsh North	29.1	29.9
5	East Loon Lake	28.4	29.9
6	Deer Lake	28.2	29.7
7	Sullivan Lake	28.2	29.7
8	Little Silver Lake	27.9	30.0
9	Schreiber Lake	26.8	27.6
10	West Loon Lake	26.0	27.6
11	Cross Lake	25.2	27.8
12	Independence Grove	24.6	27.5
13	Sterling Lake	24.5	26.9
14	Bangs Lake	24.5	26.2
15	Lake Zurich	24.0	26.0
16	Lake of the Hollow	23.8	26.2
17	Lakewood Marsh	23.8	24.7
18	Round Lake	23.5	25.9
19	Fourth Lake	23.0	24.8
20	Druce Lake	22.8	25.2
21	Sun Lake	22.7	24.5
22	Countryside Glen Lake	21.9	22.8
23	Butler Lake	21.4	23.1
24	Duck Lake	21.1	22.9
25	Timber Lake (North)	20.8	22.8
26	Wooster Lake	20.8	22.6
27	Broberg Marsh	20.5	21.4
28	Davis Lake	20.5	21.4
29	ADID 203	20.5	20.5
30	McGreal Lake	20.2	22.1
31	Lake Kathryn	19.6	20.7
32	Fish Lake	19.3	21.2
33	Redhead Lake	19.3	21.2
34	Owens Lake	19.3	20.2
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Hendrick Lake	17.7	17.7
39	Summerhill Estates Lake	17.1	18.0
40	Seven Acre Lake	17.0	15.5
41	Gray's Lake	16.9	19.8
42	Lake Barrington	16.7	17.7
43	Bresen Lake	16.6	17.8
44	Windward Lake	16.3	17.6

Table 5. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
45	Diamond Lake	16.3	17.4
46	Lake Napa Suwe	16.3	17.4
47	Long Lake	16.1	18.0
48	Dog Bone Lake	15.7	15.7
49	Redwing Slough	15.6	16.6
50	Osprey Lake	15.5	17.3
51	Lake Fairview	15.2	16.3
52	Heron Pond	15.1	15.1
53	Lake Tranquility (S1)	15.0	17.0
54	North Churchill Lake	15.0	15.0
55	Island Lake	14.7	16.6
56	Dog Training Pond	14.7	15.9
57	Highland Lake	14.5	16.7
58	Grand Avenue Marsh	14.3	16.3
59	Taylor Lake	14.3	16.3
60	Dugdale Lake	14.0	15.1
61	Eagle Lake (S1)	14.0	15.1
62	Longview Meadow Lake	13.9	13.9
63	Ames Pit	13.4	15.5
64	Hook Lake	13.4	15.5
65	Third Lake	13.4	15.5
66	Bishop Lake	13.4	15.0
67	Mary Lee Lake	13.1	15.1
68	Old School Lake	13.1	15.1
69	Buffalo Creek Reservoir	13.1	14.3
70	McDonald Lake 2	13.1	14.3
71	Old Oak Lake	12.7	14.7
72	Timber Lake (South)	12.7	14.7
73	White Lake	12.7	14.7
74	Dunn's Lake	12.7	13.9
75	Echo Lake	12.5	14.8
76	Hastings Lake	12.5	14.8
77	Sand Lake	12.5	14.8
78	Stone Quarry Lake	12.5	12.5
79	Honey Lake	12.1	14.3
80	Lake Carina	12.1	14.3
81	Lake Leo	12.1	14.3
82	Lambs Farm Lake	12.1	14.3
83	Stockholm Lake	12.1	13.5
84	Pond-A-Rudy	12.1	12.1
85	Lake Matthews	12.0	12.0
86	Flint Lake	11.8	13.0
87	Harvey Lake	11.8	13.0
88	Rivershire Pond 2	11.5	13.3
89	Antioch Lake	11.3	13.4
90	Lake Charles	11.3	13.4

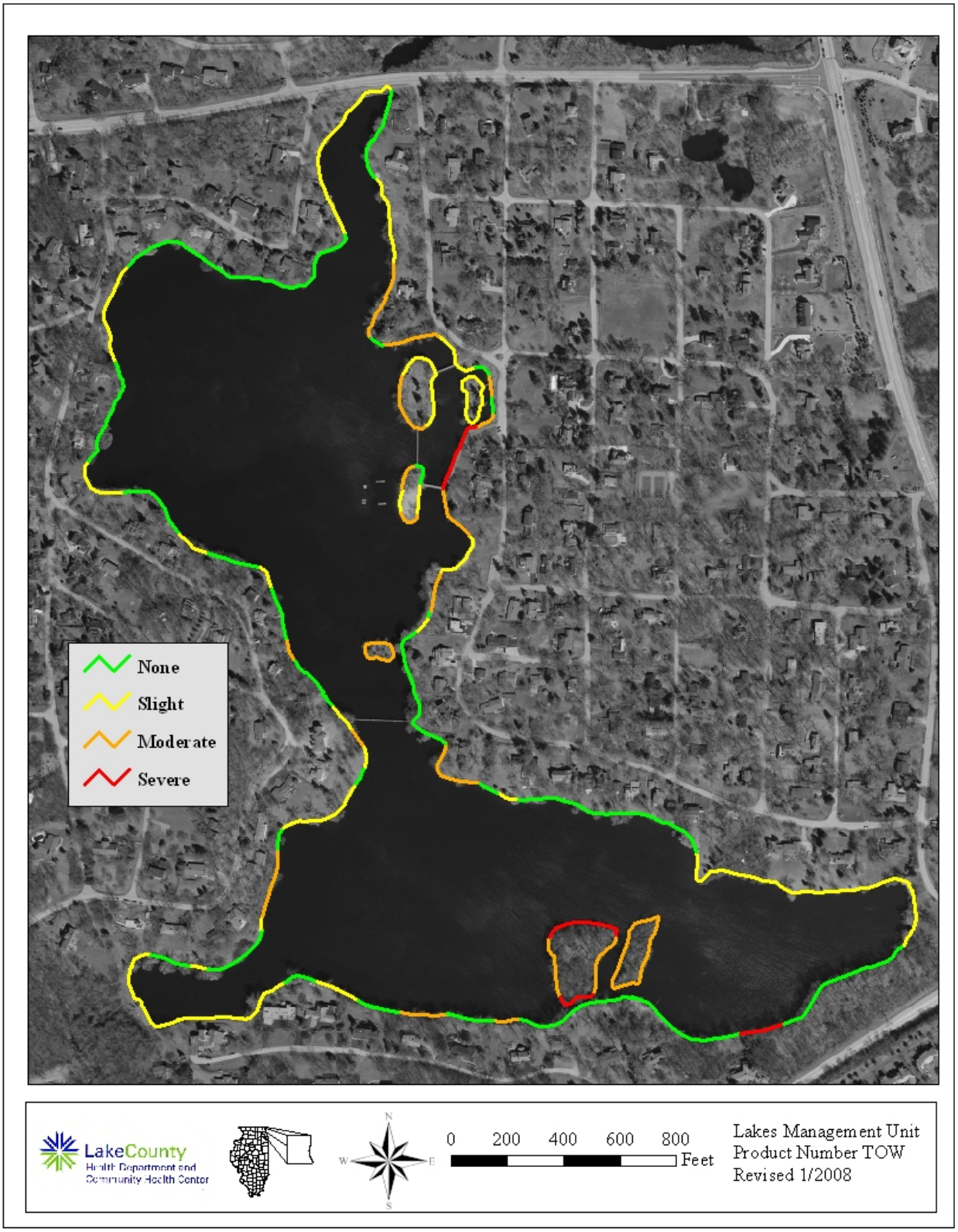
Table 5. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
91	Lake Linden	11.3	11.3
92	Lake Naomi	11.2	12.5
93	Pulaski Pond	11.2	12.5
94	Lake Minear	11.0	13.9
95	Redwing Marsh	11.0	11.0
96	**Tower Lake**	**11.0**	**11.0**
97	West Meadow Lake	11.0	11.0
98	Nielsen Pond	10.7	12.0
99	Lake Holloway	10.6	10.6
100	Countryside Lake	10.5	12.1
101	Crooked Lake	10.2	12.5
102	College Trail Lake	10.0	10.0
103	Lake Lakeland Estates	10.0	11.5
104	Valley Lake	9.9	9.9
105	Werhane Lake	9.8	12.0
106	Big Bear Lake	9.5	11.0
107	Little Bear Lake	9.5	11.0
108	Loch Lomond	9.4	12.1
109	Columbus Park Lake	9.2	9.2
110	Sylvan Lake	9.2	9.2
111	Fischer Lake	9.0	11.0
112	Grandwood Park Lake	9.0	11.0
113	Lake Fairfield	9.0	10.4
114	McDonald Lake 1	8.9	10.0
115	East Meadow Lake	8.5	8.5
116	Lake Christa	8.5	9.8
117	Lake Farmington	8.5	9.8
118	Lucy Lake	8.5	9.8
119	South Churchill Lake	8.5	8.5
120	Bittersweet Golf Course #13	8.1	8.1
121	Woodland Lake	8.1	9.9
122	Albert Lake	7.5	8.7
123	Banana Pond	7.5	9.2
124	Fairfield Marsh	7.5	8.7
125	Lake Eleanor	7.5	8.7
126	Lake Louise	7.5	8.7
127	Patski Pond	7.1	7.1
128	Rasmussen Lake	7.1	7.1
129	Slough Lake	7.1	7.1
130	Lucky Lake	7.0	7.0
131	Lake Forest Pond	6.9	8.5
132	Leisure Lake	6.4	9.0
133	Peterson Pond	6.0	8.5
134	Gages Lake	5.8	10.0
135	Grassy Lake	5.8	7.1
136	Slocum Lake	5.8	7.1

Table 5. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
137	Deer Lake Meadow Lake	5.2	6.4
138	Drummond Lake	5.0	7.1
139	IMC Lake	5.0	7.1
140	ADID 127	5.0	5.0
141	Liberty Lake	5.0	5.0
142	Oak Hills Lake	5.0	5.0
143	Forest Lake	3.5	5.0
144	Sand Pond (IDNR)	3.5	5.0
145	Half Day Pit	2.9	5.0
146	Lochanora Lake	2.5	5.0
147	Hidden Lake	0.0	0.0
148	North Tower Lake	0.0	0.0
149	Potomac Lake	0.0	0.0
150	St. Mary's Lake	0.0	0.0
151	Waterford Lake	0.0	0.0
152	Willow Lake	0.0	0.0
	Mean	**13.6**	**14.9**
	Median	**12.5**	**14.3**

Figure 6. Shoreline erosion on Tower Lake, 2007.



Zebra Mussels were first noted in 2001. During plant sampling in 2007, they were found near the dam covering a metal tomato cage. Their presence may have a significant impact on lake's water quality and food chain in the future. Information should be provided to lake users of the presence of Zebra Mussel, and how to prevent the spread of this exotic species to other inland lakes.

The most recent fish survey was performed by the Illinois Department of Natural Resources in 1987. Eleven species of fish were found, including Largemouth Bass, Bluegill, Black Bullhead, Green Sunfish, Black Crappie, Channel Catfish, and Common Carp. According to the survey, Bluegill and Black Crappie were overabundant and needed to be controlled with a higher density of predators and high fishing pressure. According to the IDNR, the optimal plant coverage for a healthy sunfish/bass fishery is 30% to 40% across the lake bottom.

LAKE MANAGEMENT RECOMMENDATIONS

Tower Lake had good water quality which could be attributed somewhat to the wetland and forest areas surrounding the lake. This also provides good wildlife habitat and aids in minimizing shoreline erosion. Plant coverage and diversity on the lake has decreased and should be looked at carefully. There are many grant opportunities available to do improvements around or in the lake (Appendix F).

Creating a Bathymetric Map

An up to date bathymetric (depth contour) map is an essential tool in effective lake management since it provides information on the morphometric features of the lake, such as depth, surface area, volume, etc. The knowledge of this morphometric information would be necessary if lake management practices, such as aquatic herbicide use or fish stocking, were part of the overall lake management plan. Tower Lake does not have a current (< 10 years old) bathymetric map with volume calculations (Appendix D1).

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 D2). In addition a permanent staff gauge should be installed to monitor fluctuations in water level.

Zebra Mussels

Zebra Mussels were identified on Tower Lake in 2001. Their presence may have a significant impact on lake's water quality and food chain in the future. Signage should be posted at access areas around the lake informing lake users of the presence of Zebra Mussel, and how to prevent the spread of this exotic species to other inland lakes (Appendix D3). Signs are available from LMU.

Reduce Conductivity and Chloride Concentrations

The current concentration of chlorides in Tower Lake has the potential to negatively impact aquatic life, from plants to fish. Road salt (sodium chloride) is the most commonly used winter road de-icer and is the major contributor to chloride and conductivity levels (Appendix D4).

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.

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

APPENDIX B. MULTI-PARAMETER DATA FOR TOWER LAKE IN 2007

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.38
05/09/2007	0.5	0.547	21.92	10.17	116.5	1.115	8.28	2390.9	Surface		
05/09/2007	1	1.004	21.52	10.21	116.1	1.117	8.27	2180.2	Surface	100%	
05/09/2007	2	2.082	20.64	10.18	113.7	1.113	8.24	1154.3	0.412	53%	1.54
05/09/2007	3	2.994	20.05	9.85	108.8	1.111	8.20	749.7	1.324	34%	0.33
05/09/2007	4	4.004	18.15	10.36	110.1	1.105	8.17	507.9	2.334	23%	0.17
05/09/2007	5	5.043	17.63	9.95	104.6	1.104	8.14	376.7	3.373	17%	0.09
05/09/2007	6	6.013	16.46	9.47	97.2	1.109	8.09	273.7	4.343	13%	0.07
05/09/2007	7	7.027	15.38	8.83	88.6	1.112	8.03	159.4	5.357	7.3%	0.10

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.67
06/13/2007	0.5	0.524	26.23	8.93	110.9	1.074	8.38	3548.2	Surface		
06/13/2007	1	1.006	26.18	8.94	110.8	1.074	8.37	3510.4	Surface	100%	
06/13/2007	2	1.990	25.60	8.82	108.2	1.070	8.36	1214.4	0.320	35%	3.32
06/13/2007	3	3.000	25.21	8.72	106.2	1.072	8.36	739.9	1.330	21%	0.37
06/13/2007	4	4.004	25.12	8.40	102.2	1.074	8.36	566.7	2.334	16%	0.11
06/13/2007	5	4.980	24.95	7.77	94.2	1.075	8.31	380.9	3.310	11%	0.12
06/13/2007	6	6.017	24.52	6.91	83.2	1.059	8.21	294.2	4.347	8%	0.06
06/13/2007	7	7.019	23.70	4.08	48.3	1.070	7.89	207.5	5.349	6%	0.07

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 1.14
07/11/2007	0.5	0.517	26.88	7.34	92.2	1.112	8.59	3460.9	Surface		
07/11/2007	1	0.984	26.87	7.38	92.6	1.111	8.54	3473.2	Surface	100%	
07/11/2007	2	1.853	26.85	7.38	92.7	1.111	8.54	1004.7	0.183	29%	6.78
07/11/2007	3	3.012	26.79	7.36	92.2	1.111	8.53	586.9	1.342	17%	0.40
07/11/2007	4	3.980	26.72	7.25	90.8	1.111	8.53	320.6	2.310	9%	0.26
07/11/2007	5	5.006	26.59	7.14	89.3	1.112	8.52	121.8	3.336	4%	0.29
07/11/2007	6	6.004	26.47	7.04	87.8	1.111	8.51	141.9	4.334	4%	-0.04
07/11/2007	7	6.978	26.27	6.75	83.9	1.112	8.50	87.3	5.308	3%	0.09
07/11/2007	8	8.002	26.24	1.03	12.8	1.112	8.25	20.6	6.332	0.6%	0.23

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.99
08/08/2007	0.5	0.515	28.77	11.52	149.6	0.989	8.56	2328.4	Surface		
08/08/2007	1	0.995	28.88	11.62	151.2	0.990	8.55	2210.8	Surface	100%	
08/08/2007	2	2.008	28.65	11.17	144.7	0.990	8.55	458.1	0.338	21%	4.66
08/08/2007	3	3.041	28.05	8.74	112.0	0.975	8.31	223.4	1.371	10%	0.52
08/08/2007	4	4.009	27.70	6.76	86.1	0.935	8.12	111.9	2.339	5%	0.30
08/08/2007	5	5.017	27.21	6.81	86.0	0.965	8.11	53.6	3.347	2%	0.22
08/08/2007	6	6.022	26.45	1.48	18.4	0.972	7.94	31.5	4.352	1.4%	0.12
08/08/2007	7	7.067	26.20	0.64	7.9	0.970	7.69	14.6	5.397	0.7%	0.14

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 1.07
09/12/2007	0.5	0.500	21.66	9.91	112.9	0.861	8.23	3484.8	Surface		
09/12/2007	1	1.028	21.71	9.85	112.3	0.860	8.16	3421.5	Surface	100%	
09/12/2007	2	1.992	20.54	9.59	106.8	0.859	8.14	757.6	0.322	22%	4.68
09/12/2007	3	2.948	20.37	8.90	98.9	0.858	8.10	331.5	1.278	10%	0.65
09/12/2007	4	4.071	20.21	8.58	95.0	0.858	8.08	124.6	2.401	4%	0.41
09/12/2007	5	4.956	20.06	8.03	88.6	0.859	8.06	53.1	3.286	1.6%	0.26
09/12/2007	6	6.009	19.99	7.73	85.2	0.859	8.04	21.0	4.339	0.6%	0.21
09/12/2007	7	7.082	19.92	7.40	81.4	0.860	8.03	7.5	5.412	0.2%	0.19

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. NH_4^+ (ammonium) is released from decomposing organic material under anoxic conditions and accumulates in the hypolimnion of thermally stratified lakes. If NH_4^+ comes into contact with oxygen, it is immediately converted to NO_2 (nitrite) which is then oxidized to NO_3^- (nitrate). Therefore, in a thermally stratified lake, levels of NH_4^+ would only be elevated in the hypolimnion and levels of NO_3^- would only be elevated in the epilimnion. Both NH_4^+ and NO_3^- can be used as a nitrogen source by aquatic plants and algae. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen plus ammonium. Adding the concentrations of TKN and nitrate together gives an indication of the amount of total nitrogen present in the water column. If inorganic nitrogen (NO_3^-, NO_2^-, NH_4^+) concentrations exceed 0.3 mg/L in spring, sufficient nitrogen is available to support summer algae blooms. However, low nitrogen levels do not guarantee limited algae growth the way low phosphorus levels do. Nitrogen gas in the air can dissolve in lake water and blue-green algae can "fix" atmospheric nitrogen, converting it into a usable form. Since other types of algae do not have the ability to do this, nuisance blue-green algae blooms are typically associated with lakes that are nitrogen limited (i.e., have low nitrogen levels).

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

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

Solids:

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

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

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

Water Clarity:

Water clarity (transparency) is not a chemical property of lake water, but is often an indicator of a lake's overall water quality. It is affected by a lake's water color, which is a reflection of the amount of total suspended solids and dissolved organic chemicals. Thus, transparency is a measure of particle concentration and is measured with a Secchi disk. Generally, the lower the clarity or Secchi depth, the poorer the water quality. A decrease in Secchi depth during the summer occurs as the result of an increase in suspended solids (algae or sediment) in the water column. Aquatic plants play an important role in the level of water clarity and can, in turn, be negatively affected by low clarity levels. Plants increase clarity by competing with algae for

resources and by stabilizing sediments to prevent sediment resuspension. A lake with a healthy plant community will almost always have higher water clarity than a lake without plants. Additionally, if the plants in a lake are removed (through herbicide treatment or the stocking of grass carp), the lake will probably become dominated by algae and Secchi depth will decrease. This makes it very difficult for plants to become re-established due to the lack of available sunlight and the lake will, most likely, remain turbid. Turbidity will be accelerated if the lake is very shallow and/or common carp are present. Shallow lakes are more susceptible to sediment resuspension through wind/wave action and are more likely to experience clarity problems if plants are not present to stabilize bottom sediment.

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

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

Alkalinity, Conductivity, Chloride, pH:

Alkalinity:

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

Conductivity and Chloride:

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

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

Eutrophication and Trophic State Index:

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

The Trophic State Index (TSI) is an index which attaches a score to a lake based on its average

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

Table 1. Trophic State Index (TSI).

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

APPENDIX D. LAKE MANAGEMENT OPTIONS

D1. 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. 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:

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D3. Zebra Mussels

Zebra Mussels get their name from the alternating black and white stripped pattern on their shells. They have spread extensively in the Great Lakes region in the past decade. They attach themselves to any solid underwater object such as boat hulls, piers, intake pipes, plants, other bivalves (mussels), and even other Zebra Mussels. Zebra Mussels originated from Eastern Europe, specifically the Black and Caspian Seas. By the mid 18th and 19th centuries they had spread to most of Europe. The mussels were believed to have been spread to this country in the mid 1980s by cargo ships that discharged their ballast water into the Great Lakes. They were first discovered in Lake St. Clair (the body of water that connects lakes Erie and Huron) in June of 1988. The mussels then spread to the rest of the Great Lakes. The first sighting in Lake Michigan was in June 1989. By 1990, Zebra Mussels had been found in all of the Great Lakes. By 1991 they had made their way into the adjacent waters of the Great Lakes such as the Illinois River, which eventually led to their spread into the Mississippi River and all the way down to the Gulf of Mexico. Other states in the Midwest have also experienced Zebra Mussel infestations of their inland lakes. Southeastern Wisconsin has about a dozen lakes infested and Michigan has about 100 infested lakes. Even though they are a fresh water mussel they have also been found in brackish (slightly saline) water and they can even live out of the water for up to 10 days at high humidity and cool temperatures. At average summer temperatures, Zebra Mussels can survive out of water for an average of five days.

The Zebra Mussels reproductive cycle allows for rapid expansion of the population. A mature female can produce up to 40,000 eggs in a cycle and up to one million in a season. Eggs hatch within a few days and young larvae (called veligers) are free floating for up to 33 days, carried along on water currents. This allows for the distribution of larvae to uninfected areas, which accelerates their spread. The larvae attach themselves by a filamentous organ (called a byssus) near their foot. Once attached to a solid surface, larvae develop into a double shelled adult within three weeks and are capable of reproduction in a year. Zebra Mussels can live as long as five years and have an average life span of about 3.5 years. The adults are typically about the size of a thumb nail but can grow as large as 2 inches in diameter. Colonies can reach densities of 30,000 - 70,000 mussels per square meter.

Due to their quick life cycle and explosive growth rate, Zebra Mussels can quickly edge out native mussel species. Negative impacts on native bivalve populations include interference with feeding, habitat, growth, movement, and reproduction. Some native species of bivalves have been found with 10,000 Zebra Mussels attached to them. Many of these native, rare, threatened and endangered bivalve species may not be able to survive if Zebra Mussels populations

continue to expand. The impact that the mussels have on fish populations is not fully understood. However, they feed on phytoplankton (algae), which is also a major food source for planktivorous fish, such as Bluegill. These fish, in turn, are a food source for piscivorus fish (fish eating fish), such as Largemouth Bass and Northern Pike. Concern has also arisen over the concentration of pollutants found in Zebra Mussels. Mussels are filter feeders, taking up water and sediment containing pollutants, which then builds to high concentrations in their tissue (bioaccumulation). Due to the large number of mussels that are consumed by fish, concentrations of pollutants are even higher in the fish (biomagnification), which are potentially consumed by humans.

In addition to the ecological impacts, there are also many economical concerns. Zebra Mussels have caused major problems for industrial complexes located on the Great Lakes and associated bodies of water. Mussels can clog water intakes of power plants, public water supplies, and other industrial facilities. This can reduce water flow (by as much as two-thirds) to heat exchangers, condensers, fire fighting equipment, and air conditioning systems. Zebra Mussels can infest inboard motor intakes and can actually grow inside the motor, causing considerable damage. Navigational buoys have sunk due to the weight of attached mussels. Corrosion of concrete and steel, which can lead to loss of structural integrity, can occur from long-term mussel attachment. A Michigan-based paper company recently reported that it had spent 1.4 million dollars in removing only 400 cubic yards of Zebra Mussels. It has been estimated that billions of dollars have been incurred in removal efforts and in damage to factories, water supply companies, power plants, ships, and the fishing industry. There are several methods of control, which include both removal and eradication. Many are site specific, so control methods are often dictated by the situation. These control methods include chemical molluscicides, manual removal, thermal irritation, acoustical vibration, toxic and non-toxic coatings, CO_2 injection, and ultraviolet light. Additionally, several biological controls are being investigated. However, there is currently no widespread/whole lake control practice that would be effective without harming other wildlife.

Surprisingly, some positive impacts have been observed from Zebra Mussel infestations. They are capable of filtering one liter of water per day. This water often contains sediment and phytoplankton, which contribute to turbidity. As a result, large infestations have brought about significant improvements in water clarity in some lakes. Due to severe mussel infestations, Lake Erie water clarity has increased four to six times what it was before Zebra Mussels invaded the lake (in addition to improvements as a result of pollution control measures). This has resulted in deeper penetration of light and an expansion of aquatic plant populations, something that has not been seen for decades. In turn, the increased plant growth is providing better fish habitat and better fishing. Unfortunately, the negative ecological and economical impacts associated with Zebra Mussels far outweigh any positive benefits.

Here are some tips from the Great Lakes Sea Grant Network that can help prevent the spread of Zebra Mussels:

- Flush clean water (tap) through the cooling system of your motor to rinse out any larvae.

- Drain all bilge water, live wells, bait buckets, and engine compartments. Make sure water is not trapped in your trailer.

- Always inspect your boat and boat trailer carefully before transporting.

- In their earlier stages, attached Zebra Mussels may not be easily seen. Pass your hand across the bottom of the boat - if it feels grainy, it is probably covered with mussels. Don't take a chance; clean them off by scraping or blasting.

- Full grown Zebra Mussels can be easily seen but cling stubbornly to surfaces. Carefully scrape the hull (or trailer), or use a high pressure spray (250 psi) to dislodge them. Or leave your boat out of the water for at least 10-14 days, preferably two weeks. The mussels will die and drop off.

- Dispose of the mussels in a trash barrel or other garbage container. Don't leave them on the shore where they could be swept back into the lake or foul the area.

- Before you leave the boat launch site, remove from the boat trailer any plant debris where tiny Zebra Mussels may be entangled.

- Always use extra caution when transporting bait fish from one lake to another. You could be carrying microscopic veligers. To be safe, do not take water from one lake to another.

- Certain polymer waxes discourage Zebra Mussels from attaching. But check your hull periodically because the mussels cling to drain holes and speedometer brackets.

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 dolomic 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.

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

2000 - 2007 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2007	
Average	**167.3**	
Median	**162.0**	
Minimum	**64.9**	**IMC**
Maximum	**330.0**	**Flint Lake**
STD	**42.0**	
n =	**803**	

	ALKanoxic 2000-2007	
Average	**200**	
Median	**193**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**48**	
n =	**253**	

	Condoxic <=3ft00-2007	
Average	**0.8856**	
Median	**0.8038**	
Minimum	**0.2542**	**Broberg Marsh**
Maximum	**6.8920**	**IMC**
STD	**0.5243**	
n =	**802**	

	Condanoxic 2000-2007	
Average	**1.0035**	
Median	**0.8340**	
Minimum	**0.3210**	**Lake Kathyrn**
Maximum	**7.4080**	**IMC**
STD	**0.7787**	
n =	**252**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2007	
Average	**0.515**	
Median	**0.150**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.082**	
n =	**808**	

*ND = Many lakes had non-detects (74.5%)
Only compare lakes with detectable concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3-Nanoxic 2000-2007	
Average	**2.070**	
Median	**1.340**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.296**	
n =	**252**	

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

	pHoxic <=3ft00-2007	
Average	**8.31**	
Median	**8.31**	
Minimum	**7.07**	**Bittersweet #13**
Maximum	**10.28**	**Round Lake Marsh North**
STD	**0.44**	
n =	**797**	

	pHanoxic 2000-2007	
Average	**7.22**	
Median	**7.21**	
Minimum	**6.24**	**Banana Pond**
Maximum	**8.48**	**Heron Pond**
STD	**0.41**	
n =	**252**	

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

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

TKNoxic <=3ft00-2007		
Average	**1.457**	
Median	**1.220**	
Minimum	**<0.1**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.830**	
n =	**808**	

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

TKNanoxic 2000-2007		
Average	**2.910**	
Median	**2.320**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.272**	
n =	**252**	

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

TPoxic <=3ft00-2007		
Average	**0.100**	
Median	**0.063**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.171**	
n =	**808**	

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

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

TSSall <=3ft00-2007		
Average	**15.5**	
Median	**8.0**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**814**	

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

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

No 2002 IEPA Chain Lakes

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

No 2002 IEPA Chain Lakes.

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

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

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

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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	http://dnr.state.il.us/orep/c2000/		X			None
Conservation Reserve Program	NRCS	http://www.nrcs.usda.gov/programs/crp/		X			Land
Ecosystems Program	IDNR	http://dnr.state.il.us/orep/c2000/ecosystem/		X			None
Emergency Watershed Protection	NRCS	http://www.nrcs.usda.gov/programs/ewp/			X	X	None
Five Star Challenge	NFWF	http://www.nfwf.org/AM/Template.cfm		X			None
Illinois Flood Mitigation Assistance Program	IEMA	http://www.state.il.us/iema/construction.htm				X	None
Great Lakes Basin Program	GLBP	http://www.glc.org/basin/stateproj.html?st=il	X		X		None
Illinois Clean Energy Community Foundation	ICECF	http://www.illinoiscleanenergy.org/		X			
Illinois Clean Lakes Program	IEPA	http://www.epa.state.il.us/water/financial-assistance/index.html					None
Lake Education Assistance Program (LEAP)	IEPA	http://www.epa.state.il.us/water/conservation-2000/leap/index.html	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
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

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	http://ecos.fws.gov/partners/		X			> 50%
River Network's Watershed Assistance Grants Program	River Network	http://www.rivernetwork.org	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	http://www.epa.state.il.us/water/financial-assistance/non point.html	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	http://www.epa.state.il.us/water/watershed/scale.html	X	X			None
Streambank Stabilization & Restoration (SSRP)	IDOA/ LCSWCD	http://www.agr.state.il.us/Environment/conserv/ or call LCSWCD at (847) 223-1056		X	X		25%
Watershed Management Boards	LCSMC	http://www.co.lake.il.us/smc/projects/wmb/default.asp	X		X	X	50%
Wetlands Reserve Program	NRCS	http://www.nrcs.usda.gov/programs/wrp/	X	X			Land
Wildlife Habitat Incentive Program	NRCS	http://www.nrcs.usda.gov/programs/whip/		X			Land

CW = Chicago Wilderness
ICECF = Illinois Clean Energy Community Foundation
IEMA = Illinois Emergency Management Agency
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IDNR = Illinois Department of Natural Resources
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LCSMC = Lake County Stormwater Management Commission
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