2008 SUMMARY REPORT
of
Lake Louise

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Lake Louise is a private lake in the Village of Barrington. It is part of the Flint Creek drainage of the Fox River watershed. Lake Louise encompasses approximately 37.8 acres and has a shoreline length of 2.24 miles. It was reported to have a maximum depth of 15 feet shortly after its creation. In 1996 the lake was partially dredged removing 25,000 cubic yards of sediment. In 2005 the Village of Barrington and the Fox Point Homeowners Association (FPHA) received a 319 grant from the Illinois Environmental Protection Agency to do work on Flint Creek upstream of Lake Louise near Surrey Lane in an effort to reduce sediment entering the lake. In 2007, Gannett Fleming conducted a bathymetric and sediment survey and estimated that 68,000 cubic yards of sediment have accumulated in the lake since the lake was originally dredged. In 2003 a maximum depth of 10 feet was recorded by the LCHD, the bathymetric map produced by Gannett Fleming in 2007 shows a maximum depth of approximately 9 feet.

Lake Louise has had a variety of lake quality issues dating back to the late 1950s. These problems include or have included excessive aquatic plants, an unhealthy fishery, abundance of carp and geese, severe algal blooms, and nutrient enrichment. In 2008, water clarity in the lake was below the county median (3.12 feet), with an average Secchi depth measured at the inlet of 1.68 feet. This is a 10% decrease in clarity from 2003 (1.86 feet). The maximum Secchi depth was recorded in June 2008 at 2.69 feet. The poor Secchi disk transparencies were due to the high concentrations of total suspended solids (TSS). The 2008 average TSS concentration measured at the inlet was 23.3 mg/L. This measurement was less than the average TSS measured at the outlet (30.0 mg/L). The high TSS concentrations are due to the shallow nature of the lake, the abundant carp population present, and the lack of aquatic vegetation. These values are significantly higher than the county median for near surface samples of 8.2 mg/L. The 2008 TSS inlet average has increased 13% from 2003 when the average concentration was 20.7 mg/L. Total phosphorus (TP) concentrations at both the inlet and outlet of Lake Louise were also very high. The 2008 average TP concentrations were 0.156 mg/L at the inlet and 0.185 mg/L at the outlet, although these are lower than the 2003 measurements, they remain well above the county median for near surface samples of 0.065 mg/L.

In Lake Louise the average conductivity in 2008 was 0.9660 mS/cm at the inlet, this is16% higher than the County median of 0.8195 mS/cm. The average measurements for Chlorides (Cl-) at the inlet (171 mg/L) and outlet (168 mg/L) were also slightly higher than the County median of 166 mg/L.

Aquatic plants were scarce in Lake Louise, due to the poor water clarity in the lake. Only four species of aquatic plants; Sago Pondweed, Small Duckweed, Curlyleaf Pondweed, and Flat-stemmed Pondweed, were detected and were only found along the shoreline. Algae blooms were common in Lake Louise during the season.

Approximately 23% of the shoreline of Lake Louise was classified as slightly eroding. Moderate erosion was found along 9% of the shoreline. Severe erosion was found along 1% of shoreline. Severe and moderately eroded areas should be remediated immediately to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs.

LAKE FACTS

Lake Name:	Lake Louise
Historical Name:	None
Nearest Municipality:	Barrington
Location:	T43N, R10E, Section 31
Elevation:	814.0 feet
Major Tributaries:	Flint Creek
Watershed:	Fox River
Sub-watershed:	Flint Creek East Branch
Receiving Water body:	Flint Lake
Surface Area:	39.7 acres
Shoreline Length:	2.24 miles
Maximum Depth:	9.8 feet (Gannett Fleming, Inc.)
Average Depth:	3.33 feet (Gannett Fleming, Inc.)
Lake Volume:	132.2 acre-feet (Gannett Fleming)
Lake Type:	Impoundment
Watershed Area:	446.0 acres (Lake County portion)
Major Watershed Land Use:	Residential
Bottom Ownership:	Fox Point Homeowner's Association
Management Entities:	Fox Point Homeowner's Association
Current and Historical uses:	Fishing, swimming, and non-motorized boating
Description of Access:	No public access

SUMMARY OF WATER QUALITY

In 2008, water samples were collected monthly from May through September at the center of the lake 3 near the Flint Creek inlet and at the outlet near the spillway (Figure 1). Generally, Lake Louise's water quality was poor (Table 1; Appendix A-C) and many of the water quality parameters measured were above the medians for Lake County (Appendix E).

Water clarity, as measured by Secchi disk transparency readings, was measured at the inlet sample site and averaged 1.68 feet for the season, which was well below the county median of 3.12 feet. The Secchi disk readings were also the poorest measured in the Flint Creek watershed (Table 2). The reading was deepest in June (2.69 feet) and shallowest in September (0.69 feet). The poor readings were due high suspended sediment which resulted from the abundant carp population, and the lack of aquatic vegetation. The carp activity in the shallow water re-suspends sediment from the lake bottom decreasing clarity and exacerbating other water quality problems. Also, stormwater runoff from the surrounding urban area likely contributed to the poor clarity as this water often contains sediment, nutrients, and pollutants.

The poor Secchi disk transparencies were correlated with high concentrations of total suspended solids (TSS). The highest TSS concentrations correspond to the poorest Secchi readings, because more suspended solids present in the water reduce the Secchi disk visibility (Figure 2). The 2008 averages for the inlet and outlet were 23.3 mg/L and 30.0 mg/L, respectively. These values were significantly higher than the county median of 8.2 mg/L and the seasonal averages for the watershed). The 2008 inlet average TSS has increased 13% from 2003 when the average concentration was 20.7 mg/L. In 2008, TSS had increased substantially after July at both sample locations. The most plausible explanation for the 2008 findings is the static water levels that occurred over the monitoring period as there was only a 0.5 inch change in the water levels in the lake. Water was flowing over the outlet structure in May and water did not flow out of the lake again until September. It is estimated that the retention time (the time it takes the volume of water in the lake to be turned over) is approximately 118 days per the morphometric table (data collected by Gannett Fleming, Inc. was interpreted by Lakes Management Unit) To track future water quality trends, it is strongly recommended that the lake become enrolled in the Volunteer Lake Monitoring Program (VMLP), which trains a volunteer to measure the Secchi disk readings bimonthly from April to October.

Total phosphorus (TP) concentrations at both the inlet and outlet of Lake Louise were very high. The 2008 average TP concentrations were 0.156 mg/L at the inlet and 0.185 mg/L at the outlet, which are both well above the county median of 0.065 mg/L. Lake Louise is considered a nutrient rich lake due to the presence of high TP concentrations (>0.05 mg/L). The 2008 average TP concentration at the inlet and outlet were lower than the 2003 inlet and outlet averages of 0.194 mg/L and 0.192 mg/L. TP concentrations present in Lake Louise can be attributed to several factors both internal and external, including stormwater, carp activity and algal populations. Another threat to the lake is fertilizer applied to the lawns contained within the watershed. It is recommended that homeowners use a phosphorus-free fertilizer on their lawns. Lake Louise had high concentrations of soluble reactive phosphorus (SRP). Aquatic organisms

Figure 1. Water quality sampling sites on Lake Louise, 2008.

Table 1. Water quality data for Lake Louise, 2003 and 2008.

2008	Inlet															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	3	204	1.37	0.351	0.224	0.092	0.011	215	NA	20.8	666	98	1.81	1.1730	7.97	9.45
18-Jun	3	200	1.34	<0.100	<0.050	0.080	<0.005	192	NA	11.0	643	136	2.69	1.0620	8.65	12.23
16-Jul	3	180	1.75	0.439	0.091	0.268	0.140	172	NA	11.6	570	116	1.71	0.9570	8.29	6.38
20-Aug	3	188	1.75	0.260	<0.050	0.175	0.044	174	NA	33.0	585	107	1.51	0.9700	8.02	6.23
17-Sep	3	142	1.62	0.269	0.369	0.164	0.034	100	NA	40.3	433	90	0.69	0.6680	7.51	6.75
	Average	183	1.57	0.330[k]	0.228[k]	0.156	0.057[k]	171	NA	23.3	579	109	1.68	0.9660	8.09	8.21

2003	Inlet															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	3	173	1.59	0.298	0.699	0.081	0.013	NA	508	12.0	549	114	1.80	0.9290	7.90	7.44
18-Jun	3	204	1.66	<0.100	<0.050	0.071	<0.005	NA	564	9.7	604	145	2.92	0.9290	7.90	9.57
23-Jul	3	169	1.99	<0.100	<0.050	0.217	0.02	NA	550	36.7	588	137	1.05	0.9420	8.54	9.42
20-Aug	3	182	1.89	<0.100	<0.050	0.280	0.12	NA	516	16.1	563	139	2.03	0.9540	8.42	6.49
25-Sep	3	175	2.23	<0.100	<0.050	0.320	0.078	NA	501	29.1	576	129	1.51	0.9229	8.88	5.81
	Average	181	1.87	0.298[k]	0.699[k]	0.194	0.058[k]	NA	528	20.7	576	133	1.86	0.9354	8.33	7.75

Glossary

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

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed
** TDS calculated using historical TDS/Cl data

Table 1. Continued.

2008	Outlet															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	0	202	1.32	0.355	0.2190	0.036	0.013	212	NA	17.0	661	100	NA	1.1660	8.03	9.20
18-Jun	0	199	1.39	0.000??	<0.050	0.077	0.005	191	NA	11.0	631	120	NA	1.0520	8.68	14.51
16-Jul	0	180	1.62	0.332	0.090	0.242	0.121	172	NA	14.4	558	98	NA	0.9620	8.46	8.94
20-Aug	0	181	4.55	<0.100	<0.050	0.399	0.008	174	NA	62.8	621	149	NA	0.9460	8.03	12.43
17-Sep	0	142	1.69	0.300	0.371	0.171	0.034	92	NA	44.6	427	88	NA	0.6560	7.95	7.65
	Average	181	2.11	0.247[k]	0.227[k]	0.185	0.036	168	NA	30.0	580	111	NA	0.9564	8.23	10.55

2003	Outlet															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	0	173	1.64	0.331	0.651	0.081	0.018	NA	518	15.0	546	111	NA	NA	NA	NA
18-Jun	0	205	1.66	<0.100	<0.050	0.070	<0.005	NA	580	8.8	582	122	NA	NA	NA	NA
23-Jul	0	169	2.13	<0.100	<0.050	0.229	0.017	NA	510	49.1	600	149	NA	NA	NA	NA
20-Aug	0	179	1.85	<0.100	0.057	0.280	0.116	NA	528	22.0	592	172	NA	NA	NA	NA
25-Sep	0	171	2.06	<0.100	<0.050	0.301	0.080	NA	518	27.2	566	128	NA	NA	NA	NA
	Average	179	1.87	0.331[k]	0.354[k]	0.192	0.058[k]	NA	531	24.4	577	136	NA	NA	NA	NA

Glossary

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

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

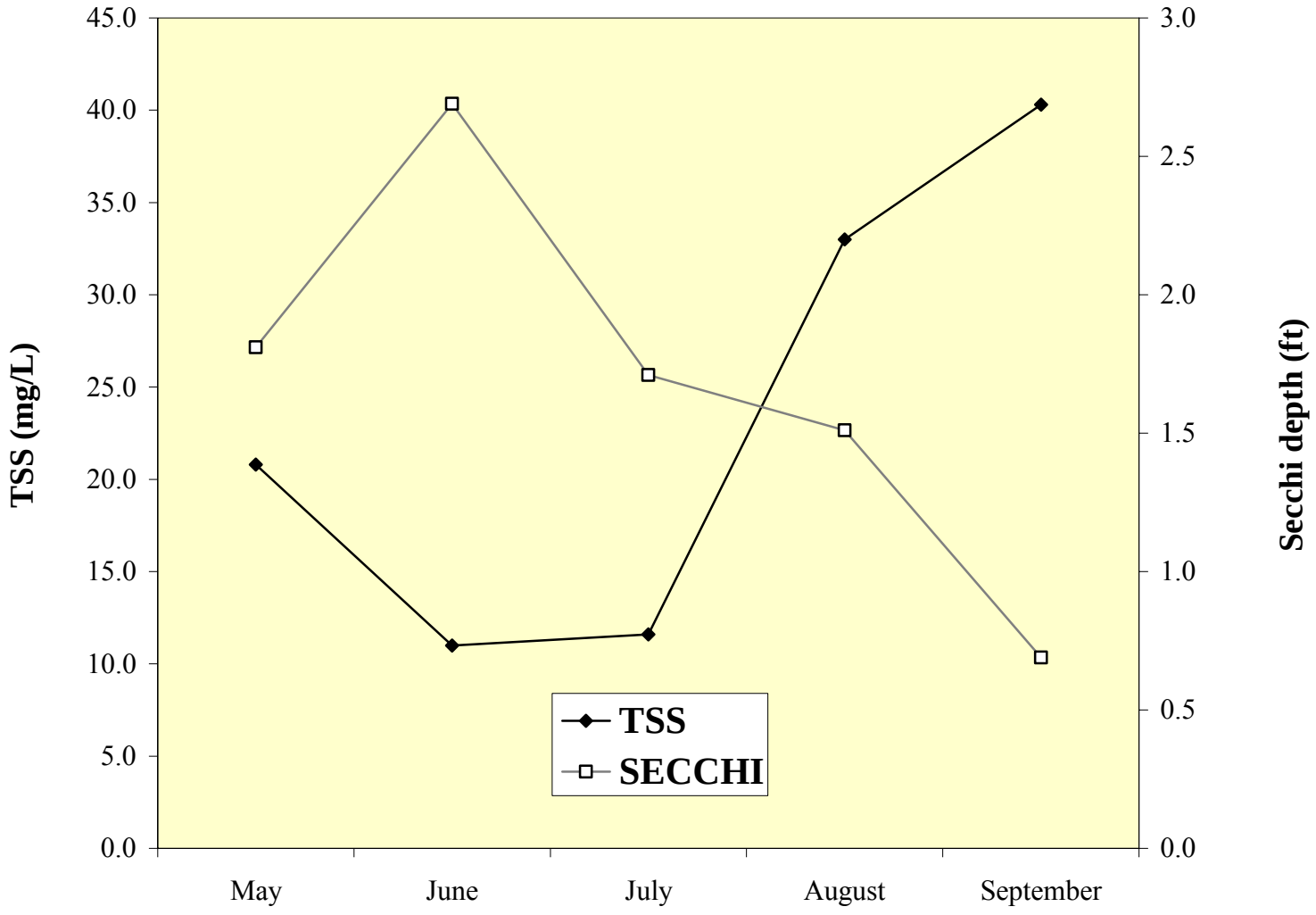
Table 2. Comparison of epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity readings in the Flint Creek watershed (Lake Zurich, Echo Lake, Honey Lake, Grassy Lake, Flint Lake, and Lake Louise)

	Lake Zurich	Lake Zurich	Lake Zurich	Lake Zurich	Echo Lake	Echo Lake	Honey Lake	Honey Lake	Honey Lake	Grassy Lake	Grassy Lake	Flint Lake	Flint Lake
Year	**1991**	**1998**	**2002**	**2008**	**2000**	**2008**	**1998**	**2001**	**2008**	**2000**	**2008**	**2003**	**2008**
Secchi (feet)	8.09	5.70	5.53	10.40	3.66	2.11	5.70	8.40	7.17	1.44	1.71	NA	NA
TSS (mg/L)	4.4	4.2	4.9	2.7	9.7	13.5	3.4	1.8	3.4	27.1	20.7	18.1	22.9
TP (mg/L)	0.023	0.017	0.028	0.016	0.079	0.125	0.040	0.038	0.034	0.195	0.161	0.564	0.293
Conductivity (milliSiemens/cm)	0.5400	0.7980	0.7593	0.9573	0.8872	1.2284	0.9370	1.1126	1.3174	0.9301	1.1608	1.5818	1.5188

	Lake Louise	Lake Louise	Flint Lake	Flint Lake
Year	**2003**	**2008**	**2003**	**2008**
Secchi (feet)	1.86	1.68	NA	NA
TSS (mg/L)	20.7	23.3	18.1	22.9
TP (mg/L)	0.194	0.156	0.564	0.293
Conductivity (milliSiemens/cm)	0.9354	0.9660	1.5818	1.5188

Direction of Watershed Flow

Figure 2. Total suspended solid (TSS) concentrations vs. Secchi disk depth for Lake Louise, 2008



usually utilize SRP as it becomes available. However, from June through August of 2008 nitrogen availability was limited, which likely made it difficult for aquatic organisms to assimilate all the available SRP, hence the elevated levels.

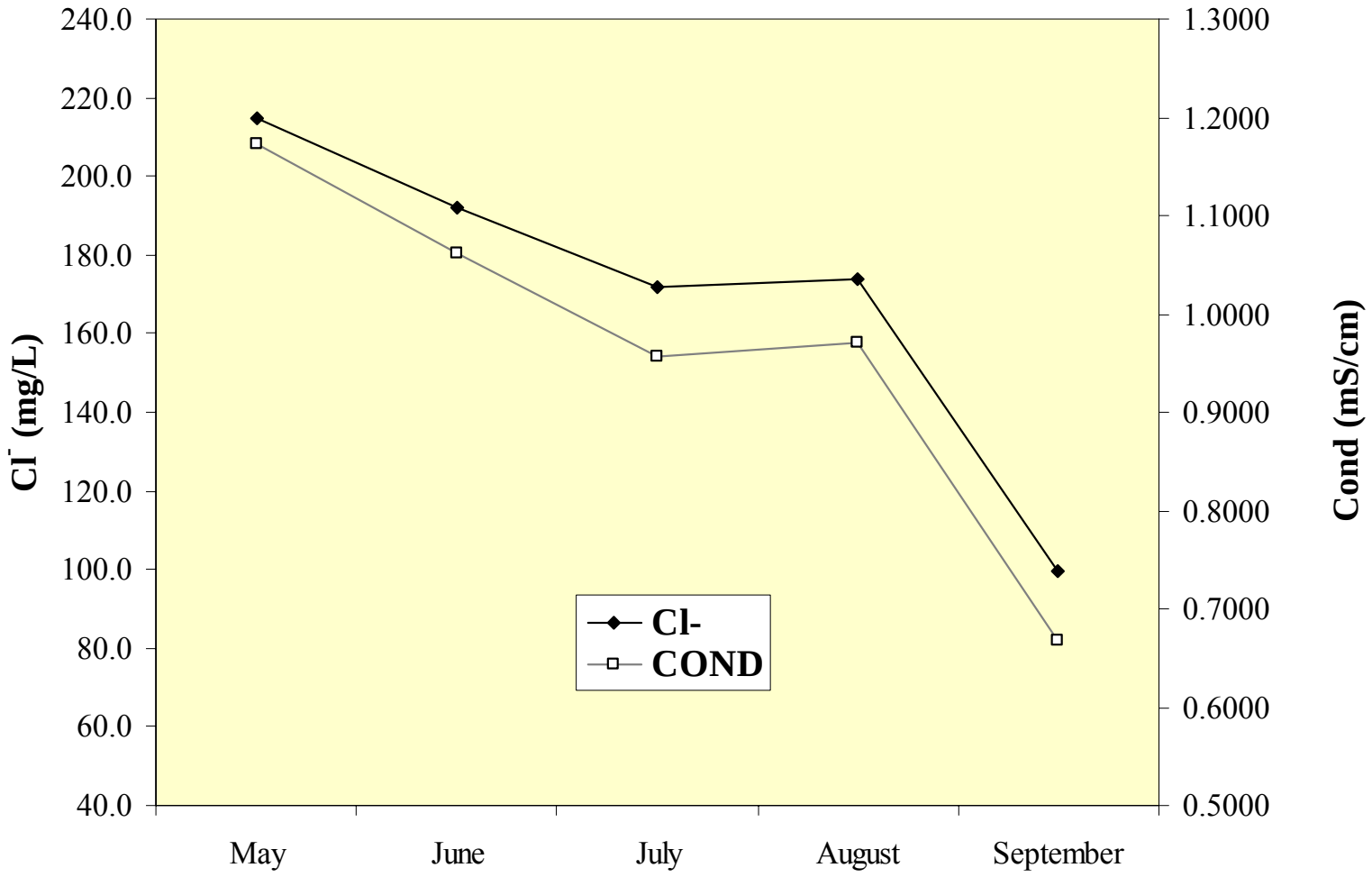
High nutrient concentrations are usually indicative of water quality problems. Algae need light and nutrients, most importantly carbon (C), nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply. This means that the nutrients nitrogen and phosphorus are usually the limiting factors in algal growth. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.) that are more difficult to control than sources of phosphorus. To compare the availability of these nutrients, a ratio of total nitrogen to total phosphorus is used (TN: TP). Ratios <10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate that there is enough of both nutrients for excessive algal growth. The average ratio between total nitrogen and total phosphorus for Lake Louise in 2008 and 2003 was 11:1; this ratio has not changed dramatically since 1998, when the ratio was 12:1. Most lakes in Lake County are phosphorus-limited. The ratio of 11:1 indicated that there are sufficient levels of both nutrients available, however, the fact that the lake is borderline N limited, this indicates that there is just way too much P present in the lake.

The 2008 seasonal average concentration for total Kjeldahl nitrogen (TKN), which is a measurement of the organic nitrogen in the water, was 1.57 mg/L at the inlet and 2.11 mg/L at the outlet, both values are above the county median of 1.20 mg/L.

The combined concentration of nitrate and nitrite nitrogen (NO3 and NO2-N) ranged from less than detectable to maximum levels of 0.369 mg/L and 0.371 mg/L at the inlet and outlet sites, respectively. These concentrations are significantly higher than the county median of 0.156 mg/L. High concentrations of nitrogen as they occurred throughout the season were sufficient to support algal blooms during the summer. Ammonia nitrogen (NH3-N) concentrations ranged from less than detectable to 0.351mg/L and 0.355 mg/L at inlet and outlet respectively, with a seasonal average of 0.248 mg/L at the outlet. Most lakes have less than detectable concentrations of ammonia since under oxic conditions it is quickly converted into nitrate nitrogen and utilized by aquatic organisms. High concentrations in Lake Louise suggest possible upstream sources.

Conductivity readings, which are correlated with chloride concentrations (Figure 3), have been increasing throughout the county in the past few years. It is believed that road salt is probably the reason for the increase because chloride concentrations detect sodium chloride and calcium chloride, which most road salt consists of. The average conductivity readings for the inlet and outlet of Lake Louise were 0.9660mS/cm and 0.9564 mS/cm, respectively. Both values were above the county median of 0.8195mS/cm and 24% higher than the 1998 readings in the lake. Chloride concentrations averaged 171 mg/L at the inlet and 168mg/L at the outlet and were higher than the county median of 166 mg/L. A study done in Canada reported 10% of aquatic species were harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with chloride concentrations as low as 12 mg/l. Alternatives to road salt should be considered. While alternatives may contain chloride, they tend to work faster at lower temperatures and therefore require less application to

Figure 3. Chloride (Cl^-) concentration vs. conductivity for Lake Louise, 2008



achieve the same result that common road salt. Some lakes in the county have seen a doubling of conductivity readings in the past 5-10 years.

Due to the shallow nature of the lake, a thermocline was never established. Dissolved oxygen (DO) concentrations in Lake Louise remained stable during the season. Generally concern arises when DO concentrations fall below 5 mg/L since some aquatic organisms can suffer stress below this level. In 2008, DO concentrations recorded throughout the water column were above 5 mg/L at both the inlet and outlet. Wind and wave action likely kept this lake well mixed.

As mentioned previously, water levels influenced the water quality in Lake Louise. Rain events contribute additional sediment and nutrients (like phosphorus) to a lake. There were no rain events that occurred within 48 hours prior to water sampling, as recorded at the Lake County Stormwater Management Commission (LCSMC) rain gage in Lake Zurich. An estimated total of 19.1 inches of rain fell in the area from May through September according to the Lake Zurich gauge.

Based on data collected in 2008, standard classification indices compiled by the Illinois Environmental Protection Agency (IEPA) were used to determine the current condition of Lake Louise. A general overall index that is commonly used is called a trophic state index or TSI. The TSI index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich productive). This index can be calculated using TP values obtained at or near the surface. The TSIp for Lake Louise in 2008, based on the average TP at the outlet, was 79.4 and classified it as a hypereutrophic lake. Lake Louise ranked 145th out of 163 Lake County lakes (Table 3).
In Lake Louise, the IEPA aquatic life impairment index was low, indicating a *Full* degree of support for all aquatic organisms in the lake. The recreation use index showed a *Partial* impairment, also due to poor water clarity. The overall use index for the lake was *Partial* support.

Establishing native plant populations or buffer strips along the lake would also help the water quality of the lake; the vegetation would stabilize shorelines, trap sediments and compete with algae for available nutrients. Another benefit to establishing this type of shoreline is it would discourage the use of the lake by Canada geese and gulls. Rain gardens are another practice that can be implemented by homeowners around the lake and within the watershed to promote water soaking into the ground versus running off into stormwater drains and eventually into the lake.

A watershed is the land and water around a lake that drains to that lake. This means that any management of the land within the watershed can directly affect the lake. To reduce impacts to the lake residents can apply phosphorus free fertilizer to their lawns, keep grass clippings away from the lake, have their septic tanks pumped and serviced regularly (if applicable), and use alternative material to road salt for winter de-icing of sidewalks and roads. Also, increased impervious surface creates increased run-off which can raise the lake level by not allowing as much water to infiltrate into the ground. Increased water in a lake creates a larger volume of water which can hold more nutrients and can also lead to flooding.

Table 3. Lake County average TSI phosphorous (TSIp) ranking 2000-2008

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Independence Grove	0.0135	39.24
4	Lake Zurich	0.0130	41.14
5	Sand Pond (IDNR)	0.0165	41.36
6	West Loon Lake	0.0140	42.21
7	Windward Lake	0.0158	43.95
8	Bangs Lake	0.0170	45.00
9	Pulaski Pond	0.0180	45.83
10	Timber Lake	0.0180	45.83
11	Fourth Lake	0.0182	45.99
12	Lake Kathryn	0.0200	47.35
13	Lake of the Hollow	0.0200	47.35
14	Banana Pond	0.0202	47.49
15	Lake Minear	0.0204	47.63
16	Cedar Lake	0.0220	48.72
17	Cross Lake	0.0220	48.72
18	Sun Lake	0.0220	48.72
19	Dog Pond	0.0222	48.85
20	Stone Quarry Lake	0.0230	49.36
21	Deep Lake	0.0234	49.61
22	Druce Lake	0.0244	50.22
23	Little Silver	0.0250	50.57
24	Round Lake	0.0254	50.80
25	Lake Leo	0.0256	50.91
26	Cranberry Lake	0.0270	51.68
27	Dugdale Lake	0.0274	51.89
28	Peterson Pond	0.0274	51.89
29	Lake Miltmore	0.0276	51.99
30	Third Lake	0.0280	52.20
31	Lake Fairfield	0.0296	53.00
32	Gray's Lake	0.0302	53.29
33	Highland Lake	0.0302	53.29
34	Hook Lake	0.0302	53.29
35	Lake Catherine (Site 1)	0.0308	53.57
36	Lambs Farm Lake	0.0312	53.76
37	Old School Lake	0.0312	53.76
38	Sand Lake	0.0316	53.94
39	Sullivan Lake	0.0320	54.13
40	Lake Linden	0.0326	54.39
41	Gages Lake	0.0338	54.92
42	Honey Lake	0.0340	55.00
43	Hendrick Lake	0.0344	55.17
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	Potomac Lake	0.0424	58.18
49	Duck Lake	0.0426	58.25
50	Old Oak Lake	0.0428	58.32
51	Deer Lake	0.0434	58.52
52	Schreiber Lake	0.0434	58.52
53	Nielsen Pond	0.0448	58.98
54	Turner Lake	0.0458	59.30
55	Seven Acre Lake	0.0460	59.36
56	Willow Lake	0.0464	59.48
57	Lucky Lake	0.0476	59.85
58	Davis Lake	0.0476	59.85
59	East Meadow Lake	0.0478	59.91
60	East Loon Lake	0.0490	60.27
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	Wooster Lake	0.0620	63.66
75	Countryside Lake	0.0620	63.66
76	Werhane Lake	0.0630	63.89
77	Liberty Lake	0.0632	63.94
78	Countryside Glen Lake	0.0642	64.17
79	Lake Fairview	0.0648	64.30
80	Leisure Lake	0.0648	64.30
81	Tower Lake	0.0662	64.61
82	St. Mary's Lake	0.0666	64.70
83	Mary Lee Lake	0.0682	65.04
84	Hastings Lake	0.0684	65.08
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	Sylvan Lake	0.0794	67.23
91	Big Bear Lake	0.0806	67.45
92	Petite Lake	0.0834	67.94

Table 3. Continued

RANK	LAKE NAME	TP AVE	TSIp
93	Timber Lake (South)	0.0848	68.18
94	Lake Marie (Site 1)	0.0850	68.21
95	North Churchill Lake	0.0872	68.58
96	Grand Avenue Marsh	0.0874	68.61
97	Grandwood Park, Site II, Outflow	0.0876	68.65
98	North Tower Lake	0.0878	68.68
99	South Churchill Lake	0.0896	68.97
100	Rivershire Pond 2	0.0900	69.04
101	McGreal Lake	0.0914	69.26
102	International Mine and Chemical Lake	0.0948	69.79
103	Eagle Lake (Site I)	0.0950	69.82
104	Valley Lake	0.0950	69.82
105	Dunns Lake	0.0952	69.85
106	Fish Lake	0.0956	69.91
107	Lochanora Lake	0.0960	69.97
108	Owens Lake	0.0978	70.23
109	Woodland Lake	0.0986	70.35
110	Island Lake	0.0990	70.41
111	McDonald Lake 1	0.0996	70.50
112	Longview Meadow Lake	0.1024	70.90
113	Lake Barrington	0.1053	71.31
114	Redwing Slough, Site II, Outflow	0.1072	71.56
115	Lake Forest Pond	0.1074	71.59
116	Bittersweet Golf Course #13	0.1096	71.88
117	Fox Lake (Site 1)	0.1098	71.90
118	Osprey Lake	0.1108	72.04
119	Bresen Lake	0.1126	72.27
120	Round Lake Marsh North	0.1126	72.27
121	Deer Lake Meadow Lake	0.1158	72.67
122	Long Lake	0.1170	72.82
123	Taylor Lake	0.1184	72.99
124	Columbus Park Lake	0.1226	73.49
125	Nippersink Lake (Site 1)	0.1240	73.66
126	Echo Lake	0.1250	73.77
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	Grassy Lake	0.1610	77.42
141	Salem Lake	0.1650	77.78
142	Half Day Pit	0.1690	78.12
143	Lake Eleanor Site II, Outflow	0.1812	79.13
144	Lake Farmington	0.1848	79.41
145	**Lake Louise**	**0.1850**	**79.43**
146	ADID 127	0.1886	79.71
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	106.26

According to the Flint Creek Watershed Plan, Lake Louise is located in the Subwatershed Management Unit (SMU) #FCE7, of the East Branch of Flint Creek, and is 679 acres. The portion of the SMU contained in Lake County is 466 acres (Figure 4). Sixty-seven percent of the land use in the 466 acre watershed of Lake Louise was occupied by single family housing (Table 4; Figure 5). Transportation came in second representing 14% of the watershed. Similarly it was estimated that single family housing contributed the largest percentage of runoff (61%) followed by transportation (35%). The ratio of watershed does not represent the runoff associated with that land use, while only representing 14% of the watershed; transportation contributed an estimated 35% of the watersheds runoff. Of further consequence, this data represents the areas contained in Lake County, so the total watershed and runoff is likely underestimated in this report.

SUMMARY OF AQUATIC MACROPHYTES

Aquatic plants were scarce in Lake Louise, due mostly to the poor water clarity and previous herbicide treatments. Sago Pondweed, Small Duckweed, Curlyleaf Pondweed, and Flat-Stemmed Pondweed were the aquatic macrophytes found during a perimeter assessment of the lake (Table 4). Curlyleaf Pondweed is an exotic species that can be problematic in some lakes in the county, but at the present time is not a priority for Lake Louise. To maintain a healthy sunfish/bass fishery, the Illinois Department of Natural Resources recommends plant (macrophyte) coverage of 30% to 40% across the lake bottom. The aquatic plants community in Lake Louise is estimated to be less than 5% consisted of scattered beds along the near-shore areas.

Table 4. Aquatic plant species found in Grassy Lake in 2008.

Small Duckweed	*Lemna minor*
Curlyleaf Pondweed^	*Potamogeton crispus*^
Sago Pondweed	*Potamogeton pectinatus*
Flatstem Pondweed	*Potamogeton zosteriformis*

^ Exotic plant

Plant species composition was very similar between 2003 and 2008. Three of the four species remained the same between the two sampling years (Curlyleaf Pondweed, Duckweed and Sago Pondweed); American Elodea, which was found in 2003 was not found in 2008. This shift in species is likely due to natural variation or sampling methodology.

In 1998, a fluridone treatment was conducted on the lake to reduce the aquatic plant population that was viewed as being at nuisance levels. The treatment was conducted at a target concentration of 15 parts per billion. The treatment resulted in a change in the lake from a plant-dominated lake to an algae dominated one. Since this fluridone treatment, the lake has had few submersed plants and is annually treated for algae. In lakes in which this switch has occurred, it is difficult to change the lake back to one dominated by plants, since algae and sediment reduce the light penetration needed for plant growth.

Figure 4. Approximate watershed delineation of the Lake County, Illinois portion of Lake Louise, 2008

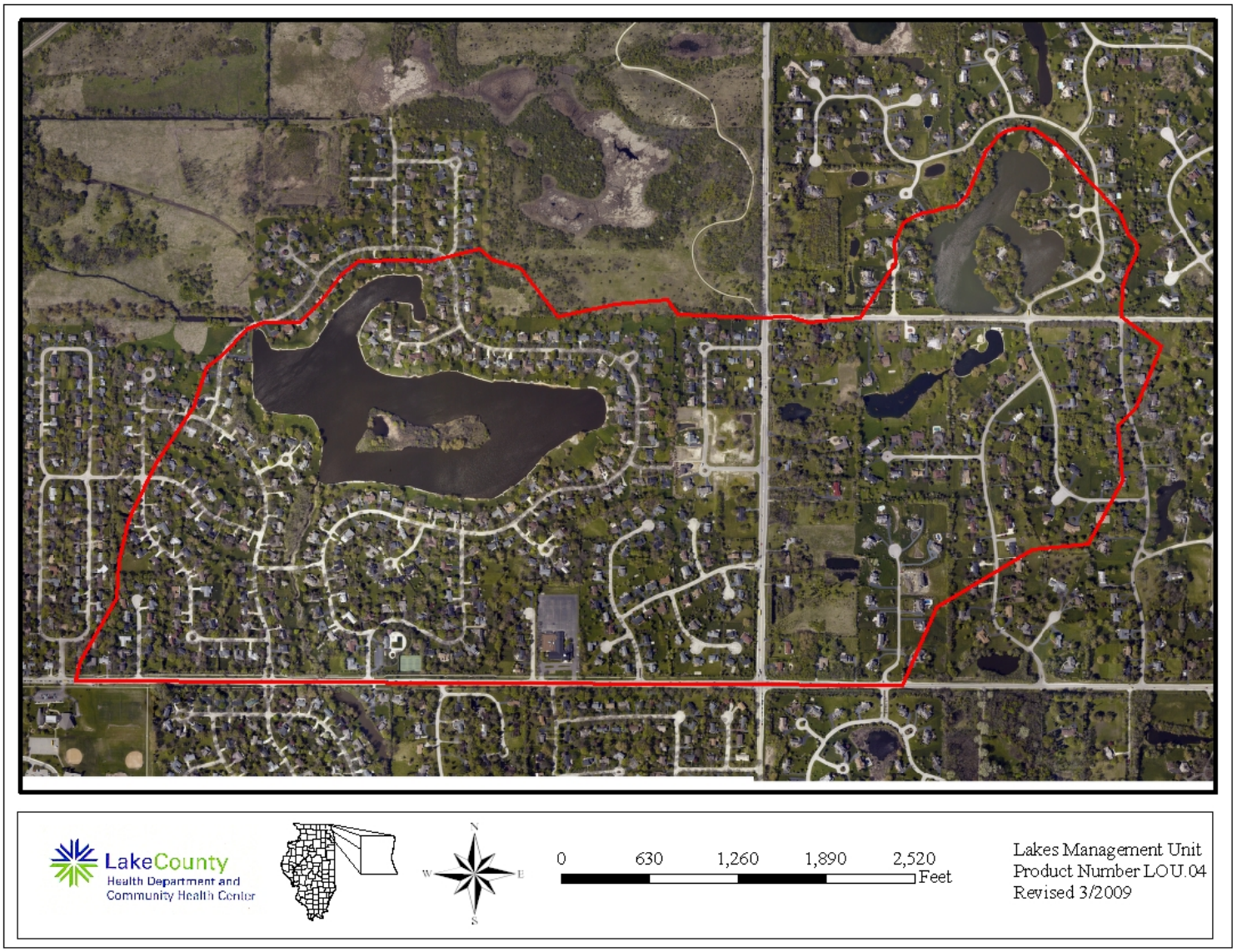


Figure 5. Approximate land use within the Lake County portion of the Lake Louise watershed, 2008.

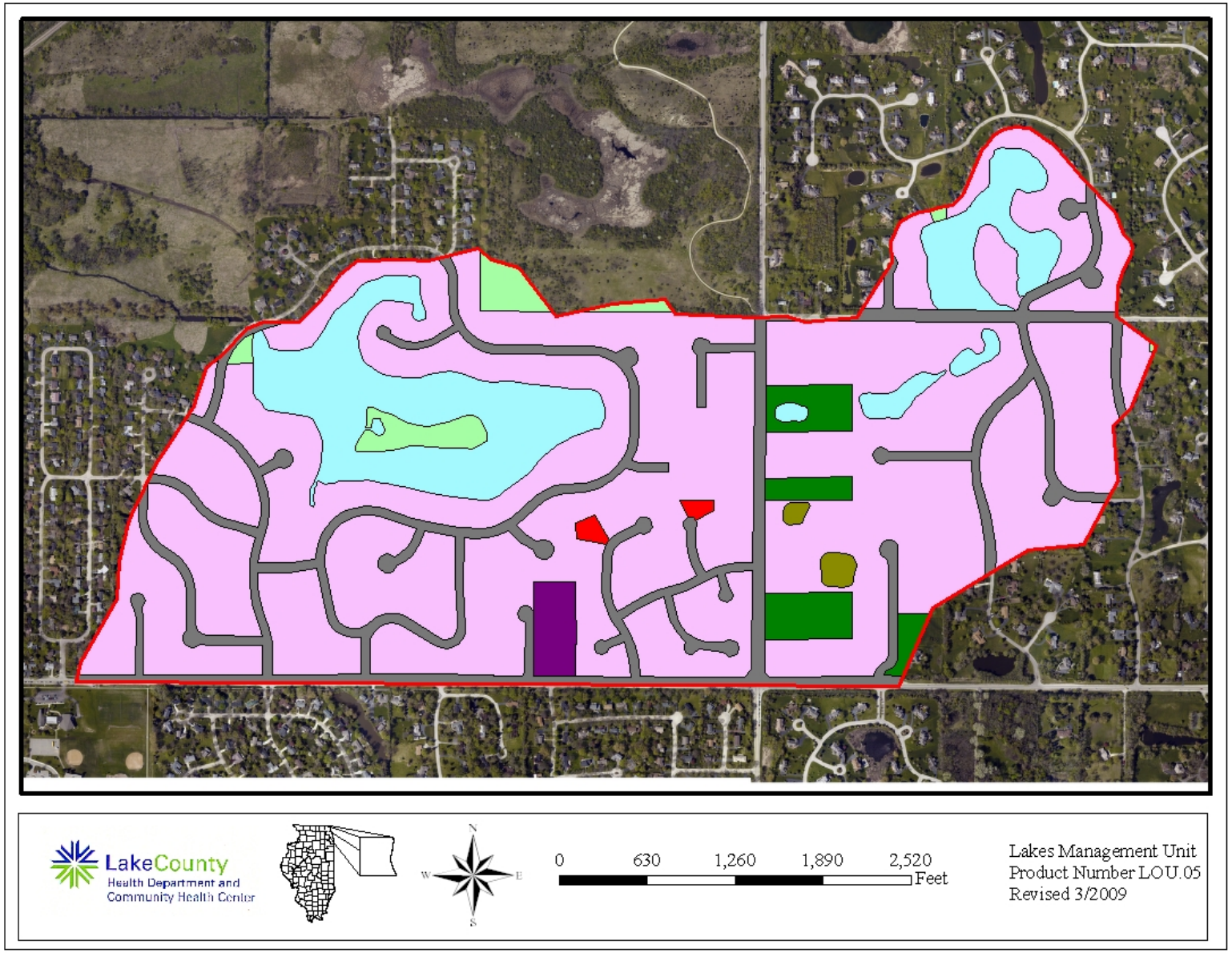


Table 5. Approximate land uses within the Lake County portion of the watershed and retention time for Lake Louise, 2008.

Land Use	Acreage	% of Total
Forest and Grassland	4.02	0.9%
Government and Institutional	4.68	1.0%
Public and Private Open Space	17.54	3.9%
Single Family	299.72	67.2%
Transportation	62.39	14.0%
Water	56.36	12.6%
Wetlands	1.27	0.3%
Total Acres	**446.00**	**100.0%**

Land Use	Acreage	Runoff Coefficient	Estimated Runoff, acre-feet.	% Total of Estimated Runoff
Forest and Grassland	4.02	0.05	0.6	0.1%
Government and Institutional	4.68	0.50	6.4	1.6%
Public and Private Open Space	17.54	0.15	7.2	1.8%
Single Family	299.72	0.30	247.3	60.7%
Transportation	62.39	0.85	145.8	35.8%
Water	56.36	0.00	0.0	0.0%
Wetlands	1.27	0.05	0.2	0.0%
TOTAL	**446.00**		**407.5**	100.0%

Lake volume	**132.19**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.32**	**years**
	118.40	**days**

The 1% light level (the point where plant photosynthesis ceases) was at the bottom of the lake in all months except August when the 1% light level was found at four feet. As mentioned previously, the water sampling site (and hence the site where the light levels were recorded) was not at the deepest point in the lake. However, since the light levels at the bottom of the lake at the sample point (5-6 feet deep) ranged from 0-4% during the season, it is unlikely that the available light levels penetrated much deeper than this at the deep hole location. This parameter is critical to aquatic plant growth and is probably the limiting factor in Lake Louise. Unless water clarity is improved, it is unlikely that aquatic plants can become established in the lake. However, it is recommended that aquatic plants are allowed to grow and expand where possible. Establishing aquatic plant populations in the lake will help improve water quality by utilizing available nutrients, thus, competing with algae, stabilizing the bottom sediment, and providing habitat for fish and wildlife. Aquatic plants could even be planted in certain areas to encourage growth. The area around the island would be a good location since the residents around the lake do not heavily use this area.

Because of the lack of aquatic plants and the high concentrations of nutrients in the lake, algae blooms were common in Lake Louise. Both planktonic and filamentous algae were seen during the season and were part of the reason the Secchi disk readings were so poor. The FPHOA hired a commercial applicator to treat the algae during the summer season. In 2008, there were 9 algaecide treatments applied to the lake. The products used were Copper Sulfate (850 pounds), Hydrothol 191 (192 ounces) and a surfactant. It should be noted that a bathymetric map was produced in January 2007, and the morphometrics (volume, area) should be updated with the applicator.

Floristic quality index is an assessment tool designed to evaluate the closeness that the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submersed plant species found in the lake. These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. In 2008 Lake Louise had a FQI of 9.0 (#110 of 152 lakes). The median FQI of lakes that we have studied from 2000-2008 is 12.5 (Table 6).

SUMMARY OF SHORELINE CONDITION

Lakes with stable water levels potentially have less shoreline erosion problems. The water level in Lake Louise fluctuated in 2008. Water level was measured at the outfall each month. The water levels dropped 0.75 inches from May to June and continued to decline slightly each month until September when there was a water level increase of 1.5 inches, for a total seasonal water level change of 0.5 inches. The Lake County Stormwater Management Commission recorded 25.14 inches of rain from May through September at the rain gauge located in Lake Zurich.

Table 7. 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	36.3	38.4
2	East Loon Lake	30.6	32.7
3	Cranberry Lake	30.1	31.6
4	Deep Lake	29.7	31.2
5	Little Silver	29.6	31.6
6	Round Lake Marsh North	29.1	29.9
7	Deer Lake	28.2	29.7
8	Sullivan Lake	28.2	29.7
9	Schreiber Lake	26.8	27.6
10	Bangs Lake	25.7	27.4
11	West Loon Lake	25.7	27.3
12	Cross Lake	25.2	27.8
13	Independence Grove	24.6	27.5
14	Sterling Lake	24.5	26.9
15	Lake Zurich	24.3	27.1
16	Sun Lake	24.3	26.1
17	Lake of the Hollow	23.8	26.2
18	Lakewood Marsh	23.8	24.7
19	Round Lake	23.5	25.9
20	Honey Lake	23.3	25.1
21	Fourth Lake	23.0	24.8
22	Druce Lake	22.8	25.2
23	Countryside Glen Lake	21.9	22.8
24	Butler Lake	21.4	23.1
25	Duck Lake	21.1	22.9
26	Timber Lake (North)	20.8	22.8
27	Broberg Marsh	20.5	21.4
28	Davis Lake	20.5	21.4
29	ADID 203	20.5	20.5
30	McGreal Lake	20.2	22.1
31	Lake Kathryn	19.6	20.7
32	Fish Lake	19.3	21.2
33	Owens Lake	19.3	20.2
34	Redhead Lake	19.3	21.2
35	Turner Lake	18.6	21.2
36	Wooster Lake	18.5	20.2
37	Salem Lake	18.5	20.2
38	Lake Miltmore	18.4	20.3
39	Hendrick Lake	17.7	17.7
40	Summerhill Estates Lake	17.1	18.0
41	Seven Acre Lake	17.0	15.5
42	Gray's Lake	16.9	19.8
43	Lake Barrington	16.7	17.7
44	Bresen Lake	16.6	17.8

Table 7. Continued

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

Table 7. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
91	Lake Naomi	11.2	12.5
92	Pulaski Pond	11.2	12.5
93	Lake Minear	11.0	13.9
94	Redwing Marsh	11.0	11.0
95	Tower Lake	11.0	11.0
96	West Meadow Lake	11.0	11.0
97	Nielsen Pond	10.7	12.0
98	Lake Holloway	10.6	10.6
99	Third Lake	10.2	12.5
100	Crooked Lake	10.2	12.5
101	College Trail Lake	10.0	10.0
102	Lake Lakeland Estates	10.0	11.5
103	Valley Lake	9.9	9.9
104	Werhane Lake	9.8	12.0
105	Big Bear Lake	9.5	11.0
106	Little Bear Lake	9.5	11.0
107	Loch Lomond	9.4	12.1
108	Columbus Park Lake	9.2	9.2
109	Sylvan Lake	9.2	9.2
110	**Lake Louise**	**9.0**	**10.4**
111	Fischer Lake	9.0	11.0
112	Grandwood Park Lake	9.0	11.0
113	Lake Fairfield	9.0	10.4
114	McDonald Lake 1	8.9	10.0
115	Countryside Lake	8.7	10.6
116	East Meadow Lake	8.5	8.5
117	Lake Christa	8.5	9.8
118	Lake Farmington	8.5	9.8
119	Lucy Lake	8.5	9.8
120	South Churchill Lake	8.5	8.5
121	Bittersweet Golf Course #13	8.1	8.1
122	Woodland Lake	8.1	9.9
123	Albert Lake	7.5	8.7
124	Banana Pond	7.5	9.2
125	Fairfield Marsh	7.5	8.7
126	Lake Eleanor	7.5	8.7
127	Patski Pond	7.1	7.1
128	Rasmussen Lake	7.1	7.1
129	Slough Lake	7.1	7.1
130	Lucky Lake	7.0	7.0
131	Lake Forest Pond	6.9	8.5
132	Leisure Lake	6.4	9.0
133	Peterson Pond	6.0	8.5
134	Gages Lake	5.8	10.0
135	Slocum Lake	5.8	7.1
136	Deer Lake Meadow Lake	5.2	6.4

Table 7. Continued

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

The results of an earlier assessment, 2003, showed approximately 76% of the shoreline of Lake Louise was classified as developed, with the only undeveloped area being the island. The most common shoreline type was riprap, which comprised 42% of the shoreline. Shrub and beach were the next most common types at 21% and 16%, respectively. Seawall (9%), lawn (5%), buffer (4%), and wetland (3%) habitat made up the remaining shoreline types. The buffer habitat (which is a strip of un-mowed vegetation preferably consisting of native plants located at the water's edge) should be expanded since the buffers benefit the lake by filtering nutrients and pollutants before they enter the lake and by creating habitat for fish and wildlife. Buffers are also not preferred habitat of Canada Geese. Several exotics were found growing along the shoreline, including buckthorn, honeysuckle, purple loosestrife, and multiflora rose. These plants are noted to be aggressively invasive and can crowd out beneficial native species. They do not offer ideal wildlife habitat and should be removed.

The shoreline was assessed in 2008 for the degree and type of shoreline erosion. The amount of shoreline that had some degree of erosion was 33%. Approximately 23% of the shoreline of Lake Louise was classified as slightly eroding (Figure 6). Moderate erosion was found along 9% of the shoreline. Severe erosion was found along 1% of the shoreline. The severe erosion occurred at two locations, an approximate 91-foot section on the eastern end of the island, and an approximate 61-foot section on the eastern shoreline. The severe and moderate eroded areas should be remediated immediately to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired by using native plantings. Riprap and seawalls are considered less preferable. 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. Although some people are hesitant about installing buffer strips along their shoreline, buffer strips can be attractive and still allow lake access by adding a mowed path to the water. Thirdly, buffer habitat can help filter pollutants and nutrients from the near shore areas and discourage geese and gulls from congregating, as it is not desirable habitat for them.

OBSERVATIONS OF WILDLIFE AND HABITAT

Due to the lake being in the middle of a residential setting with the majority of the shoreline developed, habitat for wildlife was limited. Most of the birds observed were those common in residential settings. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones and are recommended as one aspect of shoreline protection. Erecting birdhouses and allowing brush or trees that have fallen into the water to remain creates additional habitat for birds, fish, reptiles, and amphibians. The LMU recommends a formal fisheries assessment since there is no current fishery information for Lake Louise.

Figure 6. Shoreline erosion on Lake Louise, 2008

Table 7. Wildlife species observed on Lake Louise, April – September 2008.

Birds	
Double-crested Cormorant	*Phalacrocorax auritus*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Killdeer	*Charadrius spp.*
Willow Flycatcher	*Empidonax traillii*
Tree Swallow	*Iridoprocne bicolor*
Barn Swallow	*Hirundo rustico*
Catbird	*Dumetella carolinensis*
American Robin	*Turdus migratorius*
Red-winged Blackbird	*Agelaius phoeniceus*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
House wren	*Troglodytes aedon*
Cedar Waxwing	*Bombycilla cedrorum*
Reptiles	
Snapper Turtle	*Chelydra serpentina*
Fish	
Common Carp	*Cyprinus carpio*
Northern Pike	*Esox lucius*

LAKE MANAGEMENT RECOMMENDATIONS

Assess Your Lake's Fishery

There is not a current fishery survey for Lake Louise. Since one of the uses of the lake is for fishing, an updated fisheries assessment should be conducted to determine the diversity and health of the fish community (Appendix D1).

Enhance Wildlife Habitat Conditions on a Lake

With the lake being in a residential setting with the majority of the shoreline developed, wildlife habitat is limited. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones. Buffer strips, are recommended as one aspect of shoreline protection (Appendix D2).

Lakes with Shoreline Erosion

On Lake Louise, 33% of the shoreline had some type of 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).

Watershed Nutrient Reduction and Watershed Sediment Reduction

Lake Louise has seen an increase in total suspended solids concentration since 2003. Removal of carp, dredging the lake, and establishing a native aquatic plant population would be the three most effective means to improve the water quality. However, removal of carp would require using a fish poison to kill all the fish in the lake and it is likely that carp would quickly recolonize the lake due to their presence upstream and downstream (i.e., Flint Creek). Dredging the whole lake is generally cost prohibitive due to the expense of removing the sediment and identifying a disposal site. However, spot dredging areas where sedimentation has been identified as the most accelerated, may be feasible. Management within the watershed can help reduce nutrients and sediment entering the lake (Appendix D4-D5). Lake Louise has way too much phosphorus within it. Most established lawns do not require additional phosphorous fertilizer so any applied runs off and into the lake. Some local communities and homeowner associations within Lake County have adopted an ordinance banning the use of phosphorous fertilizer. For this reason, the LMU encourages the FPHA to adopt a similar bans. The usage of the lake by geese has also increased the amount of ammonia present in the lake. The FPHA should encourage residents living along the lake not to feed the geese, and if possible to install buffer strips of native vegetation or shoreline plantings which would discourage usage by geese and provide a trap for sediment.

Some progress has been made since our last study. In 2005, a partnership project, between Village of Barrington and FPHA, received funding through an US/IEPA 319 grant to improve erosion problems on Flint Creek between Surrey Lane and Lake Louise. According

to the project manager from Applied Ecological Services, the erosion problems have been solved in that stretch of the creek. Therefore any sediment inputs from Flint Creek would be coming from upstream of Surrey Lane.

Reduce Conductivity and Chloride Concentrations

The average conductivity reading in Lake Louise has increased since 1998. The chloride concentration was near the county median and 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 D6).

Grant Program Opportunities

There are opportunities to receive grants to help accomplish some of the management recommendations listed above (Appendix F).

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 9.3) overlaid a grid pattern onto an 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 LAKE LOUISE IN 2008.

Lake Louise 2008 Multiparameter data

Inlet	Text								Depth of Light		
Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Meter feet	% Light Transmission	Extinction Coefficient
										Average	0.83
05/21/2008	0	0.497	16.61	15.99	164.7	1.171	8.08	1353.9	Surface	100%	
05/21/2008	1	1.016	16.59	9.40	96.8	1.172	8.03	1349.3	Surface	100%	
05/21/2008	2	1.992	16.58	8.89	91.5	1.172	8.00	584.4	0.322	43%	2.60
05/21/2008	3	3.015	16.51	9.45	97.1	1.173	7.97	162.8	1.345	12%	0.95
05/21/2008	4	4.000	16.46	8.78	92.4	1.174	7.96	76.0	2.330	6%	0.33
05/21/2008	5	5.015	16.41	8.63	88.5	1.175	7.95	17.2	3.345	1%	0.44
05/21/2008	6	6.004	16.18	8.74	89.2	1.178	7.93	34.1	4.334	3%	-0.16

Outlet	Text								Depth of Light	
Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Meter feet	% Light Transmission
										Average
05/21/2008	0	0.567	16.03	9.20	93.6	1.166	8.03	3458.1	Surface	100%

Inlet	Text								Depth of Light		
Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Meter feet	% Light Transmission	Extinction Coefficient
										Average	0.88
06/18/2008	0	0.501	23.20	12.89	151.2	1.061	8.51	3415.1	Surface	100%	
06/18/2008	1	1.009	22.89	12.99	151.5	1.061	8.65	3413.1	Surface	100%	
06/18/2008	2	2.001	22.63	12.53	145.5	1.061	8.67	1211.7	0.331	35%	3.13
06/18/2008	3	3.149	22.49	12.23	141.6	1.062	8.65	507.0	1.479	15%	0.59
06/18/2008	4	4.025	22.39	12.66	146.3	1.062	8.66	268.0	2.355	8%	0.27
06/18/2008	5	5.004	22.30	12.42	143.3	1.062	8.65	129.4	3.334	4%	0.22
06/18/2008	6	6.002	22.24	11.54	133.0	1.063	8.53	56.1	4.332	2%	0.19

Outlet	Text								Depth of

Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Light Meter feet	% Light Transmission
										Average
06/18/2008	0	0.499	23.66	14.51	171.8	1.052	8.68	3167.1	Surface	100%

Inlet	Text								Depth of Light		
Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Meter feet	% Light Transmission	Extinction Coefficient
										Average	0.33
07/16/2008	0	0.490	27.69	9.46	120.5	0.958	8.47	1125.6	Surface	100%	
07/16/2008	1	1.497	27.36	8.91	112.8	0.955	8.41	426.6	Surface	38%	
07/16/2008	2	2.070	26.52	8.43	105.2	0.953	8.42	355.1	0.400	32%	0.46
07/16/2008	3	3.021	25.97	6.38	78.8	0.957	8.29	191.4	1.351	17%	0.46
07/16/2008	4	4.023	25.77	5.23	64.3	0.958	8.19	83.7	2.353	7%	0.35
07/16/2008	5	5.002	25.22	3.31	40.3	0.961	8.08	41.6	3.332	4%	0.21
07/16/2008	6	6.023	24.86	0.97	11.7	0.963	7.94	19.3	4.353	2%	0.18

Outlet	Text								Depth of Light	
Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Meter feet	% Light Transmission
										Average
07/16/2008	0	0.498	29.11	8.94	116.8	0.962	8.46	3701.3	Surface	100%

Inlet	Text								Depth of Light		
Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Meter feet	% Light Transmission	Extinction Coefficient
										Average	1.61
08/20/2008	0	0.508	25.98	7.27	89.8	0.969	7.86	3486.0	Surface	100%	
08/20/2008	1	0.988	25.99	7.37	91.0	0.969	7.94	3058.8	Surface	88%	
08/20/2008	2	1.889	25.94	7.01	86.5	0.969	8.01	876.8	0.219	25%	5.71
08/20/2008	3	3.020	25.79	6.23	76.7	0.970	8.02	259.8	1.350	7%	0.90

08/20/2008	4	4.038	25.72	5.02	61.7	0.970	7.97	62.5	2.368	2%	0.60
08/20/2008	5	4.993	25.45	2.09	25.6	0.974	7.87	18.5	3.323	1%	0.37
08/20/2008	6	5.936	25.11	0.48	5.9	0.977	7.73	2.6	4.266	0.1%	0.46

Outlet	Text								Depth of Light		
Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Meter feet	% Light Transmission	
										Average	
08/20/2008	0	0.633	26.68	12.43	155.5	0.946	8.03	3131.9	Surface	100%	

Inlet	Text								Depth of Light		
Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Meter feet	% Light Transmission	Extinction Coefficient
										Average	1.42
09/17/2008	0	0.496	19.21	7.60	82.5	0.658	7.72	3359.8	Surface	100%	
09/17/2008	1	1.003	19.00	7.06	76.2	0.662	7.55	3325.7	Surface	246%	
09/17/2008	2	1.989	18.77	6.98	75.1	0.666	7.53	931.0	0.319	69%	3.99
09/17/2008	3	3.006	18.65	6.75	72.4	0.668	7.51	141.8	1.336	11%	1.41
09/17/2008	4	4.003	18.48	6.40	68.4	0.676	7.50	25.2	2.333	2%	0.74
09/17/2008	5	5.013	18.32	6.04	64.4	0.690	7.48	3.8	3.343	0%	0.57
09/17/2008	6	6.010	18.24	5.68	60.4	0.703	7.45	0.7	4.340	0%	0.39

Outlet	Text								Depth of Light		
Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Meter feet	% Light Transmission	
										Average	
09/17/2008	0	0.500	19.24	7.65	80.8	0.656	7.95	2955.0	Surface	100%	

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 2000-2008 will be used in the following discussion.

Temperature and Dissolved Oxygen:

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

Monthly temperature profiles were established on each lake by measuring water temperature every foot (lakes $\leq$ 15 feet deep) or every two feet (lakes > 15 feet deep) from the lake surface to the lake bottom. These profiles are important in understanding the distribution of chemical/biological characteristics and because increasing water temperature and the establishment of thermal stratification have a direct impact on dissolved oxygen (DO) concentrations in the water column. If a lake is shallow and easily mixed by wind, the DO concentration is usually consistent throughout the water column. However, shallow lakes are typically dominated by either plants or algae, and increasing water temperatures during the summer speeds up the rates of photosynthesis and decomposition in surface waters. When many of the plants or algae die at the end of the growing season, their decomposition results in heavy oxygen consumption and can lead to an oxygen crash. In deeper, thermally stratified lakes, oxygen production is greatest in the top portion of the lake, where sunlight drives photosynthesis, and oxygen consumption is greatest near the bottom of a lake, where sunken organic matter accumulates and decomposes. The oxygen difference between the top and bottom water layers can be dramatic, with plenty of oxygen near the surface, but practically none near the bottom. The oxygen profiles measured during the water quality study can illustrate if

this is occurring. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters. Low oxygen conditions in the upper water of a lake can also be problematic since all aquatic organisms need oxygen to live. Some oxygen may be present in the water, but at too low a concentration to sustain aquatic life. Oxygen is needed by all plants, virtually all algae and for many chemical reactions that are important in lake functioning. Most adult sport-fish such as largemouth bass and bluegill require at least 3 mg/L of DO in the water to survive. However, their offspring require at least 5 mg/L DO as they are more sensitive to DO stress. When DO concentrations drop below 3 mg/L, rough fish such as carp and green sunfish are favored and over time will become the dominant fish species.

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

Nutrients:

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

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

it moves into the sunlit surface water at that time. Accordingly, many of the lakes in Lake County are plagued by dense algae blooms and excessive, exotic plant coverage, which negatively affect DO levels, fish communities and water clarity.

Lakes with an average phosphorus concentration greater than 0.05 mg/L are considered nutrient rich. The median near surface total phosphorus (TP) concentration in Lake County lakes from 2000-2008 is 0.065 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 2000-2008 was 0.181 mg/L and ranged from a minimum of 0.012 mg/L in Independence Grove 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 8.2 mg/L, ranging from below the 0.1 mg/L detection limit 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 132.8 mg/L, ranging from 34.0 mg/L in Pulaski Pond to 298.0 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 3.12 feet. From 2000-2008, 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 8.32, with a minimum of 7.06 in Deer Lake and a maximum of 10.28 in Round Lake Marsh North.

Eutrophication and Trophic State Index:

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

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

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

Table 1. Trophic State Index (TSI).

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

APPENDIX D. LAKE MANAGEMENT OPTIONS.

D1. Options 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.

D2. Options to Enhance Wildlife Habitat Conditions on a Lake

Option 1: Increase Habitat Cover

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

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

Option 2: Increase Natural Food Supply

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

Option 3: Limit Disturbance

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

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

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.

Option 6: Establish a "No Wake" Zone or No Motor Area

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

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

D4. Options for Watershed Nutrient Reduction

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

Option 1. Buffer Strips

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

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

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

Option 3. Street Sweeping

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

Option 4: Reduce Stormwater Volume from Impervious Surfaces

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

Roof downspouts should be pointed away from driveways and foundations and toward lawns or planting beds where water can soak into the soil. A splash block directly below downspouts

helps prevent soil erosion. If erosion still occurs, a flexible perforated plastic tubing attached to the downspout can dissipate the water flow.

Option 5: Required Practices for Construction

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

Option 6. Organize a Local Watershed Organization

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

Option 7. Discourage Waterfowl from Congregating

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

D5. Options for Watershed Sediment Reduction

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

Option 1. Municipal Street Sweeping

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

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

Please refer to the Watershed Development Ordinance for requirements.

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

Option 3. Agricultural Practices

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

D6. Options to Reduce Conductivity and Chloride Concentrations

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

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

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

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

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

Option 1. Proper Use on Your Property

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

Option 2. Examples of Alternatives

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

Calcium, Magnesium or Potassium Chloride

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

Calcium Magnesium Acetate (CMA)

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

Agricultural Byproducts

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

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

Option 3. Talk to Your Municipality About Using an Alternative

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

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

2000 - 2008 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2008	
Average	**167**	
Median	**162**	
Minimum	**65**	**IMC**
Maximum	**330**	**Flint Lake**
STD	**42**	
n =	**802**	

	ALKanoxic 2000-2008	
Average	**202**	
Median	**194**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**50**	
n =	**243**	

	Condoxic <=3ft00-2008	
Average	**0.8934**	
Median	**0.8195**	
Minimum	**0.2542**	**Broberg Marsh**
Maximum	**6.8920**	**IMC**
STD	**0.5250**	
n =	**806**	

	Condanoxic 2000-2008	
Average	**1.0312**	
Median	**0.8695**	
Minimum	**0.3210**	**Lake Kathyrn**
Maximum	**7.4080**	**IMC**
STD	**0.7985**	
n =	**243**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2008	
Average	**0.508**	
Median	**0.156**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.073**	
n =	**807**	

*ND = Many lakes had non-detects (74.1%)
Only compare lakes with detectable concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3-Nanoxic 2000-2008	
Average	**2.192**	
Median	**1.630**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.343**	
n =	**243**	

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

	pHoxic <=3ft00-2008	
Average	**8.32**	
Median	**8.32**	
Minimum	**7.07**	**Bittersweet #13**
Maximum	**10.28**	**Round Lake Marsh North**
STD	**0.44**	
n =	**801**	

	pHanoxic 2000-2008	
Average	**7.28**	
Median	**7.28**	
Minimum	**6.24**	**Banana Pond**
Maximum	**8.48**	**Heron Pond**
STD	**0.42**	
n =	**243**	

	All Secchi 2000-2008	
Average	**4.51**	
Median	**3.12**	
Minimum	**0.33**	**Fairfield Marsh, Patski Pon**
Maximum	**24.77**	**West Loon Lake**
STD	**3.78**	
n =	**749**	

LakeCounty
Health Department and
Community Health Center

2000 - 2008 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2008	
Average	**1.450**	
Median	**1.200**	
Minimum	**<0.1**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.845**	
n =	**802**	

*ND = 3.9% Non-detects from 15 different lakes

	TKNanoxic 2000-2008	
Average	**2.973**	
Median	**2.330**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.324**	
n =	**243**	

*ND = 2.9% Non-detects from 4 different lakes

	TPoxic <=3ft00-2008	
Average	**0.105**	
Median	**0.065**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.218**	
n =	**808**	

*ND = 2.6% Non-detects from 9 different lakes

	TPanoxic 2000-2008	
Average	**0.316**	
Median	**0.181**	
Minimum	**0.012**	**Independ. Grove**
Maximum	**3.800**	**Taylor Lake**
STD	**0.419**	
n =	**243**	

	TSSall <=3ft00-2008	
Average	**15.5**	
Median	**8.2**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**813**	

*ND = 1.5% Non-detects from 9 different lakes

	TVSoxic <=3ft00-2008	
Average	**132.8**	
Median	**129.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**39.8**	
n =	**757**	

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 <=3ft00-2008	
Average	**234**	
Median	**139**	
Minimum	**41**	**Timber Lake (N)**
Maximum	**2390**	**IMC**
STD	**364**	
n =	**125**	

	CLoxic <=3ft00-2008	
Average	**210**	
Median	**166**	
Minimum	**30**	**White Lake**
Maximum	**2760**	**IMC**
STD	**233**	
n =	**470**	

LakeCounty
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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 2000-2008 (n=1351).

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

LCHD Lakes Management Unit ~ 12/1/2008

APPENDIX F. GRANT PROGRAM OPPORTUNITES

Table F1. Potential Grant Opportunities

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

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

Table F1. Continued

Grant Program Name	Funding Source	Contact Information	Funding Focus: Water Quality/ Wetland	Funding Focus: Habitat	Funding Focus: Erosion	Funding Focus: 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/nonpoint.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

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