2007 SUMMARY REPORT
of
Grand Avenue Marsh
Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

According to a 1939 aerial photograph, Grand Avenue Marsh was part wetland and part farmland. The 1993 aerial photograph shows the marsh in its current state, probably a result of field tiles being broken and allowing the Des Plaines River to flood. Grand Avenue Marsh is currently a 14.3-acre marshland in Gurnee, east of the intersection of Hwy 21 and Hwy 132.

The lake was assessed through many parameters from May through September, 2007. Water clarity in the lake was below the county median (3.28 feet), with an average Secchi depth of 2.03 feet. This was a decrease from the 2004 average (2.39 feet), when the Lakes Management Unit last sampled the lake. Correlated with this decrease in Secchi disk depth was an increase in total suspended solids (TSS) concentration. The average TSS increased from 13.2 mg/L in 2004 to 15.6 mg/L in 2007. Conductivity is the measure of dissolved ions in water. The higher the conductivity, the more ions and the better the water can conduct electricity. Grand Avenue Marsh had a 2007 average conductivity of 0.7596 mS/cm. This was a 20% increase from the 2004 average of 0.6318 mS/cm.

Nitrogen and phosphorus are the two nutrients that can limit plant and algal growth. The 2007 average total phosphorus concentration in Grand Avenue Marsh was 0.087 mg/L, which was above the county median (0.063 mg/L), but was a decrease from the 2004 concentration (0.119 mg/L). The average total Kjeldahl nitrogen concentration in 2007 (1.22 mg/L) also decreased from 2004 (1.37 mg/L).

The aquatic plant community in the lake consisted of 10 species in July. White Water Lily was the most dominant species followed by Coontail and Eurasian Watermilfoil. Plant diversity decreased by one species between 2004 and 2007. American Pondweed, Floatingleaf Pondweed, and *Chara* spp. (a macro-algae) were found in 2007 and not in 2004. However, Flatstem Pondweed, Small Pondweed, Smartweed and Water Stargrass were found in 2004, but not in 2007. Seven species remained the same from 2004 to 2007.

The shoreline was reassessed in 2007 for significant changes in erosion since 2004. Based on the 2007 assessment, there was a decrease in shoreline erosion with approximately 50% of the shoreline having some degree of erosion. Although there was a decrease in erosion, the amount of moderate and severe erosion had increased. Overall, 50% of the shoreline had no erosion, 25% had slight erosion, 19% had moderate, and 5% had severe erosion.

LAKE FACTS

Lake Name:	Grand Avenue Marsh
Historical Name:	None
Nearest Municipality:	Gurnee
Location:	T45N, R11E, Sections 22, 23
Elevation:	654.0 feet
Major Tributaries:	None
Watershed:	Des Plaines River
Sub-watershed:	Upper Des Plaines River
Receiving Water body:	Des Plaines River
Surface Area:	14.3 acres
Shoreline Length:	1.7 miles
Maximum Depth:	7.0 feet
Average Depth:	3.5 feet (estimated)
Lake Volume:	49.9 acre-feet (estimated)
Lake Type:	Man-made
Watershed Area:	69.4 acres
Major Watershed Land uses:	Public and private open space, utility and waste facilities, and forest and grassland
Bottom Ownership:	Lake County Forest Preserve District (LCFPD)
Management Entities:	LCFPD
Current and Historical uses:	Fishing
Description of Access:	Shoreline fishing access

SUMMARY OF WATER QUALITY

Grand Avenue Marsh (GAM) receives storm water runoff from a small watershed area of 69.41 acres (Figure 1). The major land uses include utility and waste facilities (24%), public and private open space (23%), forest and grassland (15%), and transportation (12%; Figure 2). The area directly surrounding GAM is mostly park area, including baseball fields. Because the lake is surrounded by a lot of open space, it allows stormwater passing over it to be filtered of nutrients and solids before reaching the lake. (Table 1). GAM empties into the Des Plaines River but can receive overflow from the Des Plaines River during flooding which can also deliver nutrients the lake.

Water samples were taken monthly from May through September at the deepest location in the lake (Figure 3). Only one sample was taken at three feet deep from the upper water layer (epilimnion), and was analyzed for nutrients, solids, and other physical parameters (Appendix A). Due to the shallow nature of GAM, wind and wave action kept the waters mixed throughout the summer.

The average dissolved oxygen (DO) concentration was 7.78 mg/L (Table 2), with the highest reading in September (11.79 mg/L) and the lowest in June (5.53 mg/L). Hypoxic conditions (where DO concentrations fell below 5.0 mg/L and fish populations are stressed) did not occur at all during the sampling season (Appendix B).

Secchi depth (water clarity) in GAM was less than the county median (3.28 feet). The average Secchi depth in 2007 was 2.03 feet, which was a slight decrease since the 2004 sampling season (2.39 feet). July and August 2007 had the deepest Secchi reading (2.29 feet) while May had the lowest reading (1.64 feet), probably due to a moderate rainfall the day before. These Secchi depths correlate to the amounts of total suspended solids (TSS) found at the same sampling times (Figure 4). TSS are made up of any type of solid particles in the water column, including algal cells and sediment. The TSS concentration for GAM in 2007 was 15.6 mg/L. This was above the Lake County median of 8.0 mg/L (Appendix E). The average TSS increased from the 2004 average (13.2 mg/L). Carp activity can stir up bottom sediments and lead to high TSS concentrations in the water column.

Conductivity is the measure of dissolved ions within water. In GAM, average conductivity in 2007 was 0.7596 mS/cm. This was a 20% increase from the 2004 value of 0.6318 mS/cm. While this was an increase for GAM, it was still below the county median (0.8038 mS/cm). Almost all of the lakes in the county are experiencing similar increases in conductivity for the same reason. Road salts used in winter road management runoff into lakes and build up since aquatic organisms cannot use them. This leads to an increase in both conductivity and chloride ion (Cl^-) concentrations, which are correlated (Figure 5). The median Cl^- concentration in the county is 158 mg/L, but GAM contains less than this concentration (118 mg/L). Conductivity and Cl^- concentrations showed an overall decrease from May to August. This was most likely due to the road salts used in winter being diluted. 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

Figure 1. Approximate watershed delineation for Grand Avenue Marsh,2007.

Figure 2. Approximate land use within Grand Avenue Marsh watershed, 2007.

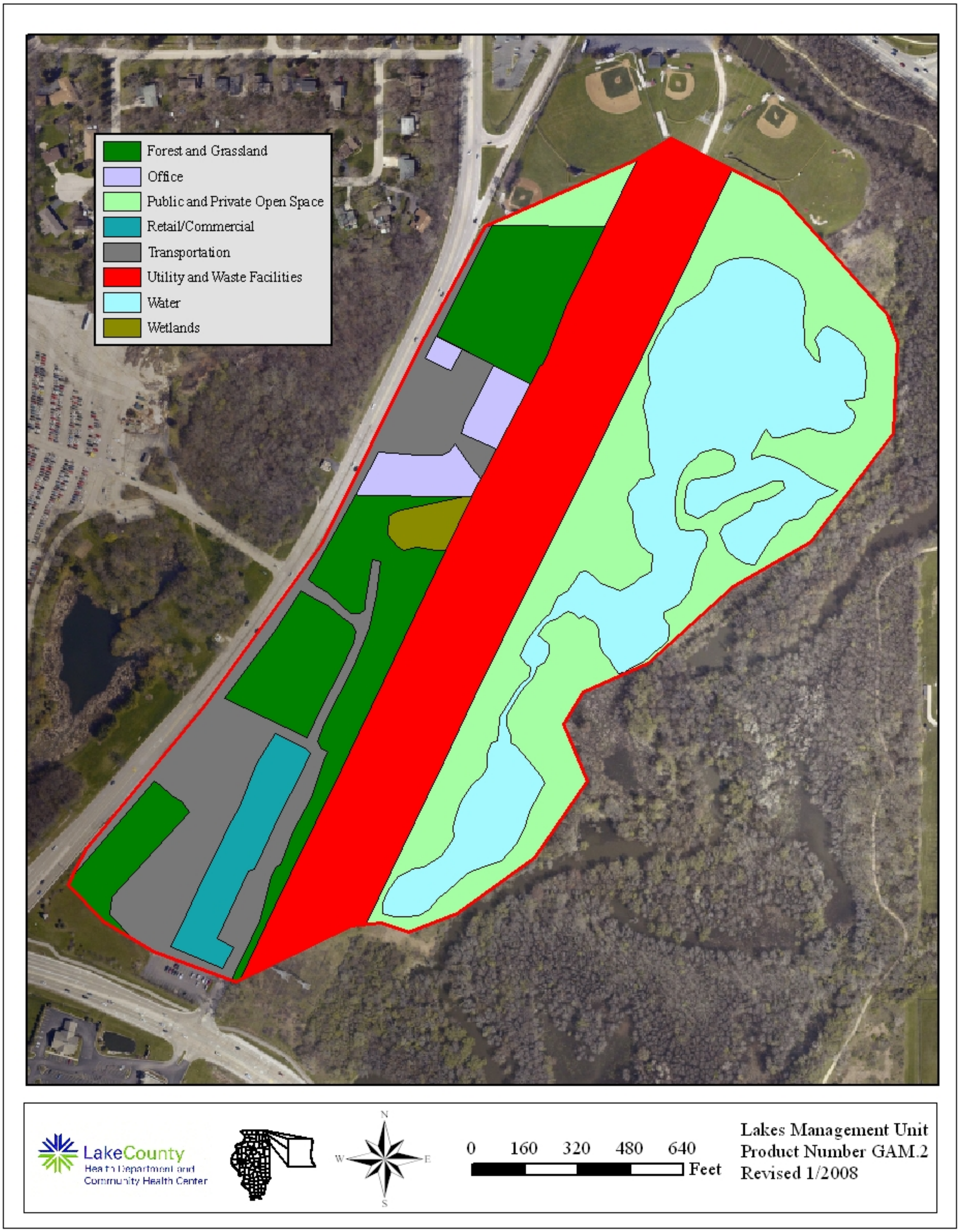


Table 1. Approximate land uses and retention time for Grand Avenue Marsh, 2007.

Land Use	Acreage	% of Total
Forest and Grassland	10.52	15%
Office	1.75	3%
Public and Private Open Space	15.98	23%
Retail/Commercial	2.09	3%
Transportation	8.47	12%
Utility and Waste Facilities	16.67	24%
Water	13.29	19%
Wetlands	0.64	1%
Total Acres	**69.41**	**100%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Forest and Grassland	10.52	0.05	1.4	3%
Office	1.75	0.85	4.1	8%
Public and Private Open Space	15.98	0.15	6.6	13%
Retail/Commercial	2.09	0.85	4.9	10%
Transportation	8.47	0.85	19.8	39%
Utility and Waste Facilities	16.67	0.30	13.8	27%
Water	13.29	0.00	0.0	0%
Wetlands	0.64	0.05	0.1	0.2%
Total Acres	**69.41**		**50.7**	100%

Lake volume	**49.9**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.99**	**years**
	359.54	**days**

NOTE: Runoff calculations do not include the acreage of the lake itself, which is part of the total watershed area

Figure 3. Access and Water quality sampling site on Grand Avenue Marsh, 2007.

Table 2. Water quality data for Grand Avenue Marsh, 2004 and 2007.

2007	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO3*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-May	3	214	1.20	<0.1	<0.05	0.074	<0.005	NA	146	20.1	595	134	1.64	0.9660	8.04	7.37
20-Jun	3	141	1.34	<0.1	<0.05	0.103	0.009	NA	133	18.0	479	127	1.97	0.7660	8.05	5.53
18-Jul	3	142	1.07	<0.1	<0.05	0.068	<0.005	NA	147	12.0	478	117	2.29	0.8170	8.55	7.17
15-Aug	3	115	1.34	<0.1	<0.05	0.102	<0.005	NA	107	16.0	388	101	2.29	0.6340	8.46	7.03
19-Sep	3	200	1.14	<0.1	<0.05	0.090	0.021	NA	59	12.0	384	95	1.97	0.6150	8.60	11.79
	Average	162	1.22	<0.1[k]	<0.05[k]	0.087	0.015[k]	NA	118	15.6	465	115	2.03	0.7596	8.34	7.78

2004	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
19-May	3	171	1.34	<0.1	3.450	0.147	0.068	388	NA	12.0	452	115	2.28	0.6620	7.39	5.31
16-Jun	3	184	1.48	<0.1	1.990	0.199	0.095	352	NA	7.8	390	95	3.35	0.6017	7.41	6.15
21-Jul	3	190	1.48	<0.1	<0.05	0.095	<0.005	316	66.4	11.0	362	84	2.79	0.6048	7.91	6.39
18-Aug	3	191	1.26	<0.1	<0.05	0.071	<0.005	352	NA	13.0	391	102	2.13	0.6337	7.56	6.37
22-Sep	0	187	1.31	<0.1	<0.05	0.085	<0.005	346	NA	22.0	412	110	1.38	0.6566	7.57	4.80
	Average	185	1.37	<0.1	NA	0.119	NA	351	NA	13.2	401	101	2.39	0.6318	7.57	5.80

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_3-N = Nitrate nitrogen, mg/L
NO2+NO3 = Nitrite and Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
TDS = Total dissolved solids, mg/L
Cl^- = Chloride ions, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

Note: "k" denotes that the actual value is known to be less than the value presented.
NA = Not Applicable
* = Prior to 2006 only Nitrate was analyzed

Figure 4. Total suspended solid (TSS) concentrations vs. Secchi disk depth for Grand Avenue Marsh, 2007.

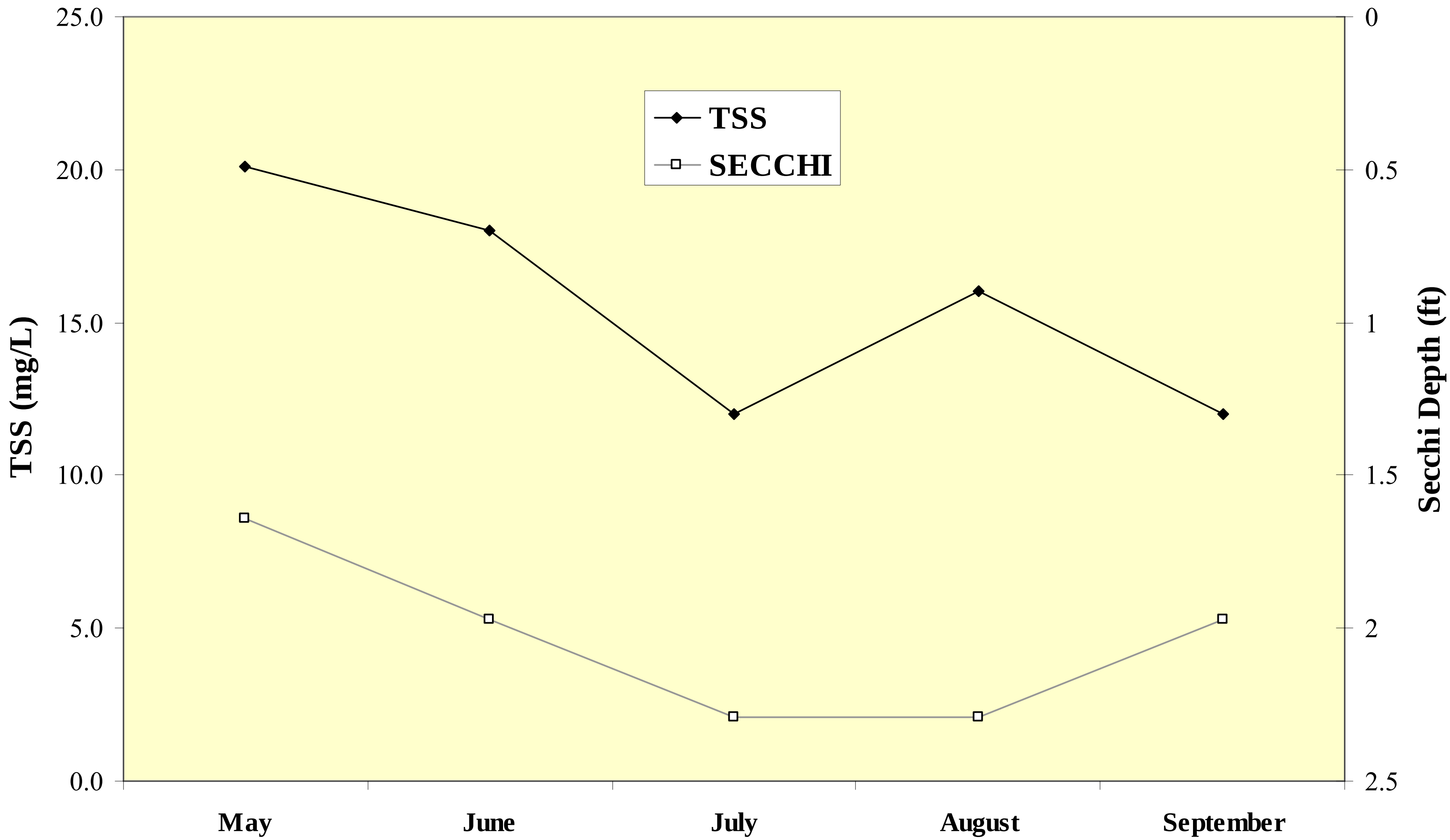
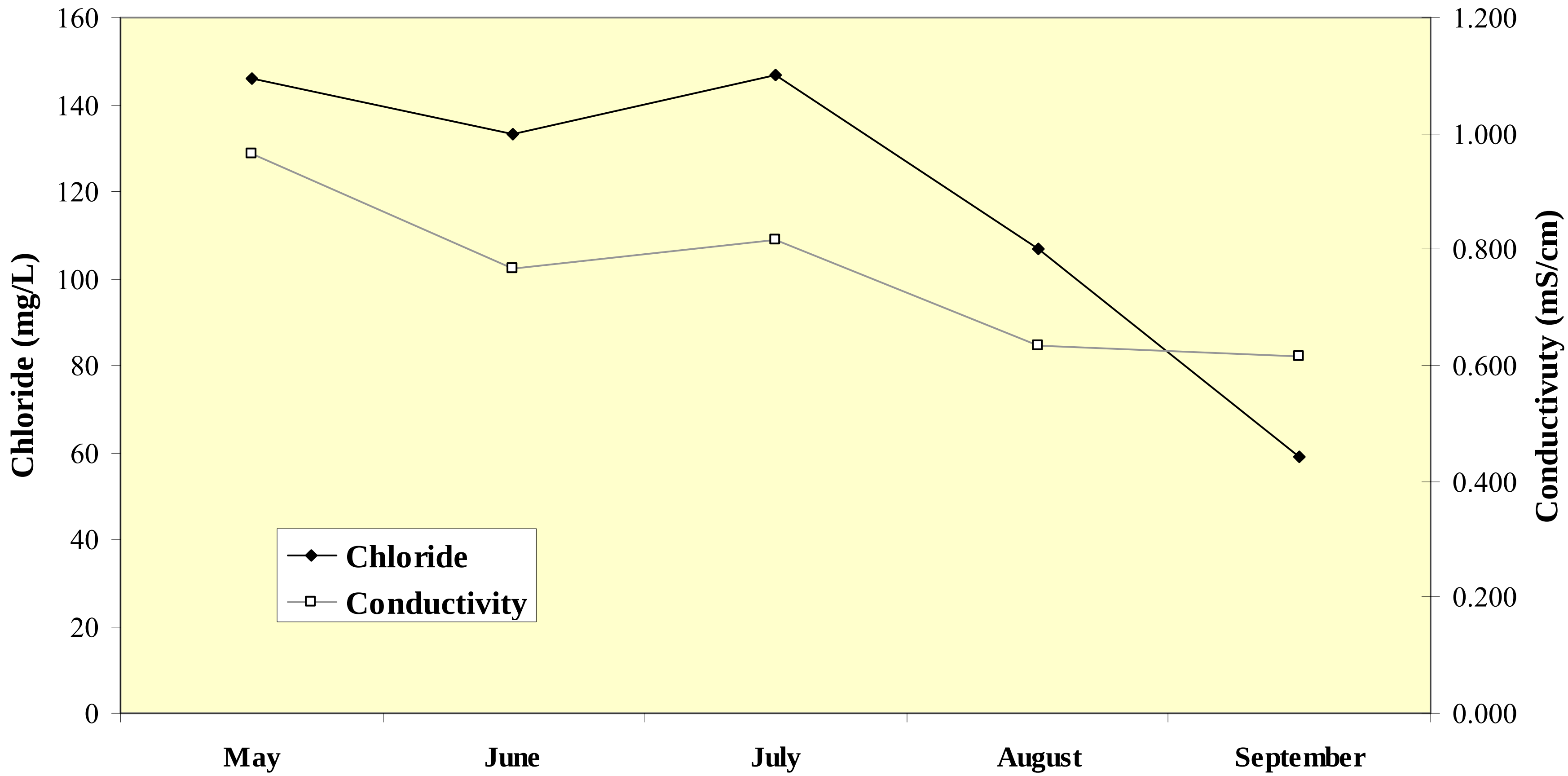


Figure 5. Chloride (Cl^-) concentration vs. conductivity for Grand Avenue Marsh, 2007.



concentrations as low as 12 mg/l. Therefore, lakes can be negatively impacted by the high Cl^- concentrations.

Another aspect of water quality is the nutrients within a water body, especially nitrogen (N) and phosphorus (P), as these are the two nutrients that can limit plant and algal growth. Carbon and light are other factors that control plant and algal growth, but these are not normally limiting. In 2007, the average total phosphorus (TP) concentration in GAM was 0.087 mg/L, which was above the county median (0.063 mg/L). TP conditions have decreased by about 37% since sampling in 2004 (0.119 mg/L). Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average total Kjeldahl nitrogen (TKN) concentration in GAM in 2007 (1.22 mg/L) also decreased from 2004 (1.37 mg/L).

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) and Secchi disk depth (TSIs). TSIp values are commonly used to classify and compare lake productivity levels (trophic state). The higher the phosphorus levels the greater the amount of plant and algal biomass, which leads to a higher TSIp and corresponding trophic state. Based on a TSIp value of 68.6, GAM was classified as eutrophic ($\geq$50, <70 TSI). A eutrophic lake is defined as a productive system that has above average nutrient levels and high algal biomass (growth). This was a great improvement from the 2004 TSIp value of 73.1 that ranked the lake as hypereutrophic (>70 TSI). Based on a Secchi TSI of 66.9, GAM was also classified as eutrophic. Overall, the trophic state of the lake was eutrophic. Based on the TSIp, GAM ranked 97th out of 163 lakes studied by the Lakes Management Unit (LMU) from 2000-2007 (Table 3).

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

SUMMARY OF AQUATIC MACROPHYTES

An aquatic plant (macrophyte) survey was conducted in July of 2007. In previous years, the sampler, with the goal of covering most of the lake and finding all species present, chose sampling sites randomly. While this method worked well, a new sampling technique was implemented in 2005, and therefore was used this year on GAM. Sampling sites were based on a grid system created by mapping software (ArcGIS), with each site located 30 meters (100 feet) apart. On GAM, there were 62 sampling sites in 2007 (Figure 6). Overall, there were 10 aquatic plant species found (Table 4), with White Water Lily having the highest density at 79% of the sites (Table 5a). Coontail and Eurasian Watermilfoil (EWM) were also found at 69% and 60% of the sites, respectively. This coverage was similar to 2004 when White Water Lily was found at 76% of sites, Coontail was found at 62% and EWM was found at 51%. Plants need at least 1% of surface light levels in order to survive. Plants were found down to a depth of 6.8 feet, which relates to the 1% light level since light went all the way to the bottom. Out of the 62 sample sites, plants were found at 60 of them (Table 5b). These sample sites covered the entire lake, and therefore the lake had approximately 97% plant coverage. Ideally, a lake should have

Table 3. 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 3. 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 3. 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 3. 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 6. Aquatic plant sampling grid that illustrates plant density on Grand Avenue Marsh, July 2007.

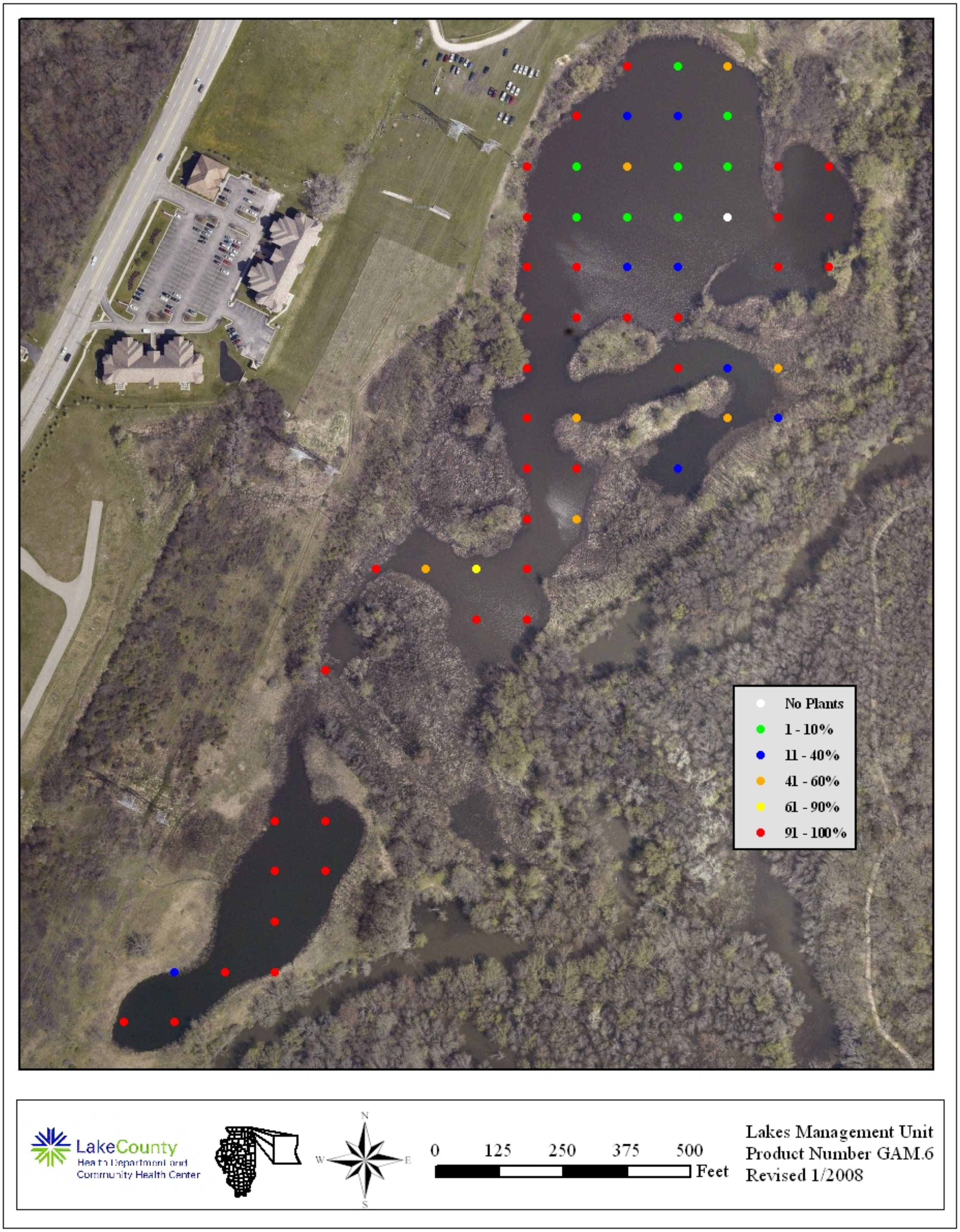


Table 4. Aquatic plant species found in Grand Avenue Marsh in 2007.

Coontail	*Ceratophyllum demersum*
Chara (Macro algae)	*Chara* spp.
Small Duckweed	*Lemna minor*
Eurasian Watermilfoil^	*Myriophyllum spicatum*
White Water Lily	*Nymphaea tuberosa*
Curlyleaf Pondweed^	*Potamogeton crispus*
American Pondweed	*Potamogeton nodosus*
Sago Pondweed	*Potamogeton pectinatus*
Flatstem Pondweed	*Potamogeton zosteriformis*
Giant Duckweed	*Spirodella polyrhiza*

^ Exotic plant

Table 5a. Aquatic plant species found at the 62 sampling sites on Grand Avenue Marsh, July 2007. Maximum depth that plants were found was 6.8 feet.

Plant Density	American Pondweed	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Watermilfoil	Floatingleaf Pondweed	Giant Duckweed	Sago Pondweed	White Water Lily
Absent	59	61	19	38	33	25	57	52	35	13
Present	2	1	11	22	12	21	5	10	16	22
Common	1	0	3	2	2	7	0	0	3	14
Abundant	0	0	5	0	12	6	0	0	5	9
Dominant	0	0	24	0	3	3	0	0	3	4
% Plant Occurrence	5	2	69	39	47	60	8	16	44	79

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

Rake Density (coverage)	# of Sites	% of Sites
No Plants	2	3%
>0-10%	8	13%
10-40%	8	13%
40-60%	7	11%
60-90%	1	2%
>90%	36	58%
Total Sites with Plants	60	97%
Total # of Sites	62	100%

30-40% plant coverage in order to sustain a healthy fishery, according to the IDNR. Because GAM is shallow and receives direct storm water runoff from its watershed, it experiences a high nutrient and TSS load, and also has an established Common Carp population, which makes it difficult to improve water clarity. The high-density plant community can help utilize the high nutrient load experienced by GAM.

Plant diversity decreased by one species between 2004 and 2007. American Pondweed, Floatingleaf Pondweed and *Chara* spp. (a macroalgae) were found in 2007 and not in 2004. However, Flatstem Pondweed, Small Pondweed, Smartweed and Water Stargrass were found in 2004, but not in 2007. Seven species remained the same from 2004 to 2007. The changes can probably be attributed to the affects of the Des Plaines River encouraging hardy plants, to natural variation and sampler bias. GAM continues to harbor two invasive species, EWM and Curlyleaf Pondweed, which are encouraged by the frequent flooding of the river.

Floristic Quality Index (FQI) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates there were large numbers of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for 2000-2007 Lake County lakes was 13.6. GAM had a FQI of 14.3 in 2007, which ranked it 58th out of the 152 lakes recorded (Table 6). This was a decrease since the 2004 survey was conducted, when the FQI was 16.9.

SUMARY OF SHORELINE CONDITION

Lakes with stable water levels potentially have less shoreline erosion problems. The water level in GAM fluctuated monthly in 2007. A stake pounded along the shore west of launch was used to measure the water level each month. The water level rose 0.25 inches from May to June and then fell 5.5 inches in July. From July to August the level increased by six inches. In September the level fell by 1.75 inches for a seasonal loss of 1.25 inches. This fluctuation in water level was a result of large rains that fell across Lake County during the summer of 2007.

In 2004 an assessment was conducted to determine the condition of the shoreline at the water/land interface. The most common shoreline type was shrub (81.6%), with the remaining 18.4% classified as wetland. There were some nonnative aggressive plants growing within the buffer strips and other locations along the shoreline. These included Purple Loosestrife and Buckthorn. The shoreline was also assessed for the degree of erosion. Approximately 54% of the shoreline was classified as slightly eroding, 3% as moderately eroding, and less than 1% as severely eroding. The moderate erosion was located along a small peninsula of land along the northwestern section of the lake. This area likely eroded due to fluctuating water levels since it is an isolated location, inaccessible to fishermen. However, the severe erosion is located along the northern shoreline where fishing activities occur. The shoreline was reassessed in 2007 for significant changes in erosion since 2004. Based on the 2007 assessment, there was a decrease in shoreline erosion with approximately 50% of the shoreline having some degree of erosion

Table 6. 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	Sullivan Lake	28.2	29.7
7	Deer 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	Lakewood Marsh	23.8	24.7
17	Lake of the Hollow	23.8	26.2
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	Wooster Lake	20.8	22.6
26	Timber Lake (North)	20.8	22.8
27	Davis Lake	20.5	21.4
28	Broberg Marsh	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	Redhead Lake	19.3	21.2
33	Owens Lake	19.3	20.2
34	Fish Lake	19.3	21.2
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	Third Lake	16.8	18.7
43	Lake Barrington	16.7	17.7
44	Bresen Lake	16.6	17.8

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
45	Windward Lake	16.3	17.6
46	Lake Napa Suwe	16.3	17.4
47	Diamond Lake	16.3	17.4
48	Long Lake	16.1	18.0
49	Dog Bone Lake	15.7	15.7
50	Redwing Slough	15.6	16.6
51	Osprey Lake	15.5	17.3
52	Lake Fairview	15.2	16.3
53	Heron Pond	15.1	15.1
54	North Churchill Lake	15.0	15.0
55	Lake Tranquility (S1)	15.0	17.0
56	Island Lake	14.7	16.6
57	Dog Training Pond	14.7	15.9
58	Highland Lake	14.5	16.7
59	Taylor Lake	14.3	16.3
60	**Grand Avenue Marsh**	**14.3**	**16.3**
61	Eagle Lake (S1)	14.0	15.1
62	Dugdale Lake	14.0	15.1
63	Longview Meadow Lake	13.9	13.9
64	Hook Lake	13.4	15.5
65	Bishop Lake	13.4	15.0
66	Ames Pit	13.4	15.5
67	Old School Lake	13.1	15.1
68	McDonald Lake 2	13.1	14.3
69	Mary Lee Lake	13.1	15.1
70	Buffalo Creek Reservoir	13.1	14.3
71	White Lake	12.7	14.7
72	Timber Lake (South)	12.7	14.7
73	Old Oak Lake	12.7	14.7
74	Dunn's Lake	12.7	13.9
75	Stone Quarry Lake	12.5	12.5
76	Sand Lake	12.5	14.8
77	Hastings Lake	12.5	14.8
78	Echo Lake	12.5	14.8
79	Stockholm Lake	12.1	13.5
80	Pond-A-Rudy	12.1	12.1
81	Lambs Farm Lake	12.1	14.3
82	Lake Leo	12.1	14.3
83	Lake Carina	12.1	14.3
84	Honey Lake	12.1	14.3
85	Lake Matthews	12.0	12.0
86	Harvey Lake	11.8	13.0
87	Flint Lake	11.8	13.0
88	Rivershire Pond 2	11.5	13.3
89	Lake Linden	11.3	11.3
90	Lake Charles	11.3	13.4

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
91	Antioch Lake	11.3	13.4
92	Pulaski Pond	11.2	12.5
93	Lake Naomi	11.2	12.5
94	West Meadow Lake	11.0	11.0
95	Tower Lake	11.0	11.0
96	Redwing Marsh	11.0	11.0
97	Lake Minear	11.0	13.9
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	Lake Lakeland Estates	10.0	11.5
103	College Trail Lake	10.0	10.0
104	Valley Lake	9.9	9.9
105	Werhane Lake	9.8	12.0
106	Little Bear Lake	9.5	11.0
107	Big Bear Lake	9.5	11.0
108	Loch Lomond	9.4	12.1
109	Sylvan Lake	9.2	9.2
110	Columbus Park Lake	9.2	9.2
111	Lake Fairfield	9.0	10.4
112	Grandwood Park Lake	9.0	11.0
113	Fischer Lake	9.0	11.0
114	McDonald Lake 1	8.9	10.0
115	South Churchill Lake	8.5	8.5
116	Lucy Lake	8.5	9.8
117	Lake Farmington	8.5	9.8
118	Lake Christa	8.5	9.8
119	East Meadow Lake	8.5	8.5
120	Woodland Lake	8.1	9.9
121	Bittersweet Golf Course #13	8.1	8.1
122	Lake Louise	7.5	8.7
123	Lake Eleanor	7.5	8.7
124	Fairfield Marsh	7.5	8.7
125	Banana Pond	7.5	9.2
126	Albert Lake	7.5	8.7
127	Slough Lake	7.1	7.1
128	Rasmussen Lake	7.1	7.1
129	Patski Pond	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	Slocum Lake	5.8	7.1
135	Grassy Lake	5.8	7.1
136	Gages Lake	5.8	10.0

Table 6. Continued.

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

(Figure 7). Although there was a decrease in erosion, the amount of moderate and severe erosion had increased. Overall, 25% had slight erosion, 19% had moderate and 5% had severe erosion. The area of severe erosion should be addressed soon. Most of the erosion appeared to be where fishermen access the lake. Some type of control should be employed in these areas to allow access for fishing, but also protect the shoreline from further erosion. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. If these shorelines are repaired by the installation of a buffer strip with native plants, the benefits can be three-fold. First, the erosion is repaired and the new native plants can stabilize the shoreline to prevent future erosion. Second, the addition of native plants adds habitat for wildlife to a shoreline that is otherwise limited in habitat. Thirdly, buffer habitat can help filter pollutants and nutrients from the near shore areas and keep geese and gulls from congregating, as it is not desirable habitat for them.

Another major concern on GAM was the trash along the shoreline. This garbage mainly consists of beverage (plastic and glass bottles, cans, etc.) and bait containers (Styrofoam, plastic, etc.). This trash was the result of people that did not clean up after themselves before leaving the Forest Preserve. Trash not only lends to a poor appearance but can also negatively impact wildlife. A trash receptacle should be placed along the shoreline for the users to deposit their trash.

SUMMARY OF WILDLIFE AND HABITAT

Visual wildlife observations were made on a monthly basis during water quality and plant sampling activities. GAM is located in a rural setting with the shoreline mainly undeveloped. This provides excellent habitat for a variety of birds, mammals, and other wildlife. Good numbers of wildlife, particularly birds, were noted on and around GAM (Table 7).

No formal fish survey has been conducted on GAM. Due to its connection with the Des Plaines River, GAM probably contains a variety of fish species. A fisheries assessment should be conducted to determine the diversity and health of the fish community.

Figure 7. Shoreline erosion on Grand Avenue Marsh, 2007.

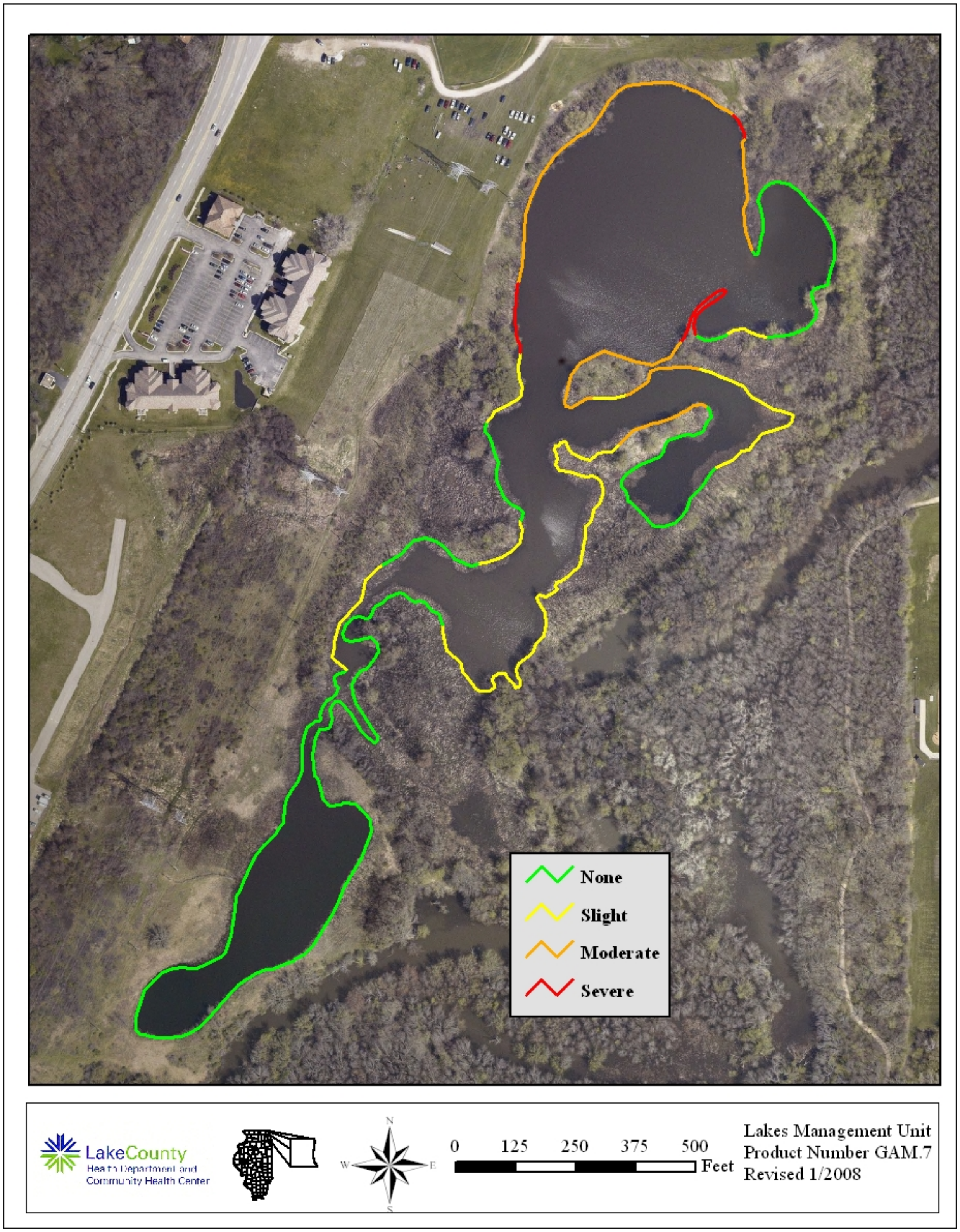


Table 7. Wildlife species observed on and around Grand Avenue Marsh, May – September 2007.

Birds	
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Barn Swallow	*Hirundo rustica*
American Crow	*Corvus brachyrhynchos*
American Robin	*Turdus migratorius*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Northern Cardinal	*Cardinalis cardinalis*
Amphibians	
Bull Frog	*Rana catesbeiana*
Fish	
Common Carp	Cyprinus carpio

LAKE MANAGEMENT RECOMMENDATIONS

Overall, the water quality of GAM is poor, due in part to its shallow nature and frequently flooding of the Des Plaines River. The land surrounding GAM is owned by the LCFPD and is a good refuge for many wildlife species. To improve the quality of GAM, the LMU recommends trash receptacles be placed near lake access as well as the following recommendations. There are opportunities to receive grants to help accomplish some of the management recommendations listed above (Appendix F).

Creating a Bathymetric Map

A bathymetric (depth contour) map is an essential tool in effective lake management since it provides information on the morphometric features such as depth, surface area, volume, etc. GAM does not have a current bathymetric map with volumetric calculations. Maps can be created by the LMU (Appendix D1).

Assess Your Lake's Fishery

At this time no information about the fishery in GAM known. A formal fisheries assessment should be conducted to determine the diversity and health of the fish community (Appendix D2).

Lakes with Shoreline Erosion

On GAM, 50% of the shoreline had some type of erosion. Some type of control should be employed to allow access for fishing, but also protect the shoreline from further erosion. All of the eroded areas should be remediated to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation instead of riprap or seawalls (Appendix D3).

Reduce Conductivity and Chloride Concentrations

The average conductivity reading in GAM has increased since 2004. Although the chloride concentration was below the county median, it was still high enough to potentially have impacts on aquatic life. The use of road salts for winter road management is a major contributor to chloride concentrations and conductivity. Proper application procedures and alternative methods can be used to keep these concentrations under control (Appendix D4).

Participate in the Volunteer Lake Monitoring Program (VLMP)

To track future water quality trends, it is recommended the lake become enrolled in the Volunteer Lake Monitoring Program (VMLP), which trains a volunteer to measure the Secchi disk readings on a bimonthly basis from April to October (Appendix D5). In addition to the VMLP, a staff gauge should be installed to monitor the lake level each month.

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 GRAND AVENUE MARSH, 2007.

Grand Avenue Marsh 2007 Multiparameter data

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
											1.30
05/16/2007	0.5	0.50	19.47	7.11	77.6	0.9670	7.90	1254.9	Surface		
05/16/2007	1	1.01	19.45	7.16	78.1	0.9680	8.02	732.2	Surface	100%	
05/16/2007	2	2.04	19.39	7.29	79.5	0.9660	8.04	137.1	0.369	19%	4.54
05/16/2007	3	3.00	19.35	7.37	80.2	0.9660	8.04	36.1	1.332	5%	1.00
05/16/2007	4	4.02	19.25	7.39	80.3	0.9640	8.07	17.3	2.347	2%	0.31
05/16/2007	5	5.02	19.23	7.39	80.3	0.9640	8.07	7.7	3.347	1.1%	0.24
05/16/2007	6	6.04	19.23	5.08	55.2	0.9640	8.07	1.3	4.365	0.2%	0.41

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
											2.19
06/20/2007	0.5	0.53	25.23	6.03	73.4	0.7640	8.05	2847.0	Surface		
06/20/2007	1	1.04	25.23	5.64	68.6	0.7660	8.03	2852.7	Surface	100%	
06/20/2007	2	1.96	25.24	5.69	69.4	0.7650	8.04	376.6	0.286	13%	7.08
06/20/2007	3	3.00	25.07	5.53	67.2	0.7660	8.05	56.2	1.333	2%	1.43
06/20/2007	4	4.09	25.03	5.25	63.7	0.7660	8.03	47.8	2.415	2%	0.07
06/20/2007	5	5.04	24.98	4.42	53.6	0.7670	7.95	24.7	3.365	0.9%	0.20

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
											1.47
07/18/2007	0.5	0.50	24.96	7.47	90.6	0.8160	8.63	1475.7	Surface		
07/18/2007	1	1.09	24.95	7.29	88.4	0.8170	8.56	2006.9	Surface	100%	
07/18/2007	2	2.02	24.94	7.28	88.1	0.8170	8.55	326.8	0.354	16%	5.13
07/18/2007	3	3.03	24.89	7.17	86.7	0.8170	8.55	271.2	1.357	14%	0.14
07/18/2007	4	4.00	24.90	7.14	86.5	0.8170	8.55	120.5	2.331	6%	0.35
07/18/2007	5	5.02	24.85	6.64	80.3	0.8170	8.51	48.4	3.345	2%	0.27

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
											1.26
08/15/2007	0.5	0.48	26.03	7.31	90.3	0.6330	8.56	462.3	Surface		
08/15/2007	1	1.02	26.02	7.29	90.1	0.6330	8.50	401.3	Surface	100%	
08/15/2007	2	2.01	26.03	7.26	89.6	0.6340	8.48	85.2	0.338	21%	4.58
08/15/2007	3	3.01	26.01	7.03	86.8	0.6340	8.46	35.6	1.336	9%	0.65
08/15/2007	4	4.01	25.95	5.45	67.3	0.6390	8.27	16.3	2.335	4%	0.33
08/15/2007	5	5.00	25.86	4.06	50.0	0.6440	8.10	7.6	3.332	2%	0.23
08/15/2007	6	5.99	25.72	0.13	1.7	0.6470	7.76	0.9	4.323	0.2%	0.49

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
											1.96
09/19/2007	0.5	0.49	20.23	12.17	134.7	0.6040	8.94	2865.5	Surface		
09/19/2007	1	1.00	20.21	11.97	132.4	0.6140	8.74	2484.8	Surface	100%	
09/19/2007	2	1.99	20.20	11.87	131.3	0.6040	8.66	278.2	-0.671	87%	-0.21
09/19/2007	3	3.01	20.17	11.79	130.3	0.6150	8.60	104.8	0.315	10%	6.95
09/19/2007	4	4.00	20.12	11.70	129.2	0.6050	8.58	43.7	1.339	4%	0.73
09/19/2007	5	5.00	19.68	10.76	117.7	0.6080	8.54	19.8	2.327	2%	0.38

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 ≤ 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. Options to assess your lake's fishery

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

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

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

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

D3. Options for Lakes with Shoreline Erosion

Option 1: Install a Seawall

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

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

Option 2: Install Rock Rip-Rap or Gabions

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

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

Permits are required if replacing existing or installing new rip-rap or gabions and must be acquired prior to work beginning.

Option 3: Create a Buffer Strip

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

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

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

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

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

Option 5: Install A-Jacks®

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

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.

D5. Participate in the Volunteer Lake Monitoring Program

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

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

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

For information, please contact:

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

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: Water Quality/ Wetland	Funding Focus: Habitat	Funding Focus: Erosion	Funding Focus: Flooding	Cost Share
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: Water Quality/ Wetland	Habitat	Erosion	Flooding	Cost Share
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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