Monitoring of the
Big Sandy Area Lakes Watershed

2011 and 2012

Funding and Technical Assistance provided by:

Minnesota Pollution Control Agency,
Surface Water Assessment Program
Aitkin County SWCD

April 2013

Janet Smude, District Technician
Aitkin County SWCD

Monitoring of the Big Sandy Area Lakes Watershed
Summers 2011 and 2012
Aitkin County Soil & Water Conservation District
and Minnesota Pollution Control Agency

During the summers of 2011 and 2012, two lakes and one stream site in the Big Sandy Area Lakes Watershed were selected for monitoring through the Minnesota Pollution Control Agency's Surface Water Assessment Program. The goal of the monitoring was to complete the dataset for each site, and provide a sufficient number of data points for water quality assessment by the MPCA. Both of the selected lakes are minimally developed. Water quality data is of interest to local partners as "unimpacted" reference information. The stream selected for monitoring has shown elevated levels of nutrients at other monitored locations. The sites listed below were monitored through this effort.

Lakes monitored:

Bass Lake	(01-0063)
Remote Lake	(01-0038)

Stream sites monitored:

Sandy River (S003-306; CR 62/230th Avenue Crossing, west of McGregor)

A map of the sampling sites included in this effort is located in Appendix A.

Program oversight and coordination was provided by the Aitkin County Soil and Water Conservation District. Volunteer assistance was utilized to conduct the lake sampling. All costs associated with the monitoring were supported by a Surface Water Assessment Grant from the MPCA.

Discussion – Lake Sampling Results:

Lake Methods:

One site on each of the two lakes was monitored. A sampling schedule for each lake was designed with a goal of completing a dataset which will be used by the MPCA for assessment of the waterbody. Lakes were sampled during the months of June through September. Flexibility was built into the sampling to allow for variations in the volunteer's schedule. Dedicated volunteers ensured that the work was completed.

Lake surface samples were collected with 2m integrated samplers, typically at the deepest location on the lake. Laboratory analysis was conducted by ERA Laboratories, Inc. in Duluth, Minnesota, using EPA-approved methods.

Each water sample was analyzed for the following parameters:

Total Phosphorus (TP)
Chlorophyll a, and

Pheophytin
Secchi Disk transparency and user perception information was also recorded at each site.

Data Summary:
Raw data collected through this effort is located in Appendix C. A summary of the data is provided below.

The main nutrient of concern is phosphorus. Phosphorus enrichment of a water body can result in a variety of negative impacts, such as excessive plant growth, algae blooms, and lowering of oxygen levels. The average 2011and 2012 Total Phosphorus (TP) levels for each lake are shown in Chart 1.

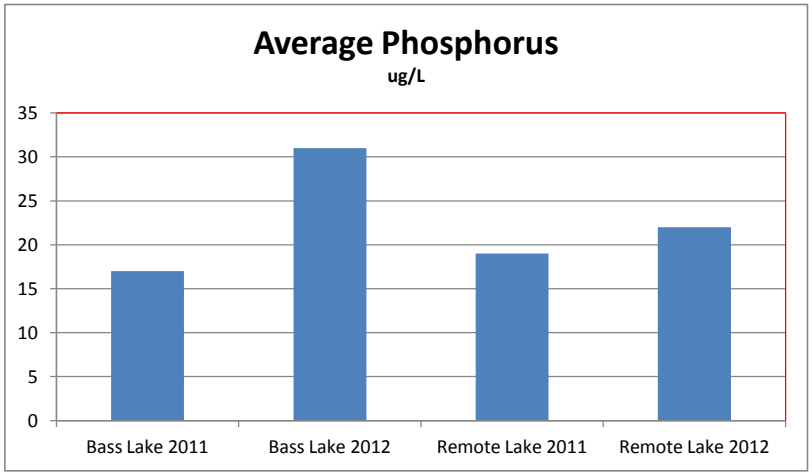
Chlorophyll a (Chl-a) was also measured. Chlorophyll a is the main pigment in algae. The concentration of this pigment is used to estimate the quantity of algae found in the lake. Algae is a normal component of water bodies, however high concentrations can result in low levels of dissolved oxygen and reduced recreation suitability.

Secchi disk readings measure the depth of light penetration into the water. This parameter often has a direct correlation to the levels of phosphorus and chlorophyll a found in the water body.

Table 1. Summer 2011 and 2012 Average Water Quality Parameters for Monitored Lakes

Parameter	**TP (ug/L)**	**Chl-a (ug/L)**	**Secchi (m)**	**Secchi (ft.)**
Bass Lake	24	13	1.8	5.8
Remote Lake	20	6.6	2.1	6.9
Ecoregion Range	**14-27**	**<10**	**2.4-4.6**	**8-15**

Chart 1. 2011 & 2012 Average Lake Phosphorus Levels



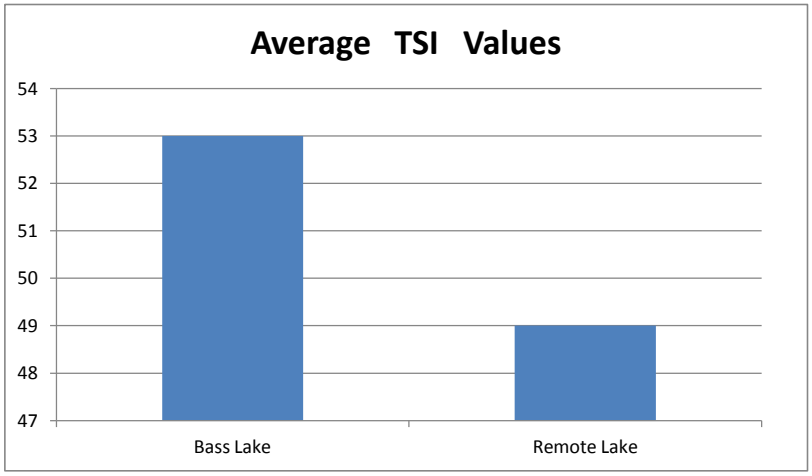
Note: Average Total Phosphorus results for these lakes fell within the suggested phosphorus level for our area of Minnesota, however in 2012 Bass Lake slightly exceeded the expected value.

Data for each lake was used to calculate Trophic Status Index values. Carlson's Trophic State Index (TSI) is a common method of characterizing a lake's overall health. "Trophic Status" refers to the level of productivity in a lake, as measured by phosphorus and algae content, and the depth of light penetration. In general, the lower the TSI Value, the better the health of the lake. TSI's are calculated for Phosphorus, Chlorophyll a, and Secchi Transparency. These three numbers are then averaged to result in an overall TSI value for each lake. These values are shared in the following table and chart. The figure in Appendix B shows the Carlson's Trophic State Index, with the Northern Lakes and Forests Ecoregion range indicated by a red line.

Table 2. Summary of Lake TSI Values

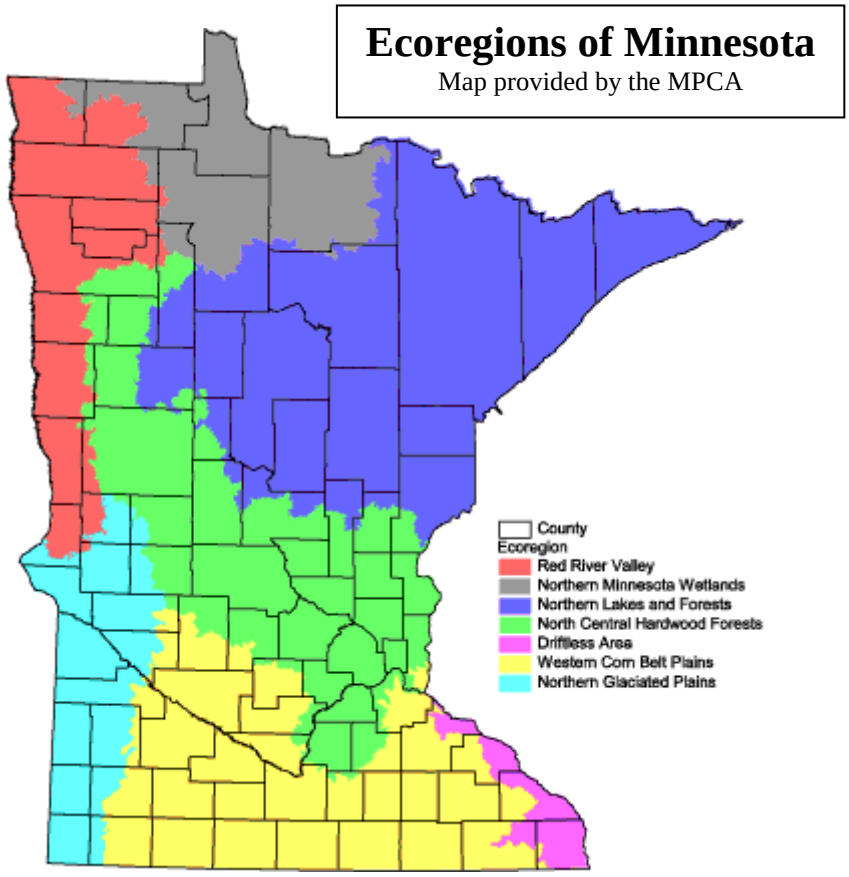
	TSIP (Phosphorus)	**TSIC (Chlorophyll a)**	**TSIS (Secchi)**	**Overall TSI**	
Bass Lake	50.0	55.7	51.8	53	
Remote Lake	47.3	49.1	49.3	49	

Chart 2. Average 2011 and 2012 TSI Values



Discussion:

All of the lakes monitored for this study are located in the Northern Lakes and Forest (NLF) Ecoregion of the state. Ecoregions are grouped together based on soils, landforms, potential natural vegetation, and land use. Comparing a lake's water quality to that of reference lakes in the same ecoregion provides one basis for characterizing the condition of the lake.



The Northern Lakes and Forests Ecoregion is heavily forested and comprised of steep, rolling hills interspersed with pockets of wetlands, bogs, lakes and ponds. Lakes are typically deep and clear, with good gamefish populations. These lakes are very sensitive to damage from atmospheric deposition of pollutants, storm water runoff from logging operations, urban and shoreland development, mining, inadequate wastewater treatment, and failing septic systems. Agriculture is somewhat

limited by the hilly terrain and lack of nutrients in the soil, though there are some beef and dairy cattle farms.

The monitored lakes fell within the expected ecoregion range for Total Phosphorus, and Chlorophyll a. Chlorophyll a values did experience a spike in late July and August of 2012. This is likely due to the extreme rainfall and flooding that affected this area. Both Bass Lake and Remote Lake transparency readings were slightly lower than expected. This may be attributed to the tannic acid / bog stain of the water of many northern Minnesota lakes. Annual variability due to weather conditions may likely be behind the change in readings. In general, results are slightly worse expected. TSI values are near the upper end of mesotrophic status and are an indicator of the good health of the lakes. Given the fact that these lakes have minimal development on their shorelines, it was hoped that they would be better than average examples of water quality. That being said, it is still important to remember that the overall water quality is good, while several nearby lakes are experiencing impairments.

The data that was collected in 2011 and 2012 was sufficient to complete the assessment dataset for these two lakes. This data will be used by the Minnesota Pollution Control Agency to determine what future activities are needed on each lake to keep them healthy. Neither of these lakes will be placed on the Impaired Waters List.

Recommendations for Lake Sites:

Summer-mean secchi transparency generally provides a good indication of trophic status of Minnesota Lakes. It is recommended that each lake continue collecting secchi transparency data, and submitting it to the MPCA Citizen Lake Monitoring Program, for inclusion in their statewide database. Secchi transparency should continue to be a good estimator for TP and chlorophyll-a values, as well as an indicator of overall water quality.

The Aitkin County Water Planning Task Force strives to provide funding and/or technical assistance each year for lake water quality monitoring. Lake associations may consider requesting funding for chemical analysis every 5 to 10 years. This, in combination with the secchi data, will allow for tracking of water quality trends.

Each lake should continue to be vigilant about managing sources of phosphorus. Common sources of phosphorus to lakes include shoreline erosion, lawn fertilizer, runoff from impervious surfaces such as homes and roads, faulty septic systems, and agricultural practices. Many of these are sources that can be minimized through the implementation of Best Management Practices. The local Soil and Water Conservation District can provide technical assistance in this implementation, and often has cost share funds available to assist with project costs. Any future development on these lakes should be done with the goal of minimizing impacts to water quality. Lakeshore landowners are encouraged to take advantage of educational opportunities that become available and learn new techniques and innovations in lake and watershed management.

Discussion – Stream Sampling Results:

Stream Methods:

One site on the Sandy River was monitored. Samples were taken from May through September. The sampling schedule was designed with a goal of completing a dataset which will be used by the MPCA for assessment of the river. Monitoring included a combination of field sampling and laboratory analysis. Samples were taken with a weighted bucket.

Field sampling was conducted with a SONDE 6820 water quality meter, which was available on loan from the MPCA, and a 100 cm Transparency Tube. The following parameters were monitored with the meter:

Temperature	Dissolved Oxygen	Salinity
pH	Specific Conductance	

Additional data collected in the field included stream height, weather conditions, user perception information, and transparency/clarity.

Laboratory analysis of water samples was provided by ERA Laboratories, Inc. in Duluth, Minnesota, using EPA-approved methods. Water samples were analyzed for the following parameters:

- Total Phosphorus (TP)
- Nitrate + Nitrite Nitrogen
- Total Kjeldahl Nitrogen
- Total Suspended Solids, and
- E.Coli

Data Summary: Raw data collected through this effort is included in Appendix C. Data collected can be compared to other streams/rivers in the Northern Lakes and Forests Ecoregion, just as the lake data was.

Phosphorus is a nutrient essential to the growth of organisms. This is commonly the limiting factor to plant growth in surface water bodies. Total Phosphorus measures the quantity of the nutrient in solution (reactive) and in particle form. Phosphorus also contributes to the eutrophication or greening of water bodies.

Nitrogen is another nutrient essential for plant growth, however it does not play as big a role in eutrophication of water bodies as phosphorus. Elevated levels of this nutrient may be caused by septic systems, manure, or over application of fertilizers.

pH is a measure of the acidity or alkalinity of the water. The pH scale ranges from 1 to 14, with 1 being the most acidic and 14 being the most alkaline. Pure water is neutral with a pH of 7. Typical streams in this ecoregion of Minnesota are slightly alkaline.

Total Suspended Solids is a measure of the very small particles remaining dispersed in the stream due to turbulent mixing. Cloudy conditions are a visual indicator of this parameter. High values can interfere with light penetration, and result in a buildup of sediment that will reduce the quality of the aquatic habitat.

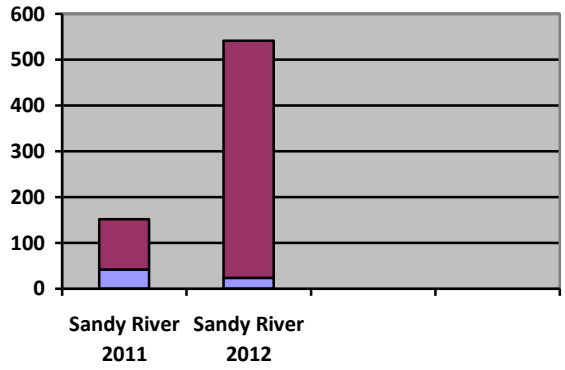
Table 3. Summer 2011 - 2012 Average Water Quality Parameters for the Sandy River.

	Total Phosphorus (mg/L)	Field pH	Total Suspended Solids (mg/L)	Nitrogen (mg/L)
Sandy River at CR 62 – 2011	0.081	7.3	5.0	<0.05
Sandy River at CR 62 – 2012	0.103	7.2	7.3	0.045
Sandy River ar CR 62 – 2011 &2012	0.092	7.2	6.22	0.045
Ecoregion Range	0.02 – 0.05	7.6 – 7.9	1.8 - 6	0.01 – 0.09

Discussion: Stream conditions at the monitored Sandy River site were generally fair. Average monitored values fell within the expected range for Total Nitrogen. The average pH value was slightly lower than expected. Total Suspended Solids were slightly higher than expected. Phosphorus numbers are significantly higher than expected. In general, these numbers are encouraging. Weather patterns in the summer of 2012 provided extreme stream flow conditions. This stream site was flooded for a portion of the summer. This was followed by drought conditions in the late summer and fall. Because of this unusual flow condition, an additional year of monitoring is recommended. This would help to remove variability cause due to weather and flow conditions.

E-Coli readings were also taken at the stream site – six in 2011 and nine in 2012. These samples complete the assessment dataset for this parameter. E. coli bacteria have been commonly found in recreational waters. Their presence is used to indicate recent fecal contamination, but this may not be indicative of human waste. E. coli are harbored in all warm-blooded animals: birds and mammals alike. Some soil types may also harbor E. coli bacteria. Bacterial contamination can result from a combination of many factors including non-point sources, transport in streams and stream water quality, and other environmental factors. Non-point sources are increasingly recognized as contributors of bacterial loads. Growth and reproduction of bacteria in stream sediments from previous human and animal inputs can be the source of outbreaks, if supported by other environmental factors. Results for this parameter varied greatly. The greatest readings were all found in 2012. The average of the 6 readings in 2011 was 70. This more than doubled, for an average reading of 154 in 2012.

Chart 3. E.Coli Readings By Year, Minimum and Maximum Results



Water heights and flow volumes varied throughout the monitoring period. Higher levels were experienced in the early summer, with lower stream levels later in the season. Flooding in June of 2012 was severe. This variance in rainfall and stream flow has a definite affect on the water quality of the stream, and should be kept in mind when reviewing the data. The two years of monitoring required for assessment serves to reduce the variance in the water quality due to weather patterns.

The data collected in 2011 and 2012 completed the assessment dataset for this stream site.

Recommendations for Stream Sites:

Tracking water transparency with a transparency tube is easy and inexpensive. Changes in transparency tell us when key water pollutants are present in the stream. Continued monitoring through the Citizen Stream Monitoring Program is recommended. This data would be included in the MPCA statewide database.

The Aitkin County Water Planning Task Force strives to provide funding and/or technical assistance each year for water quality monitoring. Periodic chemical analysis in combination with regular transparency tube readings, would allow for tracking of trends in water quality.

Area residents should continue to be vigilant about managing sources of phosphorus and soil erosion. Common sources of phosphorus to streams include bank erosion, lawn fertilizer, runoff from impervious surfaces such as homes and roads, faulty septic systems, and agricultural practices. Many of these are sources that can be minimized through the implementation of Best Management Practices. The local Soil and Water Conservation District can provide technical assistance in this implementation, and often has cost share funds available to assist with project costs. Landowners are encouraged to take advantage of educational opportunities that become available and learn new techniques and innovations in watershed management.

Expenditure Summary

Significant volunteer labor was donated to make this effort a success. Without the assistance of the volunteers, this data could not have been gathered. Expenditures related to the project are listed below:

Sample Collection & Shipment	
Volunteer Coordination	$ 240.00
Sample Shipping to Laboratory	$ 647.94
SWCD Staff Time & Travel Reimbursement	$ 3,660.41
Laboratory Analysis	
Lake Samples	$ 792.00
Stream Samples	$ 1,681.50
Data Management	$ 495.00
Grant Administration & Required Reports	$ 555.00
Total Expenses =	**$ 8,071.85**

Impaired Waters and Total Maximum Daily Loads

The Minnesota Pollution Control Agency has been charged with assessing the waters of the State and listing any impairments. "Impaired Waters" are those waters that do not meet water-quality standards for one or more pollutants, thus they are "impaired for their designated uses". Data collected through these efforts will be used in the next assessment process. The State is required to prepare a Total Maximum Daily Load study for each impairment on the list. A TMDL study determines the maximum amount of a pollutant that a water body can receive and still meet standards. TMDLs also set limits and reduction goals for restoring impaired waters. It is best for lakes to maintain good water quality, and avoid being listed as impaired. It is, however, good to know that there is a process, and assistance, for dealing with sources of impairment.

Additional Sources of Information:

Minnesota Pollution Control Agency website – MPCA Reports, Fact Sheets, and Newsletters: www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/lakes/citizen-lake-monitoring-program/clmp-reports-fact-sheets-and-newsletters.html

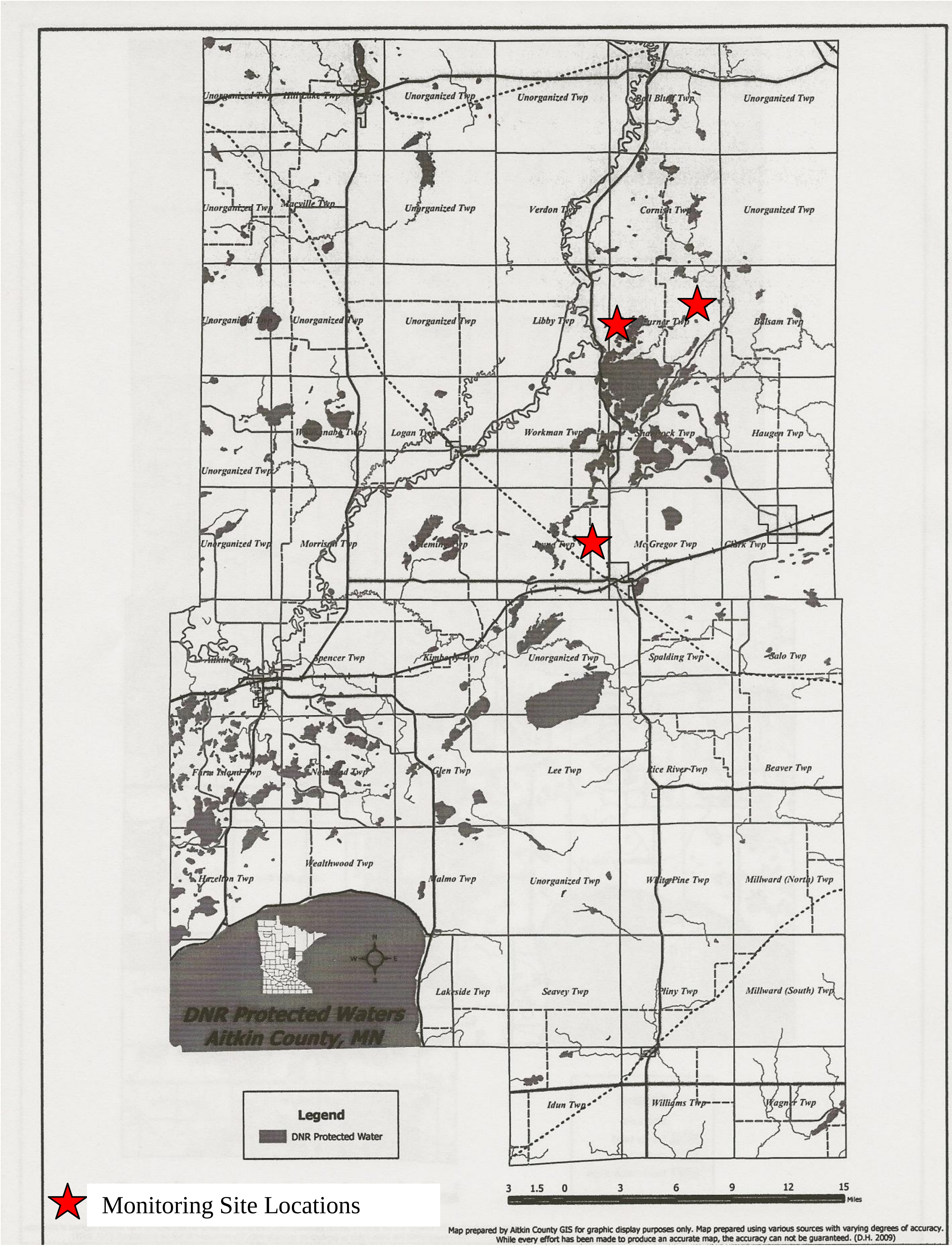
Minnesota Department of Natural Resources Website: www.dnr.state.mn.us

Minnesota Pollution Control Agency Website: www.pca.state.mn.us

Aitkin County Soil and Water Conservation District (218) 927-6565
www.aitkincountyswcd.org

Aitkin County Planning and Zoning Office (218) 927-7342

Appendix A: Map of Water Quality Monitoring Sites



Appendix B. Carlson's Trophic State Index, based on a scale of 0 – 100. (Carlson 1977)

TSI < 30 Classical Oligotrophy: Clear water, oxygen throughout the year in the hypolimnion, salmonid fisheries in deep lakes.

TSI 30 - 40 Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer.

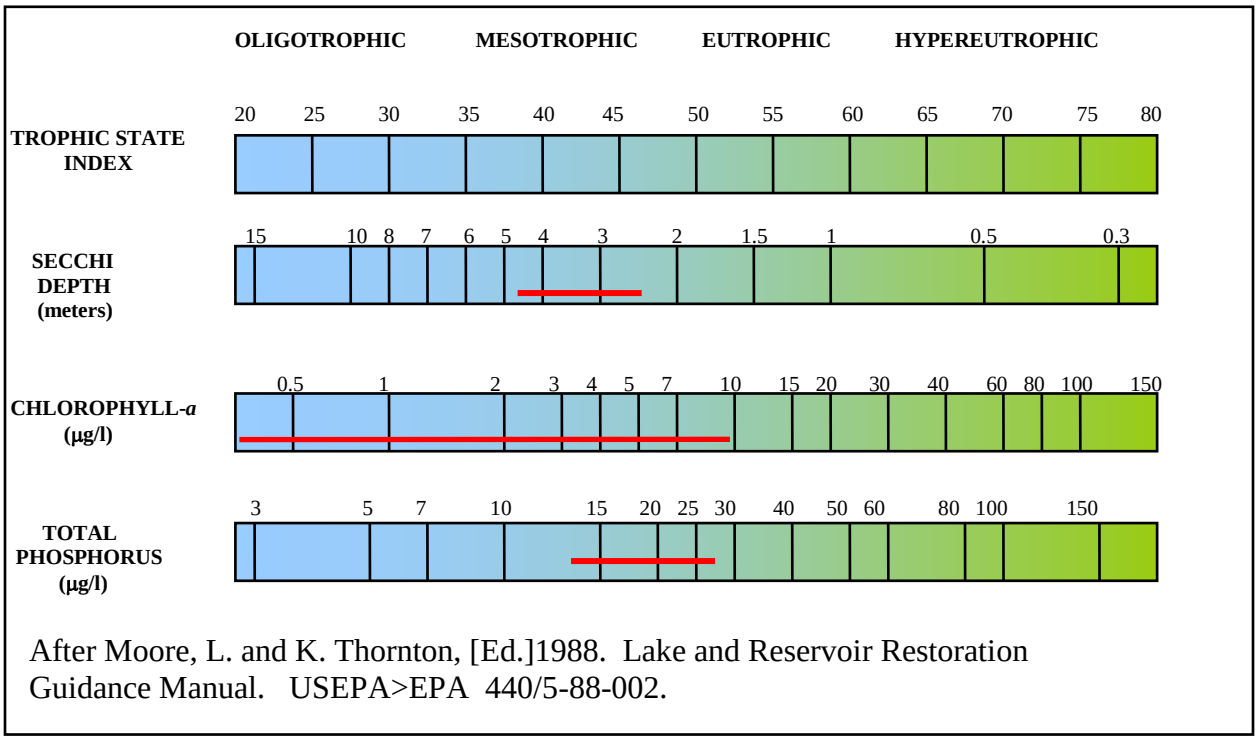
TSI 40 - 50 Water moderately clear, but increasing probability of anoxia in hypolimnion during summer.

TSI 50 - 60 Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnia during the summer, macrophyte problems evident, warm-water fisheries only.

TSI 60 - 70 Dominance of bluegreen algae, algal scums probable, extensive macrophyte problems.

TSI 70 - 80 Heavy algal blooms possible throughout the summer, dense macrophyte beds, but extent limited by light penetration. Often would be classified as hypereutrophic.

TSI > 80 Algal scums, summer fish kills, few macrophytes, dominance of rough fish.



After Moore, L. and K. Thornton, [Ed.]1988. Lake and Reservoir Restoration Guidance Manual. USEPA>EPA 440/5-88-002.

NLF Ecoregion Range, 25th – 75th percentile:

Appendix C : Water Quality Data