2013 Red Lake Band of Chippewa Indians Surface Water Data Summary 10/30/2013

Report to the United States Environmental Protection Agency

2013 Surface Water Data Summary

Beginning in 2008, guidance from the United States Environmental Protection Agency (EPA) Region 5 requests a Water Quality Assessment Report covering the preceding 2 year grant period under CWA Section 106 grant funds. All data collected during the 2 grant period is to be reported in this assessment. This report fulfills this obligation.

For questions or additional information regarding this assessment, contact:

Shane E. Bowe, Aquatic Biologist
Red Lake Band of Chippewa Indians
Red Lake Department of Natural Resources
Water Resources Program
15761 High School Drive
Red Lake, MN 56671
(218)-679-1608
sbowe@redlakenation.org

Red Lake Department of Natural Resources – Water Resources
Allen Pemberton, RL DNR Director
Joel Rohde, Water Resources Program Director

Authors:
Shane E. Bowe
Kayla J. Bowe

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List of Abbreviations and Acronyms

Alk	Alkalinity
Chl *a*	Chlorophyll *a*
Cond	Conductivity
DO	Dissolved Oxygen
DOC	Dissolved organic carbon
MPCA	Minnesota Pollution Control Agency
N+N	Inorganic Nitrogen (Nitrates + Nitrites)
NH3	Ammonia-nitrogen
NLF	Northern Lakes and Forests Ecoregion
NMW	Northern Minnesota Wetlands Ecoregion
OP	Orthophosphorus
QAPP	Quality Assurance Protection Plan
RL DNR	Red Lake Department of Natural Resources
SD	Secchi disk transparency readings
SOP	Standard Operating Procedure
SO4	Sulfate
Temp	Temperature
Turb	Turbidity
TKN	Total Kjeldahl nitrogen
TN	Total nitrogen
TP	Total Phosphorus
TDP	Total dissolved phosphorus
TDS	Total dissolved solids
TSI	Trophic State Index
TSS	Total Suspended Solids
TSVS	Total suspended volatile solids
WQS	Water quality standards

Introduction and Executive Summary

The Red Lake Indian Reservation, located in north-central Minnesota, is one of two closed Reservations in the United States and contains the largest land base in USEPA Region V that is entirely under Tribal ownership. The Red Lake Band (RLB) owns nearly 55% of all Indian land in Region V, and total land holdings are in excess of 835,000 acres consisting of approximately 310,000 acres of forest, 240,000 acres of lakes, 540,000 acres of wetlands, and over 242 miles of rivers and streams. Approximately 5,000 enrolled members live on the Reservation with another 5,000 plus members residing off the Reservation, most of who live in the Minneapolis-St. Paul area and still use the vast natural resources of the Reservation.

Natural resources represent the most important source of employment to the members of the Red Lake Band of Chippewa Indians. Historically, the two biggest industries have been commercial fishing and logging. Combined, they provided employment for more than 700 Band members and generated income and revenue in excess of $5,000,000 in 1993. These two industries affect every member on the Reservation. The Red Lakes commercial fishery is the largest freshwater commercial fishery cooperative in the United States. Protection and restoration of natural resources is a high priority for the Band.

In addition to the economic importance, the natural resources of the Reservation provide important social and cultural benefits which are vital to the well-being of Band members. These include the use of fish, wildlife, and plants for food, medicine, recreation, and spiritual needs.

Waters of the Reservation are located in the northwest part of EPA's Aggregate Nutrient Ecoregion 8 – Nutrient Poor Largely Glaciated Upper Midwest and Northeast Region. This region is further divided into level 3 ecoregions. The area north of the southern shore of Lower Red Lake is the Northern Minnesota Wetlands Ecoregion. This region is a vast, nearly level marsh covered with boreal forest and swamp vegetation. A large portion of this region is covered with standing water and also includes the Red Lakes. The portion of the reservation located south of Lower Red Lake is found in the northern portion of the Northern Lakes and Forests Ecoregion. This is a region of nutrient poor glacial soils, with coniferous and northern hardwood forests interspersed with aspen stands. The portion of this ecoregion located on the Reservation contains undulating glacial till plains, broad lacustrine basins, and sandy outwash plains but lacks the extensive moraine hills found in the rest of the ecoregion. The lakes found in this ecoregion are generally clearer and less productive than those found further south in the state. This is where the majority of the Tribe's small lakes are located. A small portion of the southwest corner of the Reservation falls into the Lake Agassiz Plain Ecoregion.

The tribe is currently working towards the development of water quality standards (WQS). The Minnesota Pollution Control Agency (MPCA) water quality standards and ecoregion criteria for water quality were used as reference values to estimate overall condition of the Red Lake Reservation's streams and rivers.

As shown below in Figure 1, Battle River Inlet, North and South Branch Rivers, Blackduck River Inlet and Highway 1 Bridge sites, Cormorant, Tamarac, Sandy, and Clearwater Rivers, and Red Lake River at the Outlet and Rock Dam flow onto or off the diminished Reservation and are found in the Northern Minnesota Wetlands (NMW) Ecoregion. Additionally, Harrison, Poplar, Bear, Pine, Stony, Pickerel, and Un-named Streams are part of the NMW Ecoregion and located at the Northwest Angle. The Mud River Inlet and Middle sites and Pike Creek Inlet, Boundary, and Off-Reservation sites are located in the Northern Lakes and Forests (NLF) Ecoregion and flow onto the diminished Reservation.

The Red Lake Department of Natural Resources Water Resources Program (Waters Program) currently monitors lakes and streams of the Red Lake Reservation using various monitoring techniques that contribute to the over-arching goal of protecting the quality of waters used by tribal members. In order to successfully prevent and/or correct water quality impairments, it is necessary that the Waters Program collects and reviews the most extensive, meaningful, and accurate data possible.

Under Section 106 of the Federal Clean Water Act (CWA), tribes are not required to submit a 305(b) report. However, tribal water programs funded under 106 grants are required to submit an annual assessment report. This report fulfills that obligation.

General water quality of the Red Lake Reservation

The overall quality of the monitored lakes on the Red Lake Reservation is very good. Of the 109 lakes over 10 acres in size, 85 have been sampled at least once. The Water Resources Program continues to expand the number of lakes sampled. The program expects to collect at least one full season of data from each of the 107 small lakes on the Reservation. This data will allow spatial analysis of water quality and a refined determination of background nutrient levels for establishment of appropriate water quality standards.

The vast majority of lakes are maintaining nutrient levels with no significant trends. Upper and Lower Red Lake continue to maintain nutrient levels above or near the eutrophic threshold. However, this is likely due to a combination of nutrient inputs from natural sources in the adjacent landscape and unique lake morphology. Expansion of the existing monitoring data set may appear to indicate that lakes are decreasing in quality (more lakes are considered eutrophic in this report than in the last). However, a closer inspection of the data will reveal that this is simply a result of sampling more lakes.

Of the 242 miles of streams on the Reservation, 23 sampling sites are monitored on 16 of approximately 17 streams. The actual number of designated streams and their classification will be determined in the future. Most of the streams have been sampled since the early 1990s; however, some streams either have no data or no current data. Overall, water quality flowing to and from Lower and Upper Red Lake is excellent and within the Minnesota Pollution Control Agency's (MPCA) state water quality standards and ecoregion criteria.

It is likely that some perceived impairments are a result of natural background conditions. An example of such a stream is the Battle River. The levels of dissolved oxygen near the lake are very close to 5 mg/L during some periods. This is the lower limit for a warm water fishery. The likely cause of this near impairment is a combination of low flow as the river widens and nears Lower Red Lake and agricultural practices in the watershed. Low flow is a natural occurrence and is expected with such a low gradient stream. No amount of restoration upstream is likely to result in significantly faster flowing waters at the inlet. Additionally, dissolved oxygen readings have more often been recorded prior to 9 AM in recent years.

This is not intended to imply that improvements are not possible, only that the majority of the perceived impairment may be natural or at least unlikely to be changed without lowering of lake levels. Changes in the watershed that result in increasing shade, reducing erosion, and restoring wetland water holding capacity to stabilize flows may all result in an improvement to water quality. While the band has not yet applied for 303(d) authority so the stream will not be listed as impaired, improving the Battle River water quality is still a priority of the Red Lake Department of Natural Resources and its state and local partners.

Monitoring and Assessment Program and Methods

Purpose

The overall focus of the program is to establish and maintain water and wetland quality as part of a comprehensive Tribal water and wetland program. The program, under this grant, employs 1.3 FTE biologists(down from 2.5), and 2.3 FTE water quality technicians (down from 2.75) to plan, administer and report on the project goals and objectives listed below, work with other government agencies, and deal with issues related to Tribal wetlands and water quality as they arise. The following is a list of the major projects which were addressed in FY11 and 12 under this program.

Program needs and priorities addressed under our FY11 and 12 EPA 106 grant were:

1) Water Quality Standards: Development, Approval, Enforcement
2) Lake/Stream/Flowing Well Nutrient and Biological Studies
3) Continuous Monitoring Stations
4) Data Review and Reporting
5) Exotic Aquatic Plant Species Education
6) Watershed/Natural Resource Mapping and Spatial Analysis
7) Wetlands Program

By implementing the above programs we are accomplishing the following:

- Continuous operation of Base Water and Wetland Programs.

- We have a better understanding of land uses in the Reservation's watersheds and how they may affect water and wetland quality. This also will give us the ability to spatially analyze water quality data in reference to existing GIS layers as well as entering much of our current data into a new GIS(s).

- We have an expanded chemical and biological database that will represent a much greater percentage of Band land in each of the ten USGS 8-digit watersheds. Specifically, we have collected data on additional lakes and will have a better understanding of their internal dynamics, and how to best protect them for future generations.

- Re-assessment of stream biological and water quality criteria will help us determine if watershed quality is deteriorating and will also allow us to gauge or update our current management strategies.

- In recent years, we have strengthened our working relationships with other government agencies (Red Lake Watershed District, Beltrami County Soil and Water Conservation District (SWCD), and Minnesota Pollution Control Agency [MPCA]) in the co-management of watersheds. We will work hard to improve on and continue those efforts. Continuation of the NPS Reduction and Buffer Zone Education Program will expand that effort to target problem areas within the Red Lake watershed, in particular the Blackduck River and other high load sub-watersheds. We are also expanding our efforts to practice basin-wide management as part of the Red River Basin Monitoring Network.

- We have continued to update and publish information on heavy metal contamination of fish in local lakes.

- Implementation of WQS will allow us to better protect our water resources by providing a standard to follow and give us an invaluable enforcement tool. Progress toward acquiring our TAS designation has been made.

- Automatic gauging and sampling equipment is still a high priority for us. We were able to purchase new equipment in 2011. Three sites were monitored in 2011 and two in 2012 for dissolved oxygen, temperature, and water levels.

As Water Quality Standards are put into place in the future, assessments will follow the guidance provided by EPA in its Consolidated Assessment and Listing Methodology (CALM). This guidance is intended for states and integrates the 305(b) Report with the 303(d) Total Maximum Daily Loads (TMDL) List. It also provides a general framework to document how water quality (WQ) data and information for environmental decision making is collected and used. The purposes of these analyses are to determine water quality standards attainment, to identify waters that should be added to the 303(d) list, and to identify waters that are attaining standards so they can be removed from the list. CALM requires states to place water bodies into one of the following five categories. Minnesota has chosen to use these five categories even though states are given an option to categorize waters by use. Because the Red Lake Reservation shares so many waters with the state, it is in our best interest to maintain uniformity and follow the state's format to the extent possible.

The five categories in CALM are as follows:

Category 1:	All designated uses are meeting WQS
Category 2:	Some uses are meeting WQS and there are insufficient data to assess other uses
Category 3:	There are insufficient data to assess any uses
Category 4:	At least one use is impaired, but a TMDL is not required
Category 5:	At least one use is impaired and a TMDL is required. These become the TMDL List.

Because Red Lake does not yet have WQS in place, for the purposes of this report waters of the Red Lake Reservation will be separated into the 3 categories listed below:

Category 1:	Unimpaired
Category 2:	Impaired
Category 3:	Insufficient Data

Table1: Atlas of Tribal Waters

Tribal Lake Acres	240,839
Tribal River Miles	242
Tribal Wetland Acres	541,049

Table 2: Water Quality Summary Table

Categories	**Monitored**
Stream Miles Assessed	**60**
Stream Miles Assessed and Unimpaired (Cat. 1)	**2**
Stream Miles Assessed and Impaired (Cat. 2)	**58**
Stream Miles Not Assessed Due to Insufficient Data (Cat. 3)	**182**
Lakes/Basins on Red Lake Reservation (>10 acres)	**110**
Lakes/Basins Assessed	**87**
Lakes/Basins Assessed and Unimpaired (Cat. 1)	**48**
Lakes/Basins Assessed and Impaired (Cat. 2)	**7**
Lakes/Basins Assessed With Insufficient Data (Cat. 3)	**32**
Lakes/Basins Not Assessed (Cat. 3)	**23**

Monitoring Design

Table 3 describes parameters monitored for all sampling site types on the Reservation. Table 4 describes monitoring design and frequency for the various projects of the Waters Program.

Table 3. Sampling parameters by project.

	Flowing Wells	Small Lakes	Red Lakes	Streams	Wetlands	Northwest Angle	Bioassessment
DO		X	X	X	X	X	X
pH		X	X	X	X	X	X
Water temperature		X	X	X	X	X	X
Conductivity		X	X	X	X	X	X
Turbidity		X	X	X	X	X	X
Alkalinity		X	X	X	X	X	X
TP		X	X	X	X	X	X
TDP					X		
OP			X		X	X	
TKN			X	X	X	X	X
N+N	X		X	X	X	X	X
NH3			X	X	X	X	X
TN				X	X	X	X
SO4						X	
TSS			X			X	X
TSVS			X			X	
TDS			X				
DOC					X		
Chl *a*		X	X				
E. coli	X						
Arsenic	X						
Chloride	X			X		X	
Hardness						X	
Macroinvertebrates					X		X
Fish					X		X
Habitat							X
Plant Community					X		
Secchi tube transparency				X			X
Secchi disk		X			X		
Flow				X		X	X

Table 4: Program Monitoring Design and Frequency, excerpt from 2008 Monitoring Strategy

Program Area	Design	# Sites	Frequency	Resources	Program Description
Surface Water Quality Program	Targeted Assessment/ Rotating Basin	109	Monthly during summer 2X/Winter	2 FTE for 6 months	23 lakes including 22 small lakes and Red Lake are sampled on a monthly basis during summer months and twice during winter months to determine surface water quality and to track trends. Additional small lakes have been added to this group of long term monitoring lakes while others are shifted to a less intensive monitoring schedule beginning in 2007.
Surface Water Quality Program	Targeted Assessment	23	2X/Month and High Flow Events	2 FTE for 6 months	14 Stream sites are sampled covering 8 streams that flow onto Reservation lands and drain into Red Lake. One stream that flows off the Reservation is sampled at 2 sites. Sites are sampled at high flow events and monthly for water samples, 2X/month for flows, and weekly for physical parameters with some sampled more as needed. Seven streams and two open water lake sites located at the Northwest Angle are sampled monthly and at high flow events.
Surface Water Quality Program	Targeted Assessment	23	1/Summer	2 FTE for 1 month	23 lakes that are part of our long term monitoring group will be sampled for fish, macrophytes, and invertebrates beginning in 2008 as part of a pilot study.
Surface Water Quality Program	Targeted Assessment	79	10+/Summer	2 FTE for 2 months	Stream bioassessments were conducted in 1997 and 1998 on 79 sites. These sites were revisited beginning in 2009 and every year after at a rate of 10+ per year continuously. See table #10 for a list of sites.
Surface Water Quality Program (Wetlands)	Targeted Assessment	24	Biological @1/Summer Nutrients @3X/Summer	2 FTE for 2 months	24 shallow lakes (type 5 wetlands) will be sampled for biological and chemical/nutrient parameters beginning in summer 2008. The sites will be revisited annually until 2011.
Ground Water Quality Program	Targeted Assessment	22	2-3/Summer	1 FTE for .1 months	22 wells are monitored 2-3 times per year depending on available funding around 4 closed landfills on the Reservation.
Ground Water Quality Program	Targeted Assessment	5	Quarterly	1 FTE for .25 months	5 flowing wells are monitored quarterly to ensure safe drinking water is available.
Nonpoint Source Program	N/A	N/A	N/A	N/A	A program will need to be developed to monitor the success of NPS projects once implemented beginning in 2010.
Wetlands Program	N/A	N/A	N/A	N/A	Location and number of seasonal wetlands, open water wetlands and shallow lakes for pilot studies to be determined beginning in 2009.
Fish Mercury Levels	Targeted Assessment	107	Variable		Fish tissue Mercury samples are taken from experimental gill nets in Red Lake and will be taken from small lakes as bioassessment netting occurs (continuous).

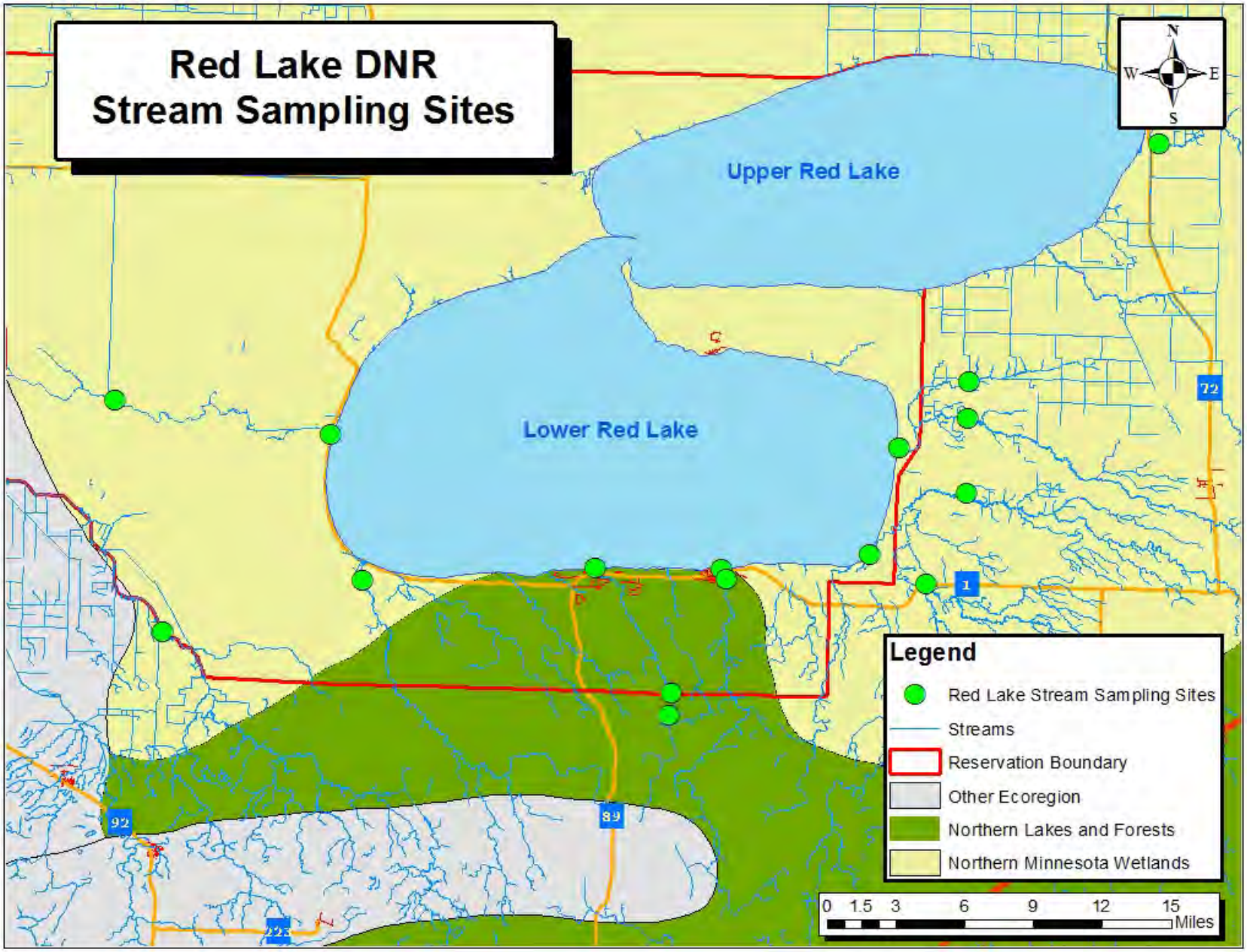

Figure 1. Red Lake Nation Stream Sampling Locations

Stream Summary

General

Streams with growing season (April—October) data collected between 2003 and 2012 are assessed in this report. Some of the streams have data that have been collected as far back as 1992. Monitoring was conducted on a quarterly, monthly, and even weekly basis for the streams. Data are collected using field forms on electronic devices and imported into a database in the office. Data is then submitted to an online database where it is subsequently submitted to WQX. Other data control is based upon our approved QAPP and SOP.

Not all streams have been monitored as extensively as other streams on the Reservation. Pike Creek, Blackduck and Clearwater Rivers have been monitored more frequently to determine possible water quality impairments for bacteria, dissolved oxygen, and turbidity. By continuing to collect data, we can detect trends and water quality impairments for streams on the Reservation. Please refer to Table 4 for the monitoring design and sampling frequency.

Data analyses were conducted using Microsoft Excel 2010. Sites with significant trends determined by linear regression in the past ten-year period are graphed and explained below. While many arguments have been made for and against this statistical approach, we have determined that a slope significantly different from zero should be used as at least a starting point for further investigation of a water body.

Trends and Exceedances

Table 5. Trends in Stream Water Quality.

Parameter	No. of Stream Miles Monitored	Threatened Stream Miles	Streams with Significant Trends
pH	60	0.1	No significant trends
DO	60	13.5	CLWR-B, PIKE-B, PIKE-I, PIKE-OR, REDL-O, SANR-U
Turbidity	60	3.25	No significant trends
TSS	60	22.5	BLAC-B, PIKE-I, PIKE-OR
Temperature	60	45.3	No significant trends
TP	60	25	BATT-SB, PIKE-I
E. coli	60	19	No significant trends
N+N	60	12	No significant trends

According to Minnesota R.ch. 7050, the MPCA has designated seven beneficial use classes for which surface waters are protected. Use Class 2 has the beneficial use of protecting aquatic life and recreation. Class 2 waters are further divided into subclasses. Class 2A refers to cold water fisheries and trout waters whereas Class 2B refers to cool and warm water fisheries. Class 2Bd refers to cool and warm water fisheries and is protected as a source of drinking water. Class 2C refers to indigenous fish and associated aquatic community, and Class 2D refers to wetlands. In order to determine impairment, at least ten observations for each parameter must be collected over a ten-year period.

Table 6. MPCA's Water Quality Values for Class 2B Streams

Parameter	Standard
DO	5 mg/L
pH	6.5-9.0
Turbidity	25 NTU
E. coli	*126 org/100mL
	**1,260 org/100 mL

*** as a geometric mean of not less than five samples within any calendar month (Apr – Oct)**
**** less than 10% of all samples taken during any calendar month individually**

Table 7. MPCA's Ecoregion Water Quality Values for Streams

	Northern Minnesota Wetlands	Northern Lakes and Forests
pH	7.6 -7.9	7.4 - 7.9
Total Suspended Solids (mg/L)	4.8-16	1.8- 6
NOx (mg/L)	0.01- 0.08	0.01- 0.09
Total Phosphorus (mg/L)	0.04 -0.09	0.02- 0.05
Turbidity (NTU)	4.1-10	1.7- 4.3
Temperature °C	0- 20	0.5-17

The above parameter ecoregion values are for the inter-quartile range between the 25th and 75th percentiles of the reference streams for each ecoregion.

Dissolved Oxygen (DO)

Dissolved Oxygen (DO) is required for essentially all aquatic organisms to live. DO is not a toxicant, and the more DO in the water, the better. If DO drops below acceptable levels (5 mg/L for streams), aquatic organisms such as fish can be killed or harmed. DO concentrations go through a diurnal cycle with concentrations reaching their maximum in late afternoon and their minimum just after sunrise. For this reason, measurements of DO are best taken no later than two hours after sunrise to be compared to the daily minimum standard. Due to seasonal and diurnal variability in DO concentrations, a total of 20 independent observations are required for DO assessments and should be made before 9:00 am in order to measure the lowest diurnal DO concentration. Microbial communities in water use oxygen to breakdown organic materials, such as manure, sewage, and decomposing algae. Low levels of dissolved oxygen can be a sign that too much organic material is in a water body. According to Minnesota Water Quality Standards, DO should not be less than 5 mg/L as a daily minimum 50 percent of the days during low flow. We have neither the data points necessary nor the stream flow information to fully assess compliance with this standard for any of our sites. However, we will target streams for more intensive monitoring when 10 percent of samples in any month fall below the 5 mg/L standard.

Two Reservation streams were monitored with continuous monitoring equipment beginning in 2011 to assess daily variations in DO. These streams include Pike Creek at one location and Mud River at two locations. In 2012, Pike Creek and one site on the Mud River were monitored.

CLWR-B, all three Pike Creek sites, REDL-O, and SANR-U showed significant declining trends for DO in the past ten-year period (See Figures 2 -6). It is possible this observed trend is due to an increase in dissolved oxygen readings being recorded prior to 9 am. We will continue to monitor these

sites closely in the next few years with readings prior to 9 am, increased number of readings, and installing continuous DO monitoring equipment where possible.

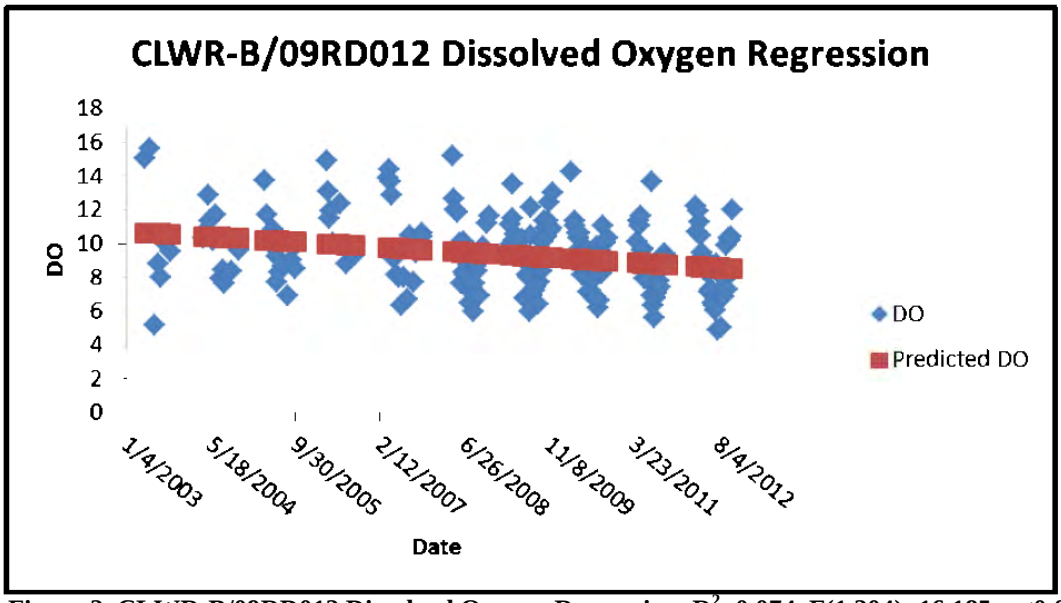

Figure 2. CLWR-B/09RD012 Dissolved Oxygen Regression. R^2=0.074, F(1,204)=16.185, *p*<0.001.

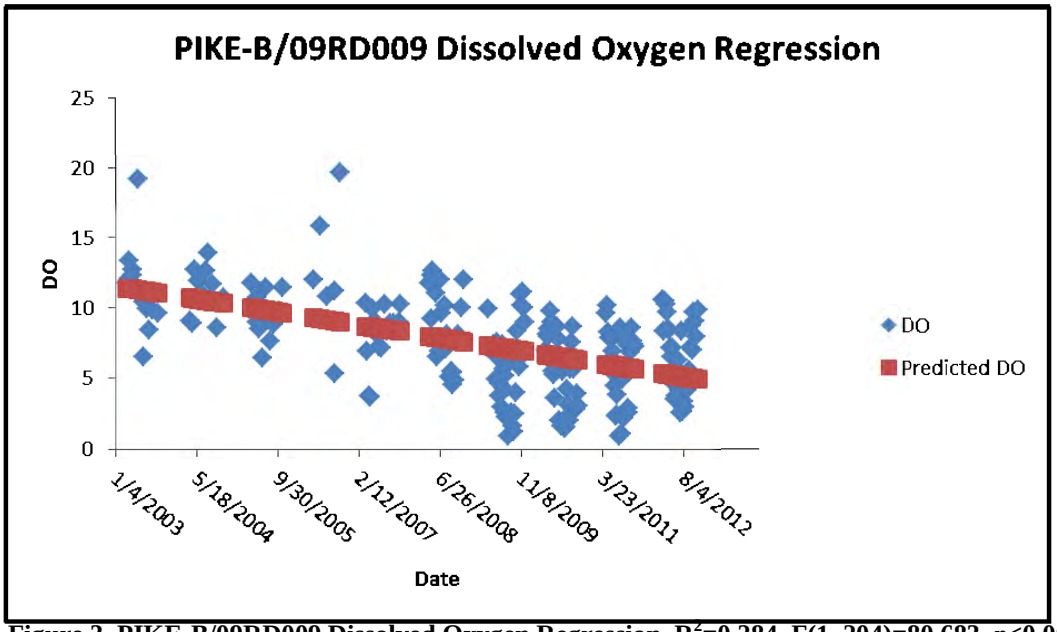

Figure 3. PIKE-B/09RD009 Dissolved Oxygen Regression. R^2=0.284, F(1, 204)=80.683, *p*<0.001.

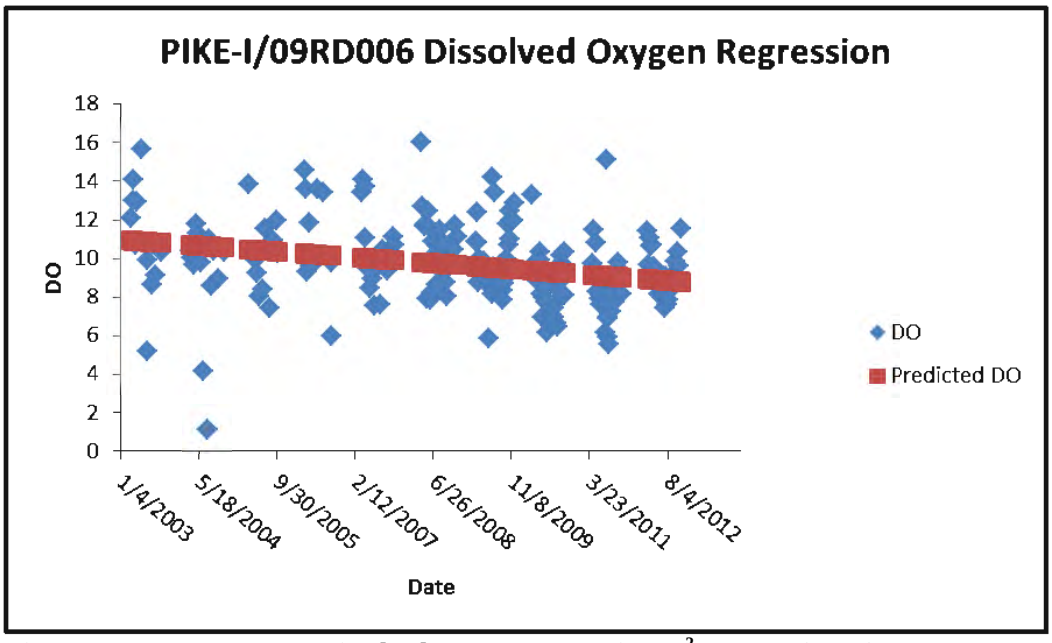

Figure 4. PIKE-I/09RD006 Dissolved Oxygen Regression. R^2=0.083, F(1,222),=20.001, *p*<0.001.

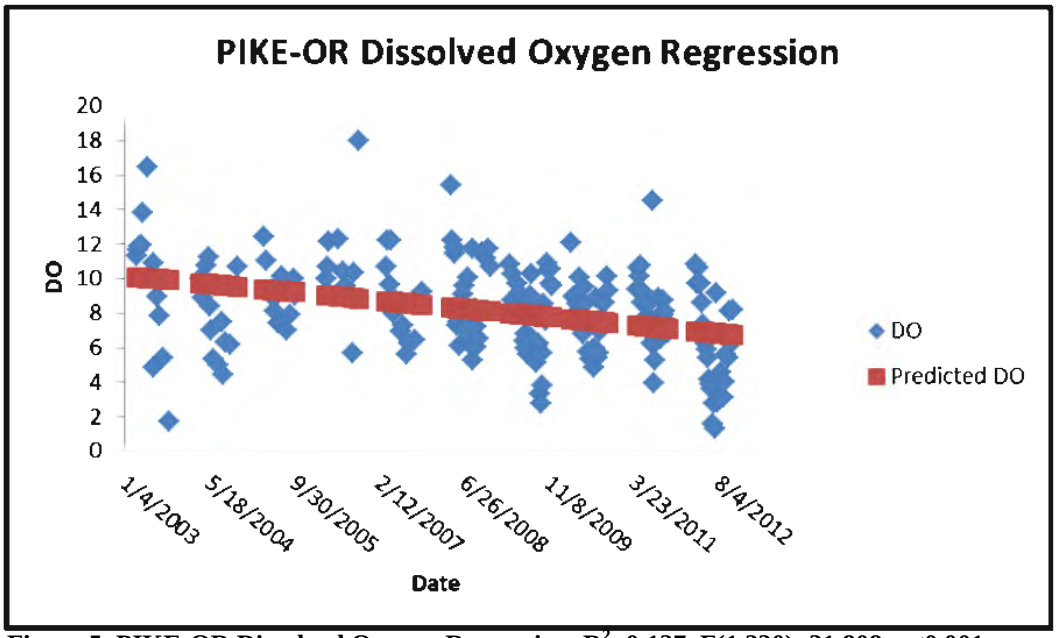

Figure 5. PIKE-OR Dissolved Oxygen Regression. R^2=0.127, F(1,220)=31.808, *p*<0.001.

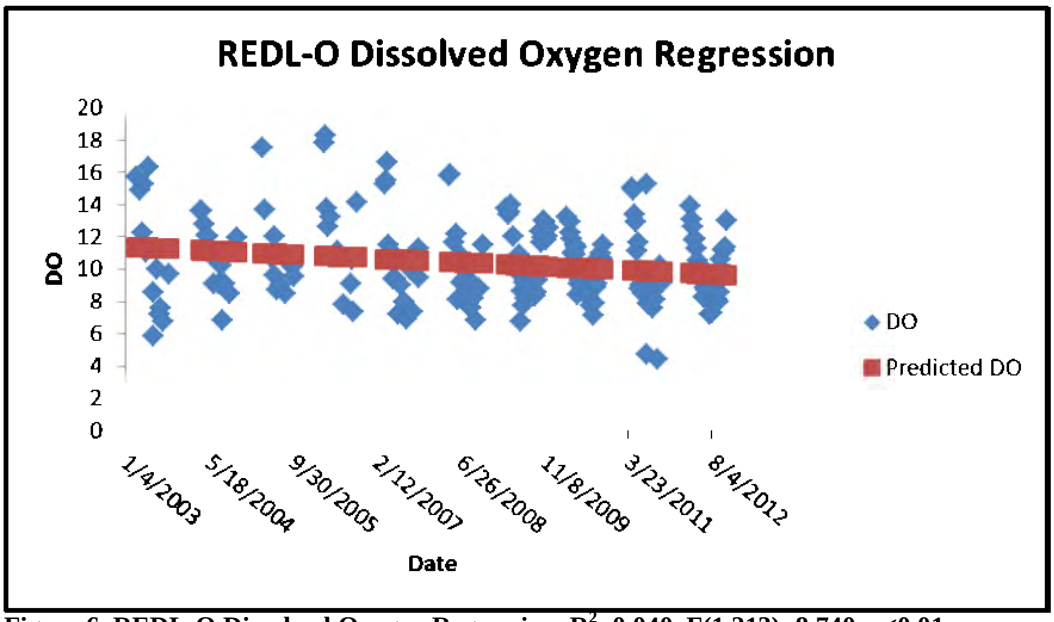

Figure 6. REDL-O Dissolved Oxygen Regression. R^2=0.040, F(1,213)=8.740, p<0.01.

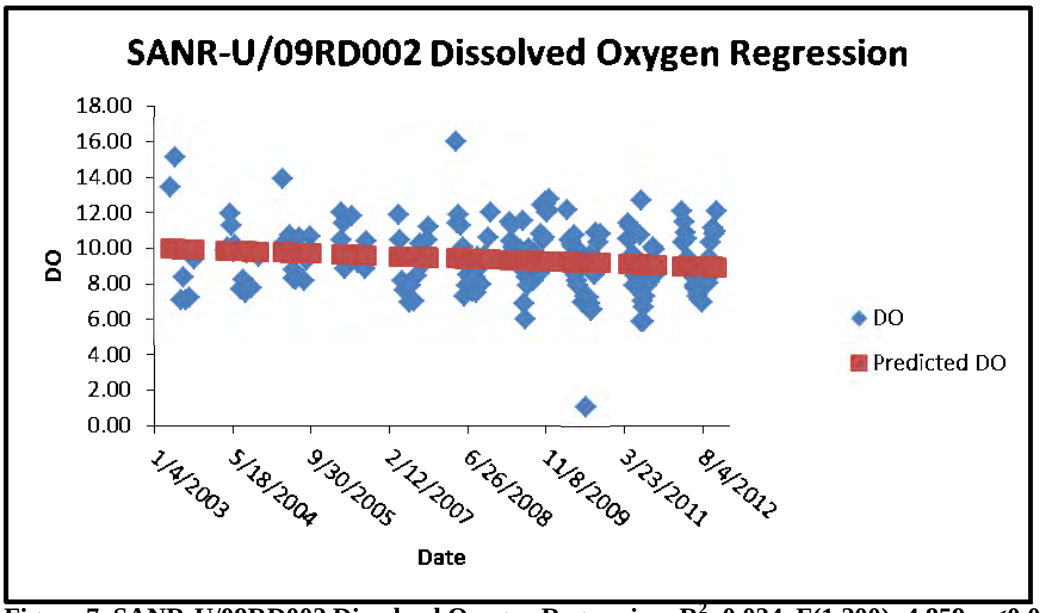

Figure 7. SANR-U/09RD002 Dissolved Oxygen Regression. R^2=0.024, F(1,200)=4.859, p<0.05.

Temperature

High water temperatures or rapid elevations of temperature above ambient can be very detrimental to fish. This is dependent on the kind of fish, time of year, and life stage of the fish at the time. MPCA WQS state that temperatures must be similar for timeframes such as weeks or seasons. Ecoregion ranges are 0-20°C for Northern Minnesota Wetlands streams and 0.5-17°C for Northern Lakes and Forests streams. No sites have shown a significant increasing temperature trend in the last ten-year period.

pH

The pH of water is a measure of the degree of its acid or alkaline reaction. A pH of 7.0 is natural; pH below 7 is acid, above 7 is alkaline. The pH standard for Class 2 waters is a minimum of 6.5 and a maximum of 9.0. Values for pH that are either too high or too low can be harmful to aquatic

organisms; however, natural waters can exhibit a very broad range of pH values. Values that are outside the range of the standard because of natural causes are not considered exceedances.

Several Reservation streams fall outside the ecoregion ranges for pH values. However, all streams have pH values that fall within the Minnesota WQS of 6.5-9.0 standard units (su). Most of the variances for ecoregion values can likely be attributed to natural causes such as waters flowing through wetland systems. No sites had significant trends.

Conductivity

Conductivity is the measure of dissolved minerals and/or ions in the water. If baseline levels of conductivity are established for an area, this measurement can be used to detect possible pollution discharges that have a high ionic strength. This would include manure directly from livestock in streams, land application, or releases from storage basins. Conductivity is affected by temperature as well as the mobility and concentration of dissolved ions such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, and iron. Conductivity can be a useful warning flag for total suspended solids and poor water quality. Conversely, as the geology of the area contains iron and many other minerals to give it hard water, the water of the area has inherently higher conductivity.

There are no ecoregion criteria or water quality standards for conductivity as set per Minnesota Pollution Control Agency.

Alkalinity

Alkalinity was sampled at least twice per year from 2003-2009after ice-out. After 2009, alkalinity was sampled monthly during the ice-free season. Monitoring for alkalinity is a measure of a stream's buffering capacity and ability to neutralize acids. Water with a low alkalinity but high pH is considered unstable. This is not the case in our streams as all streams have minimum and geomean values above EPA's alkalinity standard of 20 mg/L.

Turbidity

Turbidity is a measurement of particulates in the water that can affect water clarity and is correlated with total suspended solids. Streams with high turbidity often have high total suspended solids, low dissolved oxygen, and high nutrient and algal content. Streams that are very turbid typically have low biodiversity.

In order to designate a water body as impaired for turbidity and include it on the impaired waters list, a minimum of ten data points over a ten-year period are required. If greater than ten percent of the samples exceed the water quality standard, the water body is listed.

All streams have values below the MPCA WQS of less than 25 NTUs except for a couple of outliers which didn't exceed the greater than ten percent criteria. These outliers may be due to rainfall events. Northern Minnesota Wetlands Ecoregion criteria are between 4.1 and 10 NTUs whereas Northern Lakes and Forests Ecoregion criteria are 1.7-4.3 NTUs. Turbidity values for these ecoregions are somewhat variable. No sites showed significant trends.

Total Suspended Solids

Total suspended solids (TSS) are very small particles remaining dispersed in water due to turbulent mixing exceeding gravitational sinking that can create turbid or cloudy conditions. TSS cause a)

interference with light penetration, b) build-up of sediment, and c) potential reduction in aquatic habitat. Solids also carry nutrients that cause algal blooms and other toxic pollutants that are harmful to fish.

There are no MPCA WQS for TSS. Northern Minnesota Wetlands Ecoregion criteria are 4.8-16 mg/L, and Northern Lakes and Forests Ecoregion criteria are 1.8-6 mg/L. Three sites have shown a significant decline in TSS values over the last ten-year period: BLAC-B, PIKE-I, and PIKE-OR (Figures 8-10, respectively).

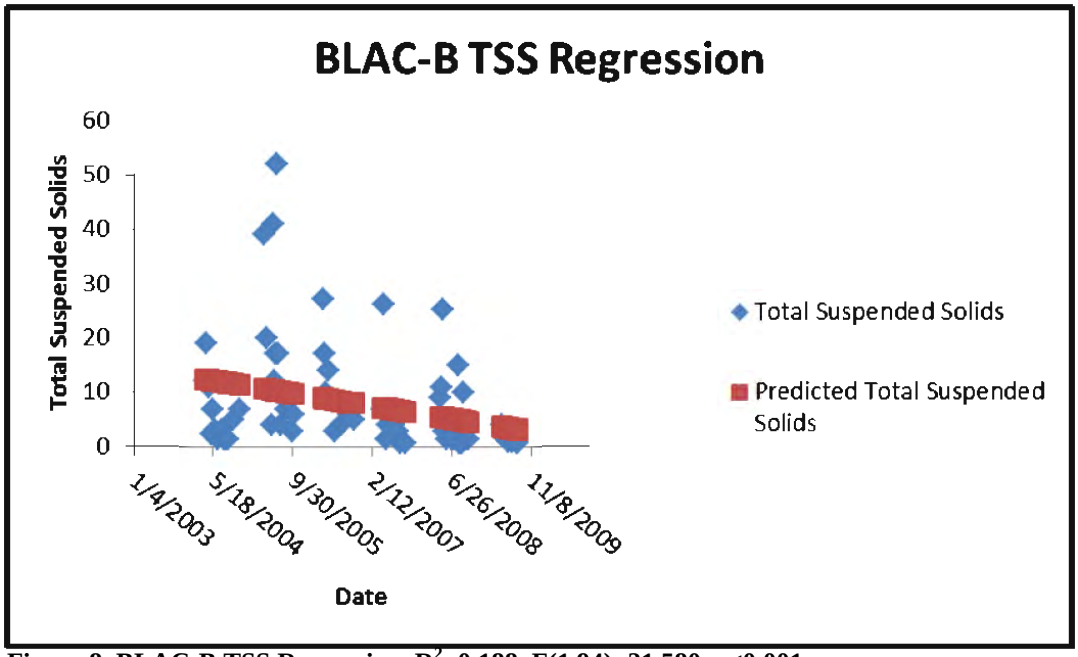

Figure 8. BLAC-B TSS Regression. R^2=0.188, F(1,94)=21.580, p<0.001.

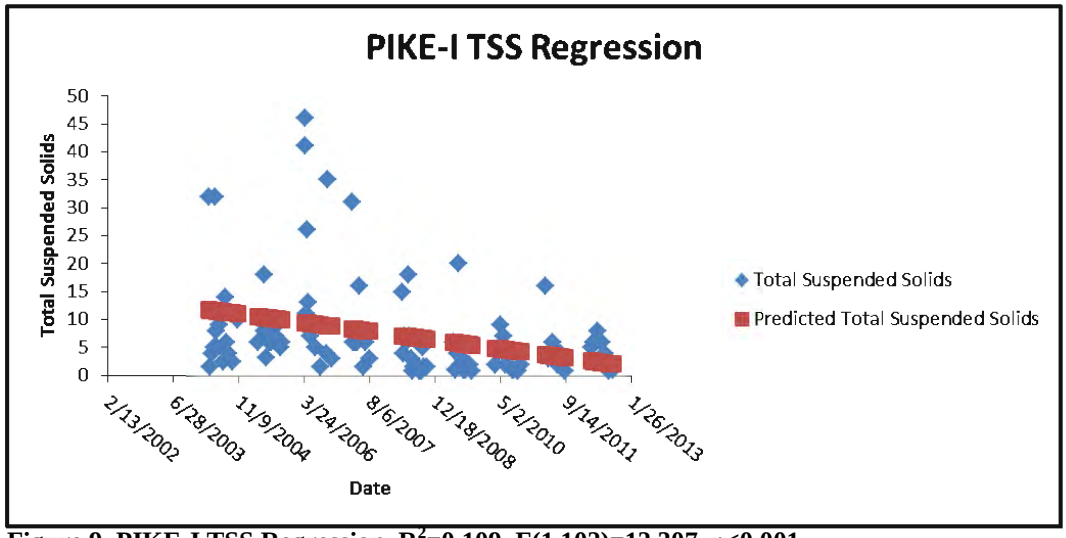

Figure 9. PIKE-I TSS Regression. R^2=0.109, F(1,102)=12.307, p<0.001.

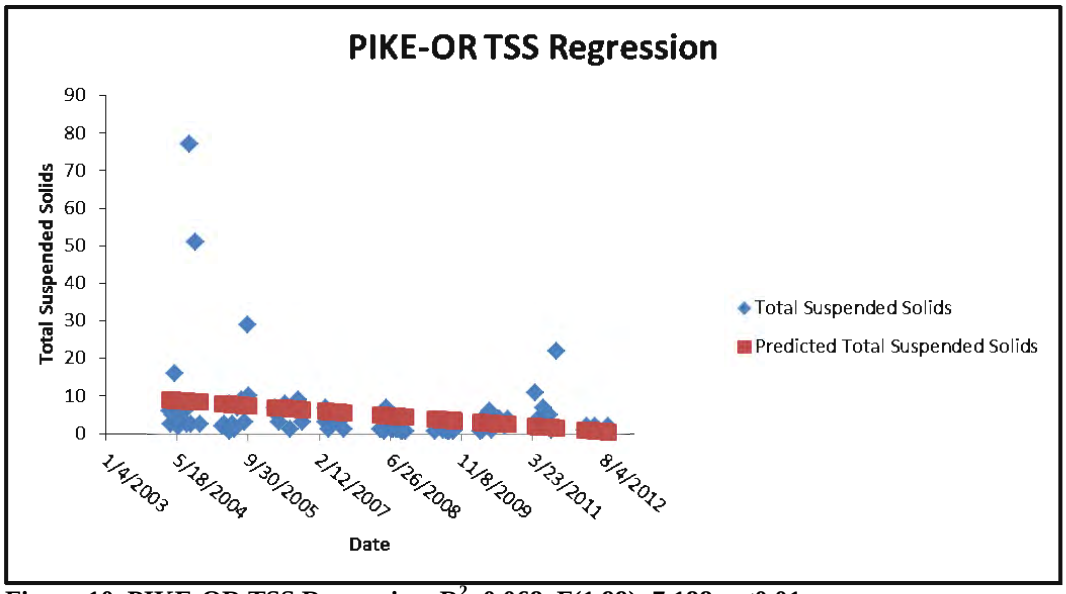

Figure 10. PIKE-OR TSS Regression. R^2=0.068, F(1,99)=7.188, p<0.01.

Total Phosphorus

Total phosphorus (TP) is a nutrient essential to the growth of organisms and is commonly the limiting factor in the primary productivity of surface water bodies. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particle form. Agricultural drainage, wastewater, and certain industrial discharges are typical sources of phosphorus and can contribute to the eutrophication of surface water bodies. A major source of phosphorus to Reservation streams if from agricultural lands.

Northern Minnesota Wetland Ecoregion criteria are 0.04-0.09 mg/L. The Cormorant River has values exceeding these criteria. Northern Minnesota Lakes and Forests Ecoregion criteria are 0.02-0.05 mg/L.

South Branch Battle River and Pike Creek Inlet had declining total phosphorus trends in the last ten-year period (Figures 11 and 12, respectively).

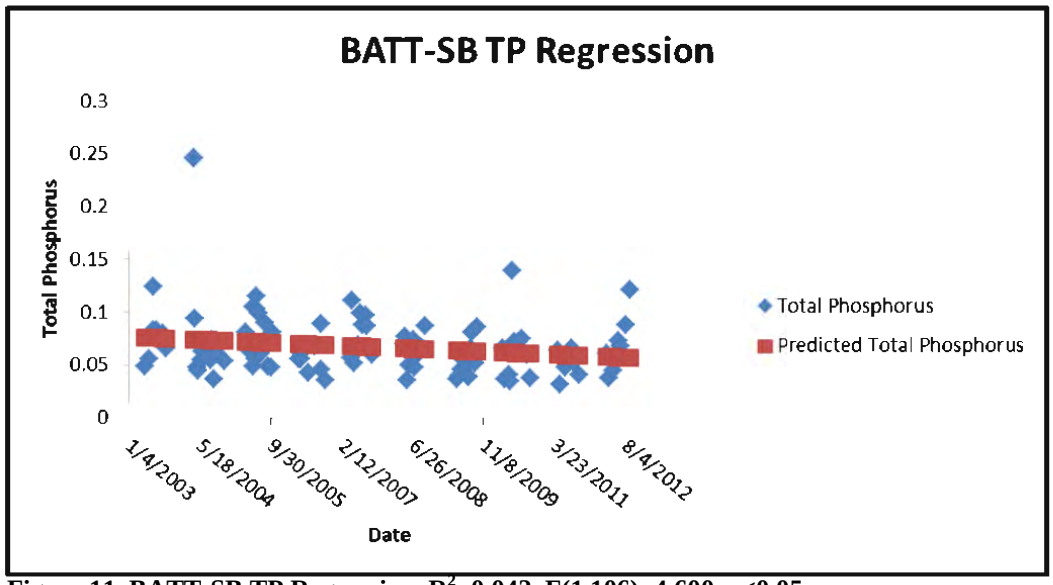

Figure 11. BATT-SB TP Regression. R^2=0.042, F(1,106)=4.600, p<0.05.

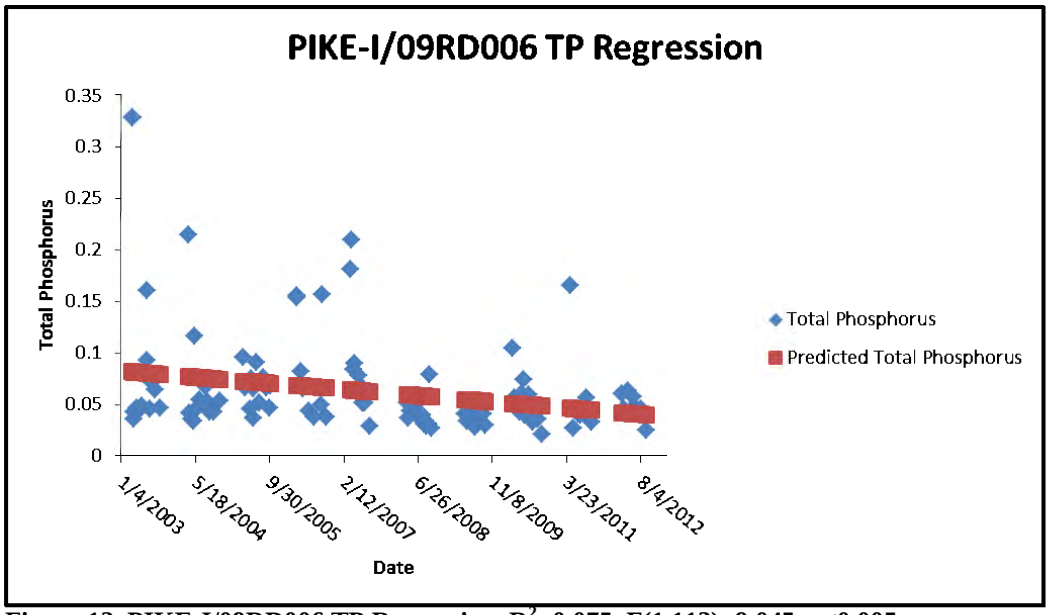

Figure 12. PIKE-I/09RD006 TP Regression. R^2=0.075, F(1,113)=9.045, *p*<0.005.

E. coli

Escherichia coli (E. coli) is a subgroup of fecal coliform bacteria that is present in the intestinal tracts and feces of warm-blooded animals. It is used as an indicator of the potential presence of pathogens. There are many different strains of *E. coli* that are classified into more than 170 serogroups. Although most strains of *E. coli* are harmless and live in the intestines of healthy humans and animals, the *E. coli* O157:H7 strain produces a powerful toxin and can cause severe illness.

There are a few sites of concern on the Reservation for *E. coli* which are explained in the site summaries.

Nitrogen

Various forms of nitrogen are analyzed for Reservation streams (TKN, N+N, and NH3). There are no Minnesota WQS for nitrogen; however, there are ecoregion values for inorganic nitrogen (N+N). No sites showed significant trends over the previous ten-year period. Concern sites are noted in the site summaries.

Bioassessment Sites

Twenty-three stream sites have been assessed for physical and chemical parameters, habitat, and fish and invertebrate communities during 2009-2012 (Figure 13, Table 8). Four of these sites have been sampled for three years as part of an intensive study (Mud River Dam Removal). One of the 23 sites has since been removed from sampling due to sampling feasibility and proximity to an existing bioassessment site. The 22 sites will be sampled on a three-year rotating basis with sites added as deemed necessary. Mussel surveys will be added to bioassessment sampling in future years. Some sites have invertebrate metric data that can be found on site summaries.

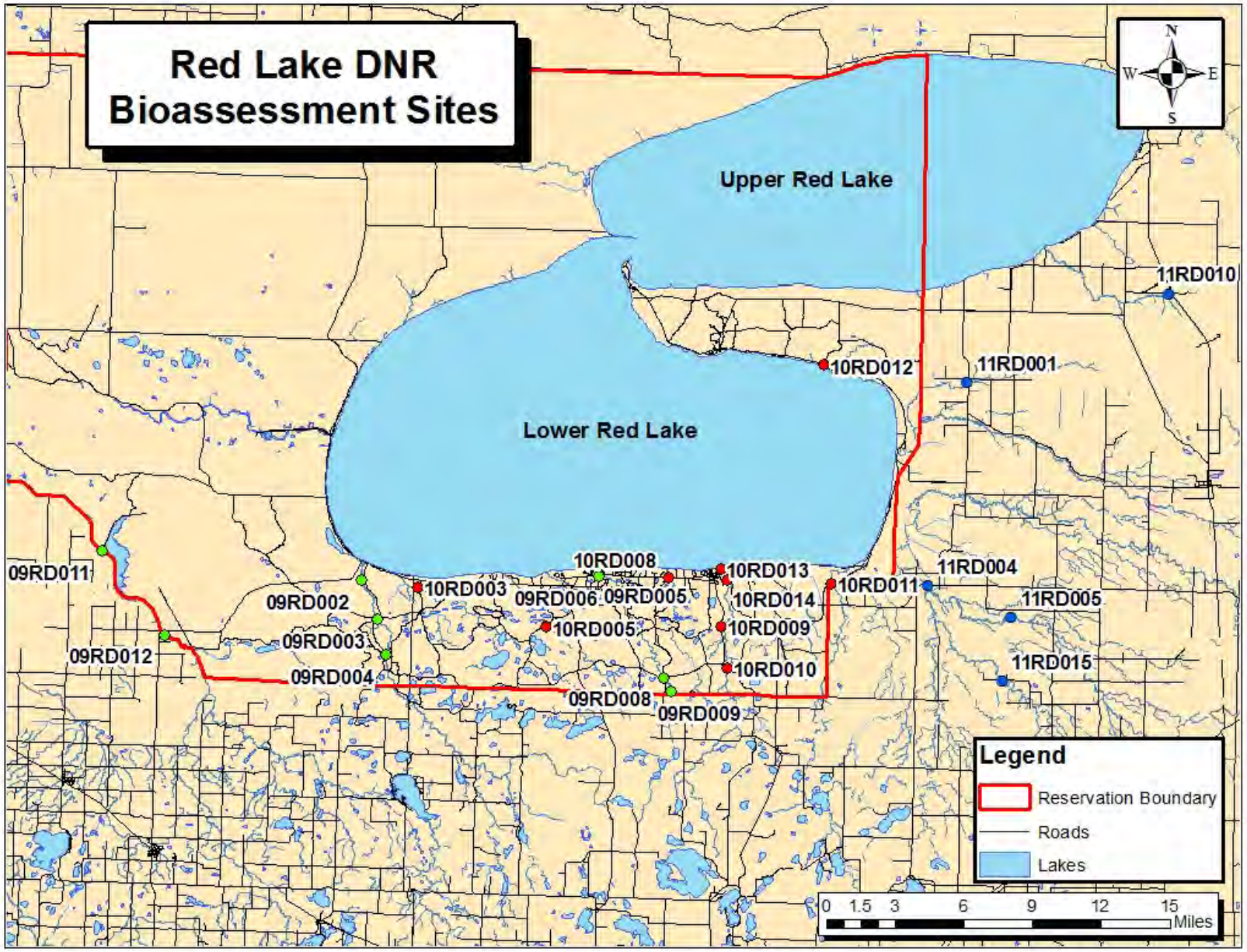

Figure 132. Bioassessment Sites

Table 8. Red Lake Bioassessment Sites

Site Code	Location	Site Code	Location
09RD002	Sandy River @ SANR-U	10RD009	Mud River @ MUDR-U
09RD003	Sandy River on Gonvick Truck Trail	10RD010	Mud River on East Fireline Trail
09RD004	Sandy River on Sandy River Trail	10RD011	Hay Creek on Ponemah Rd
09RD005	Pike Creek North of Hwy 1	10RD012	Sucker Creek on Ponemah Rd
09RD006	Pike Creek @ PIKE-I	10RD013	Mud River @ MUDR-I
09RD008	Pike Creek on West Fireline Rd	10RD014	Mud River @ MUDR-M
09RD009	Pike Creek @ PIKE-B	11RD001	North Battle @ Gauge
09RD011	Clearwater River on W. Kiwosay Dam Rd	11RD004	South Cormorant River
09RD012	Clearwater River @ CLWR-B	11RD005	South Cormorant River
10RD003	Big Rock Creek on Big Stone Trail	11RD010	Shotley Brook
10RD005	Little Rock Creek on Shell Lake Rd	11RD015	Blackduck River
10RD008	Shemahgun Creek off Hwy 1		

Flowing Wells

Five flowing wells are monitored quarterly on the Reservation for *E. coli*, nitrates and nitrites, chloride, alkalinity, and turbidity. In 2011 and 2012, sites were monitored for arsenic. All locations had values below the lowest detection limit for *E. coli* and inorganic nitrogen. Chloride values ranged from <1-6 mg/L which is within the acceptable range. Alkalinities ranged from 222-364 mg/L, and turbidity ranged from 0.61-12.8 NTUs. Arsenic was greater than the federal drinking water standard of 10 µg/l in all wells except one (FLOW-4 not detected; all others between 12-27 µg/l). Signs were posted at the high-arsenic wells indicating it was not recommended to use the water for drinking water.

Private Wells

On a per request basis, private wells are monitored for various contaminants and nutrients including *E. coli*, nitrates plus nitrites, chloride, iron, and arsenic. No private well samples are analyzed using EPA funds and results are not reported here.

Flow

Flow was measured in six streams on the reservation occurring bi-weekly with more frequent sampling to capture rainfall events greater than 0.5 inches. Flow was also measured at 4 additional sites once during the season for the bioassessment project. Of the six streams measured frequently, Clearwater River had the highest flow. Clearwater also has the largest stream order. Sandy River, North Branch Battle River, and Pike Creek have much less flow. The USGS monitors Red Lake Outlet and Battle Inlet flow.

Quality Assurance/Quality Control

Water samples were submitted to our lab as part of a double-blind study to assure quality assurance and quality control. The results of the study are found in table 9. Ammonia-nitrogen results were not

within the acceptable range, but it was determined that the sample was originally preserved by the PE provider and then additional preserved by the lab. This would reduce the pH well below the test definition causing the chemistry for the test to be out of pH specifications. Corrective action was taken by the lab. All other results fell within the acceptable range for the study.

Nature of lab support

Sample analyses are contracted with RMB Laboratories in Detroit Lakes, MN. RMB is a Minnesota Department of Health certified laboratory. All sample analyses shown in Table 3 are contracted with RMB Laboratories except for alkalinity and turbidity which are analyzed by Red Lake DNR Waters staff.

Table 9. Results of QA/QC study.

Sample Description	N+N--mg/L	NH3--mg/L	NO3--mg/L	OP--mg/L	TDS--mg/L	TKN--mg/L	TP--mg/L	TS--mg/L	TSS--mg/L	TSVS--mg/L
Red Lake East	20	5.06	20	1.22						
Red Lake West						5.9	5.96			
Red Lake North										369
Red Lake South					576				72	
Certified Values	**19.3**	**14.0**	**19.3**	**1.29**	**545**	**5.32**	**5.88**		**80.8**	**406**
Accepted Range	**15.7-22.4**	**10.4-17.4**	**15.0-23.3**	**1.01-1.59**	**420-670**	**3.60-7.04**	**4.84-6.98**		**66.0-90.0**	**344-447**

Lake Summary

Overall, the quality of the lakes of the reservation is exceptional. There are very few pollutants of concern. Nutrient levels, though somewhat high, show no significant increasing trend in most lakes. Only Upper Red Lake and a few small lakes have high enough nutrient levels to be listed as eutrophic and very few exceed the trophic status threshold set by the MPCA. There are no ecoregion specific nutrient criteria available for those lakes in the Northern Minnesota Wetlands (NMW) ecoregion. The NMW ecoregion is dominated by wetlands and peat soils, contributing to excessive background nutrient levels and stained waters. Without accounting for natural nutrient inputs, it is inappropriate to list a water as impaired. Second, Upper Red Lake is already listed by the state as impaired for Mercury in fish tissue. We concur with the state's assessment. We also lack a mercury in fish tissue standard at this time. Finally, Red Lake has not applied for 303(d) TAS. Though we are not requesting the listing of these waters as impaired now, we will continue to monitor water quality closely. We also continue to update and refine our Mercury Advisories.

No lakes have shown a statistically significant decrease in water quality over the past 10 years using all 3 indicators (TSI levels for Chlorophyll *a*, TP, and Secchi). However, Lower Red Lake has shown increases in both TP and Chlorophyll *a*. We will continue to monitor them closely and are increasing the number of monitored lakes on the reservation so we might be able to capture more subtle changes in water quality. See Appendix B for individual lake assessments.

Lakes assessment data quality:

Lakes with growing season (May—September) data collected in 2009 and 2010 are summarized in this report. The State of Minnesota analyzes data collected over the previous decade to assess water quality standard violations. We use the same approach but include all historical data during trend assessment. This report is a water quality data summary of all extant data for lakes of the Red Lake Reservation.

Chlorophyll *a* (Chl *a*), Total Phosphorus (TP), and Secchi disk transparency readings (SD) are all analyzed during assessment years. Trophic State Index (TSI) values are also calculated for all lakes using TP values as well as number of observations (N), geometric means, quartile data, minimums, maximums, and standard deviations. This report summarizes these data for each lake in a separate lake report being developed for stakeholders. A small number of lakes have shown significant increasing or decreasing trends in one or two of the three TSI metrics. No lakes have shown significant changes in all three.

Data quality guidelines in Table 2 were drawn from MPCA guidelines, which are in turn based on USEPA guidance. "Data quality" assessment should not be confused with "Quality Control" measures taken during data collection. Data collected by the Red Lake DNR was collected under an approved QAPP, following proper SOPs. Therefore, it is assumed that all data in the Red Lake DNR database has met the "Quality Control" guidelines. The "data quality" assessment is focused on collecting enough data points to capture variance and to perform a robust analysis of the data.

Trophic Status and Trend analysis:

Carlson's Trophic State Index was used to assess trophic status for lakes. This index uses a log transformed summer SD value to estimate algal biomass in a lake. Index values range from 0—100+

with lower values indicating more oligotrophic conditions and higher values indicated more eutrophic values. TSI values were calculated as follows:

TSI(SD) = 60 - 14.41 ln(SD);
TSI(Chl *a*) = 9.81 ln (CHL a) + 30.6;
TSI(TP) = 14.42 ln(TP) + 4.15;
(chl-a and TP in micrograms per liter (µg/L) and SD transparency in meters).

TSI values are calculated for TP, SD, and Chl *a* data when all three were available. However, it's often the case that TP is used in place of the other two. This is because TP is often a more meaningful indicator of conditions around the lake. Excessive or increases in nutrient inputs are more directly measured by TP levels. An increase in TP over time is more likely to be related to land use in a lake catchment than a decrease in SD readings will necessarily be.

In the absence of TP data, SD values are used to determine trophic status. The lakes of the Red Lake Reservation tend to have highly stained water, resulting in lower SD values than would normally be associated with lakes of similar productivity. So, the sole use of SD based TSI values will be avoided whenever possible.

TSI values are commonly separated into Trophic Classes using the breakpoints in Table 10. In reality, this separation is arbitrary and is better described as a continuum. Figure 16 shows a more realistic interpretation of trophic status. While Trophic Classes are not ignored when characterizing a particular body of water, they will not be used to designate a lake as impaired or fully supporting.

As indicated in figures 14 and 15 below, most lakes on the Reservation (60%) fall within the mesotrophic range. Twenty three lakes (26%), some used as trout fisheries, are classified as oligotrophic. Only 12 lakes (14%) are classified as eutrophic and no lakes are classified as hypereutrophic. These classifications serve only to assist in describing conditions present in lakes and will be used in individual lake reports but not in this assessment.

Table 10: Lake TSI and Trophic Class

TSI	Chl *a*	TP	SD	Trophic Class
<30—40	0—2.6	0—12	>8—4	Oligotrophic
40—50	2.6—7.3	12—24	4—2	Mesotrophic
50—70	7.3—56	24—96	2—0.5	Eutrophic
70+	56+	96+	0.5—0.0	Hypereutrophic

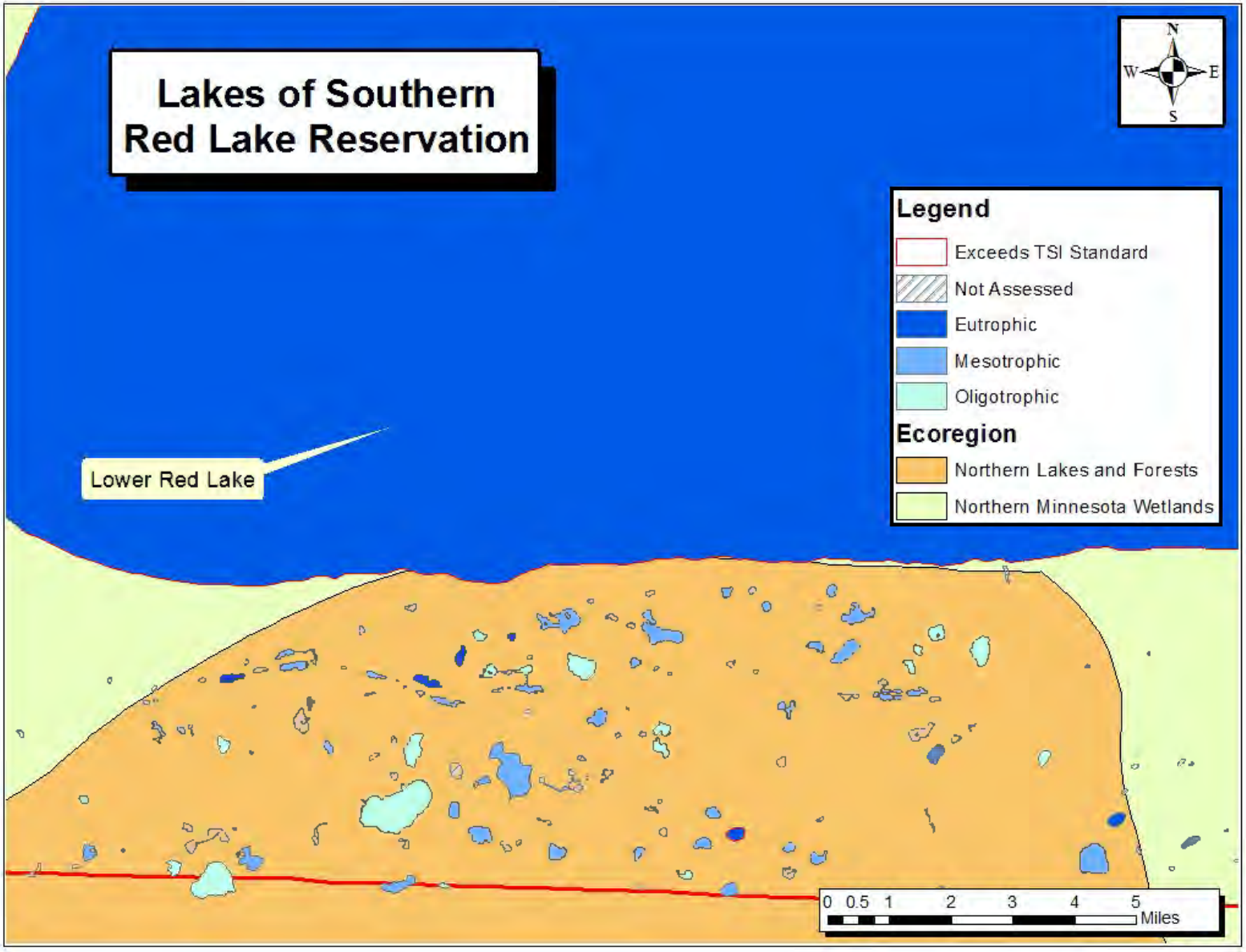

Figure 14: Lakes found in the southern portion of the Reservation. Colors indicate ecoregions and trophic class.

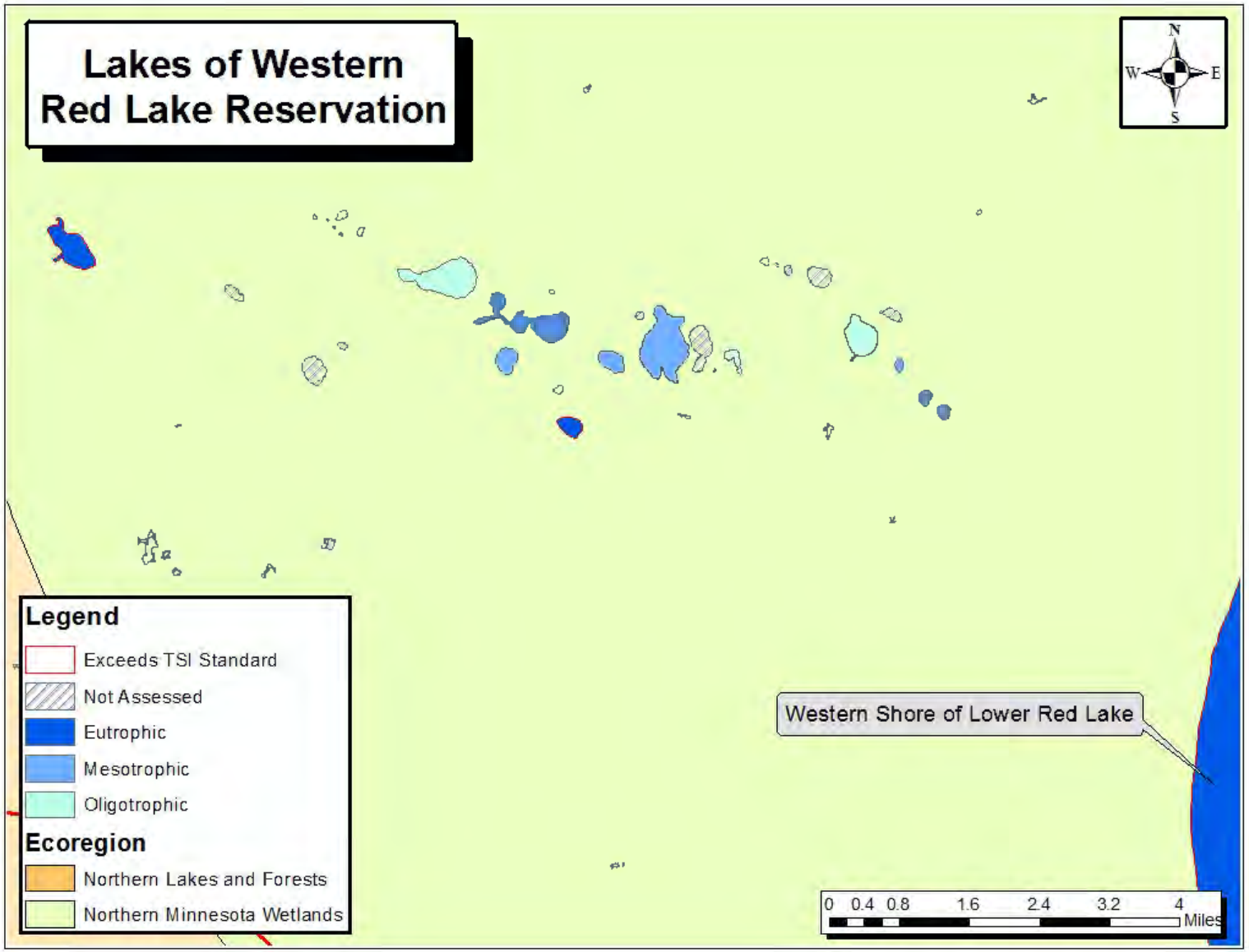

Figure 15: Lakes found on the western portion of the Reservation. Colors indicate ecoregion and trophic class.

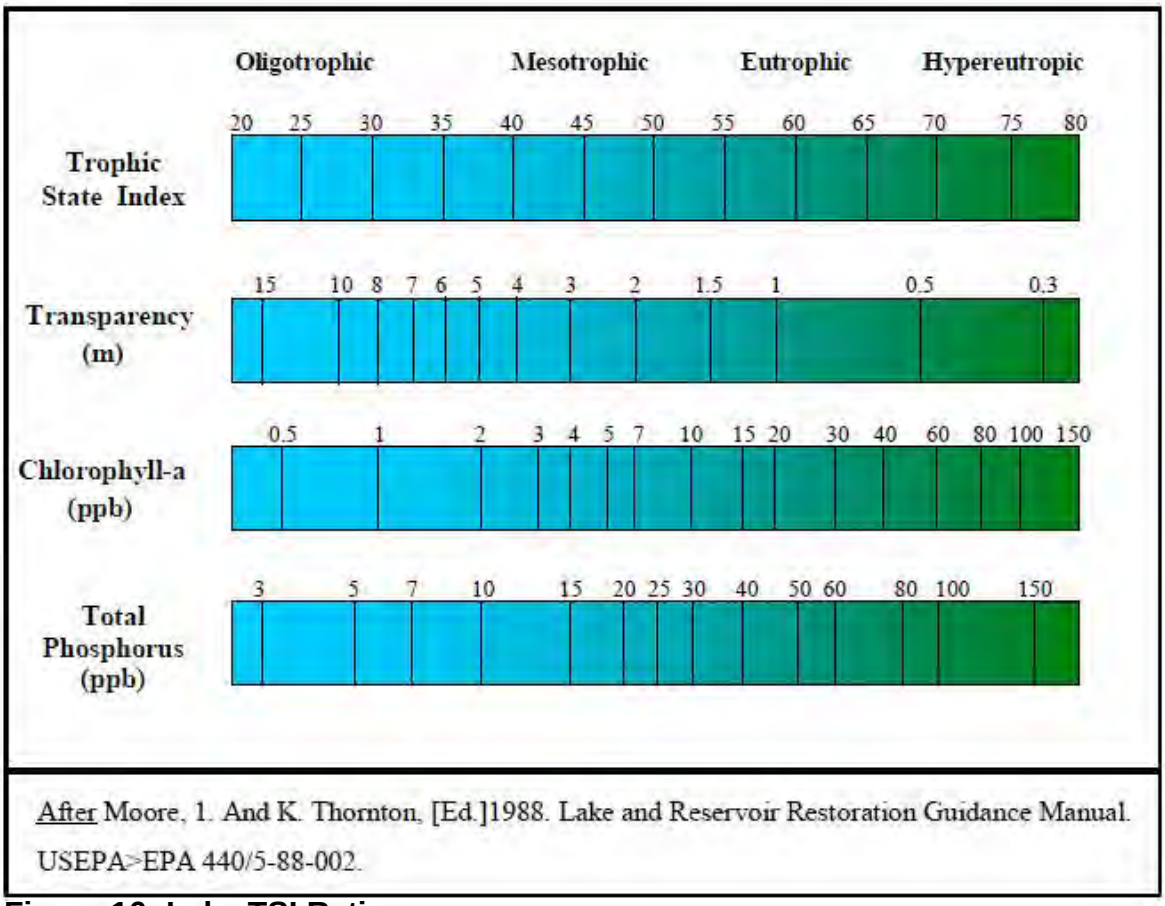

Figure 16: Lake TSI Rating

Assessment of Trophic Status:

The state of Minnesota contains nearly 12,000 lakes of more than 10 acres in size. Out of necessity, the MPCA has established TSI criteria for lakes based on ecoregion. To maintain uniformity, we will use these criteria on the lakes of the Red Lake Reservation for this assessment. However, in future assessments it is our intent to establish lake specific criteria and to conduct careful trend analyses rather than rely on very general criteria.

MPCA has developed criteria for the Northern Lakes and Forests (NLF) ecoregion based on an analysis of 30 reference lakes with TP measurements falling between 14—27. No specific criteria for the Northern Minnesota Wetlands (NMW) ecoregion has been developed. The lakes of this region tend to be shallow, surrounded by wetlands, and higher in nutrients. Ecoregion specific criteria should be established for these lakes. We are currently working on the development of one. Until development is complete, we will continue to use the NLF ecoregion criteria shown in Table 11 but will not designate lakes as impaired when they exceed the criteria without detailed review and analysis. Shallow lakes (Type 5 Open Water Wetlands) will not be designated as impaired when values exceed the ecoregion criteria, but trends will be analyzed and interpreted as appropriate.

Table 11: NLF Lake Trophic Status

Trophic Status Thresholds for Determination of Use Support for Lakes in the Northern Lakes and Forests Ecoregion According to MPCA.							
	TP ppb	Chl *a* ppb	SD m	TP Range ppb	TP ppb	Chl *a* ppb	SD m
305 (b): Designation	**Full Support: Not Listed**			**Partial Support Review**	**Non-Support: Listed**		
Raw Data	**<30**	**<10**	**≥1.6**	**30-35**	**>35**	**>12**	**<1.4**
(TSI)	(<53)	(<53)	(<53)	(53-56)	(>56)	(>55)	(>55)

The majority of Red Lake Reservation's lakes are located within the NLF ecoregion, with a small number of shallow lakes and the Upper and Lower Red Lakes in the NMW ecoregion. All lakes on the Reservation are located in the Red River Basin within HUCs 09020302, 09020303, and 09020305. For the purpose of this assessment, "lakes" will be considered bodies of water with a surface area of > 10 acres and a maximum depth of > 2m.

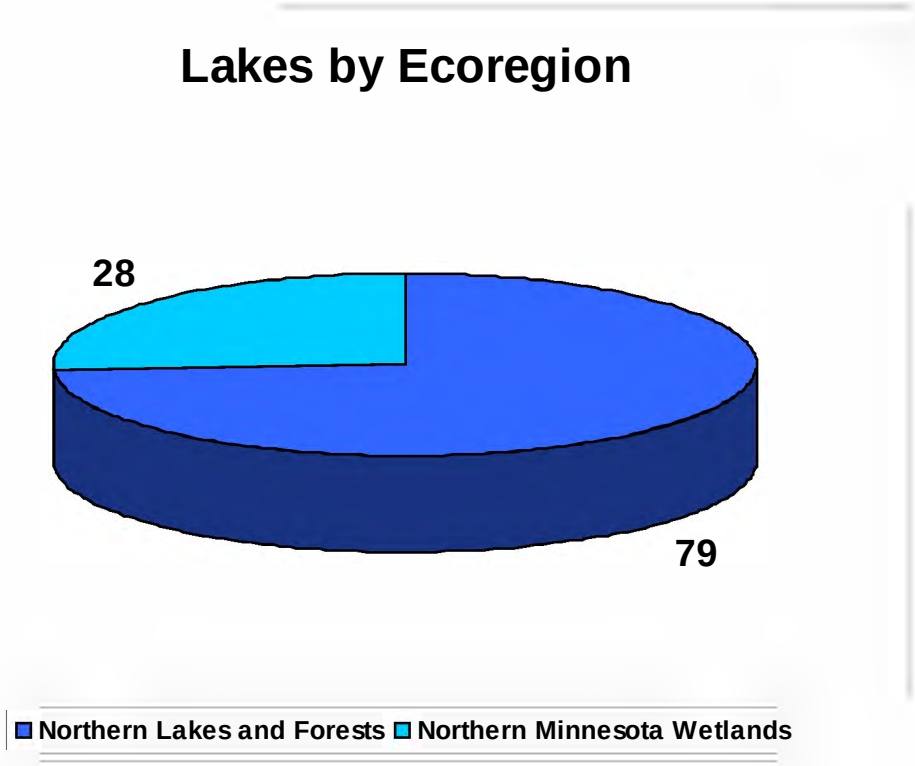

Figure 17: Number of Lakes by Ecoregion

All lakes located within the NLF ecoregion meet nutrient criteria with one exception. Dickens Lake has a geometric mean that sits just slightly above the accepted nutrient criteria (53.83). However, since 1998 water quality has steadily improved. Further analysis of this lake and land use practices will be conducted over the next two years to determine whether an impaired designation is appropriate. Current data suggests that a flood event in 1997 resulted in the destruction of a beaver impoundment and a massive influx of nutrients from a nearby wetland. The lake appears to be steadily recovering.

Lakes in the NMW ecoregion tend to be shallow lakes associated with large expanses of marsh and other wetland areas. Upper and Lower Red Lake are located immediately adjacent to the largest

peatland expanse in the United States. The nutrients feeding these lakes resulting in their heightened trophic status are believed to be natural and are not considered an impairment by the Band at this time. More important to the health of these systems is whether there is an upward trend in TP levels. Unfortunately, the nature of the bathymetry in these lakes results in constant resuspension of sediments and extremely variable TP concentrations. We believe that a more constant TP number may be achievable using winter samples only and will consider this as a future option. Analyzing past data have resulted in no increasing trends in any water quality parameters in Upper Red Lake but possible increases in Lower Red Lake (TP and Chl *a,* but not Secchi). Our major concern at this time in the Red Lakes is Mercury.

All other lakes with sufficient data fall below the NLF TP criteria. Furthermore, no single lake out of 27 with excellent data sets shows a significant increasing trend in nutrient concentrations. This was determined using regression analysis. Significance was determined using ANOVA. A number of lakes show slight increases or decreases in TSI concentrations over the past 10 years. Though not statistically significant, these lakes will be monitored more closely in the next 5 years to determine if trends exist.

Conclusions

There are three major conclusions derived during the development of the 2012 assessment. These conclusions are still valid.

1. **The quality of the waters of the Red Lake Reservation remains high.**
   Overall, streams of the Reservation exceed standards only in the case of high or low natural background conditions. The vast majority are very safe, healthy waters. Lakes on the Reservation show no major increasing trends in nutrient concentrations. They have seen very minimal development in the adjacent areas with no plans for future disturbance. This has contributed significantly to their overall health.

2. **Increased monitoring in some areas of concern is necessary.**
   The few streams that seem to show trends toward degradation will be monitored very closely in the upcoming years. We are still dedicated to developing a continuous monitoring program that will give us constant data on stream health. Lake monitoring frequency may need to be increased to estimate any significant trends. We feel that student and volunteer monitoring programs may help us solve this problem. Specific sites and water quality concerns include the following:

   Dissolved Oxygen levels in Blackduck, Battle, Pike, and Red Lake River stream sites.

   Due to this reports findings, the following sites on the Diminished Reservation will be monitored closely for potential impairments: BATT-I for DO, TP, temp; BATT-NB for DO, N+N, TP, *E. coli;* BATT-SB for TP, TSS, N+N; BLAC-H for TP, TSS, N+N, temp, *E. coli*; BLAC-I for DO, TP, temp; CLWR-B for TP, TSS, N+N, temp, *E. coli;* CORM-B for DO, TSS, TP, N+N, temp; MUDR-I for TP, TSS, temp, *E. coli*; MUDR-M for TP, TSS, temp, *E. coli*; PIKE-B for DO, TP, TSS, temp, *E. coli;* PIKE-I for N+N, TP, TSS, temp, *E. coli*; PIKE-OR for DO, TP, TSS, temp; REDL-O for TSS, pH, temp; ROCK-O for temp; SANR-U for TSS, temp, *E. coli*; TAMA-B for DO, N+N, TP, temp. Sites no longer sampled but still assessed included Blackduck River at BLAC-B (impaired for temp, TP, TSS), Tamarac River at TAMA-I (site no longer sampled; summary provided in table; no impairments analyzed), and Clearwater River at CLWR-D/09RD011 (not enough data to assess). Sites at the NWA

will be monitored for the following potential impairments: BEAR-I for temp; HARR-I for temp; PINE-I for DO; POPL-I for temp and turbidity; STON-I for DO and temp; and UNAM-I for TP and TSS. Most bioassessment sites don't currently have enough data to assess for potential impairments. See site summary pages for more detailed information.

Contributions of Tribal waters to Lake of the Woods water quality should continue to be monitored and assessed if funding can be acquired.

Lakes will continue to be monitored in keeping with our approved monitoring strategy.

3. **Water quality standards must be made a priority for the Band.**

   While water quality standard development has been a priority for years, progress has been slow. We plan to make every effort to get standards approved and in place in the next two years. This will greatly aid us in protecting waters of the Red Lake Reservation.