2009 SUMMARY REPORT
of
Owens Lake

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
POPULATION HEALTH SERVICES
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EXECUTIVE SUMMARY

Owens Lake is a 5-acre impoundment located in southwestern Lake County and it is listed as an ADID (advanced identification) wetland by the U.S. Environmental Protection Agency. Owens Lake receives water from the 341-acre watershed and empties into Davis Lake via a spillway on the north side of the lake. The lake is part of a Lake County Forest Preserve District property and is managed for its natural resources and aesthetics.

The water quality of Owens Lake has improved significantly since we last monitored in 2000. The Lake County median Secchi disk transparency (water clarity) for the period 2000-2009 was 3.15 feet. Owens Lake averaged 5.30 feet during 2009. The average water clarity of Owens is likely better, as on two occasions the Secchi disc was obscured by excessive vegetation and thus excluded from the calculation. The water clarity improved over what was recorded in 2000 (median=4.38 feet). Water clarity is influenced by the amount of total suspended solids (TSS) in the water column. In 2009 the average TSS was 3.5 mg/L. The amount of TSS measured has decreased significantly since 2000 when the TSS average was 11.0 mg/L and is well below the county median of 7.9 mg/L.

The 2009 average total phosphorus (TP) concentration of 0.058 mg/L was just below the county median of 0.063 mg/L. This was a decrease from the 2000 survey when the average TP concentration was 0.124 mg/L. The Lake County median conductivity reading was 0.7910 milliSiemens/cm (mS/cm). During 2009, the average conductivity reading in Owens Lake was lower than the county median measured at 0.6424 mS/cm, however, it has increased from the concentration measured in 2000 of 0.5395mS/cm. Conductivity is positively correlated with chloride (Cl^-) concentrations. The average Cl^- concentration in Owens Lake was less than the Lake County median of 145 mg/L during 2009, with an average of 93 mg/L. An estimate of chlorides present in the lake during 2000 indicates that there has been an increase in chloride concentration occurring in Owens Lake.

Owens Lake's aquatic plant community diversity was average, however, there were no exotic aquatic species detected in the lake during 2009. A total of eight plant species were detected in the lake in 2009. Coontail and Watermeal were the dominant species in the lake. Watermeal was so abundant at times during our sampling that it looked as though there was an algae bloom. Duckweed was the only other species found at every sampling point on the lake besides Coontail and Watermeal. White Crowfoot, which was not detected during the July survey, was observed in the outlet channel in spring. The shoreline was assessed for erosion in 2009. Based on the 2009 assessment 73% of the shoreline was experiencing some level of erosion. Sixty-one percent was assessed as having moderate erosion, and the remaining 12% showed signs of slight erosion. Much of the erosion occurred in areas with a honeysuckle, buckthorn, multiflora rose understory. It is recommended that invasive species be removed from the understory and seeding or planting of native species occur to stabilize the shorelines.

Owens Lake is located in a forest preserve district property in a very rural setting with a mainly undeveloped shoreline. This provides excellent habitat for a variety of birds, mammals, and other wildlife. The undeveloped areas were mainly wooded. Where not wooded, a trail system exists which was installed by the LCFPD in 2000.

LAKE FACTS

Lake Name:	Owens Lake ~ ADID 125
Historical Name:	None
Nearest Municipality:	Wauconda
Location:	T44N, R10E, Section 29, SE 1/4
Elevation:	814.0 feet mean sea level
Major Tributaries:	None
Watershed:	Fox River
Sub-watershed:	Squaw Creek
Receiving Waterbody:	Davis Lake
Surface Area:	5.1 acres
Shoreline Length:	1.5 miles
Maximum Depth:	7.0 feet
Average Depth:	3.5 feet (estimated)
Lake Volume:	17.9 acre-feet (estimated)
Lake Type:	Impoundment (flooded wetland- 1940)
Watershed Area:	341.3 acres
Major Watershed Land Uses:	Public and Private Open Space and Single Family
Bottom Ownership:	Public and Private
Management Entities:	Lake County Forest Preserve District
Current and Historical Uses:	Natural Resources and Aesthetics
Description of Access:	Public and Private

SUMMARY OF WATER QUALITY

Water samples were collected monthly from May through September at the deepest point in the lake (Figure 1, Appendix A). Owens Lake was sampled at the lake's surface and at three feet during the June visit. In all other months only a surface sample was taken. The samples were analyzed for various water quality parameters (Appendix B).

The Lake County median Secchi disk transparency (water clarity) for the period 2000-2009 was 3.15 feet. Owens Lake averaged 5.30 feet during 2009. The average water clarity of Owens is better than indicated, as on two occasions the Secchi disc was obscured by excessive vegetation and thus was excluded from the calculation. In August, the Secchi disc could be seen at the lake bottom (Table 1). LCHD-ES recommends that the LCFPD participate in the Volunteer Lake Monitoring Program (VLMP) on all of their lakes. This would provide some data to help 1.) fill in data gaps on years when LCHD-ES is not actively monitoring the lake and 2.) assist the LCFPD with management decisions on their lakes.

Water clarity is influenced by the amount of total suspended solids (TSS) in the water column. TSS is affected by non-volatile solids such as sediment and volatile solids (TVS) that are organic in nature such as plants, algae and other aquatic organisms. In 2009 the average TSS concentration was 3.5 mg/L. TSS and water clarity have both improved substantially since 2000 and the average TSS concentration measured in Owens Lake is well below the county median (7.9 mg/L) (Appendix E). The concentration of total volatile solids (TVS) recorded in 2009 was 105 mg/L and is only slightly below the county median of 125.5 mg/L. Algae and plants dominated the lake. Algae was prolific in the lake at all but two of our site visits. In July and September, Watermeal (*Wolfia columbiana*) dominated the lake surface. During September, Watermeal was so thick it had the appearance of an algal bloom until one was close enough to discern what it was.

Another factor affecting water clarity was the amount of nutrients in the water. Typically, lakes are either phosphorus (P) or nitrogen (N) limited. This means that one of the nutrients is in short supply and any addition of that nutrient to the lake will result in an increase of plant and/or algal growth. Most lakes in Lake County are phosphorus limited. To compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) was used. Ratios less than or equal to 10:1 indicate nitrogen is limiting, ratios greater than or equal to 15:1 indicate phosphorus is limiting, and ratios greater than 10:1, but less than 15:1 indicate there is enough of both nutrients to facilitate excess algae or plant growth. Owens Lake had a TN:TP ratio of 20:1 indicating the limiting nutrient was phosphorus. The average TP in the lake was 0.058 mg/L, at this concentration, this lake is listed as impaired by phosphorus. During the period of May through July there was still plenty of phosphorus available in the water to support growth of both plants and algae. Phosphorus is easier to control than nitrogen. Nitrogen naturally occurs in high concentrations and come from a variety of sources (soil, air, etc.), which are more difficult to control than sources of phosphorus. One source of phosphorus that businesses and homeowners can control is the amount of phosphorus in the fertilizers used on their property. It is recommended that homeowners and businesses within the watershed use phosphorus-free fertilizers.

Figure 1. Water quality sampling site on Owens Lake, 2009.

Table 1. Water quality data for Owens Lake, 2000 and 2009.

2009	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	0	194	0.85	<0.1	<0.05	0.048	0.006	102	428	5.5	444	110	2.79	0.7560	8.79	12.73
17-Jun	3	184	0.95	<0.1	<0.05	0.117	0.065	106	421	2.2	458	121	6.40	0.7430	7.88	3.48
22-Jul	0	144	0.93	<0.1	<0.05	0.046	0.007	86	339	6.8	365	115	0.00[a]	0.5790	7.09	9.14
19-Aug	0	122	0.98	<0.1	<0.05	0.040	0	85	309	1.5	326	100	6.70	0.5210	9.44	8.64
23-Sep	0	147	0.91	<0.1	<0.05	0.038	0	86	356	1.6	341	79	0.00[a]	0.6130	9.57	9.56
	Average	158	0.92	<0.1	<0.05	0.058	0.016	93	371	3.5	387	105	5.30[b]	0.6424	8.55	8.71

2000	Epilimnion															
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
15-May	3	154	1.22	<0.1	<0.05	0.051	0.012	77	400	2.0	430	144	6.00	0.6451	8.64	10.25
19-Jun	3	173	1.49	<0.1	2.960	0.095	0.008	76	396	7.6	460	183	3.15	0.6415	7.78	11.33
17-Jul	3	137	0.98	<0.1	0.171	0.127	0.054	3	264	6.0	276	93	4.13	0.4113	7.35	2.91
21-Aug	3	162	0.87	<0.1	0.067	0.229	0.034	27	268	31.0	345	125	4.95	0.4875	7.49	1.36
18-Sep	3	177	1.42	<0.1	<0.05	0.118	0.015	35	290	8.3	319	101	3.68	0.5122	7.59	4.97
	Average	161	1.20	<0.1	1.066[k]	0.124	0.025	44	324	11.0	366	129	4.38	0.5395	7.77	6.16

Glossary

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

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed
a = Secchi depth was obstructed by plants
b = Secchi disk depth average does not include data from when Secchi disk was obstructed by plants

The average epilimnetic total phosphorus (TP) concentration significantly decreased by 113% from 2000 (0.124 mg/L) to 0.058 in 2009, and averaged lower than the Lake County epilimnetic median of 0.063 mg/L. There were external sources of TP affecting Owens Lake such as stormwater from the 341 acres within its watershed (Figure 2). 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. In 2009, lakes within the Squaw Creek watershed were monitored. This included Owens Lake, Davis Lake, Old Oak Lake, Schreiber Lake, which drain into Tamarack Lake before entering Squaw Creek (Figure 3). Owens Lake's above average water quality is a result of it being at the top of its watershed (Table 2). This is true even given the Toll Brothers development which has occurred since the last time Owens Lake was monitored, 2000.

Perhaps the improvement in water quality was due to the very wet years that we have witnessed. It was reported by the state climatologist's office that Illinois had its fourth wettest year on record in 2009 with 50.27 inches of precipitation falling. This followed the second wettest year of 2008 in which 50.46 inches fell. In theory our area potentially had up to 100.73 inches of precipitation, which amounts to a surplus 22.4 inches of precipitation in that two year period (http://www.isws.illinois.edu/atmos/statecli/). Rain events can contribute additional sediment or nutrients (like phosphorus) to a lake, which may influence water sample results. Rain events occurred within 48 hours prior to sampling in June (0.56 inches) and July (0.06 inches) as recorded at the Lake County Stormwater Management Commission (LCSMC) rain gage in Wauconda. Based on this gage there was 23.06 inches of rain that fell in the area from April 1 – September 30. Monthly precipitation as measured at LCSMC Wauconda station yielded 5.35, 4.12, 3.32, 5.00 and 3.23 inches of rain, for May, June, July, August and September, respectively. Years of high precipitation can provide overall better water quality especially in lakes that have small volumes, as the retention time in these lakes are less, therefore waters are replenished more frequently. In other words, the pollutants retained in the lake are purged from that system or diluted.

Using 2008 aerial photography, private and public open space (29%) and single family (25%) were the major land uses within the Owens Lake watershed (Figure 4). Single family contributed half (50%) of the estimated runoff in the watershed. (Table 3). It is important to keep in mind that although the amount of estimated runoff from certain areas may be low, those areas can still deliver high concentrations of TSS, nitrogen and TP. For instance, much of the private and public open space is currently managed by a golf course. So the inputs can of nitrogen and TP could be quite high at times as they dewater the golf course and fertilize greens and fairways. The retention time (the amount of time it takes for water entering a lake to flow out again) was calculated to be approximately 47 days.

Total phosphorous can be used to calculate the trophic state index (TSIp), which classifies lakes according to the overall level of nutrient enrichment. The TSIp score falls within the range of one of four categories: hypereutrophic, eutrophic, mesotrophic and oligotrophic. Hypereutrophic lakes are those with excessive nutrients that can support nuisance algae growth reminiscent of "pea soup" and have a TSI score greater than 70. Lakes with a TSI score of 50 or greater are classified as eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae. Mesotrophic and oligotrophic lakes have lower nutrient levels. These are very clear

Figure 2. Approximate watershed delineation for Owens Lake, 2009

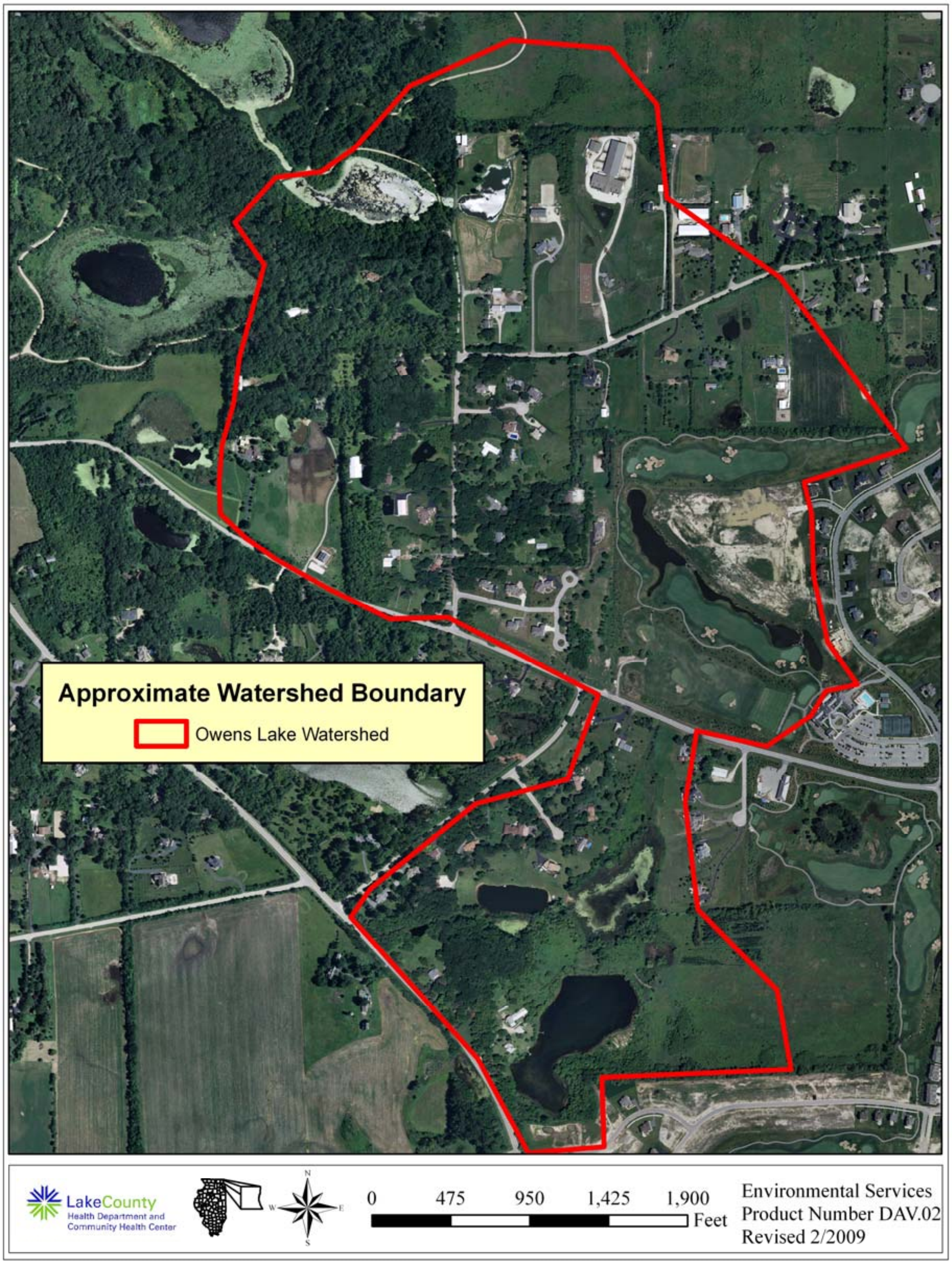


Figure 3. Lakes monitored by LCHD Environmental Services Unit within the Squaw Creek watershed, 2009.

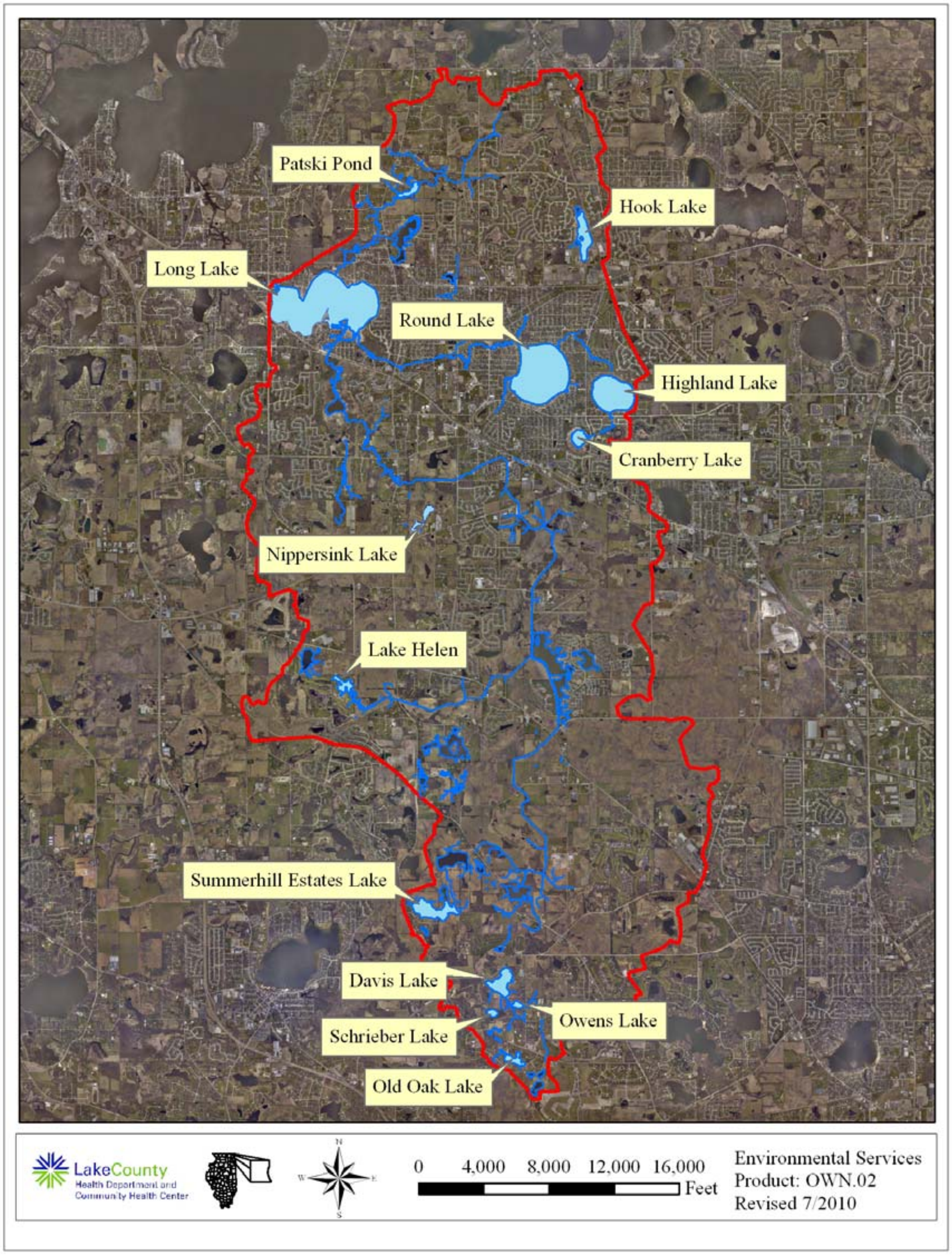


Table 2. Comparison for epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity readings in the Squaw Creek watershed (Cranberry Lake, Highland Lake, Round Lake, Long Lake, Old Oak Lake, Schreiber Lake, Davis Lake, Owens Lake, Summerhill Estates Lake, Lake Helen, Nippersink Lake (LCFPD), Patski Pond, Hook Lake)

Lake Name	Year	Secchi (feet)	TSS (mg/L)	TP (mg/L)	Conductivity (milliSiemens/cm)
Cranberry Lake	2000	10.96	1.2	0.024	0.3809
Cranberry Lake	2005	10.52	1.5	0.024	0.5625
Cranberry Lake	2006	9.33	1.6	0.024	0.6019
Cranberry Lake	2007	9.06	1.8	0.023	0.5138
Cranberry Lake	2008	9.63	2.2	0.027	0.5070
Cranberry Lake	2009	8.56	3.7	0.036	0.4262
Highland Lake	1991	7.08	3.4	0.039	NA
Highland Lake	1996	7.98	2.4	0.023	0.4076
Highland Lake	2001	6.58	3.3	0.030	0.5560
Highland Lake	2009	6.97	4.8	0.020	0.5834
Round Lake	1989	7.07	4.4	0.100	NA
Round Lake	1991	5.20	5.4	0.031	NA
Round Lake	1995	7.44	3.4	0.024	0.6290
Round Lake	1999	10.32	2.7	0.015	0.8364
Round Lake	2003	6.25	3.5	0.025	1.0730
Round Lake	2009	7.01	3.0	0.023	1.2292
Long Lake	1996	2.44	13.9	0.086	0.5222
Long Lake	2001	4.11	9.7	0.092	0.9430
Long Lake	2005	4.18	10.9	0.076	1.0821
Long Lake	2006	4.52	7.2	0.068	1.1120
Long Lake	2007	3.24	11.1	0.103	0.9066
Long Lake	2008	2.69	11.6	0.117	0.8722
Long Lake	2009	4.16	10.2	0.092	0.7587
Old Oak Lake	2003	5.08	3.6	0.043	0.7240
Old Oak Lake	2009	4.85	4.9	0.049	0.7700
Schreiber Lake	1999	9.70	3.4	0.035	0.2750
Schrieber Lake	2003	9.59	3.1	0.043	0.2882
Schrieber Lake	2009	7.25	2.8	0.040	0.2582
Owens Lake	2000	4.38	11.0	0.124	0.5395
Owens Lake	2009	5.30	3.5	0.058	0.5274
Davis Lake	2000	8.14	2.1	0.048	0.5143
Davis Lake	2009	9.65	2.6	0.065	0.6306
Summmerhill Estates Lake	2004	3.65	6.1	0.138	0.5858
Summmerhill Estates Lake	2009	3.27	9.4	0.199	0.5552
Lake Helen	2009	6.43	4.1	0.072	0.4742
Lake Nippersink (LCFPD)	2009	1.73	18.9	0.100	0.4588
Patski Pond	2004	NA	52.7	0.251	0.8194
Patski Pond	2009	NA	33.7	0.197	0.8994
Hook Lake	2004	5.03	5.1	0.030	1.1067
Hook Lake	2009	3.95	6.5	0.041	1.4690

Figure 4. Approximate landuse within the Owens Lake watershed, 2009 (Based upon 2008 aerial imagery).

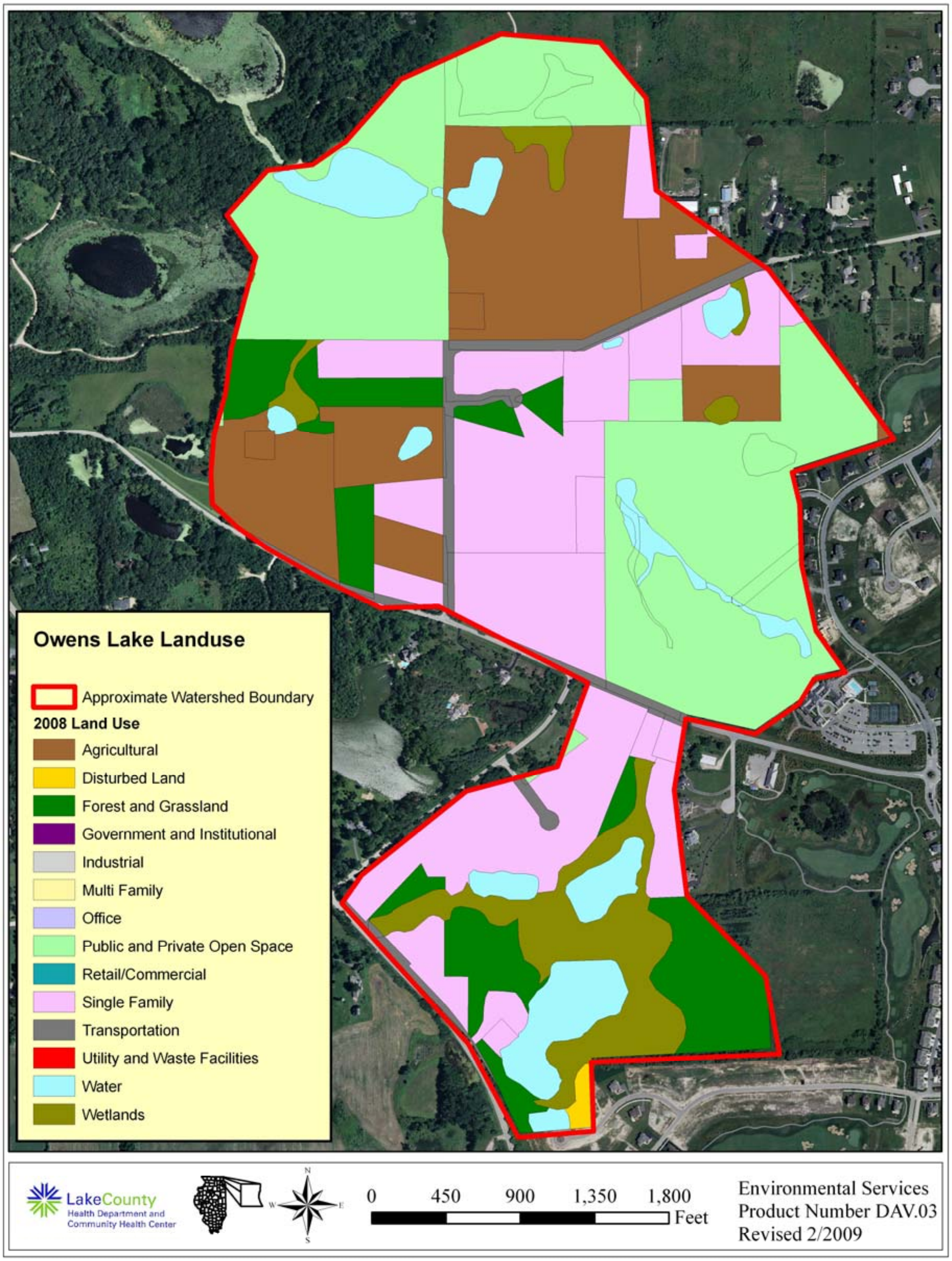


Table 3. Approximate land uses and retention time for Owens Lake, 2009 (Based on 2008 aerial imagery).

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	61.55	0.05	8.5	5.9%
Disturbed Land	1.03	0.05	0.1	0.1%
Forest and Grassland	33.51	0.05	4.6	3.2%
Government and Institutional	0.00	0.50	0.0	0.0%
Industrial	0.00	0.50	0.0	0.0%
Multi Family	0.00	0.50	0.0	0.0%
Office	0.00	0.85	0.0	0.0%
Public and Private Open Space	100.11	0.15	41.3	28.9%
Retail/Commercial	0.00	0.85	0.0	0.0%
Single Family	85.89	0.30	70.9	49.5%
Transportation	10.52	0.50	14.5	10.1%
Utility and Waste Facilities	0.00	0.30	0.0	0.0%
Water	24.74	0.00	0.0	0.0%
Wetlands	23.95	0.05	3.3	2.3%
TOTAL	**341.29**		**143.1**	100.0%

Lake volume	**18.53**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.13**	**years**
	47.25	**days**

lakes, with little algal growth. Most lakes in Lake County are eutrophic. The trophic state of Owens Lake in terms of its phosphorus concentration during 2009 was eutrophic, with a TSIp score of 62.7 which ranked it 71 out of 165 lakes in Lake County based on average TP concentrations (Table 4).

The Illinois Environmental Protection Agency (IEPA) has assessment indices to classify Illinois lakes for their ability to support aquatic life and recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations (TSIp), and aquatic plant coverage. According to this index, Owens Lake provides *Full* support of aquatic life and *Partial* support of recreational activities. The lake provides *Partial* overall use.

Conductivity is a measurement of water's ability to conduct electricity and is correlated with chloride (Cl^-) concentrations. Compared to lakes in undeveloped areas, lakes with residential and/or urban land uses in their watershed often have higher conductivity readings and higher Cl^- concentrations because of the use of road salts. Stormwater runoff from impervious surfaces such as roads and parking lots can deliver high concentrations of Cl^- to nearby waterbodies. The Lake County epilimnetic median conductivity reading was 0.791 milliSiemens/cm (mS/cm). During 2009, the Owens Lake average conductivity reading was lower, at 0.6424 mS/cm. Although this is less than the Lake County median, since 2000 there have been a considerable increases of land which is now considered transportation within the watershed which is related to the Toll Brothers Development. This likely resulted in the 19% increase in conductivity from the 2000 average of 0.5395 mS/cm. Cl^- concentration in Owens Lake although lower than the Lake County epilimnetic median of 145 mg/L during 2009, with an average of 93 mg/L, theoretically has increased since 2000 (Figure 5). There was a big drop in chloride levels from June (106 mg/L) to July (86 mg/L), this is likely due to heavy rainfall amounts occurring between sample events. The concern with elevated chloride levels in lakes is that it could impact the entire lake ecosystem, due to the more dense water affecting lake mixing, and the sensitivity to lake inhabitants of increased chloride levels. A study done in Canada reported 10% of aquatic species were harmed by prolonged exposure to Cl^- concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with Cl^- concentrations as low as 12 mg/l.

Practices that can be adopted by the lakes residents and their surrounding communities are to; apply phosphorus free fertilizer to their lawns, have their septic tanks pumped and serviced regularly, 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.
pH was problematic in Owens Lake. There were wide fluctuations in pH ranging from 7.09 in July to 9.57 in September. A pH measured above 9.0 at any time during the monitoring year is considered an impairment for aquatic life by the Illinois Environmental Protection Agency. The pH likely spiked to those levels due to photosynthesis by plants. Reducing the abundance of vegetation may help to remedy high pH. As it stands at this time, the large fluctuations in pH does not make this a conducive candidate for a fishery.

Table 4. Lake County average TSI phosphorous (TSIp) ranking 2000-2009.

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	Cedar 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	Highland Lake	0.0200	47.35
14	Banana Pond	0.0202	47.49
15	Lake Minear	0.0204	47.63
16	Cross Lake	0.0220	48.72
17	Sun Lake	0.0220	48.72
18	Dog Pond	0.0222	48.85
19	Lake of the Hollow	0.0230	49.36
20	Stone Quarry Lake	0.0230	49.36
21	Round Lake	0.0230	49.36
22	Deep Lake	0.0234	49.61
23	Bangs Lake	0.0240	49.98
24	Druce Lake	0.0244	50.22
25	Little Silver	0.0250	50.57
26	Lake Leo	0.0256	50.91
27	Dugdale Lake	0.0274	51.89
28	Peterson Pond	0.0274	51.89
29	Lake Miltmore	0.0276	51.99
30	Lake Fairfield	0.0296	53.00
31	Third Lake	0.0300	53.20
32	Gray's Lake	0.0302	53.29
33	Lake Catherine (Site 1)	0.0308	53.57
34	Lambs Farm Lake	0.0312	53.76
35	Old School Lake	0.0312	53.76
36	Sand Lake	0.0316	53.94
37	Lake Linden	0.0326	54.39
38	Gages Lake	0.0338	54.92
39	Honey Lake	0.0340	55.00
40	Hendrick Lake	0.0344	55.17
41	Cranberry Lake	0.0360	55.82
42	Sullivan Lake	0.0370	56.22
43	Diamond Lake	0.0372	56.30
44	Channel Lake (Site 1)	0.0380	56.60
45	Ames Pit	0.0390	56.98
46	Schreiber Lake	0.0400	57.34

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
47	White Lake	0.0408	57.63
48	Hook Lake	0.0410	57.70
49	Potomac Lake	0.0424	58.18
50	Duck Lake	0.0426	58.25
51	Deer Lake	0.0434	58.52
52	Nielsen Pond	0.0448	58.98
53	Turner Lake	0.0458	59.30
54	Seven Acre Lake	0.0460	59.36
55	Willow Lake	0.0464	59.48
56	Lucky Lake	0.0476	59.85
57	East Meadow Lake	0.0478	59.91
58	Old Oak Lake	0.0490	60.27
59	East Loon Lake	0.0490	60.27
60	Countryside 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 Napa Suwe (Outlet)	0.0570	62.45
69	Lake Christa	0.0576	62.60
70	Lake Charles	0.0580	62.70
71	**Owens Lake**	**0.0580**	**62.70**
72	Crooked Lake	0.0608	63.38
73	Waterford Lake	0.0610	63.43
74	Wooster Lake	0.0610	63.43
75	Lake Naomi	0.0616	63.57
76	Lake Tranquility S1	0.0618	63.62
77	Werhane Lake	0.0630	63.89
78	Liberty Lake	0.0632	63.94
79	Countryside Glen Lake	0.0642	64.17
80	Lake Fairview	0.0648	64.30
81	Leisure Lake	0.0648	64.30
82	Davis Lake	0.0650	64.34
83	Tower Lake	0.0662	64.61
84	St. Mary's Lake	0.0666	64.70
85	Mary Lee Lake	0.0682	65.04
86	Hastings Lake	0.0684	65.08
87	Lake Helen	0.0720	65.82
88	Spring Lake	0.0726	65.94
89	ADID 203	0.0730	66.02
90	Bluff Lake	0.0734	66.10
91	Harvey Lake	0.0766	66.71
92	Broberg Marsh	0.0782	67.01

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
93	Sylvan Lake	0.0794	67.23
94	Big Bear Lake	0.0806	67.45
95	Petite Lake	0.0834	67.94
96	Timber Lake (South)	0.0848	68.18
97	Lake Marie (Site 1)	0.0850	68.21
98	North Churchill Lake	0.0872	68.58
99	Grand Avenue Marsh	0.0874	68.61
100	Grandwood Park, Site II, Outflow	0.0876	68.65
101	North Tower Lake	0.0878	68.68
102	South Churchill Lake	0.0896	68.97
103	Rivershire Pond 2	0.0900	69.04
104	McGreal Lake	0.0914	69.26
105	Long Lake	0.0920	69.35
106	International Mine and Chemical Lake	0.0948	69.79
107	Eagle Lake (Site I)	0.0950	69.82
108	Valley Lake	0.0950	69.82
109	Dunns Lake	0.0952	69.85
110	Fish Lake	0.0956	69.91
111	Lochanora Lake	0.0960	69.97
112	Woodland Lake	0.0986	70.35
113	Island Lake	0.0990	70.41
114	McDonald Lake 1	0.0996	70.50
115	Nippersink Lake	0.1000	70.56
116	Longview Meadow Lake	0.1024	70.90
117	Lake Barrington	0.1053	71.30
118	Redwing Slough, Site II, Outflow	0.1072	71.56
119	Lake Forest Pond	0.1074	71.59
120	Bittersweet Golf Course #13	0.1096	71.88
121	Fox Lake (Site 1)	0.1098	71.90
122	Osprey Lake	0.1108	72.04
123	Bresen Lake	0.1126	72.27
124	Round Lake Marsh North	0.1126	72.27
125	Deer Lake Meadow Lake	0.1158	72.67
126	Taylor Lake	0.1184	72.99
127	Columbus Park Lake	0.1226	73.49
128	Nippersink Lake (Site 1)	0.1240	73.66
129	Echo Lake	0.1250	73.77
130	Grass Lake (Site 1)	0.1288	74.21
131	Lake Holloway	0.1322	74.58
132	Lakewood Marsh	0.1330	74.67
133	Redhead Lake	0.1412	75.53
134	Forest Lake	0.1422	75.63
135	Antioch Lake	0.1448	75.89
136	Slocum Lake	0.1496	76.36
137	Pond-a-Rudy	0.1514	76.54
138	Lake Matthews	0.1516	76.56

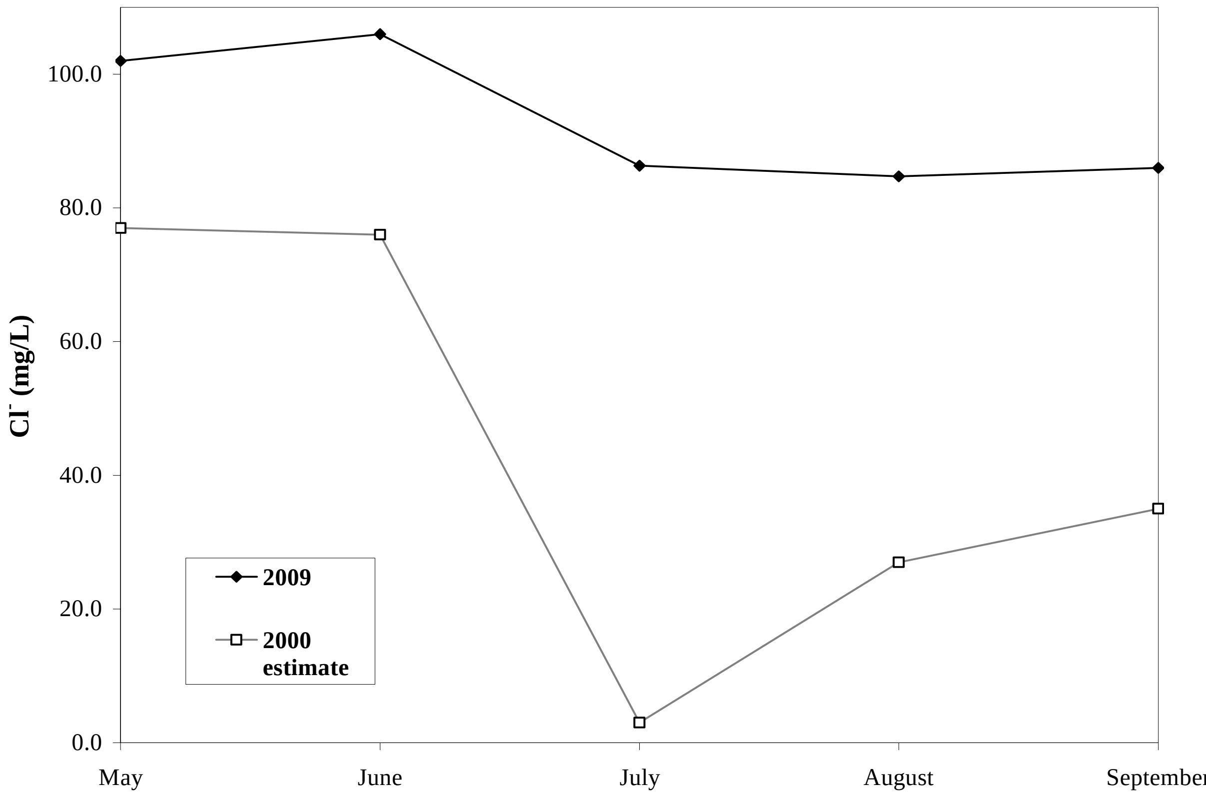
Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
93	Sylvan Lake	0.0794	67.23
94	Big Bear Lake	0.0806	67.45
95	Petite Lake	0.0834	67.94
96	Timber Lake (South)	0.0848	68.18
97	Lake Marie (Site 1)	0.0850	68.21
98	North Churchill Lake	0.0872	68.58
99	Grand Avenue Marsh	0.0874	68.61
100	Grandwood Park, Site II, Outflow	0.0876	68.65
101	North Tower Lake	0.0878	68.68
102	South Churchill Lake	0.0896	68.97
103	Rivershire Pond 2	0.0900	69.04
104	McGreal Lake	0.0914	69.26
105	Long Lake	0.0920	69.35
106	International Mine and Chemical Lake	0.0948	69.79
107	Eagle Lake (Site I)	0.0950	69.82
108	Valley Lake	0.0950	69.82
109	Dunns Lake	0.0952	69.85
110	Fish Lake	0.0956	69.91
111	Lochanora Lake	0.0960	69.97
112	Woodland Lake	0.0986	70.35
113	Island Lake	0.0990	70.41
114	McDonald Lake 1	0.0996	70.50
115	Nippersink Lake	0.1000	70.56
116	Longview Meadow Lake	0.1024	70.90
117	Lake Barrington	0.1053	71.30
118	Redwing Slough, Site II, Outflow	0.1072	71.56
119	Lake Forest Pond	0.1074	71.59
120	Bittersweet Golf Course #13	0.1096	71.88
121	Fox Lake (Site 1)	0.1098	71.90
122	Osprey Lake	0.1108	72.04
123	Bresen Lake	0.1126	72.27
124	Round Lake Marsh North	0.1126	72.27
125	Deer Lake Meadow Lake	0.1158	72.67
126	Taylor Lake	0.1184	72.99
127	Columbus Park Lake	0.1226	73.49
128	Nippersink Lake (Site 1)	0.1240	73.66
129	Echo Lake	0.1250	73.77
130	Grass Lake (Site 1)	0.1288	74.21
131	Lake Holloway	0.1322	74.58
132	Lakewood Marsh	0.1330	74.67
133	Redhead Lake	0.1412	75.53
134	Forest Lake	0.1422	75.63
135	Antioch Lake	0.1448	75.89
136	Slocum Lake	0.1496	76.36
137	Pond-a-Rudy	0.1514	76.54
138	Lake Matthews	0.1516	76.56

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
139	Buffalo Creek Reservoir	0.1550	76.88
140	Pistakee Lake (Site 1)	0.1592	77.26
141	Grassy Lake	0.1610	77.42
142	Salem Lake	0.1650	77.78
143	Half Day Pit	0.1690	78.12
144	Lake Eleanor Site II, Outflow	0.1812	79.13
145	Lake Farmington	0.1848	79.41
146	Lake Louise	0.1850	79.43
147	ADID 127	0.1886	79.71
148	Patski Pond (outlet)	0.1970	80.33
149	Summerhill Estates Lake	0.1990	80.48
150	Dog Bone Lake	0.1990	80.48
151	Redwing Marsh	0.2072	81.06
152	Stockholm Lake	0.2082	81.13
153	Bishop Lake	0.2156	81.63
154	Ozaukee Lake	0.2200	81.93
155	Hidden Lake	0.2236	82.16
156	Fischer Lake	0.2278	82.43
157	Oak Hills Lake	0.2792	85.36
158	Loch Lomond	0.2954	86.18
159	McDonald Lake 2	0.3254	87.57
160	Fairfield Marsh	0.3264	87.61
161	ADID 182	0.3280	87.69
162	Slough Lake	0.4134	91.02
163	Flint Lake Outlet	0.4996	93.75
164	Rasmussen Lake	0.5025	93.84
165	Albert Lake, Site II, outflow	1.1894	106.26

Figure 5. 2000 (estimated) and 2009 Chloride (Cl^-) concentrations Owens Lake .



SUMMARY OF AQUATIC MACROPHYTES

An aquatic plant survey was conducted on Owens Lake in July of 2009. Owens Lake's aquatic plant community diversity was average, however, there were no exotic aquatic species detected in the lake during 2009. A total of eight plant species were detected in the lake in 2009 (Table 5a). Coontail (*Ceratophyllum demersum*) and Watermeal were the dominant species in the lake. Other plants present were Elodea (*Elodea canadensis*), Sago Pondweed (*Potamogeton pectinatus*), Star Duckweed (*Lemna trisicula*), Duckweed, White Water Lily (Nymphaea tuberosa) and White Crowfoot (*Ranunculus longirostris*). Watermeal was so abundant at times during our sampling that it looked as though there was an algae bloom. White Crowfoot, which was not detected during the July survey, was observed in the outlet channel in spring.

Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. Aquatic plants will not photosynthesize in water depths with less than 1% of the available sunlight. The shallowness of the lake and good water clarity obviously allowed for the lake to have complete coverage by aquatic plants (Table 5b).

Optimal plant coverage is 30% to 40% across the lake bottom if a goal of the lake is to maintain a healthy sunfish/bass fishery. There were sunfish and bluegill observed in the lake during 2009. However, the DO concentrations historically have been too low to support a health fishery, and the lake has historically had fish kills. In 2009, the DO concentrations fell below 5 mg/L from June through August, at this concentration fish become stressed and a fish kill could result, particularly if concentrations fall below 1 mg/L. Vegetation was present at 100% of the sites sampled (Table 5b) and there were algal blooms observed on all but one visit. Plants and algae compete with each other and fish for oxygen. Therefore if a goal of this lake is for fish habitat, care needs to be taken when putting together a comprehensive aquatic plant management plan. Alternatives for reducing the abundance of vegetation and introducing oxygen into the system would need to be among the factors considered. Follow up is critical for an aquatic management plan to achieve long-term success and considers both the short and long-term needs of the lake.

The Floristic Quality Index (FQI) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. 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 floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for 2000-2009 Lake County lakes was 12.5 (Table 6). Owens Lake had a FQI of 16.3 in 2009 ranking it 44 of 154 lakes.

Table 5a. Aquatic vegetation species found at the 22 sampling sites on Owens Lake, August 2009. Maximum depth that plants were found was 6.2 feet.

August						
Plant Density	Coontail	Duckweed	Elodea	Sago pondweed	Star duckweed	Watermeal
Absent	0	0	19	21	8	0
Present	0	0	1	0	5	0
Common	2	5	0	0	9	2
Abundant	2	7	0	1	0	5
Dominant	18	10	2	0	0	15
% Plant Occurrence	100.0	100.0	13.6	4.5	63.6	100.0

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

August		
Rake Density (Coverage)	# of Sites	%
No plants	0	0.0%
>0 to 10%	0	0.0%
>10 to 40%	0	0.0%
>40 to 60%	0	0.0%
>60 to 90%	0	0.0%
>90%	22	100.0%
Total Sites with Plants	22	100.0%
Total # of Sites	22	100.0%

Table 6. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native)

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	38.2	40.2
2	Cranberry Lake	32.5	33.3
3	East Loon Lake	30.6	32.7
4	Deep Lake	29.7	31.2
5	Little Silver	29.6	31.6
6	Bangs Lake	29.5	31.0
7	Round Lake Marsh North	29.1	29.9
8	Deer Lake	28.2	29.7
9	Sullivan Lake	26.9	28.5
10	West Loon Lake	25.7	27.3
11	Cross Lake	25.2	27.8
12	Wooster Lake	25.0	26.6
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	Schreiber Lake	23.9	24.8
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	Lake of the Hollow	23.0	24.8
23	Druce Lake	22.8	25.2
24	Countryside Glen Lake	21.9	22.8
25	Butler Lake	21.4	23.1
26	Davis Lake	21.4	21.4
27	Duck Lake	21.1	22.9
28	Timber Lake (North)	20.8	22.8
29	ADID 203	20.5	20.5
30	Broberg Marsh	20.5	21.4
31	McGreal Lake	20.2	22.1
32	Lake Kathryn	19.6	20.7
33	Fish Lake	19.3	21.2
34	Redhead Lake	19.3	21.2
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Lake Helen	18.0	18.0
39	Old Oak Lake	18.0	19.1
40	Hendrick Lake	17.7	17.7
41	Long Lake	17.2	19.0
42	Seven Acre Lake	17.0	15.5
43	Gray's Lake	16.9	19.8
44	**Owens Lake**	**16.3**	**17.3**

Table 6. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
45	Countryside Lake	16.7	17.7
46	Highland Lake	16.7	18.9
47	Lake Barrington	16.7	17.7
48	Bresen Lake	16.6	17.8
49	Diamond Lake	16.3	17.4
50	Windward Lake	16.3	17.6
51	Dog Bone Lake	15.7	15.7
52	Redwing Slough	15.6	16.6
53	Osprey Lake	15.5	17.3
54	Lake Fairview	15.2	16.3
55	Heron Pond	15.1	15.1
56	Lake Tranquility (S1)	15.0	17.0
57	North Churchill Lake	15.0	15.0
58	Dog Training Pond	14.7	15.9
59	Island Lake	14.7	16.6
60	Grand Avenue Marsh	14.3	16.3
61	Lake Nippersink	14.3	16.3
62	Taylor Lake	14.3	16.3
63	Dugdale Lake	14.0	15.1
64	Eagle Lake (S1)	14.0	15.1
65	Longview Meadow Lake	13.9	13.9
66	Third Lake	13.9	16.6
67	Ames Pit	13.4	15.5
68	Bishop Lake	13.4	15.0
69	Buffalo Creek Reservoir	13.1	14.3
70	Mary Lee Lake	13.1	15.1
71	McDonald Lake 2	13.1	14.3
72	Old School Lake	13.1	15.1
73	Dunn's Lake	12.7	13.9
74	Summerhill Estates Lake	12.7	13.9
75	Timber Lake (South)	12.7	14.7
76	White Lake	12.7	14.7
77	Hastings Lake	12.5	14.8
78	Sand Lake	12.5	14.8
79	Stone Quarry Lake	12.5	12.5
80	Lake Carina	12.1	14.3
81	Lake Leo	12.1	14.3
82	Lambs Farm Lake	12.1	14.3
83	Pond-A-Rudy	12.1	12.1
84	Stockholm Lake	12.1	13.5
85	Grassy Lake	12.0	12.0
86	Lake Matthews	12.0	12.0
87	Flint Lake	11.8	13.0
88	Harvey Lake	11.8	13.0
89	Lake Napa Suwe	11.7	13.9
90	Rivershire Pond 2	11.5	13.3

Table 6. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
91	Antioch Lake	11.3	13.4
92	Hook Lake	11.3	13.4
93	Lake Charles	11.3	13.4
94	Lake Linden	11.3	11.3
95	Lake Naomi	11.2	12.5
96	Pulaski Pond	11.2	12.5
97	Lake Minear	11.0	13.9
98	Redwing Marsh	11.0	11.0
99	Tower Lake	11.0	11.0
100	West Meadow Lake	11.0	11.0
101	Nielsen Pond	10.7	12.0
102	Lake Holloway	10.6	10.6
103	Crooked Lake	10.2	12.5
104	College Trail Lake	10.0	10.0
105	Lake Lakeland Estates	10.0	11.5
106	Valley Lake	9.9	9.9
107	Werhane Lake	9.8	12.0
108	Big Bear Lake	9.5	11.0
109	Little Bear Lake	9.5	11.0
110	Loch Lomond	9.4	12.1
111	Columbus Park Lake	9.2	9.2
112	Sylvan Lake	9.2	9.2
113	Fischer Lake	9.0	11.0
114	Grandwood Park Lake	9.0	11.0
115	Lake Fairfield	9.0	10.4
116	Lake Louise	9	10.4
117	McDonald Lake 1	8.9	10.0
118	East Meadow Lake	8.5	8.5
119	Lake Christa	8.5	9.8
120	Lake Farmington	8.5	9.8
121	Lucy Lake	8.5	9.8
122	South Churchill Lake	8.5	8.5
123	Bittersweet Golf Course #13	8.1	8.1
124	Woodland Lake	8.1	9.9
125	Albert Lake	7.5	8.7
126	Banana Pond	7.5	9.2
127	Fairfield Marsh	7.5	8.7
128	Lake Eleanor	7.5	8.7
129	Patski Pond	7.1	7.1
130	Rasmussen Lake	7.1	7.1
131	Slough Lake	7.1	7.1
132	Lucky Lake	7.0	7.0
133	Lake Forest Pond	6.9	8.5
134	Ozaukee Lake	6.7	8.7
135	Leisure Lake	6.4	9.0
136	Peterson Pond	6.0	8.5

Table 6. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
137	Gages Lake	5.8	10.0
138	Slocum Lake	5.8	7.1
139	Deer Lake Meadow Lake	5.2	6.4
140	ADID 127	5.0	5.0
141	IMC Lake	5.0	7.1
142	Liberty Lake	5.0	5.0
143	Oak Hills Lake	5.0	5.0
144	Forest Lake	3.5	5.0
145	Sand Pond (IDNR)	3.5	5.0
146	Half Day Pit	2.9	5.0
147	Lochanora Lake	2.5	5.0
148	Echo Lake	0.0	0.0
149	Hidden Lake	0.0	0.0
150	North Tower Lake	0.0	0.0
151	Potomac Lake	0.0	0.0
152	St. Mary's Lake	0.0	0.0
153	Waterford Lake	0.0	0.0
154	Willow Lake	0.0	0.0
	Mean	**13.7**	**15.0**
	Median	**12.5**	**14.3**

SUMARY OF SHORELINE CONDITION

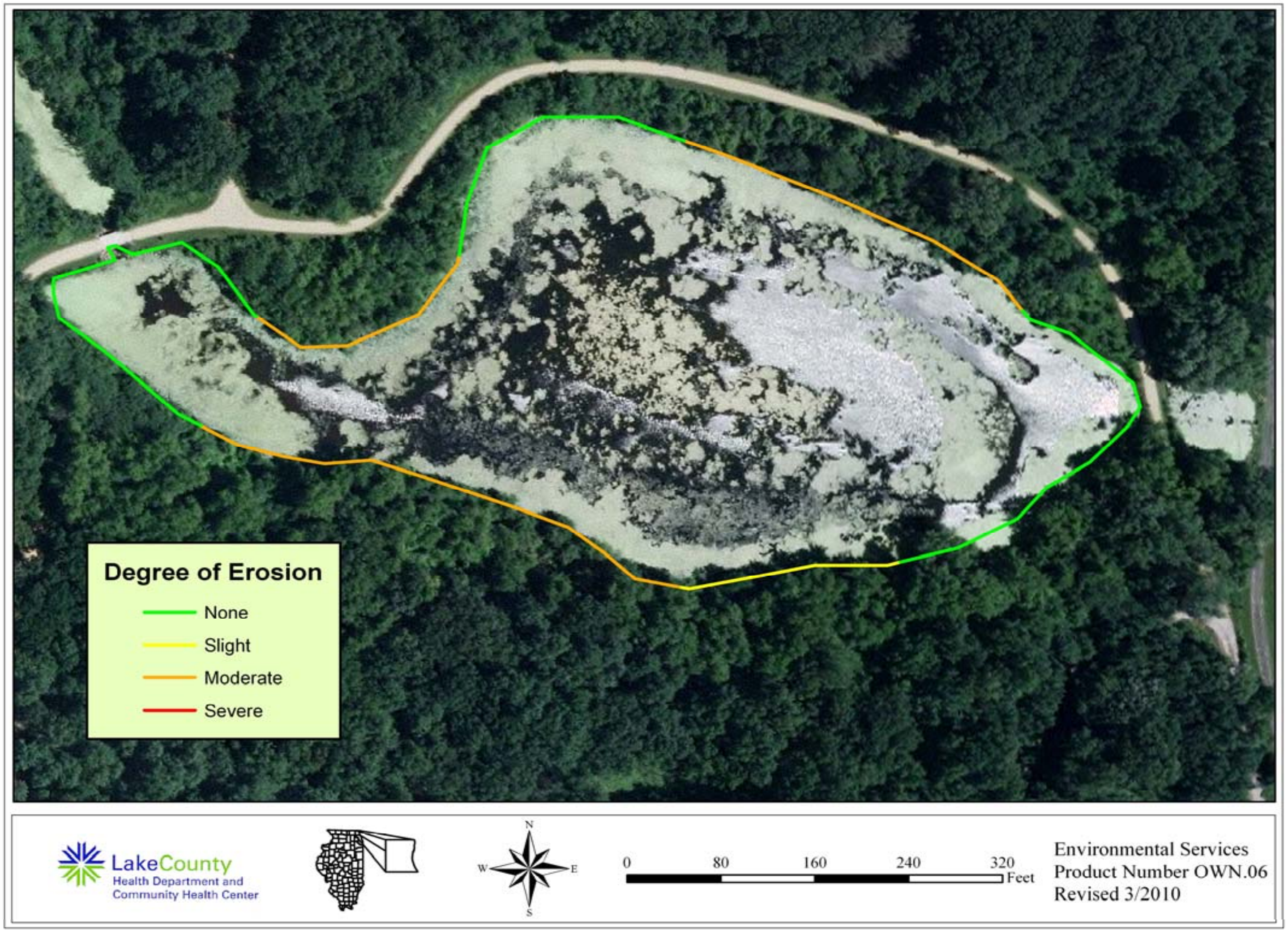
In 2009 the shoreline was assessed for the degree of erosion. Erosion is monitored as it can affect water quality of a lake by adding turbidity and increase sedimentation and nutrient levels within a lake. The shoreline was approximately one third of a mile in length. Twenty-seven percent of the shoreline had no erosion. Seventy-three percent of the shoreline had some degree of erosion, 61% had moderate erosion occurring, the remaining 12% was assessed as having slight erosion. Figure 6 depicts where and to what degree erosion was occurring along the shoreline. Erosion took place largely in areas subjected to dense wooded canopies, mainly comprised of Buckthorn (*Rhamnus cathartica*) and Boxelder (*Acer negundo*). Thinning/removal of such canopy species and installing a native buffer could help to reduce the filling of the lake and erosion which is occurring within Owens shoreline. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion.

Something has occurred in the lake since Owens was last monitored in 2000. In 2009, the location of the deep hole and the maximum depth has changed two feet, from 9 feet in 2000 to 7 feet in 2009. It is not clear if the hydraulics within the lake have changed or if there was a sediment issue during the construction phase of Toll Brothers. Having a bathymetric map of the lake for a baseline should be considered, as impacts occurring to a lake of this size, whether hydraulics, sedimentation or water quality can have larger implications than that of larger lakes.

SUMMARY OF WILDLIFE AND HABITAT

Owens Lake is situated in a forest preserve. The woodland and water interface provides excellent habitat for a variety of birds, mammals, and other wildlife. Besides fish, there were tadpoles, herons, turtles and dragonflies observed during visits. There was beaver activity noted near the outlet structure later in the year. It is recommended that a fish survey be conducted on Owens Lake to assess the fish population as there is not one on record.

Figure 6. Shoreline erosion on Owens Lake, 2009.



LAKE MANAGEMENT RECOMMENDATIONS

Owens Lake has both positive and negative aspects. Some of the positives include a large portion of the shoreline being undeveloped providing good wildlife habitat. To improve the quality of Owens Lake, the LCHD - ES has the following recommendations:

- **Create a Bathymetric map**

  It is recommended that a bathymetric map be created for Owens Lake. A bathymetric map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management (Appendix D1).

- **Participate in VLMP**

  LMU recommends that the LCFPD participate in the Volunteer Lake Monitoring Program. We also recommend the installation and monitoring of a staff gauge in the lake to monitor the lake level on years when the LCHD does not monitor. This could assist in the overall management of the lake (Appendix D2).

- **Aquatic Plant Management**

  A key to a healthy lake is a well-balanced aquatic plant population. Aquatic plants compete with algae for nutrients and stabilize bottom substrate, which in turn improves water clarity. Putting together a good aquatic plant management plan should not be rushed. The plan should be based on the management goals of the lake, habitat maintenance/restoration, and limitations of the lake. Follow up is critical for an aquatic plant management plan to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake (Appendix D3).

- **Reduce Conductivity and Chloride Concentrations**

  The average conductivity in Owens Lake was up 25% from the 2000 monitoring year. In addition, the chloride concentration was greater than 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. Although roads only make up 10% of the landuse within the watershed, they contribute 30% of the estimated runoff. Proper application procedures and alternative methods can be used to keep these concentrations under control (Appendix D4).

Lakes with Shoreline Erosion

The shoreline of Owens Lake had 23% classified as slightly eroded. Thirty-three percent of the lake was assessed as having moderate to severe erosion problems. The areas of moderate to severe erosion should be remediated as soon as possible to prevent loss of shoreline and continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation. (Appendix D5).

Watershed Nutrient Reduction and Watershed Sediment Reduction

Owens Lake has seen a decrease in the concentration of total suspended solids (TSS) since 2000. TSS is affected by many different forces within the lake and the lakes watershed, such as nutrients, pollutants, eroding shorelines, plants and algae. Owens Lake has experienced a significant decrease in volume due to sedimentation. Management within the watershed and along the lake shorelines can help to reduce nutrients and sediment entering the lake (Appendix D6). The phosphorus concentration in Owens lake and the ratio of TN:TP indicate a phosphorus limited system. The TP concentration measured in 2009 was sufficient to cause algal blooms and excessive plant growth both were measured and observed. Steps should be taken throughout the watershed to help maintain these levels to prevent problematic algae blooms (Appendix D7). Most established lawns/turf do not require additional phosphorous fertilizer so any applied generally runs off into the lake. Some local communities within Lake County have adopted an ordinance banning the use of phosphorous fertilizer. Since 25% of the total runoff is estimated to be contributed from single family land use, LCHD-ES encourages that property owners within the watershed use phosphorus-free fertilizers, if fertilization is necessary and that the municipalities within the watershed adopt a phosphorous fertilizer ban.

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 *OWENS LAKE* IN *2009*

Owens Lake 2009 Multiparameter data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	3.33
5/20/2009	0	0.53	19.64	12.73	139.3	0.7560	8.79	3581	Surface		
5/20/2009	1	1.16	19.13	12.57	136.1	0.7600	8.71	3441	Surface	100%	
5/20/2009	2	2.08	18.48	11.96	127.9	0.7640	8.64	374	0.333	10%	6.662
5/20/2009	3	3.19	17.79	10.20	107.6	0.7660	8.50	374	1.435	10%	0.000

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	0.85
6/17/2009	0	0.50	19.41	9.29	100.9	0.7390	7.57	474	Surface		
6/17/2009	1	1.03	19.97	6.07	66.8	0.7390	8.13	831	Surface	100%	
6/17/2009	2	2.08	19.77	5.26	57.7	0.7390	8.01	220	0.33	27%	4.010
6/17/2009	3	3.10	19.64	3.48	38.1	0.7430	7.88	161	1.35	19%	0.234
6/17/2009	4	4.03	19.57	2.42	26.5	0.7500	7.72	100	2.28	12%	0.207
6/17/2009	5	5.04	18.54	1.24	13.3	0.8840	7.43	90	3.29	11%	0.035
6/17/2009	6	6.13	17.41	0.52	5.5	0.9250	7.20	44	4.38	5%	0.164
6/17/2009	7	6.98	17.06	0.37	3.9	0.9440	7.01	4	5.23	0.5%	0.440

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	2.01
7/22/2009	0	0.50	22.62	8.44	97.9	0.5790	9.10	3670	Surface		
7/22/2009	1	1.00	21.31	6.56	74.1	0.5840	8.95	3383	Surface	100%	
7/22/2009	2	2.01	19.92	2.89	31.8	0.6170	8.33	772	-0.75	92%	-0.109
7/22/2009	3	3.01	19.23	0.62	6.8	0.6240	7.36	294	0.26	21%	5.794
7/22/2009	4	4.01	19.10	0.69	7.5	0.6810	7.22	8	1.26	8%	0.766
7/22/2009	5	5.00	18.35	1.12	12.0	0.7600	6.94	0	2.26	0%	1.603

Owens Lake 2009 Multiparameter data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient NA
8/19/2009	0	0.29	24.35	8.64	103.4	0.5210	9.44	NA	Surface		
8/19/2009	1	1.02	23.08	4.73	55.3	0.5260	9.36	NA	Surface	NA	
8/19/2009	2	2.01	21.93	1.77	20.3	0.5860	8.55	NA	0.26	NA	NA
8/19/2009	3	2.98	20.69	0.92	10.3	0.6700	7.70	NA	1.23	NA	NA
8/19/2009	4	4.01	19.47	0.62	6.8	0.7360	7.22	NA	2.26	NA	NA
8/19/2009	5	4.93	17.96	0.56	5.9	0.8090	6.92	NA	3.18	NA	NA
8/19/2009	6	6.01	16.86	0.51	5.3	0.8720	6.75	NA	4.26	NA	NA

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient NA
9/23/2009	0	0.30	19.84	9.56	105.0	0.6130	9.57	NA	Surface		
9/23/2009	1	1.01	19.64	7.47	81.7	0.5880	9.02	NA	Surface	NA	
9/23/2009	2	2.00	19.41	7.53	81.9	0.5870	8.99	NA	0.25	NA	NA
9/23/2009	3	3.00	19.14	5.86	63.5	0.5940	8.92	NA	1.25	NA	NA
9/23/2009	4	4.00	18.26	2.67	28.4	0.6540	8.67	NA	2.25	NA	NA
9/23/2009	5	5.00	17.88	1.17	12.4	0.7190	8.25	NA	3.25	NA	NA
9/23/2009	6	6.01	17.11	0.72	7.5	0.8580	7.84	NA	4.26	NA	NA
9/23/2009	7	7.06	16.53	0.53	5.5	1.0010	7.35	NA	5.31	NA	NA

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 2000-2009 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 2000-2009 was 0.063 mg/L and ranged from a non-detectable minimum of <0.010 mg/L on five lakes to a maximum of 3.880 mg/L on Albert Lake. The median anoxic TP concentration in Lake County lakes from 2000-2009 was 0.167 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 was 7.9 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 2000-2009, Ozaukee Lake had the lowest Secchi depths (0.25 feet) and West Loon Lake had the highest (24.77 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 was 8.34, with a minimum of 7.07 in Bittersweet #13 Lake and a maximum of 10.40 in Summerhill Estates Lake.

Eutrophication and Trophic State Index:

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

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

Table 1. Trophic State Index (TSI).

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

APPENDIX D. LAKE MANAGEMENT OPTIONS

D1. Option for Creating a Bathymetric Map

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

D2. Participate in the Volunteer Lake Monitoring Program

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

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

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

For information, please contact:

VLMP Regional Coordinator: Mike Adam
Lake County Health Department – Environmental Services
500 W. Winchester Unit 102
Libertyville, IL 60048
(847) 377-8030

D3. Options for Aquatic Plant Management

Option 1: Aquatic Herbicides

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

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

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

Option 2: Mechanical Harvesting

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

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

Option 3: Hand Removal

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

Option 4: Water Milfoil Weevil

Euhrychiopsis lecontei (E. lecontei) is a biological control organism used to control Eurasian Watermilfoil (EWM). E. lecontei is a native weevil, which feeds exclusively on milfoil species. It is stocked as a biocontrol and is commonly referred to as the Eurasian Watermilfoil weevil. Currently, the Environmental Services has documented weevils in 35 Lake County lakes. Many of these lakes have seen declines in EWM densities in recent years. Weevils are stocked in known quantities to achieve a density of 1-4 weevils per stem. As weevil populations expand, EWM populations may decline. After EWM declines, weevil populations decline and do not feed on any other aquatic plants. Currently only one company, EnviroScience Inc., has a stocking program (called the MiddFoil® process). The program includes evaluation of EWM densities, of current weevil populations (if any), stocking, monitoring, and restocking as needed.

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

Option 5: Reestablishing Native Aquatic Vegetation

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

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

D4. Options to Reduce Conductivity and Chloride Concentrations

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

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

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

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

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

Option 1. Proper Use on Your Property

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

Option 2. Examples of Alternatives

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

Calcium, Magnesium or Potassium Chloride

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

Calcium Magnesium Acetate (CMA)

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

Agricultural Byproducts

- Usually mixed with calcium chloride to provide anti-corrosion properties.

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

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

Option 3. Talk to Your Municipality About Using an Alternative

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

D5. 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 Environmental Services for a list of consultants.

D6. Options for Lakes with Shoreline Erosion

Option 1: Install a Seawall

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

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

Option 2: Install Rock Rip-Rap or Gabions

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

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

Option 3: Create a Buffer Strip

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

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

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

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

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

Option 5: Install A-Jacks®

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

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

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

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

D7. Options for Watershed Nutrient Reduction

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

Option 1. Buffer Strips

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

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

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

Option 3. Street Sweeping

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

Option 4: Reduce Stormwater Volume from Impervious Surfaces

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

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

Option 5: Required Practices for Construction

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

Option 6. Organize a Local Watershed Organization

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

Option 7. Motor Boat Restrictions for Shallow Lakes

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

Option 8. Discourage Waterfowl from Congregating

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

D8. 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.

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

2000 - 2009 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2009			ALKanoxic 2000-2009	
Average	**166**		Average	**198**	
Median	**161**		Median	**189**	
Minimum	**65**	**IMC**	Minimum	**103**	**Heron Pond**
Maximum	**330**	**Flint Lake**	Maximum	**470**	**Lake Marie**
STD	**42**		STD	**49**	
n =	**819**		n =	**251**	

	Condoxic <=3ft00-2009			Condanoxic 2000-2009	
Average	**0.8846**		Average	**1.0121**	
Median	**0.7910**		Median	**0.8431**	
Minimum	**0.2260**	**Schreiber Lake**	Minimum	**0.3210**	**Lake Kathyrn, Schreiber Lake**
Maximum	**6.8920**	**IMC**	Maximum	**7.4080**	**IMC**
STD	**0.5217**		STD	**0.7784**	
n =	**823**		n =	**251**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2009			NH3-Nanoxic 2000-2009	
Average	**0.514**		Average	**2.134**	
Median	**0.160**		Median	**1.430**	
Minimum	**<0.05**	***ND**	Minimum	**<0.1**	***ND**
Maximum	**9.670**	**South Churchill Lake**	Maximum	**18.400**	**Taylor Lake**
STD	**1.087**		STD	**2.325**	
n =	**824**		n =	**251**	

*ND = Many lakes had non-detects (76.5%)
Only compare lakes with detectable
concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

*ND = 20.3% Non-detects from 32 different lakes

	pHoxic <=3ft00-2009			pHanoxic 2000-2009	
Average	**8.35**		Average	**7.31**	
Median	**8.34**		Median	**7.33**	
Minimum	**7.07**	**Bittersweet #13**	Minimum	**6.24**	**Banana Pond**
Maximum	**10.40**	**Summerhill Estates**	Maximum	**8.48**	**Heron Pond**
STD	**0.46**		STD	**0.41**	
n =	**818**		n =	**251**	

	All Secchi 2000-2009	
Average	**4.56**	
Median	**3.15**	
Minimum	**0.25**	**Ozaukee Lake**
Maximum	**24.77**	**West Loon Lake**
STD	**3.80**	
n =	**763**	

LakeCounty
Health Department and
Community Health Center

2000 - 2009 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2009	
Average	**1.418**	
Median	**1.180**	
Minimum	**<0.1**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.826**	
n =	**824**	

*ND = 3.8% Non-detects from 15 different lakes

	TKNanoxic 2000-2009	
Average	**2.883**	
Median	**2.235**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.300**	
n =	**251**	

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

	TPoxic <=3ft00-2009	
Average	**0.099**	
Median	**0.063**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.171**	
n =	**824**	

*ND = 2.4% Non-detects from 8 different lakes

	TPanoxic 2000-2009	
Average	**0.311**	
Median	**0.167**	
Minimum	**0.012**	**Independ. Grove**
Maximum	**3.800**	**Taylor Lake**
STD	**0.417**	
n =	**251**	

	TSSall <=3ft00-2009	
Average	**15.3**	
Median	**7.9**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**830**	

*ND = 1.3% Non-detects from 8 different lakes

	TVSoxic <=3ft00-2009	
Average	**129.7**	
Median	**125.5**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**39.8**	
n =	**774**	

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 <=3ft00-2009	
Average	**198**	
Median	**117**	
Minimum	**3.5**	**Schreiber Lake**
Maximum	**2390**	**IMC**
STD	**327**	
n =	**159**	

	CLoxic <=3ft00-2009	
Average	**191**	
Median	**145**	
Minimum	**2.7**	**Schreiber Lake**
Maximum	**2760**	**IMC**
STD	**220**	
n =	**561**	

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 2000-2009 (n=1378).

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

LCHD Lakes Management Unit ~ 12/9/2009

LakeCounty
Health Department and
Community Health Center

APPENDIX F. GRANT PROGRAM OPPORTUNITES

Table F1. Potential Grant Opportunities

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

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

Table F1. Continued

Grant Program Name	Funding Source	Contact Information	Funding Focus: Water Quality/ Wetland	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/non point.html	X	X			>40%
Section 1135: Project Modifications for the Improvement of the Environment	USACE	312-353-6400, 309-794-5590 or 314-331-8404		X			25%
Stream Cleanup And Lakeshore Enhancement (SCALE)	IEPA	http://www.epa.state.il.us/water/watershed/scale.html	X	X			None
Streambank Stabilization & Restoration (SSRP)	IDOA/ LCSWCD	http://www.agr.state.il.us/Environment/conserv/ or call LCSWCD at (847) 223-1056		X	X		25%
Watershed Management Boards	LCSMC	http://www.co.lake.il.us/smc/projects/wmb/default.asp	X		X	X	50%
Wetlands Reserve Program	NRCS	http://www.nrcs.usda.gov/programs/wrp/	X	X			Land
Wildlife Habitat Incentive Program	NRCS	http://www.nrcs.usda.gov/programs/whip/		X			Land

CW = Chicago Wilderness
ICECF = Illinois Clean Energy Community Foundation
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