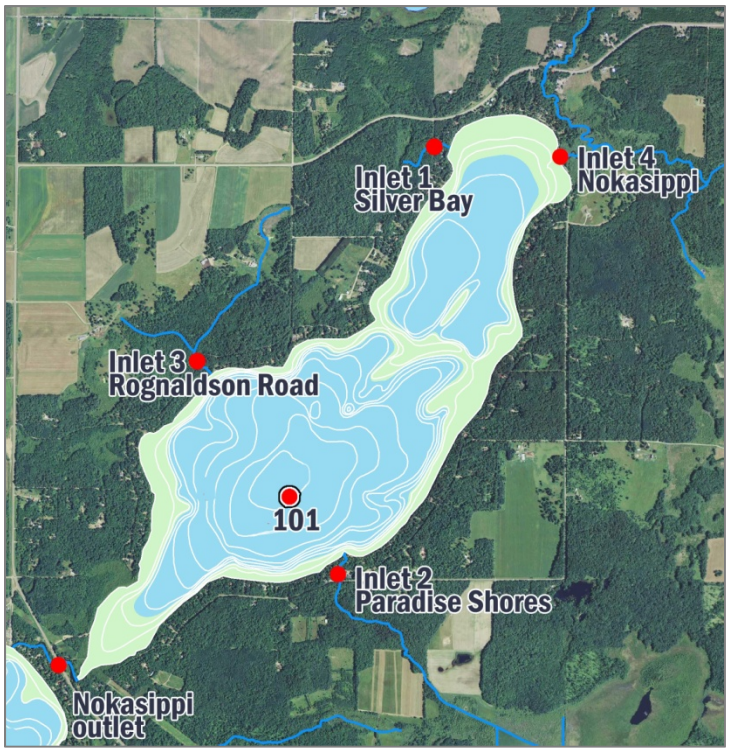
Upper South Long Lake — Crow Wing County

Summary

Upper South Long Lake is a mesotrophic/eutrophic lake in Crow Wing County. Algae concentration results (chlorophyll a) show that the lake experiences algae blooms every summer. There are no detectable trends in water clarity over the past 28 years. This means that the lake is stable, with no indications of declining water quality. Upper South Long Lake has a good amount of historical water quality monitoring data, which makes a lake evaluation like this possible. Monitoring should continue to enable future water quality analyses.



Lake Vitals

MN Lake ID:	18-0096-00
Ecoregion:	Northern Lakes and Forests
Major Drainage Basin:	Upper Mississippi River
Surface area (acres):	795
Littoral area (acres):	283
% Littoral area:	36%
Max depth:	47 (ft) 14.3 (m)
Aquatic Invasive Species:	none

Water Quality Characteristics

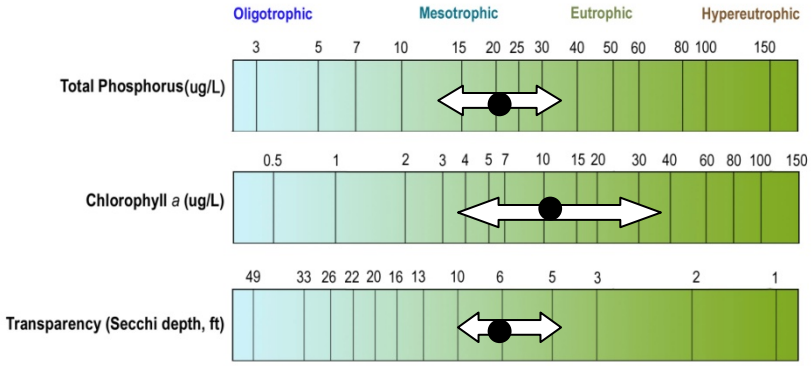
Years monitored: 2009 - 2015

Parameters	Site 101
Total Phosphorus Mean (ug/L):	21.2
Total Phosphorus Min (ug/L):	14.0
Total Phosphorus Max (ug/L):	35.0
Number of Observations:	34
Chlorophyll-a Mean (ug/L):	12.3
Chlorophyll-a Min (ug/L):	4.0
Chlorophyll-a Max (ug/L):	32.0
Number of Observations:	34
Secchi Depth Mean (ft):	6.8
Secchi Depth Min (ft):	5.0
Secchi Depth Max (ft):	10.0
Number of Observations:	34

Trophic State Index

Trophic State: Mesotrophic/Eutrophic border

The figure below shows the minimum and maximum values with the arrows and the mean with the black dot (site 101).



Ecoregion Comparisons

(Primary site only. Comparisons are based on interquartile range, 25th - 75th percentile, for ecoregion reference lakes)

Ecoregion:	Northern Lakes and Forests
Total Phosphorus:	Within Expected Range
Chlorophyll-a:	Above Expected Range, which indicates poorer than expected water quality for the area
Secchi Depth:	Below Expected Range, which indicates poorer than expected water quality for the area

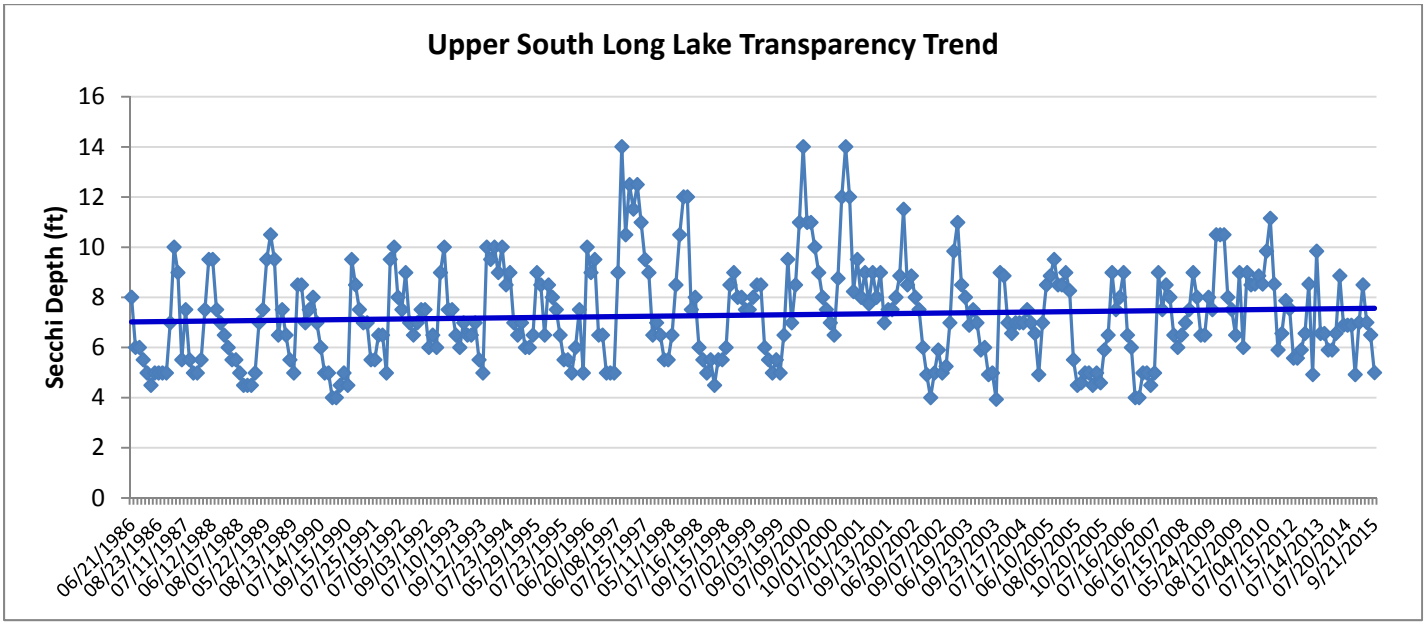
Trend Analysis Report

For detecting trends, a minimum of 8-10 years of data with 4 or more readings per season are recommended. Minimum confidence accepted by the MPCA is 90%. This means that there is a 90% chance that the data are showing a true trend and a 10% chance that the trend is a random result of the data. Only short-term trends can be determined with just a few years of data, because there can be different wet years and dry years, water levels, weather, etc, that affect the water quality naturally.

Upper South Long Lake had enough data to perform a trend analysis for all three parameters (Table 1). The data was analyzed using the Mann Kendall Trend Analysis.

Table 1. Trend analysis for Upper South Long Lake.

Lake Site	Parameter	Date Range	Trend
205	Transparency	1986-2015	No trend
205	Transparency	2000-2015	No trend
201	Total Phosphorus	2009-2015	No trend
201	Chlorophyll-a	2009-2015	No trend

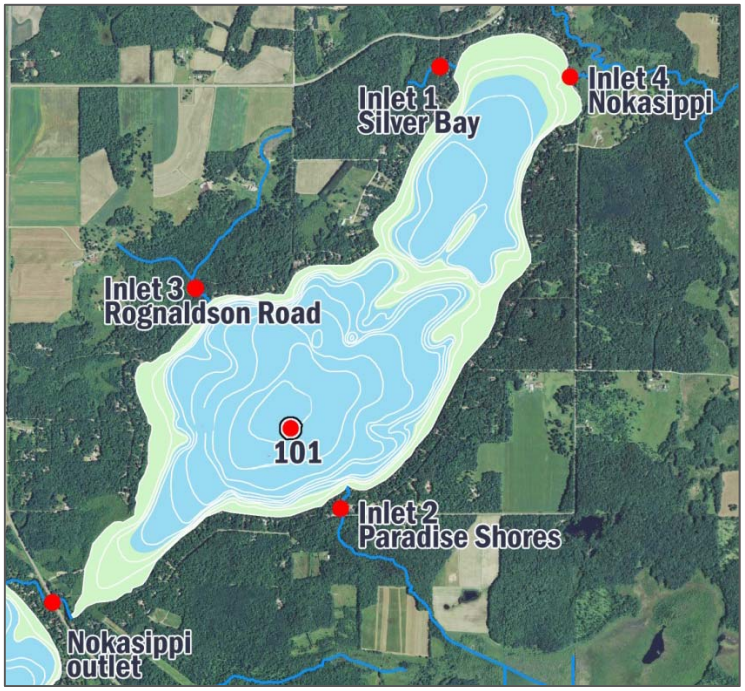


Upper South Long Lake shows no evidence of water quality trends for any of the parameters monitored over the past 28 years. Overall, these trend results show that the water quality in Upper South Long Lake is stable, with no indication of decline. Transparency monitoring should continue so that this trend can be tracked in future years.

Guidelines for monitoring lake trends

1. Focus on one primary site per basin. You can add additional sites in some years, but monitor the primary site every year without gaps. You can only run one trend at each site.
2. Collect at least 4-5 samples per summer, evenly spaced, May through September. If you collect less than 4 samples a summer, you can't calculate a representative average, so you can't be confident in your trend analysis.
3. To calculate a trend you need 8-10 years of consistent data.
    a. Monitor transparency (Secchi disk) every year without stopping. Weekly is best if possible, the next best is every other week, the minimum is once per month.
    b. If you want to determine the trend for phosphorus and chlorophyll a, you must monitor them every year for at least 8 years in a row without gaps.

Stream Analysis Report



The Upper South Long Lake Improvement District (USLLID) has been collecting stream samples at four inlets since 2012 (see map). Total phosphorus and orthophosphorus are the main nutrients that feed the plants and algae in the lake. Total suspended solids (TSS) are the particles in the water that cause it to be cloudy, and can indicate erosion. Conductivity is an indicator of the concentrations of dissolved electrolyte ions in the water. Every creek will have a baseline conductivity depending on the local geology and soils. Higher conductivity will result from the presence of various ions including nitrate, phosphate, and sodium. A pH range between 6.5 to 8.0 is what the largest variety of freshwater aquatic organisms prefer. The pH in the inlets to Upper South Long Lake fall into this range (Table 6).

Site 1, Silver Bay

Site 1, Silver Bay, has higher phosphorus and total suspended solids than the ecoregion ranges (Tables 2-4). Even though they are higher than the ecoregion ranges, they are not much above. The monitoring results are showing there could be some erosion occurring along the inlet that is bringing particles and nutrients to the lake. The effect of this stream on Upper South Long Lake would depend on how often this stream is flowing. If it only flows after large rain events, it is not adding many nutrients to the lake. If it is always flowing and flowing quickly, it is adding more nutrients to the lake. See the Next Steps section for suggestions. The pH is not a concern at Site 1, Silver Bay, and this monitoring can be discontinued.

Site 1, Silver Bay, has a recycling/salvage yard upstream, so USLLID has also been monitoring it for metals, including Aluminum, Copper, Iron, Lead, Zinc, pH and Chemical Oxygen Demand (COD). The results from this monitoring all came in under the impaired waters standards and MPCA recommended benchmarks (Table 7), except TSS and Iron. TSS and Iron are not a concern, however. TSS in streams is caused by soil erosion along the stream bank, so the high TSS at the Silver Bay inlet is likely due to that and not the recycling/salvage yard. Iron is naturally occurring in the bedrock and soil, so the high iron is likely just from the environment, not the recycling/salvage yard. See the Next Steps section for follow up suggestions.

Site 2, Paradise Shores

Site 2, Paradise Shores had a wash out in 2012-2013, and has been monitored since then for its impact to the lake. TSS was monitored in 2013 and was very low (1-2 mg/L), showing there was no adverse impact to water quality. Phosphorus, TSS, pH and conductivity are all typical for streams in the area, so this site does not appear to be a concern (Tables 2-6).

Inlet 3, Rognaldson Road

The phosphorus, TSS and pH at Rognaldson Road are all typical for streams in the area, so this site does not appear to be a concern (Tables 2-4). Inlet 3, Rognaldson Road, has a higher conductivity than the other stream sites, but it could just be this way naturally (Table 5). Because the total phosphorus and orthophosphorus is relatively low at this site, the conductivity is not a concern because the ions are not likely excess phosphorus, which is what feeds the plants and algae.

Inlet 4, Nokassippi River

The Nokassippi River has been monitored by a couple different groups in the past. It is the largest inlet to Upper South Long Lake, meaning it contributes the most water to the lake of all the inlets. The phosphorus, TSS, pH and conductivity are all well under the typical range for streams in the area, so this inlet is likely not a concern for the lake (Tables 2-6).

Table 2. Total phosphorus results (ug/L) for Upper South Long Lake Inlets.

	Ecoregion Range	Average	Minimum	Maximum	Number of samples
Inlet 1 Silver Bay Rd	20 - 50	68	32	108	8
Inlet 2 Paradise Shores Rd	20 - 50	58	21	80	8
Inlet 3 Rognaldson Rd	20 - 50	42	22	102	8
Inlet 4 Nokasippi River	20 - 50	37	24	70	8

Table 3. Ortho phosphorus results (ug/L) for Upper South Long Lake Inlets.

	Ecoregion Range	Average	Minimum	Maximum	Number of samples
Inlet 1 Silver Bay Rd	NA	46	13	119	8
Inlet 2 Paradise Shores Rd	NA	41	6	74	8
Inlet 3 Rognaldson Rd	NA	25	14	40	8
Inlet 4 Nokasippi River	NA	11	5	19	8

Table 4. Total suspended solids results (mg/L) for Upper South Long Lake Inlets.

	Ecoregion Range	Average	Minimum	Maximum	Number of samples
Inlet 1 Silver Bay Rd	1.8 - 6	18	0	126	10
Inlet 2 Paradise Shores Rd	1.8 - 6	2	1	3	8
Inlet 3 Rognaldson Rd	1.8 - 6	6	0	15	8
Inlet 4 Nokasippi River	1.8 - 6	4	1	10	8

Table 5. Specific conductance results (µS/cm) for Upper South Long Lake Inlets. The ecoregion range it is compared to is for lakes, not streams, so the range is likely lower than what it would be for streams.

	Ecoregion Range	Average	Minimum	Maximum	Number of samples
Inlet 1 Silver Bay Rd	50 - 250	NA	NA	NA	0
Inlet 2 Paradise Shores Rd	50 - 250	203	114	293	8
Inlet 3 Rognaldson Rd	50 - 250	410	376	429	8
Inlet 4 Nokasippi River	50 - 250	218	177	252	8

Table 6. pH for Upper South Long Lake Inlets.

	Ecoregion Range	Average	Minimum	Maximum	Number of samples
Inlet 1 Silver Bay Rd	7.6 - 7.9	7.1	6.4	7.5	10
Inlet 2 Paradise Shores Rd	7.6 - 7.9	7.0	6.5	7.8	8
Inlet 3 Rognaldson Rd	7.6 - 7.9	7.3	7.0	7.7	8
Inlet 4 Nokasippi River	7.6 - 7.9	7.4	7.3	7.7	8

Table 7. Metal results for the Silver Bay inlet compared to benchmarks for auto salvage yards and scrap recycling facilities.

Parameter	Benchmark Value for Auto Salvage Yards	Benchmark Value for Scrap Recycling Facility	Silver Bay Maximum Value	Silver Bay Average
Total Aluminum	1.5 mg/l	0.75 mg/l	0.33 mg/L	0.11 mg/L
Total Iron	1.0 mg/l	1.0 mg/l	5.6 mg/L	2.4 mg/L
Total Lead	0.164 mg/l	0.164 mg/l	<0.01 mg/L	<0.01 mg/L
Total Suspended Solids	100 mg/l	100 mg/l	126 mg/L	20.4 mg/L
Chemical Oxygen Demand	120 mg/l	NA	88.1 mg/L	34.5 mg/L
pH	NA	6.0-9.0	7.75	7.11
Total Copper	NA	0.028 mg/l [1]	<0.01 mg/L	<0.01 mg/L
Total Zinc	NA	0.234 mg/l [1]	0.048 mg/L	0.014 mg/L

Next Steps

Metals monitoring

Because the extra parameters at Silver Bay are not showing high or concerning levels, this extra monitoring could be discontinued. If anything changes with the recycling/salvage yard in the future these parameters could be monitored again. LID representatives could also show the monitoring data from the Silver Bay site to the Melissa Wenzel at the MPCA to compare it to the stormwater monitoring results that the recycling/salvage yard is required to collect (Melissa.Wenzel@state.mn.us, 651-757-2816).

Inlet monitoring

Most of the inlets are not currently showing a major concern. The Silver Bay inlet has the highest phosphorus and total suspended solids, meaning that there could be some stream bank erosion occurring. It would be useful to do some on-the-ground inspection of the stream to see if there are any areas that could be improved. If there are areas with erosion, contact the Crow Wing Soil and Water Conservation District for advice and cost-share funding to fix the areas. Inlet monitoring wouldn't need to continue, although if an eroding stream bank was fixed, the stream could be monitored again to see if phosphorus and total suspended solids levels decreased as a result of the fix.

In-lake monitoring

In-lake monitoring at site 101 should continue every year to track water quality trends. Collect 4-5 lake samples per summer, evenly spaced between May and September. Secchi readings can be collected more often such as weekly or every other week.

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