Hutchinson
Environmental Sciences Ltd.

Development and Application of a Water Quality Model for Lakes in the City of Greater Sudbury

Prepared for: The City of Greater Sudbury
Job #: J110057

January, 2014

Final Report

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January 13, 2013 HESL Job #: J110057

Stephen Monet
Manager, Environmental Planning Initiatives
City of Greater Sudbury
Sudbury, ON P3A 5P3

Dear Sir:

Re: Final Report - Development and Application of a Water Quality Model for Lakes in the City of Greater Sudbury

We are pleased to submit this final report that provides an approach to guide policy for the management of un-serviced lakeshore development on City of Greater Sudbury (CGS) area lakes that is protective of water quality. Our final report includes minor revisions to our draft submissions dated a) July 29th, 2013, to address comments from the Province and b) December 23rd, 2013 to address your comments of January 10th, 2014.

This has been a most challenging assignment as the Province's recommended approach to setting lakeshore development capacity proved not to be fully suited for CGS lakes due to inaccuracies in Province's Lakeshore Capacity Model predictions. We have therefore developed an alternate approach that classifies lakes into categories that require different levels of management protection for consideration in policy. The classification system is based on three criteria including long-term records of measured phosphorus concentrations, the degree of phosphorus loading from human sources relative to natural sources, and the responsiveness of lakes to phosphorus loading. This approach will provide the CGS with a technically sound framework for setting planning policies for un-serviced shoreline development that meet the intent of the Provincial Water Quality Objective for phosphorus in Precambrian Shield lakes and the Provincial Policy Statement.

In closing, we thank the City for selecting Hutchinson Environmental Sciences Ltd. to complete this project.

Sincerely,
Hutchinson Environmental Sciences Ltd.

T.KRR

Tammy Karst-Riddoch, Ph.D.
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Signatures

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Executive Summary

The City of Greater Sudbury (CGS) retained Hutchinson Environmental Sciences Ltd. to provide technical guidance for the development and redevelopment of unserviced shoreline lots in support of Official Plan policies that are protective of water quality, technically sound, defensible, and which meet the intent of the Provincial Water Quality Objectives and Provincial Policy Statement.

The Provincial Water Quality Objective (PWQO) for lakes on the Precambrian Shield allows human sources to increase phosphorus by 50% over a modeled background concentration to a maximum of 20 μg/L. The Province recommends the use of their Lakeshore Capacity Model (LCM) to assess background phosphorus concentration and to determine the amount of unserviced shoreline development that can occur on lakes to meet the PWQO for phosphorus.

The LCM was developed using the most recent Provincial guidance and suggested input parameters and coefficients. It was applied on a watershed scale to include all lakes with a surface area greater than 10 ha within the CGS, as well as 44 upstream lakes that drain to them but that lie beyond city boundaries, for a total of 354 lakes within a total watershed area of 7,559 km^2.

Evaluation of LCM results against measured phosphorus concentration data collected for 65 lakes between 2001 and 2012 by the CGS revealed that the model does not provide sufficiently accurate predictions of phosphorus concentration in CGS lakes to determine defensible capacity limits for unserviced shoreline development using the Provincial approach.

Evaluation of model variance against the model's input parameters and assumptions did not identify any systematic source of error, suggesting that error is due to multiple sources. Overall, the model had a tendency to overestimate phosphorus concentrations in lakes with human development in the watershed.

An alternate approach to water quality protection was therefore recommended that uses those components of the LCM for which there is a greater degree of confidence to provide the necessary defensibility and rigour to policy. The criteria include:

1. Whether or not the existing phosphorus load to the lake is 50% greater than the natural or "background" load.
2. Whether the lake has a High Responsiveness or Low Responsiveness to phosphorus loading.

The criteria were used to classify CGS area lakes into three categories of protection for planning policies ("Enhanced", "Moderate" and "Standard") based on the following matrix:

Management Classification of CGS Lakes

	P load ≥BG+50%	P load <BG+50%
High Responsiveness	Enhanced (33 lakes)	Moderate (112 lakes)
Low Responsiveness	Moderate (30 lakes)	Standard (179 lakes)

We recommend the development of planning policies for new shoreline un-serviced lot creation that would a) prevent additional phosphorus loads to “Enhanced” management lakes, b) minimize phosphorus loads as much as possible to avoid degradation of water quality in “Moderate” management lakes, and c) to foster best management practices that would mitigate phosphorus loads to “Standard” management lakes.

The management approach also recognizes three triggers based on measured or observed responses to phosphorus loading. If phosphorus concentration in a lake exceeds 20 μg/L, if there is an increasing trend in phosphorus concentration (or a decreasing trend in water clarity or hypolimnetic oxygen), and/or a bluegreen algal bloom is reported and confirmed, more investigation should be considered by the City to evaluate the cause of the trend or bloom and to respond as required by amendments to policy or through lake-specific Watershed Management Plans that are being developed by the City.

Continued monitoring is recommended to track changes in water quality so that management efforts can be assessed and revised over time if necessary, but also to improve estimates of phosphorus loads to refine the management classification of lakes.

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1. Introduction

The City of Greater Sudbury (CGS) retained Hutchinson Environmental Sciences Ltd. to provide technical guidance for the development and redevelopment of unserviced shoreline lots in support of Official Plan policies that are protective of water quality, technically sound, defensible, and which meet the intent of the Provincial Water Quality Objectives and Provincial Policy Statement.

Water quality means many things and can be expressed in different ways. Water quality in the CGS area lakes has been impaired by more than a century of atmospheric acid and metal deposition from mining and smelting activities, but has been on a trajectory of recovery in the past several decades. Management of these stressors extends beyond the activities of the CGS, and also requires coordinated action among industry, and provincial and federal governments. Other water quality stressors include discharge of treated municipal effluent, urban runoff and shoreline development. These activities introduce nutrients, specifically phosphorus, to surface waters. Nutrient enrichment, or “eutrophication”, can result in losses of water clarity, increased potential for unsightly and even toxic blooms of algae and cyanobacteria and depletion of oxygen in the deeper portions of stratified lakes. Understanding the interactions between nutrient enrichment, metal and acid stress is beyond the scope of this project, but nutrient inputs to the lakes can be managed by land-use policies.

The Provincial Water Quality Objective (PWQO) for lakes on the Precambrian Shield allows human sources to increase phosphorus by 50% over a modeled background concentration to a maximum of 20 μg/L in order to protect water quality from eutrophication, (MOE et al., 2010). Background phosphorus concentration is the concentration that would occur in a lake without the influence of human activities in the watershed. The Province recommends the use of the Lakeshore Capacity Model (LCM; MOE et al., 2010) as a tool to assess the amount of unserviced shoreline development that can occur on lakes to meet the PWQO for phosphorus. The model calculates the background concentration, adds 50% to this figure and then determines the amount of unserviced shoreline development that would cause phosphorus concentrations to rise to this level while taking into account existing human phosphorus sources in the watershed. Human sources of phosphorus are determined using information on shoreline development type and density, land use characteristics and point sources of phosphorus along with assumptions on phosphorus loading from each of these human sources.

Although advocated by the MOE, in practice, the LCM may not be accurate enough to support strict lakeshore development capacities expressed as numbers of unserviced shoreline residences. The model provides good estimates of phosphorus loads and how a lake responds to those loads, however, and where the model fails to provide accurate predictions of phosphorus concentrations, it can still provide valuable information upon which to base management decisions. The LCM can be best used as a screening tool to a) link all lakes in a watershed together and b) identify those lakes which are sensitive to phosphorus loading; but should not be considered as a substitute to a lake specific management plan that is based on good site-specific measurements, local knowledge and the input of lake users.

Since 2000, the CGS has implemented a Lake Water Quality Program, which collects data on lake health and promotes stewardship practices among shoreline residents. In addition, the CGS has several water protective policies in its current Official Plan. Development of a technically sound and defensible enhancement of existing land-use policies for unserviced shoreline lot development was approached on this project through the following steps:

- Apply the Provincial LCM to lakes in the City of Greater Sudbury on a whole watershed scale to determine background phosphorus concentration and predict how the lakes respond to existing and future human phosphorus loads.
- Assess the accuracy of the LCM predictions and ensure that the assumptions, variables and data used as input to the model are accurate, sound and defensible.
- Provide recommendations to manage shoreline development of un-serviced lots that recognizes limitations of the LCM and the intent of the PWQO and Provincial Policy Statement for the protection of water quality.

2. CGS Lakes and Watersheds

Phosphorus is readily transported by water. It enters surface water from precipitation, tributary flow, overland runoff, direct discharge and groundwater. In lakes, the concentration of phosphorus is determined by the quantity of water in the surface water body, mixing regimes that influence loss to the sediments and outflow which transports water carrying phosphorus downstream. Hydrological connectivity of lakes is therefore important in the determination of phosphorus loads and concentrations in surface water as phosphorus contained in an upstream lake forms part of the phosphorus load to downstream lakes, and is the basis for the watershed-scale approach used in the LCM.

There are 310 lakes with a surface area greater than 10 ha in 23 subwatersheds within the CGS as well as 44 upstream lakes that drain to them but that lie beyond city boundaries. The LCM was set up to include all of these lakes for a total of 354 lakes within a total watershed area of 7,559 km^2 (Figure 1). A complete list of lakes, their geographic coordinates, surface areas and local catchment areas are provided in Appendix A and a map illustrating hydrological connectivity is provided in Appendix B.

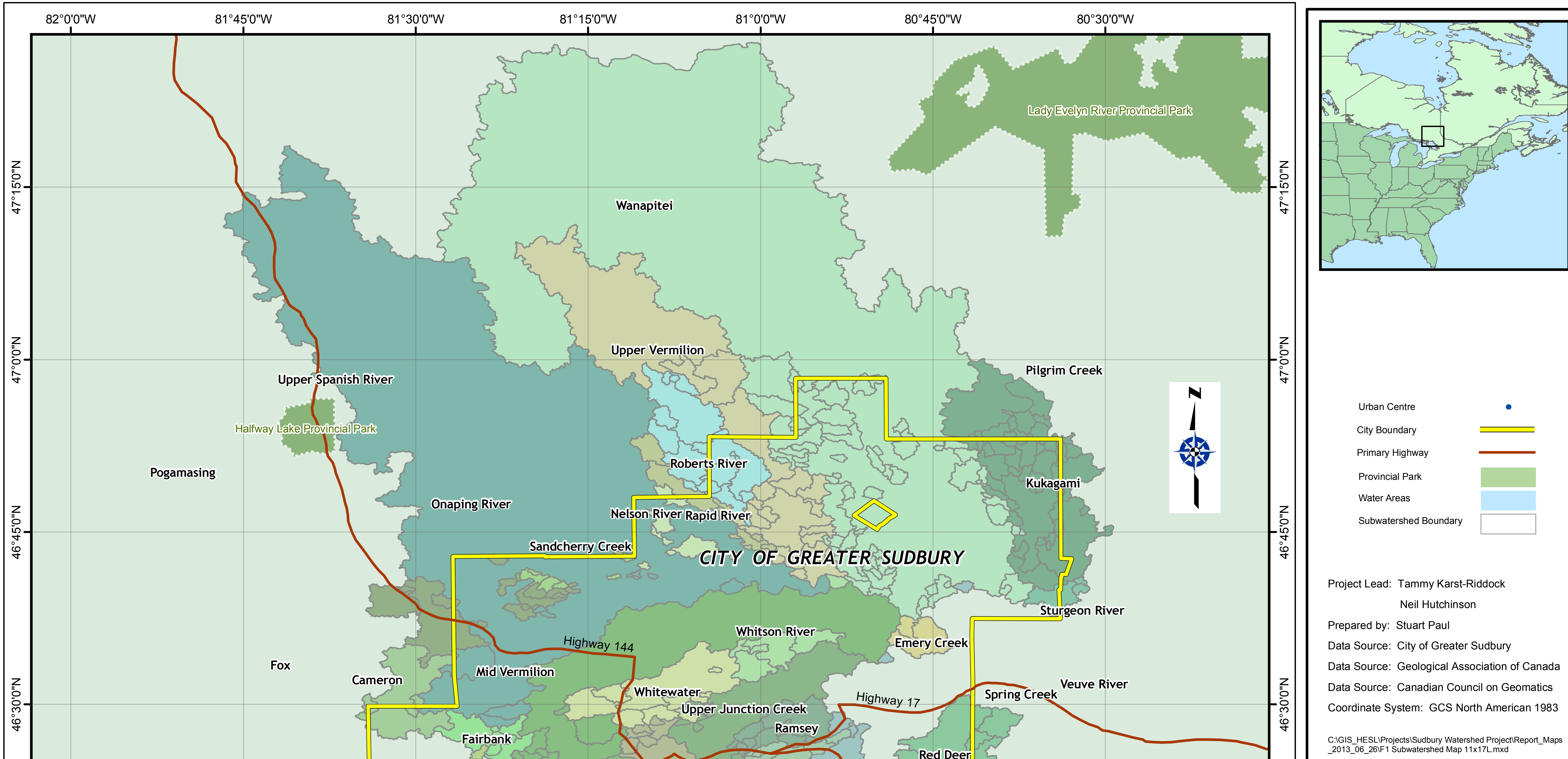


Figure 1: City of Greater Sudbury Subwatersheds

J110057

June, 2013

Hutchinson Environmental Sciences Ltd.

3. Existing Phosphorus Concentration in CGS Lakes

Confidence in the LCM's ability to predict phosphorus concentration requires validation of model results against measured values. The LCM is a steady-state model, that is, it predicts long-term average conditions, and so results should be validated against long-term measured data to account for inter-annual variability in phosphorus measurements. The Province recommends the collection of at least two years of spring overturn total phosphorus data to be 95% confident of being within 20% of the long-term mean concentration (MOE et al., 2010) for comparison with the LCM results.

The CGS has been monitoring total phosphorus concentrations in lakes since 2001 following the Province's Lake Partner Program (LPP) protocol. For this program, duplicate water samples are collected in spring before stratification. The samples are field-filtered with an 80-μm mesh screen to remove coarse materials and analyzed for total phosphorus concentration at the Trent University laboratory at the Dorset Environmental Science Centre (DESC), in Dorset, ON. DESC provides the lowest available detection limit (and resultant precision) in the Province (2 Standard Deviations between duplicates = +/- 0.7 μg/L), and this lab analyzes all phosphorus samples collected for the LPP.

Phosphorus concentration data from the CGS water quality monitoring program were screened for data quality (i.e., sample contamination, statistical outliers) and used to calculate the long-term phosphorus concentration of lakes for evaluation of the LCM model results and to identify trends. While total phosphorus concentration data have been collected for Greater Sudbury area lakes by other agencies, only the CGS data are assessed in this study to ensure consistency (i.e., timing and location of sample collection, laboratory methods and detection limits).

3.1 Phosphorus Data Screening

A consistent percentage of the samples (~5%) analyzed at the DESC laboratory have larger than expected differences between field duplicates. Much investigation has failed to identify the cause for these differences, but in almost every case when the samples were reanalyzed, the retested pair of samples agreed with the lower of the two original samples in the bad split (Bev Clark, pers. comm.). Field duplicates for the Sudbury data set that differed by more than 5 μg/L or by more than 30% were considered to be bad splits (Hyatt et al., 2011) and the higher value was discarded in each case.

In relatively small datasets, the calculation of average total phosphorus concentration is sensitive to outliers, that is, extreme values that are not representative of the site condition. Outliers were assessed statistically using the Grubb's Test (Grubbs, 1969) and the Dixon Test (Dean and Dixon, 1951). These tests only identify outliers that are extreme maximum values, and low outliers were identified if the minimum value was ≤50% of the mean concentration. Low outliers may occur due to laboratory error or mislabelling of samples.

3.2 Results

Spring total phosphorus concentration data collected by the CGS (2001-2012) exist for 66 Sudbury area lakes located in 19 subwatersheds of which 61 lakes have at least two years of data to confidently assess the long-term mean concentration (Table 1). Bad splits were identified for 10% of the sample pairs (50 of 498 sample pairs) from 32 of the lakes. This percentage is higher than the percentage of bad splits for samples analyzed at the DESC (~5%), and so continued vigilance in following sampling protocol is recommended when collecting water samples to minimize the potential for sample contamination. Nine outliers were identified by both the Grubb's and Dixon tests and were removed from further analysis. Five suspected outliers with extreme low values were also removed from the analysis. These outliers should be reassessed by comparison with data from additional years of sampling as the monitoring program progresses. All phosphorus data and samples identified as bad splits or outliers are provided in Appendix C.

Overall, the lakes monitored by the CGS have a similar distribution of total phosphorus concentration as Ontario lakes monitored by the LPP (Figure 2). The majority of the lakes (61%) are oligotrophic with total phosphorus concentration less than 10 μg/L, which is the same percentage of oligotrophic lakes observed in the Ontario LPP lakes set. A greater number of the CGS lakes (46%), however, have concentrations less than 6 μg/L in comparison to 21% for other lakes in Ontario. Twelve percent of the CGS monitoring lakes are considered eutrophic with total phosphorus concentration greater than 20 μg/L, and exceed the interim Provincial Water Quality Objective (PWQO) for the protection of aquatic life (MOE, 1994). The remaining 27% of the monitored lakes are mesotrophic with total phosphorus concentrations between 10 and 20 μg/L.

Fifty seven of the sixty six 66 lakes that are presently monitored by the CGS have at least three years of measured total phosphorus concentration data and so were assessed for trends. There were no significant (p<0.05) increasing trends in total phosphorus concentrations in any of those lakes based on linear regression or the Kendall test for data with normal or non-normal distribution of residuals, respectively. Twelve lakes displayed a significant decrease in total phosphorus concentration including Ramsey Lake, an important source of municipal drinking water (Table 2). The reason for the decrease cannot be determined by the present study, but may be due to lower phosphorus loading from reduced human sources (e.g., septic hook-up to sanitary sewer, improved treatment of sewage effluent, implementation of BMPs), watershed processes that alter nutrient supply (e.g., reduced nutrient loading with forest re-growth, changes in hydrology) or even broader regional-scale changes related to climate and acid deposition. Several lakes on the Canadian Shield in south central Ontario have displayed a decrease in total phosphorus concentration over the last decade in the absence of increased human activity in their watersheds suggesting that this may be a regional scale process (Eimers, 2009; Quinlan et al., 2008; Yan et al., 2008), which could be influencing Greater Sudbury area lakes as well.

Table 1. Mean Spring Overturn Total Phosphorus (TP) Concentrations in City of Greater Sudbury Area Lakes (2001-2012, n=66)

Lake	Sub-watershed Code	Mean TP (µg/L)	N_{years}	Std. Dev.	Lake	Sub-watershed Code	Mean TP (µg/L)	N_{years}	Std. Dev.
Ashigami	S	4.5	4	0.5	Long	P	7.2	9	0.8
Beaver (Big)	LV	14.8	5	4.1	Makada	P	5.9	8	0.8
Beaver (Little)	LV	23.0	6	3.3	Matagamasi	K	3.9	4	1.7
Bethel	R	36.9	7	8.9	McCharles	LV	29.7	10	12.8
Brodill	EWR	5.5	7	1.7	McCrea	WR	10.6	7	2.7
Camp	P	3.4	7	0.5	McFarlane	P	10.7	11	1.8
Chief	EWR	5.5	6	3.8	Middle	R	5.8	7	0.7
Clear	OR	2.6	1		Minnow	R	37.2	11	11.2
Clearwater	P	3.3	6	0.7	Mud	LJC	46.8	7	17.0
Crooked	UJC	11.2	7	4.5	Nelson	NR	3.7	7	0.7
Crowley	P	5.5	6	1.9	Nepahwin	R	12.3	11	2.7
Daisy	P	4.1	2	0.8	Onwatin	UV	7.6	6	0.6
Dixon (Little Joe)	RPR	4.2	1		Panache	P	4.9	9	1.3
Ella (Capreol)	W	5.3	7	1.2	Pine	P	4.0	4	0.5
Ella (Lorne)	LV	7.8	7	4.1	Raft	EWR	6.5	9	1.7
Fairbank	FB	4.8	10	0.7	Ramsey	R	10.8	10	3.1
Forest	P	3.7	6	0.6	Rat (Kusk)	LV	14.8	8	1.8
Frenchman	UV	4.8	9	1.3	Red Deer	RD	20.0	5	4.2
Garson	WR	13.8	2	1.0	Richard	P	9.3	10	1.6
Gordon	MV	9.4	7	3.5	Robinson	R	24.0	9	3.9
Grassy	LV	15.9	7	2.2	Silver	P	6.1	8	1.8
Greens	UV	5.9	1		Simmons	MV	16.0	2	1.1
Hanmer	UV	4.7	8	0.7	Simon	LJC	33.3	11	8.6
Hannah	R	6.7	6	0.5	Skill	FB	11.7	6	1.6
Ironside	RBR	5.7	6	1.1	St. Charles	R	10.7	8	1.6
Joe	RPR	4.1	8	0.6	T (Dill)	EWR	17.6	8	7.4
Kasten (Bibby)	EWR	11.7	5	4.1	Tilton	P	4.9	8	1.1
Kelly	UJC	23.7	2	2.0	Vermilion	MV	10.8	8	1.9
Kukagami	K	3.5	5	0.6	Wanapitei	W	4.1	3	1.5
Linton	P	4.8	5	1.3	Whitewater	WW	16.8	10	5.9
Little Panache	P	12.4	11	4.1	Whitson	WR	6.0	7	0.8
Little Raft	EWR	9.6	7	1.6	Windy	OR	3.5	7	0.7
Lohi	P	5.1	9	1.6	Wolf (Broder)	K	4.4	1	

Figure 2. Comparison of the distribution of spring overturn total phosphorus concentration in CGS lakes and other Ontario lakes monitored by the MOE Lake Partner Program.

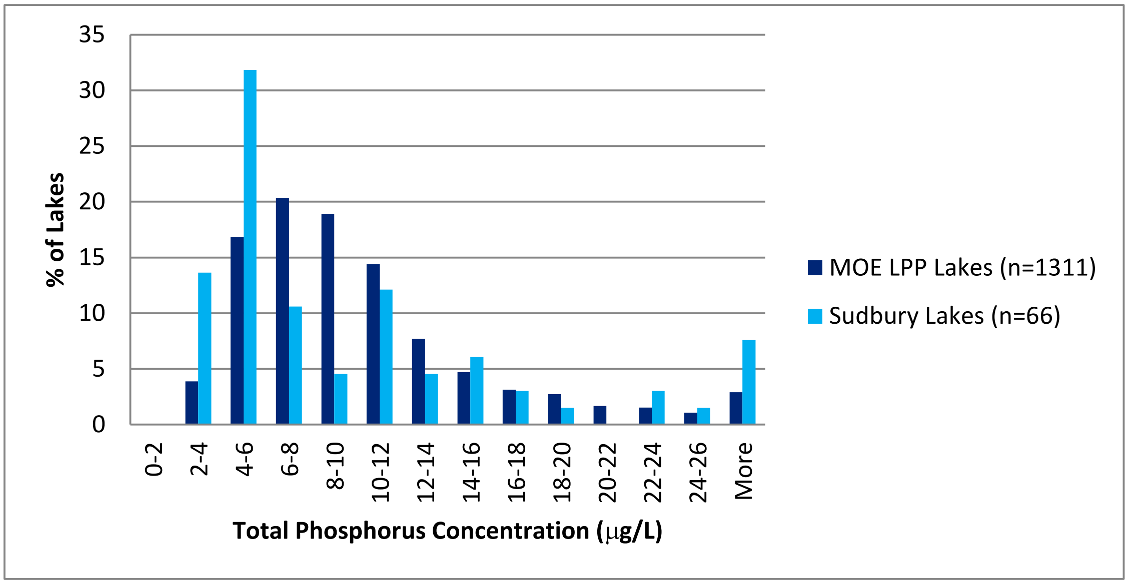


Table 2. CGS Lakes with Significant Decreasing Total Phosphorus Concentrations

Lake	n_{years}	Slope	R^2	Significance (*p*-value)	Mean TP_{so} (µg/L)
Bethel	7	-1.99	0.68	0.00	36.9
Brodill	7	-0.27	0.40	0.01	5.5
Clearwater	6	-0.21	0.35	0.02	3.3
Crooked	7	-1.04	0.56	0.03	11.2
Gordon	7	-0.90	0.70	0.01	9.4
Hanmer	8	-0.15	0.70	0.01	4.7
Linton	5	-0.25	0.71	0.00	4.8
Little Raft	7	-0.33	0.51	0.04	9.6
McFarlane	11	-0.34	0.46	0.01	10.7
Ramsey	10	-0.71	0.73	0.00	10.8
T (Dill)	8	-1.41	0.47	0.04	17.6
Vermilion	8	-0.39	0.75	0.00	10.8

4. Lakeshore Capacity Model (LCM) Development

The LCM was developed for CGS lakes using the most recent Provincial guidance and suggested input parameters and coefficients (MOE et al., 2010), which are summarized in Table 3. The model includes all lakes with a surface area greater than 10 ha within the CGS as well as upstream lakes that drain to them that lie beyond city boundaries, for a total of 357 lakes.

The following sections describe the various input parameters and calculations used to develop the model.

Table 3. Summary of Model Input Parameters

Parameter	Value
Precipitation P Deposition Rate (mg/m²/yr)	16.70
P-export (mg/m²/yr)	
Wooded area (<15% cleared area)[1]:	
Wetland Area <3.5%	5.50
Wetland Area ≥3.5%	(0.47 * wetland area) + 3.82
Cleared area (<15% forested area):	
Wetland Area <3.5%	9.80
Wetland Area ≥3.5%	((0.47 * wetland area) + 3.82)*1.8
Urban Area (low intensity)	50
Urban Area (high intensity)[1]	132
Lake shore lot	9.80
Golf Courses	14
Usage Figures (capita years/yr)	
Permanent Occupancy	2.56
Seasonal Occupancy	0.69
Extended Seasonal	1.27
Resorts	1.18
Campgrounds/Tent Trailers/RV parks	0.37
Phosphorus Supply from Tile Field (kg/capita/yr)	
Cottages, Residences, Tent/trailers (within 300 m of shoreline)	0.66
Youth Camps (kg/camper/year) (70 days at 1.8 g/camper/day)	0.125
Average Developed Areas (m²/unit) (may be smaller than actual lot size)	
Shoreline Lot	3,789
Resort/Trailer lot	1,000

Notes: [1]The Lakeshore Capacity Handbook does not provide a suggested phosphorus export coefficient for high intensity urban development and a value of 132 mg/m^2/year was used, which has been accepted and used by the MOE in other studies (e.g., HESL et al., 2011).

4.1 Background Phosphorus Sources

Background sources of phosphorus include natural runoff loading from the watershed, atmospheric loading, and internal loading. The following sections describe the modeling values used for each of these natural sources

4.1.1 Runoff Loading

Natural phosphorus loads from the overland runoff in the watershed originate from phosphorus-bearing soils and decomposed organic matter. Groundwater may also contribute to natural phosphorus loads, but in Shield environments, these contributions are considered negligible or are reported as surface water given interception of shallow subsurface groundwater flow (close connectivity between shallow groundwater and surface waters) (Paterson et al., 2006). Two different estimates of natural load were used:

- Where wetlands represented less than 3.5% of the catchment, phosphorus export coefficients of 5.5 and 9.8 mg/m^2/yr were used for forested and cleared (>15% cleared area) catchment areas, respectively (Paterson et al., 2006).
- Wetlands can significantly increase phosphorus loads from the watershed (Dillon and Molot, 1997). Twenty years of monitoring data at 20 lake watersheds in central Ontario by the Dorset Environmental Science Centre (DESC) showed that natural phosphorus loads increased with wetland area following the equation:

  P export (kg/yr) = catchment area (km^2) * (0.47 * % wetland area + 3.82)

  This wetland equation was therefore used to determine phosphorus load to lakes with ≥3.5% wetland area in their catchment. For cleared catchments, this load was multiplied by 1.8 following Paterson et al. (2006).

4.1.2 Atmospheric Loading

In nature, phosphorus has almost no gaseous forms and so the major transport mechanism is by water flow. Nevertheless, significant amounts of phosphorus are transported via the atmosphere as dust or rainfall, and exported to lakes by deposition. For many lakes, atmospheric deposition constitutes a significant portion of the total phosphorus load, particularly for those lakes with a large surface area relative to their catchment area, such as headwater lakes.

Atmospheric loads are difficult to measure due to complexities with the collection and interpretation of precipitation chemistry data. It is preferable to use estimates derived from regional, long-term study locations where reliable estimates of phosphorus in rainfall have been derived using long-term, multiple station datasets. In this case, a phosphorus deposition rate of 0.167 kg/ha/yr derived from 17-year records (1984-2001) at three meteorological stations at the Ontario Ministry of the Environment's Dorset Environmental Science Centre represent the nearest relevant deposition values and the best available record.

Atmospheric loads to land surfaces are captured by the export coefficients used to calculate watershed loads in Section 4.1.1.

4.1.3 Internal Phosphorus Loading

Phosphorus in lake sediments can contribute a large portion of the total phosphorus loading to lakes through a process called “internal phosphorus loading”. This can occur in shallow, non-stratified lakes where wind mixing causes resuspension of sediments into the water column. Phosphorus is released into the water column by mineralization of organic matter in the resuspended sediments. Release of phosphorus by mineralization of sediment organic matter can also occur in shallow areas of warm water bodies. Internal phosphorus loading can also occur in deep stratified lakes that have an anoxic hypolimnion, that is, no oxygen in the deep, cool layer of water that overlies the sediments. In that case, phosphorus is released from anoxic sediments and enters the water column.

Internal phosphorus loading was not calculated explicitly, but was accounted for in the model by adjusting the settling velocity of phosphorus in lakes with confirmed anoxia and in shallow lakes (see Section 4.3).

4.2 Human Phosphorus Sources

Human sources of phosphorus include point and non-point sources. Point source loads are direct inputs from a specific pollution source such as a waste water treatment plant or an industrial effluent discharger, and can be determined directly from measurements of concentration and volume of the discharge. Non-point sources are diffuse sources, which include septic systems, urban runoff (storm water) or runoff from agricultural areas and golf courses. These are difficult to measure on a site by site basis and so loads from these sources are generally estimated through the export coefficients presented in Table 3. Point and non-point sources may discharge directly to the water body or may enter from the watershed upstream of the water body.

4.2.1 Wastewater Treatment Plants (WWTPs)

Treated sewage discharge flows and phosphorus concentrations from wastewater treatment plants (WWTPs) and sewage lagoons were obtained from the CGS Annual Wastewater Reports (2007-2011). Mean annual phosphorus loads are provided in Table 4, and were calculated as:

$$\text{Phosphorus Load} = \text{Discharge X Total Phosphorus Concentration}$$

Table 4. Average Annual Effluent Discharge, Phosphorus Concentrations and Loads from Sudbury Area Wastewater Treatment Plants and Sewage Lagoons (2007-2011)

Plant		Average Annual Discharge (m^3)	Average Effluent Total Phosphorus Concentration (mg/L)	Average Annual Phosphorus Load (kg/yr)
WWTPs	Azilda	866,688	0.28	241
	Chelmsford	1,568,966	0.22	339
	Coniston	398,443	1.47	587
	Dowling	683,816	0.53	362
	Falconbridge	96,088	0.11	11
	Levack	298,718	0.35	104
	Lively	369,223	0.42	157
	McFarlane[1]	15,464	0.34	5
	Sudbury	21,309,120	0.35	7,373
	Valley East	2,068,962	0.44	902
	Walden	902,830	0.41	374
Lagoons	Capreol	980,158	1.59	1,543
	Chelmsford[2]	16,155	no data	no data
	Garson[3]	152,868	2.88	812
	Wahnapitae	362,334	0.13	50

Notes: [1]2005-2007 data only; [2]diverted to Chelmsford WWTP but receives emergency bypasses, no loads were assumed from this lagoon due to bypass events in the model; [3]diverted to the Sudbury WWTP since 2009

4.2.2 Septic Systems

Calculation of phosphorus loads from septic systems within 300 m of the shoreline of a lake or tributary follows the approach recommended by MOE et al. (2010) where:

Load per septic system (kg) = per capita phosphorus load (kg/capita/yr) * occupancy rate (capita yrs/yr)

The per capita phosphorus load to septic systems is estimated to be 0.66 kg/capita/yr based on a review of measured data and the literature pertaining to phosphorus concentrations in septic systems and average water usage (Paterson et al., 2006). Occupancy rates of 2.56, 1.27, 0.37 capita yrs/yr were applied to permanent residences, extended-seasonal residences, and campgrounds/tent trailers, respectively. Extended seasonal occupancy rate was chosen over the lower seasonal value of 0.69 capita yrs/yr as it was assumed that in most cases, seasonal residences would have reliable year-round road access. For youth camps, a load of 0.125 kg/camper/yr (1.8 g/day per camper over 70 days) was used.

The total number of septic systems and occupancy rates (permanent or seasonal) was estimated by the number of un-serviced lots that lie (wholly or in part) within 300 m of the shoreline of lakes based on data provided by the CGS. Campgrounds and the number of campsites/tent trailer sites and youth camps and number of campers were identified by a desktop search including Google Earth imagery.

While shoreline septic systems can be a significant source of phosphorus to lakes, recent scientific studies have shown that much of the septic phosphorus load is attenuated by acidic and mineral-rich soils found in the Precambrian Shield. Mechanistic evidence (Stumm and Morgan, 1970; Jenkins et al., 1971; Isenbeck-Schroter et al., 1993) and direct observations made in septic systems (Willman et al., 1981; Zanini et al., 1997; Robertson et al., 1998; Robertson, 2003, Robertson, 2008) all show strong adsorption of phosphate on charged soil surfaces and mineralization of phosphate with iron (Fe) and aluminum (Al) in soil. The mineralization reactions, in particular, appear to be favoured in acidic and mineral rich groundwater in Precambrian Shield settings (Robertson et al., 1998; Robertson, 2003), such that over 90% of septic phosphorus may be immobilized. The mineralization reactions appear to be permanent (Isenbeck-Schroter et al., 1993). Recent studies conclude that most septic phosphorus may be stable within 0.5 m of the tile drains in a septic field (Robertson et al., 1998, Robertson, 2003).

Trophic status modelling also supports the mechanistic and geochemical evidence of phosphorus attenuation by soils. Dillon et al. (1994), for example, reported that only 26% of the potential loading of phosphorus from septic systems around Harp Lake, Muskoka, could be accounted for in the measured phosphorus budget of the lake. The authors attributed the variance between measured and modelled estimates of phosphorus to retention of septic phosphorus in thick tills in the catchment of Harp Lake.

Potential septic system phosphorus loads were estimated assuming that all of the septic phosphorus moves to lakes (0% attenuation by soils), following MOE guidance. Attenuation of septic phosphorus by soils was investigated as a possible source of error in the model predictions by running the model with 76% attenuation of septic phosphorus in line with the findings of Dillon et al. (1994) (see Section 5.1.5).

4.2.3 Land Use

4.2.3.1 Agriculture

Agricultural lands in the CGS are located primarily within the “Valley” along the Whitson River. Agricultural lands also occur in Rayside-Balfour draining to Vermilion Lake and in the Whitewater Lake subwatershed. All of these agricultural areas eventually drain to the Vermilion River. Agricultural practices are mixed and include livestock operations (horse, sheep, cattle, pigs) with pasture and cropland. A phosphorus export coefficient of 30 $mg/m^2/yr$ for cropland was chosen for the agricultural areas, which is the mean export from 198 watersheds draining cropland in North America calculated by Chambers and Dale (1997; range = 12-39 $mg/m^2/yr$) and recommended for use in MOE’s Lakeshore Capacity Model (MOE et al., 2010). Phosphorus export from the agricultural areas could be refined with more detailed agricultural land use data (e.g., area and type of cropland, number and type of livestock).

4.2.3.2 Urban Lands

Urban runoff includes runoff from paved areas, disturbed surfaces, parking lots, lawns (fertilized and non-fertilized) and rooftops. This runoff can contain phosphorus from direct additions (i.e., fertilizers, animal droppings) and indirect sources such as erosion induced by increased runoff. The characteristics of urban runoff will therefore vary with the contributing areas and sources.

The LCM recommends a phosphorus export coefficient of 50 mg/m^2/yr for low intensity urban areas on the Precambrian Shield. This coefficient was applied to urban lands with the exception of those in larger urban centres. A higher export coefficient of 132 mg/m^2/yr developed by the MOE for application to high intensity urban areas (HESL, 2012) was used for larger urban centres of the CGS including Azilda (Whitewater Lake), Capreol (Marshy and Greens lakes), Sudbury (Ramsey, Kelly, Minnow, McFarlane, St. Charles Robinson and Nepahwin lakes), Falconbridge (Norway Lake), Lively (Mud Lake), Walden (Simon Lake), Val Therese (SU-235) and Chelmsford (SU-235).

4.2.3.3 Golf Courses

A phosphorus export of 0.28 kg/hole was used to calculate phosphorus loads from golf courses (Hyatt et al., 2011), which was derived from an estimated phosphorus export of 14 mg/m^2/yr for cleared area at Precambrian Shield golf courses (Winter and Dillon, 2006) and assuming that each hole has, on average, 20,000 m^2 of cleared area. Golf courses and the number of holes for each golf course were identified by a desktop search.

4.3 Phosphorus Retention in Lakes

Not all phosphorus contained in a lake is passed on to downstream lakes because a portion of the phosphorus is lost from the water column to the sediments. This portion is estimated in the model by a retention coefficient that describes the proportion of the phosphorus load to a lake that is expressed as concentration. Retention (R) is based on the relationship between the areal water load (q_s) to a lake and the settling velocity (v) of phosphorus where $R = v/(v+q_s)$. The settling velocity of phosphorus is 12.4 m/yr for stratified oligotrophic lakes on the Precambrian Shield and 7.2 m/yr for those lakes with anoxic hypolimnia. The lower settling velocity is used for lakes that have an anoxic hypolimnion as a surrogate to account for internal phosphorus loading (i.e., the release of phosphorus from sediments) that occurs under anoxic conditions.

The model was developed to predict phosphorus concentrations in stratified lakes and so is not well suited for use with shallow lakes. In shallow lakes, phosphorus is less likely to settle to the lake sediments as the lakes are more subject to wind mixing and the LCM therefore tends to underestimate the phosphorus concentrations in these lakes. The settling velocity for anoxic lakes of 7.2 m/yr was used to account for the fact that shallow lakes also generate an internal load.

The CGS conducted an end-of-summer sampling program from August 28th to September 25th, 2012 to collect depth measurements, dissolved oxygen and temperature profiles and total phosphorus samples from 21 lakes for which internal phosphorus loading was suspected or for lakes with unknown depth and stratification patterns based on an initial review of existing water quality data (Table 5). Ten lakes had low hypolimnetic oxygen concentration of <1 mg/L at end-of-summer and were sampled at 1-m off bottom (1-mob) to determine if there was an internal load. The phosphorus samples at 1-mob were contaminated by sediment in three of the lakes suggesting that the sediment was disturbed during sampling and could not be used to assess internal phosphorus loading. Of the remaining 7 lakes, three (Bethel, Simon and Red Deer lakes) had elevated phosphorus concentration in the hypolimnion indicating internal phosphorus loading due to anoxia. Eight lakes were shallow and not thermally stratified at the time of sampling, and had potential for internal phosphorus loading due to mineralization of organic matter in resuspended or shallow water sediments.

Lakes without depth or oxygen data were assumed to be stratified and have an oxic hypolimnion (no internal phosphorus loading).

Table 5. Comparison of Spring Overturn, Ice-Free (estimated), and End-of-Summer Total Phosphorus Concentrations for Lakes Monitored in 2012

Subwater-shed Code	Lake	Total Phosphorus Concentrations (µg/L)				Stra-tified ?	Anoxia and Internal Phosphorus Loading Comments
		Spring Turnover	Ice Free[1]	End-of-Summer Euphotic	End-of-Summer 1-mob[2]		
R	Bethel	36.9	36.1	69.7	175.3	No	Internal loading due to anoxia/resuspension
LJC	Simon	33.3	32.5	205.9	4,463.2	Yes	Internal loading due to anoxia
LV	McCharles	29.7	28.9	42.3	24.5	Yes	Suspect end-of-summer data (ephotic zone concentrations should be lower than at 1-MOB)
R	Robinson	24.0	23.2	26.7		No	Internal load due to resuspension possible
LV	Beaver (Little)	23.0	22.2	14.7		No	No evidence of internal loading due to anoxia
RD	Red Deer	20.0	19.2	14.3	184.4	Yes	Evidence of internal loading due to anoxia
WW	Whitewater	16.8	16.1	11.4	12.0	No	No evidence of internal loading due to anoxia
LV	Beaver (Big)	14.8	14.1	10.4		No	No evidence of internal loading due to anoxia
P	Little Panache	12.4	11.7	6.0	98.9	Yes	Inconclusive – sediment in sample
R	Ramsey	12.3	11.6	10.3		Yes	No evidence of internal loading due to anoxia
R	Nepahwin	10.8	10.1	8.7	75.9	Yes	Inconclusive – sediment in sample
P	McFarlane	10.7	10.1	6.3	21.1	Yes	Inconclusive – sediment in sample
P	Richard	9.3	8.6	9.7		No	No evidence of internal loading due to anoxia
R	Hannah	6.7	6.1	6.1		No	No evidence of internal loading due to anoxia
P	Silver	6.1	5.5	4.4		No	No evidence of internal loading due to anoxia
R	Middle	5.8	5.2	5.0	23.7	Yes	No evidence of internal loading due to anoxia
FB	Fairbank	4.8	4.2	3.4		Yes	No evidence of internal loading due to anoxia
UV	Frenchman	4.8	4.2	3.5	15.7	Yes	No evidence of internal loading due to anoxia
UV	Hanmer	4.7	4.1	4.7		No	No evidence of internal loading due to anoxia
RPR	Joe	4.1	3.5	2.4		Yes	No evidence of internal loading due to anoxia
OR	Windy	3.5	2.9	3.1		Yes	No evidence of internal loading due to anoxia

Notes: [1]calculated from measured mean spring total phosphorus concentration data following Hyatt et al. (2011) (See Section 4.4).
[2]Measurements taken at 1-m off the lake bottom (1-mob) in lakes with low hypolimnetic dissolved oxygen (<1 mg/L).

5. Model Validation

Confidence in the LCM's ability to predict phosphorus concentrations requires validation of model results against measured values. The model is considered to provide reasonable estimates of phosphorus concentration if the measured and modeled values agree to within 20% (MOE et al., 2010).

The LCM is a steady-state model and therefore, results need to be validated against long-term mean measured data to account for inter-annual variability in phosphorus measurements. Results from the spring sampling surveys (Section 2.2) were compared to modelled phosphorus concentrations to assess the reliability of the model to predict responses of the lakes to phosphorus inputs from shoreline development.

The phosphorus model predicts mean ice free total phosphorus (TP_{if}) concentration which was converted to spring turnover total phosphorus (TP_{so}) concentrations for comparison with measured values following Hyatt et al. (2011), whereby:

$$TP_{if} = 0.992 * TP_{so} - 0.563$$

Overall, there was a poor relationship between measured and modelled estimates of total phosphorus for the 65 "validation" lakes in the CGS lakes for which measured data exist. The modelled results showed a tendency to overestimate phosphorus concentrations (Figure 3, Table 6). The mean and median positive errors (overestimates) were 106% and 83% and the mean and median negative errors (underestimates) were 23 and 16% (Table 6). Error exceeded 20% in 64% of the lakes and exceeded 40% in 46% of lakes.

Figure 3. Accuracy of the CGS water quality model to predict phosphorus concentration (N=66 lakes). Dotted lines enclose +/-20% about the 1:1 line.

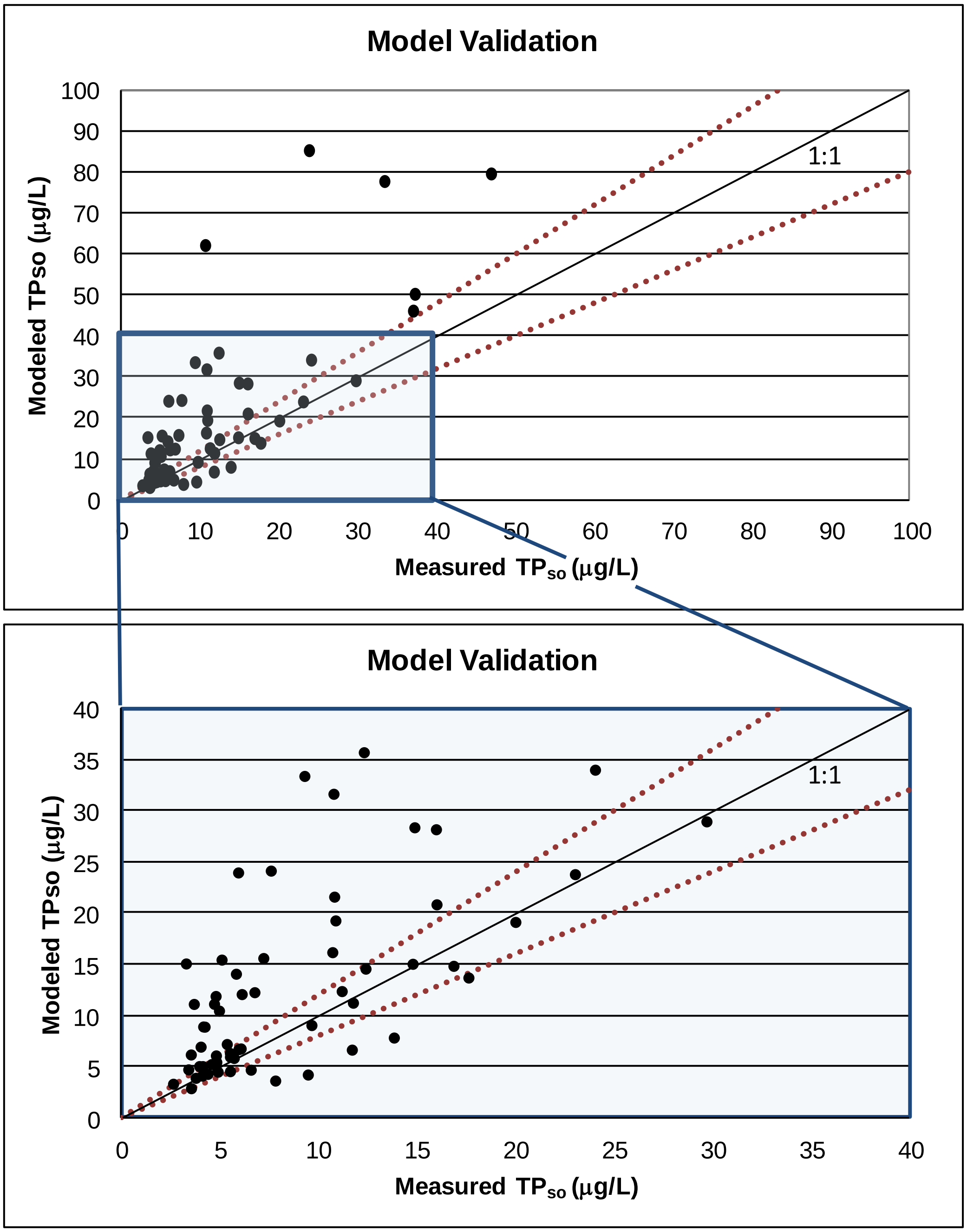


Table 6. Predictive Error of the LCM for CGS Lakes (N=66 lakes)

	All Lakes		Lakes with >20%error		Lakes with >40% Error	
	-ve error	+ve error	-ve error	+ve error	-ve error	+ve error
N lakes	14	52	6	38	4	30
Mean % Error	-22	96	-40	128	-48	154
Median % Error	-15	73	-42	101	-47	118

Notes: -ve error is underestimation of phosphorus concentration by the LCM and +ve error is overestimation.

Model error was assessed on a subwatershed basis (Appendix D). High model error was most pervasive for lakes in the northwest, west and southern subwatersheds that have disturbance from urban and shoreline development, agriculture and mining. The model however, generally performed well for the validation lakes located in the eastern (East Wanapitei River, Kukagami, Sturgeon River, Red Deer River) subwatersheds with greater than 20% error for 3 of 11 lakes with monitoring data. These subwatersheds are mostly forested with little to no development or agriculture but some disturbance from mining activity. The model overestimated phosphorus concentration for Matagamasi Lake by 31%, but this lake is complex and should be modeled as separate basins which may correct the model error. Furthermore, this lake has very low phosphorus concentration (mean TP_{so} = 3.9 µg/L) and model error is therefore sensitive to small variance in measured data. The model also underestimated phosphorus concentration in two lakes in the East Wanapitei subwatershed (Raft and T/Dill lakes) by more than 20%, but the cause of the underestimation cannot be determined with existing data.

While the LCM mostly provides acceptable estimates for lakes in the eastern subwatersheds, there are, however, few monitored lakes in these subwatersheds (11 monitored lakes out of 71 lakes in these subwatersheds). A greater number of validation lakes would be required to confirm the applicability of the model for lakes in these subwatersheds.

There are several potential sources of error that can result in poor predictions by the LCM. Common reasons for poor model performance include:

- Unknown shallow or anoxic conditions of lakes,
- Unusual hydrological characteristics (e.g., flow through lakes that have lower or negligible phosphorus retention),
- Complex lakes with hydrologically distinct basins,
- Lakes with characteristics that fall outside the range of those for the calibration lakes upon which the LCM was originally calibrated,
- Poor quality data or insufficient years of measured phosphorus data to confidently determine the long term mean,
- Inaccurate shoreline development counts and occupancy rates,
- Attenuation of septic system phosphorus by soils (the LCM assumes that 100% of the phosphorus from septic systems that lie within 300 m of the shoreline of a lake moves to the lake, but recent scientific studies show much of this phosphorus can be attenuated by soils),
- Inaccurate estimation of wetland area, and

- High concentration of dissolved organic carbon (DOC)

For the Greater Sudbury area, there are added uncertainties in the model related to phosphorus export and responses of lakes to phosphorus loading in watersheds that are acidified and disturbed by mining activity. Moreover, several of the lake catchments have a large proportion of bare rock outcrops that may affect water and nutrient transport to lakes. These characteristics are outside of the range of watershed characteristics that were used to calibrate the LCM and detailed site-specific study would be required to confirm phosphorus and water loading from these watersheds and the expression of those loadings into phosphorus concentration in the lakes.

A series of analyses was undertaken to determine if there were systematic errors or biases in the model approach that could account for the poor fit between measured and modelled phosphorus concentrations. The analyses focussed on potential sources of error for undeveloped lakes, as the absence of development means that human phosphorus sources need not be considered as a source of uncertainty. The estimate of total phosphorus concentration becomes increasingly uncertain with the addition of development phosphorus sources including:

- Septic Systems – There is uncertainty in assumed mobility of phosphorus from septic systems, occupancy rates, usage, and the number of septic systems on the lake.
- Urban development and Agriculture – Phosphorus export for these land uses was determined from a literature review and may not be representative of these land uses in the CGS
- Mining – Several lake catchments are heavily influence by active mining activity, and phosphorus export from these areas is not well understood.

The model tended to underestimate phosphorus concentration in undeveloped lakes with model error ranging from 31% to -43% (median positive error = 9%; median negative error = -29%) (Figure 4, Table 7). Increasing the sample size to include lakes in which 3% of the total phosphorus load was from development (Development Index, D.I. = 1.03) increased the median error to a range of 17% to -43%.

Figure 4. Model error for lakes with <3% potential phosphorus load from development (Development Index < 1.03), n=11. Dotted lines enclose +/-20% error.

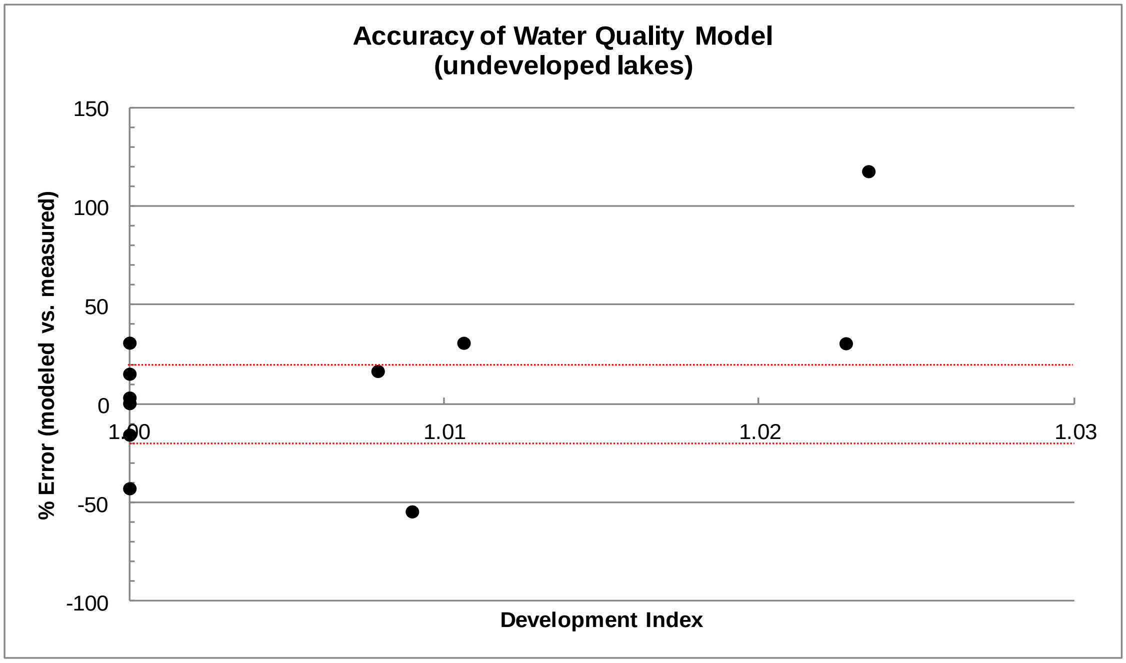


Table 7. Percentage Error of Modeled Phosphorus Concentrations in CGS Lakes with Little Development (D.I. < 1.03) or No Development (D.I. = 1)

	All Lakes		D.I. <1.03		D.I. = 1	
	+ve error	-ve error	+ve error	-ve error	+ve error	-ve error
Mean % Error	96	-22	29	-37	13	-29
Median % Error	73	-15	17	-43	9	-29
N lakes	52	14	9	3	4	2
N lakes with >±20% error	38	6	4	2	1	1

Notes: -ve error is underestimation of phosphorus concentration by the LCM and +ve error is overestimation.

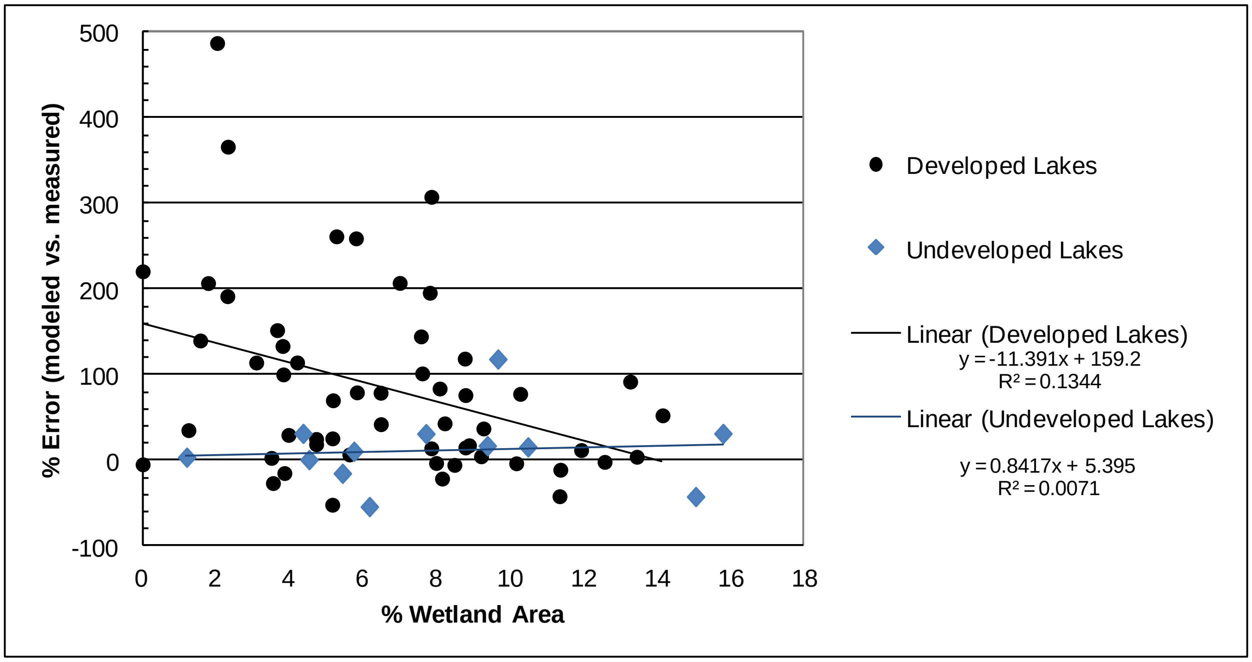
5.1 Potential Sources of Model Error

5.1.1 Wetlands

There are two sources of natural phosphorus load, atmospheric and overland runoff, and the latter is best related to the percentage of wetland in the watershed of a lake (Dillon and Molot, 1997; Paterson et al, 2006).

Model error was not related to the amount of wetland in the watershed of undeveloped lakes, but decreased significantly with increased wetland area in developed lakes (Figure 5). It is most likely that factors other than wetland area are the source of error for developed lakes, otherwise it would be expected that a similar significant relationship would occur with undeveloped lakes.

Figure 5. Model error as a function of wetland area.



Atmospheric phosphorus loading was not considered as a significant source of error as it is based on long-term (17 years) measured values for central Ontario that should not differ considerable for the CGS.

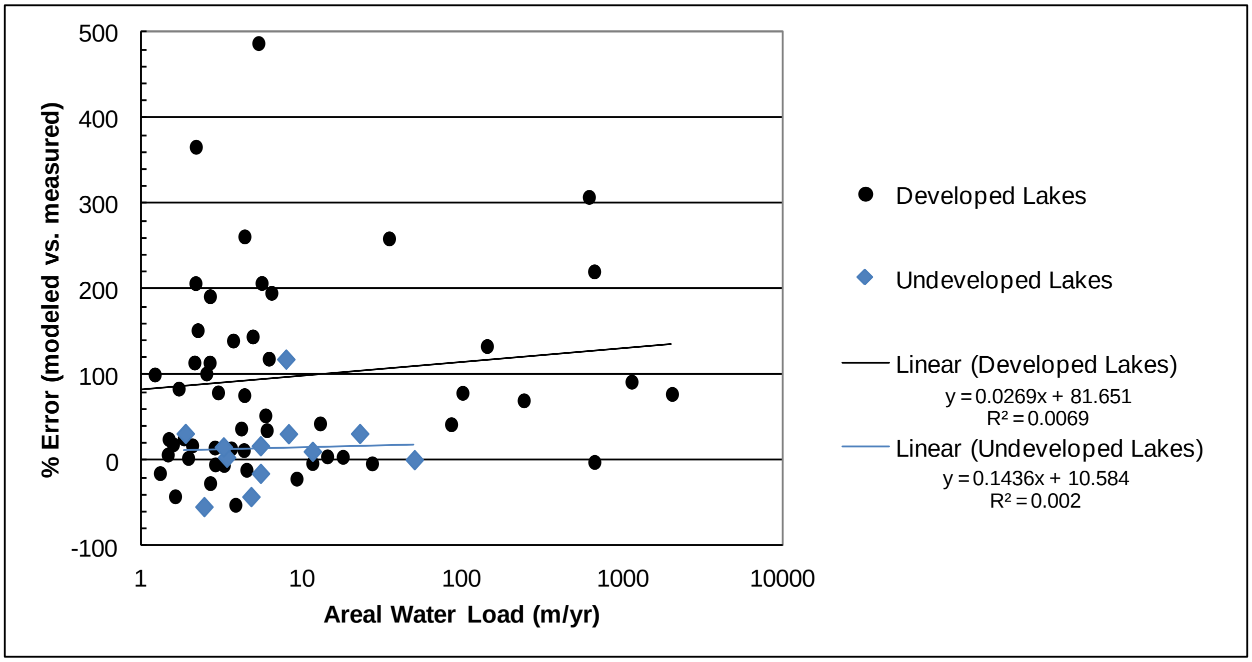
Conclusion: Model error is not systematically related to wetland area for undeveloped lakes.

5.1.2 Hydrology Estimates

The conversion of phosphorus loadings to phosphorus concentration in a lake is dependent on the hydrology of the lake, which is expressed as the areal water load in m/yr, or the total depth of runoff from the watershed (in m^3/yr) applied to the surface area of the lake (in m^2). Model error was not significantly related to areal water load (Figure 6).

Conclusion: Model error is not systematically related to estimates of hydrology.

Figure 6. Relationship of model error to areal water load.



5.1.3 Watershed Function

The LCM was developed from calibrated headwater lakes. Although the MOE et al. (2010) guidance manual rightfully advises that lake modelling be done in a watershed context, any modelling effort must proceed from the untested assumption that the model works as well for lakes downstream in a watershed as it does for headwater lakes, and that the assumptions and calibrations that apply to small lakes with relatively small ratios of watershed area to lake area (i.e., for headwater lakes) also apply to all lakes in a watershed. The CGS model challenges the assumptions used for calibration of the LCM, as it includes large lakes, large watershed areas and many lakes besides headwater lakes. If the assumptions used to calibrate the LCM lakes were violated when attempting to model lakes in the CGS area, then one would expect to observe a systematic model bias related to the ratio of watershed area to lake area.

Model error showed no systematic relationship with the ratio of watershed area/lake area (Figure 7), lake depth (Figure 8) or headwater position (Figure 9, Table 8).

Figure 7. Relationship of model error to ratio of watershed area/lake area.

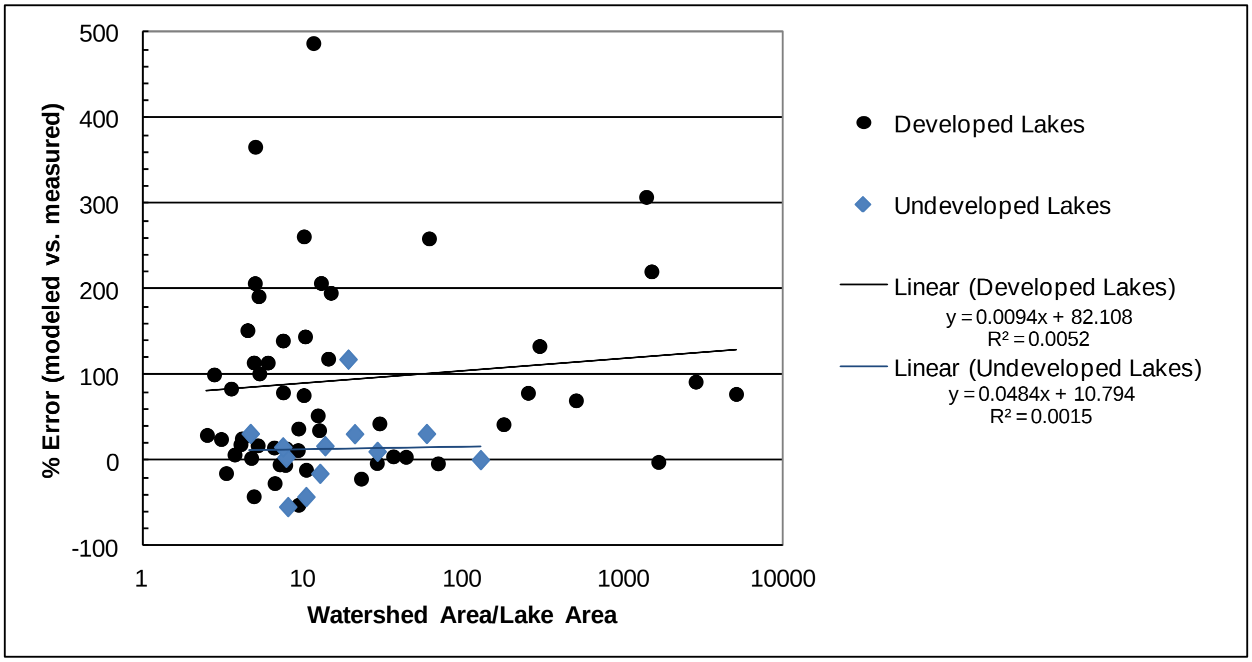


Figure 8. Relationship of model error to lake maximum depth (excludes Lake Wanapitei, maximum depth = 142 m).

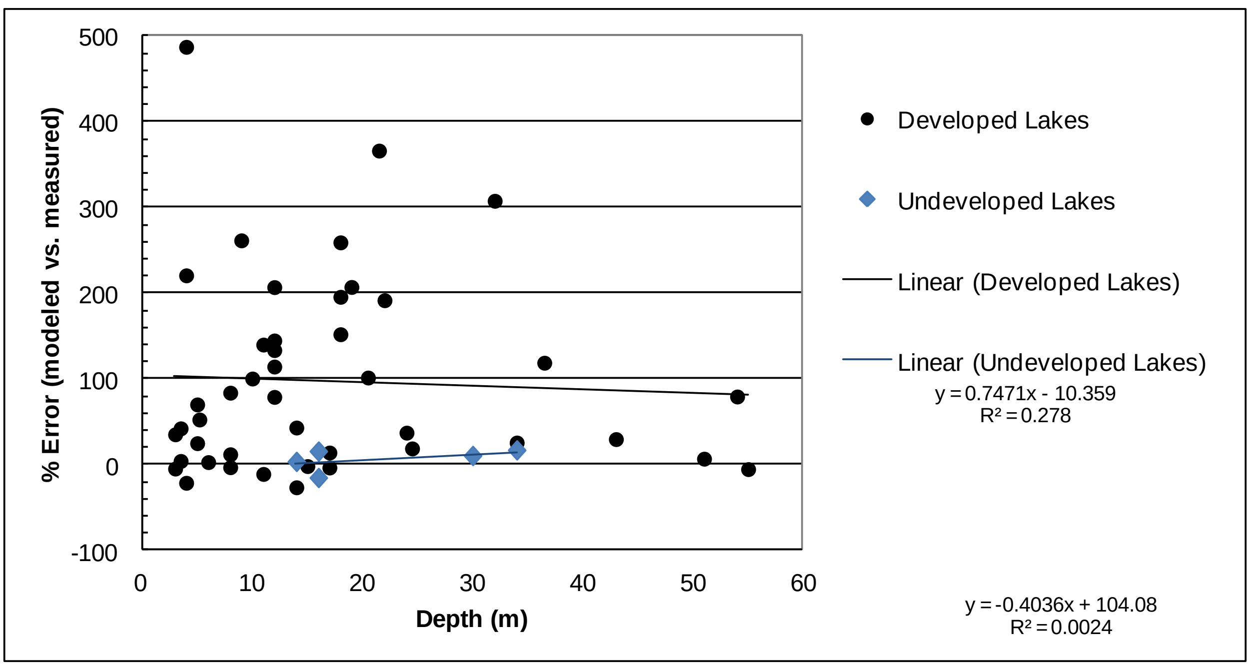


Figure 9. Accuracy of the CGS water quality model to predict phosphorus concentration in headwater and non-headwater lakes (N=65 lakes). Dotted lines enclose +/-20% about the 1:1 line.

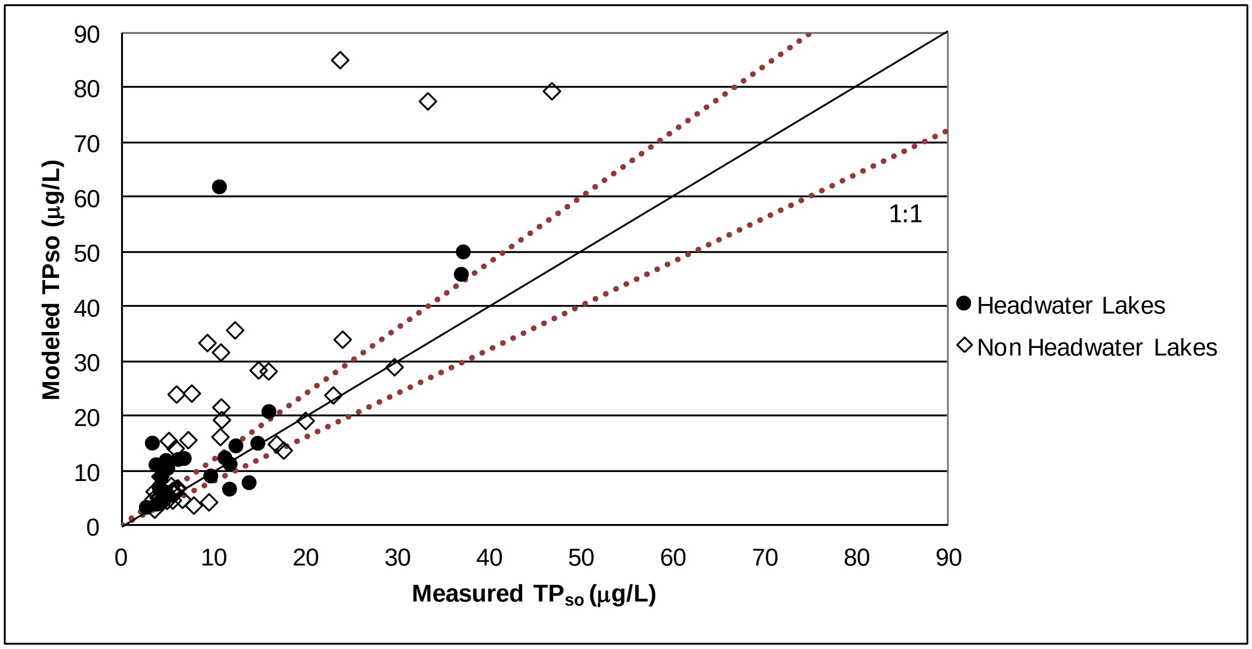


Table 8. Summary of CGS Water Quality Model Error for Headwater and Non-Headwater Lakes (N=66).

	Headwater Lakes		Non-Headwater Lakes	
	-ve error	+ve error	-ve error	+ve error
N lakes	4	20	10	32
Mean % Error	-23	95	-21	97
Median % Error	-24	33	-15	78

Conclusions:

Model error showed no systematic relationship with the ratio of watershed area/lake area.

Model error was not related to lake depth for those lakes where depth was known.

Model error was not systematically related to headwater position of a lake in a watershed.

5.1.4 Oxygen Status

The values for settling velocity used in the LCM are averages taken from a large set of studies (Dillon et al., 1986) to describe all stratified lakes on the Precambrian Shield. The smaller value of 7.2 m/yr for anoxic lakes was developed from a single lake that undergoes anoxia during the open water season

(Dillon et al., 1986). The results for lakes with anoxic and oxic hypolimnia were compared to determine if there was systematic error induced in the model through the use of the prescribed settling velocities.

The CGS has oxygen monitoring data for 14 stratified lakes that were collected at end-of-summer 2012 (see Section 4.3, Table 5). Eight of the lakes had an anoxic hypolimnion and seven of the lakes had an oxic hypolimnion, and all had development. The model error was similar whether the lakes were anoxic or oxic; the model greatly overestimated phosphorus concentration in both cases (Table 9). In the model, lakes without measured temperature or oxygen were assumed to be stratified with an oxic hypolimnion (n=323). Although some of these may, in fact, be anoxic, that cannot be confirmed for the model. For the validation lakes without measured oxygen data (n=37), the model overpredicted phosphorus concentrations by a mean of 78% (median = 40%) and underpredicted by a mean of 29% (median = 27%). If some of the 323 lakes are anoxic, that could explain a portion of the error for lakes that are underpredicted by the model, but this would not improve the larger positive error in the model as the use of the settling velocity for anoxia results in higher modeled phosphorus concentrations.

Table 9. Relationship of model error to hypolimnetic oxygen status in stratified lakes.

	Measured Anoxic Hypolimnion		Measured Oxic Hypolimnion		Assumed Oxic Hypolimnion	
	+ve error	-ve error	+ve error	-ve error	+ve error	-ve error
N lakes	3	2	5	0	28	9
Mean % Error	84	-3	113	-	78	-29
Median % Error	101	-3	29	-	40	-27

Conclusion:

Model error was not systematically related to oxygen status, but the occurrence of unknown anoxic lakes may explain underprediction of phosphorus concentration by the model for some lakes.

5.1.5 Influence of Development

Model error was likely related to the expression of phosphorus loads from human development in CGS area lakes, as % model error was significantly related to the proportion of the total phosphorus load that was assumed to come from development. This was calculated as the Development Index (D.I.), which is the ratio of total assumed phosphorus load to natural load (i.e., a lake with no human development would have a DI = 1 and a lake where human development had increased the total load by 50% would have a DI = 1.5).

At a D.I. <2 (200% over background), there was scatter in % error of the model with a tendency to both over- and under-predict by more than 20% (Figure 10). At D.I. >2, the model overpredicted phosphorus concentration in all of the lakes (Figure 10). For lakes in which septic systems were the only human source of phosphorus (i.e., no contribution of phosphorus from other human sources including urban, agriculture or point sources), percentage error in the model ranged from -54% to 207% (n=19) (Figure

11). The model generally overestimated phosphorus concentration in these lakes, suggesting that attenuation of phosphorus by soils may be contributing to some of the observed error for some of the lakes.

Figure 10. Relationship between % model error and development index (D.I.) in CGS area lakes. Dotted lines enclose +/-20% error.Dotted lines enclose +/-20% error.

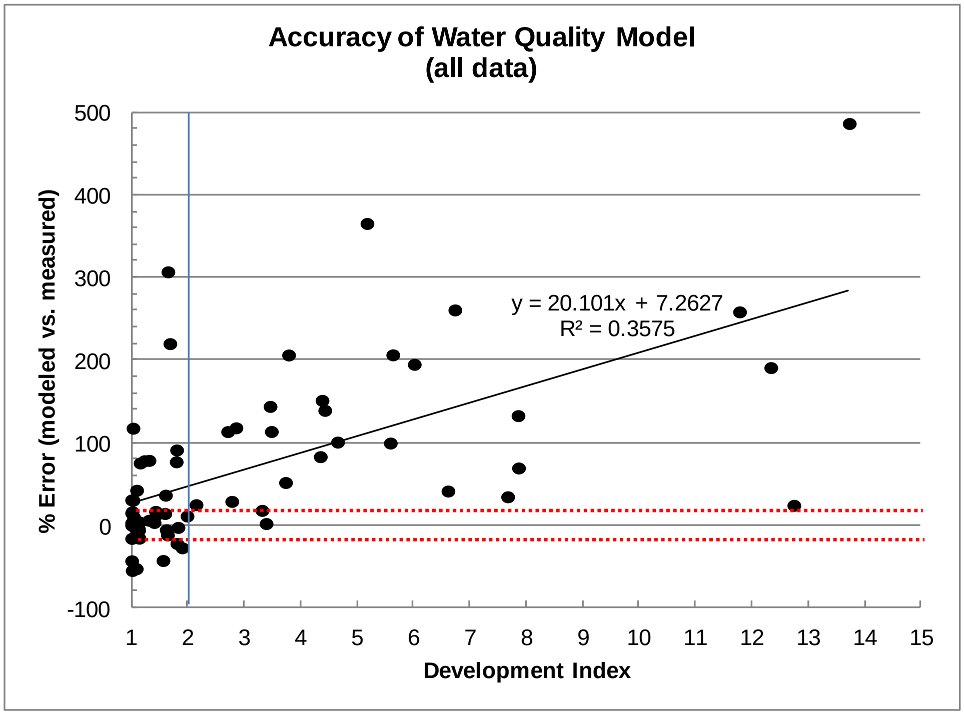
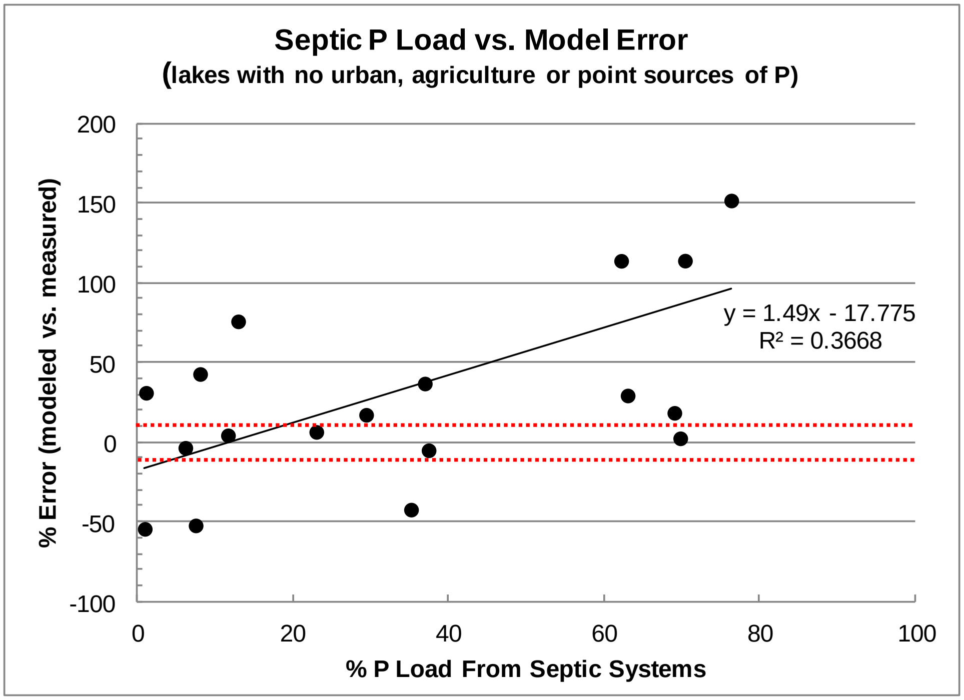


Figure 11. Model error compared to % phosphorus load from septic systems for lakes with no other sources of human phosphorus. Dotted lines enclose +/-20% error.



Lakes with phosphorus loads from urban lands, agricultural lands, and/or point sources of sewage effluent modeled poorly in the LCM. The model error was >20% in nearly all lakes with these sources of phosphorus, with no tendency to either over- or under-predict concentrations (Figure 12). The large variability in model error suggests that phosphorus export from urban and agricultural lands varies between watersheds and this was not well represented by the 'average' export coefficients that were used in the LCM. For the point sources of sewage effluent, phosphorus loads were based on measured effluent concentrations and flows, providing confidence in loading estimates. Still, lakes with this source of phosphorus modeled poorly; phosphorus concentration was greatly over-predicted for all but one lake. This suggests that lakes in the CGS may not be responding as expected to phosphorus loads from point sources of effluent.

The model error was determined by converting modeled ice-free phosphorus concentration to spring overturn concentration for comparison with measured values. The equation to convert the values was developed from mostly oligotrophic lakes (Hyatt et al. 2011) and may not be appropriate for several of the mesotrophic and eutrophic lakes in the CGS dataset. Total phosphorus concentrations tend to increase over the ice-free season in productive lakes, but decrease in oligotrophic lakes. This would result in an apparent over-prediction of phosphorus concentrations in lakes at the higher end of the phosphorus gradient (TP > 15 μg/L).

Conclusions:

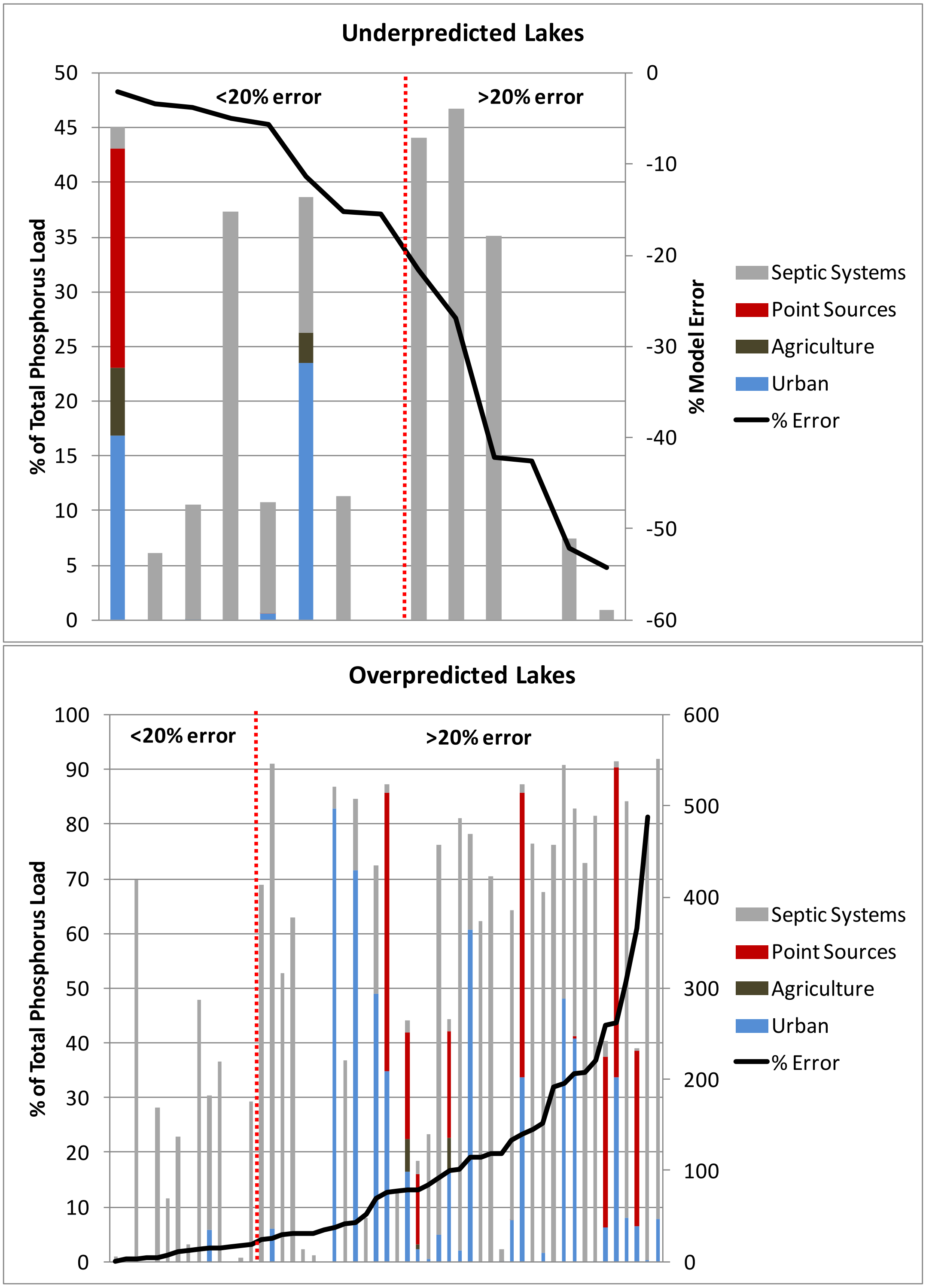
- **There was no systematic relationship between model error and contribution of phosphorus from septic systems or runoff loads from human development (urban and agricultural areas),**

- **Phosphorus export from urban and agricultural areas were likely variable and not well represented by ‘average’ export coefficients recommended for use in the LCM,**
- **Phosphorus loads from sewage effluent were not expressed as measured concentrations in lakes,**
- **The established relationship between spring overturn and ice-free total phosphorus concentration may not be applicable to CGS lakes with high phosphorus concentration (>15 μg/L), which would overestimate the model error for these lakes.**

Summary

The lakeshore capacity model developed for the CGS lakes did not provide accurate predictions of phosphorus concentrations due to multiple sources of error. Specific thresholds or capacities developed using the model could not be defended on the basis of model accuracy.

Figure 12. % Error and relative contribution of human sources of phosphorus for lakes in the CGS area for which the LCM model underpredicts (top panel) and overpredicts (bottom panel) phosphorus concentrations.



6. Approach to Managing Lakeshore Development

The revised Provincial Water Quality Objective (PWQO) for lakes on the Precambrian Shield allows a 50% increase in phosphorus concentration from a modeled baseline of water quality in the absence of human influence to a maximum cap of 20 μg/L (MOE et al., 2010). The Province recommends the use of the Lakeshore Capacity Model (LCM) to determine the baseline or "background" phosphorus concentration of lakes and to assess the number of unserviced shoreline lots that can be developed without exceeding the revised PWQO, that is, the development "capacity". The LCM must produce sufficiently accurate estimates of water quality, however, in order to support this approach and provide the City with a defensible means to approve or decline shoreline development applications on unserviced lots.

The Province recognizes the need for accurate model results and has recommended that in cases where the model fails, the interim PWQO for phosphorus be followed as a guideline. The interim PWQO for phosphorus (MOE, 1994) is an average ice-free concentration of 10 μg/L for lakes naturally below this value, and a cap of 20 μg/L to avoid nuisance concentrations of algae in lakes. This tiered approach, however, would eventually result in all lakes converging on 10 μg/L or 20 μg/L and would not protect the diversity of water quality among lakes, in particular, the large number of very low productivity lakes in the CGS. Moreover, a model would still be required to assess lake response to phosphorus loads from development upon which to base "capacity" limits (i.e. how many lots could be added to maintain a lake below the 10 or 20 μg/L PWQO).

The model results for the CGS area lakes were not sufficiently accurate to follow the Province's revised PWQO approach to set capacity limits and the interim PWQO is not protective of diversity in water quality. Nevertheless, planning to protect water quality requires some way of estimating capacity, or of managing development so that water quality is not impaired until such time as an improved model or alternate approaches are available (such as incorporation of phosphorus abatement into the Ontario Building Code for septic systems). Some form of modelling is necessary to predict the response of lakes in the CGS to unserviced shoreline development, but planning should be built around those components of the model for which there is a higher degree of confidence (Table 10).

A lake classification system was developed and is recommended in recognition that:

- the lake model can be used and defended in the context of a) estimating potential loads of phosphorus to the lake from natural and human sources and b) assessing the relative responsiveness of a lake to loadings, but
- the model does not provide estimates of absolute phosphorus concentrations in individual lakes that could be defensibly used to set and defend specific lake capacities in planning policy, and
- the CGS maintains a program of lake monitoring and these data can, and should be, used to inform planning policy.

The classification is therefore based on the strongest aspects of the model and on the use of records of measured water quality of the City of Greater Sudbury. Taken together, these can be used to protect and maintain the water quality of lakes within the City.

Table 10. Model Components and Evaluation of Confidence

Component	Confidence
Lake, watershed areas	High Confidence - based on recent data and GIS
Natural Atmospheric Load	High Confidence - long-term (17 years) measured data from MOE, but is specific to Muskoka-Haliburton area.
Natural Load from Wetland	Moderate Confidence - Measured and published relationship from MOE may differ for acidified watersheds in CGS - Wetland areas are based on recent data and GIS, but the wetland classification for CGS may differ from that used to derive the Dillon and Molot export equation used by the MOE model.
Depth of Runoff	Moderate Confidence - Data from long term monitoring programs, but these are regional and not lake specific
Settling Velocity	Low Confidence - Two values (oxic and anoxic) used for all lakes. - No settling velocity has been developed specifically for shallow lakes - Insufficient data (lake depth, hypolimnetic oxygen status and phosphorus concentration) to assess all lakes in the study area
Predicted Background and BG + 50% Concentrations	Low Confidence - Model error >20%
Human Phosphorus Load to septic system	Moderate Confidence -Based on measured water usage and effluent phosphorus concentrations, but data are old - usage is based on published values for areas in south central Ontario that have not been updated in ~20 years and may not reflect conditions in the CGS. -likely site-specific errors in occupancy estimates
Human Phosphorus Load to lake –septics	Low Confidence - Published studies of W. Robertson show that phosphorus is not always mobile -Increasing acknowledgment of attenuation by soils from the MOE and OMB -Phosphorus may not be mobile in some cases in the CGS
Human Phosphorus to lake –runoff	Moderate Confidence - A known component, export coefficients are estimates only and not verified for the CGS subwatersheds of which several have been acidified and have high concentrations of phosphorus binding metals
Predicted Present Day Concentration	Low confidence - Figure 3, Table 5 - Poor model performance for 60% of the validation lakes (n=65); 20% are underestimated by an average of 42% and 40% are overestimated by an average of 130%
Measured Present Day Concentration	High Confidence

6.1 Lake Classification Criteria and Triggers

6.1.1 Classification Criteria

The recommended approach to establish the level of protection required for lakes in the CGS includes an evaluation of two primary criteria. These criteria are calculated for each lake using components of the LCM for which there is a greater degree of confidence to provide the necessary defensibility and rigour to policy. The criteria include:

Criterion 1. Whether or not the existing phosphorus load to the lake is 50% greater than the natural or "background" load.

This criterion meets the intent of the revised PWQO to limit the increase in phosphorus concentration of lakes to 50% over background (BG+50%). If phosphorus loads exceed BG+50%, there is a potential for concentration to also exceed BG+50%.

There are two outcomes to the test of this criterion:

1. A lake is "Over threshold" if the potential phosphorus load with existing development exceeds background plus 50% (≥BG+50%).
2. A lake is "Under threshold" if the potential phosphorus load from existing development is less background plus 50% (<BG+50%).

	Criterion 1. Threshold	
	Over Threshold	Under Threshold
Phosphorus Load	≥BG+50%	<BG+50%

This approach is more protective than that of MOE et al. (2010) because it does not rely on accurate predictions of phosphorus concentrations in lakes and removes the concern that the model does not predict well. The only way that human phosphorus could cause the concentration to exceed BG+50% would be if a) the loading was >50% above background, and b) all of it migrated to the lake. A threshold of BG+50% (as load) removes any potential that concentration could exceed BG+50% and is therefore conservative. Furthermore, based on the evaluation of model results, it is likely that phosphorus loads from human sources are overestimated for most of the CGS lakes, in which case, estimates of existing phosphorus loads are conservative estimates for evaluation against BG+50%.

Lakes determined to be "Over threshold" by this approach could be addressed through planning policy to prevent additional phosphorus loading through site specific Best Management Practices or Low Impact Development techniques. It would not be necessary to freeze additional development on this basis alone; that decision would need to be informed by results of Criterion 2 and subsequent triggers.

Criterion 2. Whether the lake has a High Responsiveness or Low Responsiveness to phosphorus loading.

Phosphorus loading is only one determinant of lake response; the other is how the lake processes its phosphorus load and is a function of hydrology (flushing rate) and the removal of phosphorus from the water column to the sediments. If these attributes remain constant, lake responsiveness can be assessed using the LCM by adding a theoretical amount of phosphorus loading to a lake and then determining how the lake will respond, i.e. the % change in phosphorus concentration that would occur. This step does not require a model with the ability to predict the absolute concentration of phosphorus reliably - it must only be able to distinguish the relative response between lakes to a standard phosphorus load and assign a responsiveness based on the difference.

To assess responsiveness to phosphorus loading, each lake is modelled using the LCM with areal load of phosphorus to the lake surface that corresponds to one seasonal residence for every 4 acres (1.6 ha) of lake surface. The standard load corresponds to a “social density filter” that has been used in some jurisdictions to determine if a lake is considered to be crowded or not. Lakes with more than one residence/1.6 ha are considered to be overcrowded, or to exceed a social threshold. If the standard load causes the predicted phosphorus concentration to increase by >50% then one concludes that if the lake were to be developed to the limit for social crowding then it could also exceed the MOE’s threshold of “Background + 50%” for phosphorus concentration.

Each lake is then classified as having “High Responsiveness” to phosphorus loading if the standard areal load of 1 lot/1.62 ha results in phosphorus concentration changing by 50% or more from the background concentration or “Low Responsiveness” if the change is less than 50%.

There are two outcomes to the test of this criterion:

1. A lake has “High Responsiveness” if the standard areal phosphorus load causes the phosphorus concentration to increase by >50%.
2. A lake has “Low Responsiveness” if the standard areal phosphorus load causes the phosphorus concentration to increase by <50%.

	Criterion 2. Responsiveness	
	High Responsiveness	Low Responsiveness
Change in phosphorus concentration with a standard aeral phosphorus load	≥ 50%	<50%

“High Responsiveness” lakes should be considered to be sensitive in planning policy because a reasonable density of development may cause the phosphorus concentration to exceed the MOE threshold.

Lakes determined to have “High Responsiveness” by this approach could be addressed through planning policy to prevent or minimize additional phosphorus loading through site specific Best Management Practices or Low Impact Development techniques. It would not be necessary to freeze additional development on this basis alone; that decision would need to be informed by results of Criterion 1 and subsequent triggers.

6.1.2 Triggers

The classification criteria above address management on the basis of the model results and the potential that a lake may be sensitive to shoreline development. Three other factors including measured phosphorus concentration, trends in phosphorus concentration (or water clarity as Secchi depth, or hypolimnetic dissolved oxygen content) and occurrence of bluegreen algal blooms are also considered in the management approach, not as criteria for classification, but as “triggers” to provide additional context in understanding lake dynamics and response. These triggers are based on measurement and observations which are:

- obtained through the CGS program, are reviewed annually and which are therefore reliable, and
- can be verified by lake residents and are therefore directly relevant to their experience.

The triggers may indicate if shoreline development is having adverse effects on water quality or if there are other factors that make a lake inherently sensitive to additional phosphorus loads.

Trigger 1. Are epilimnetic or spring overturn phosphorus concentrations >20 µg/L?

The interim PWQO for total phosphorus concentration is 20 µg/L for the protection against nuisance growth of aquatic plants and algae in lakes. If a lake has a total phosphorus concentration that exceeds the PWQO, then there is an increased risk of nuisance plant growth if additional phosphorus loads are added to the lake.

Trigger 2. Is there a statistically significant increasing trend in phosphorus concentrations (or decreasing transparency or decreasing hypolimnetic oxygen) in a lake?

A long-term trend in total phosphorus concentration, Secchi depth or hypolimnetic dissolved oxygen may indicate a response to human phosphorus loads or other factors related to climate change or natural variability. A minimum of three years of measured total phosphorus concentration data exist for 57 of the 64 lakes that are presently monitored by the CGS. At least 10 years of data, however, is recommended to assess long term changes. Only 10 lakes have at least 10 years of monitoring data. We recommend that trend analysis for total phosphorus concentrations, Secchi depth or hypolimnetic dissolved oxygen not be included as a criterion for lake classification at this stage, but be considered for inclusion in future OP revisions once more data for more lakes have been collected by the CGS monitoring program.

Trigger 3. Have cyanobacterial (blue-green algae) blooms been observed?

The factors controlling bluegreen algal (cyanobacterial) blooms are complex, but the risk of bloom activity is known to increase with increasing phosphorus concentration. Inclusion of the PWQO of 20 µg/L as a criterion for management is meant to protect lakes from nuisance growth of aquatic plants and algae, including bluegreen algae, due to elevated phosphorus concentration. In many cases, algal bloom activity can be triggered by factors other than elevated phosphorus concentrations resulting from human sources of phosphorus:

- Bluegreen algae are known to bloom in warm, shallow and still waters and so an extended period of hot, calm weather may trigger blooms despite relatively low total phosphorus concentration.

- Bluegreen algal blooms also occur in some stratified lakes that have low surface water total phosphorus concentration (<20 μg/L) but have elevated phosphorus concentration in the hypolimnion due to internal loading of phosphorus from anoxia. Unlike many other types of algae, bluegreen algae can control their buoyancy and can move down in the water column to take advantage of high phosphorus concentrations at the top of the hypolimnion of these lakes,
- Some species of blue-green algae (e.g. *Gloeotrichia echinulata*) take phosphorus directly from lake sediments and then adjust their buoyancy in order to rise to the euphotic zone to bloom.

Therefore, while factors other than human sources of phosphorus may trigger algal blooms in lakes, increasing phosphorus loads do contribute to the problem.

6.2 Lake Management Classifications

Lakes were classified into three categories of protection for planning policies to manage shoreline development, "Enhanced", "Moderate" and "Standard" (Figure 13) using Criteria 1 and 2 above.

Figure 13. Management Classification Matrix for Planning Policies

	P Load ≥BG+50%	P Load <BG+50%
High Responsiveness	Enhanced	Moderate
Low Responsiveness	Moderate	Standard

"Enhanced" management is recommended for lakes that:

a. have a phosphorus load that could cause them to exceed the revised PWQO for total phosphorus concentration (i.e., P Load ≥BG +50%) and have high responsiveness to phosphorus loads.

These lakes have either been, or are likely to be impaired by phosphorus inputs from human sources. Additional phosphorus loads could further impair water quality in these lakes and should be avoided by, for example, implementing Best Management Practices for phosphorus abatement or limiting the creation of new un-serviced shoreline lots.

"**Moderate"** management is recommended for lakes that:

a. have a phosphorus load that that could cause them to exceed the revised PWQO for total phosphorus concentration (i.e., P Load ≥BG +50%) but have low responsiveness to phosphorus loads, or

b. have a phosphorus load that would not cause them to exceed the revised PWQO for total phosphorus concentration (i.e., P Load <BG +50%) but have high responsiveness to phosphorus loads.

These lakes are unlikely to be impaired by phosphorus loads exceeding BG+50% as they have low responsiveness, or they have high responsiveness but their loads do not exceed BG+50% so they have some capacity for additional loads. Additional shoreline un-serviced lot creation therefore can be permitted, but policies should be put in place so that the potential for additional phosphorus loads is minimized as much as possible to avoid degradation of water quality.

"Standard" management is recommended for lakes that have a phosphorus load that would not cause them to exceed the revised PWQO for total phosphorus concentration (i.e., P Load <BG +50%) and have a low responsiveness to phosphorus loads. These lakes have capacity for additional shoreline un-serviced lot creation, but policies should still be implemented to protect water quality from additional phosphorus loads.

Application of Triggers

The “triggers” address uncertainty in the model-based classification system by adding additional information from the monitoring program.

Trigger 1. Are epilimnetic or spring overturn phosphorus concentrations >20 µg/L?

If “yes” then the lake exceeds MOE’s PWQO threshold for increased likelihood of cyanobacterial blooms (MOE 1994). If the lake is over threshold for phosphorus load (Criterion 1) and is sensitive to phosphorus loads (Criterion 2) then it is reasonable to conclude that the lake is at risk of blooms now and that additional phosphorus loading should be avoided. Planning policy should be focussed on preventing additional loading by implementing Best Management Practices or limiting the creation of new un-serviced shoreline lots.

If “yes” and the lake is not over threshold for phosphorus load (Criterion 1) and is not sensitive to phosphorus loads (Criterion 2) then it is reasonable to conclude that the lake may still be at risk of blooms as the total phosphorus concentrations exceed 20 µg/L. Additional phosphorus loading should be avoided. Planning policy should be focussed on preventing additional loading by implementing Best Management Practices or limiting the creation of new un-serviced shoreline lots.

Trigger 2. Is there a statistically significant increasing trend in phosphorus concentrations (or decreasing transparency or decreasing hypolimnetic oxygen) in a lake?

If “yes” and the lake is over threshold for phosphorus load (Criterion 1) and is sensitive to phosphorus loads (Criterion 2) then it is reasonable to conclude that additional phosphorus loading would be adverse. Planning policy should be focussed on preventing additional loading by implementing Best Management Practices or limiting the creation of new un-serviced shoreline lots.

If “yes” but the lake is under threshold or not sensitive then other factors (i.e., climate change) should be investigated as potential causes and there is no need for additional policy.

We note that the CGS does not yet have long-term (<10 yr) records of water quality for most lakes to inform the use of trends as a management trigger. We recommend, however, that the City continue its monitoring program and implement trends in total phosphorus, Secchi depth or dissolved oxygen as management triggers when sufficient data are accumulated.

Trigger 3. Have cyanobacterial (blue-green algae) blooms been confirmed?

If “yes” and the lake is over threshold for phosphorus load (Criterion 1) and is sensitive to phosphorus loads (Criterion 2) then it is reasonable to conclude that human phosphorus loading may be the cause and that additional loading would be adverse. Planning policy should be focussed on preventing additional loading by implementing Best Management Practices or limiting the creation of new un-serviced shoreline lots.

If “yes” but the lake is under threshold or not sensitive then other factors (i.e., climate change, internal loading) should be investigated as potential causes and there is no need for additional policy.

6.2.1 Interpretation for Policy

If classification is "Enhanced" and any flag is triggered then policies ensuring no additional phosphorus loading or a planning freeze (no additional lot creation) may be warranted.

If the classification is "Moderate" or "Standard" and any flag is triggered then "Moderate" or "Standard" planning policy would apply, but a causation study would be warranted and any revisions to planning policy would be based on the outcome. For example, if a lake classified as "Moderate" has total phosphorus concentration >20 μg/L (Trigger 1) and a causation study shows that human development has caused the concentration to increase to > 20 mg/L, then policies for "Enhanced" management may be applied by the City.

If no flags are triggered the "Enhanced", "Moderate" and "Standard" management policies would apply in accordance with the lake classification.

The classifications and management responses are summarized in Table 11.

Table 11. Management classifications and responses

	Management Response	
Classification	No Triggers	Triggers
Enhanced	Enhanced	No additional loading or limit the creation of new un-serviced shoreline lots
Moderate	Moderate	Causation Study
Standard	Standard	Causation Study

6.2.2 Planning Policies and Application

The classifications and triggers presented above are implemented into planning policy by linking increasing lake sensitivity with increasingly stringent site specific management techniques and Best Management Practices (BMPs; Table 12) to mitigate the potential for phosphorus loading.

Official plan policies would dictate that any additional severances be subject to Best Management Practices in accordance with lake classifications. An application for severance would trigger the need for a site specific investigation of the subject property which would be documented in a report by a qualified person to confirm that the appropriate BMPs were in place, or could be implemented, to mitigate the potential for phosphorus loading. Approval of the application would be dependent on the outcome of the site investigation showing that it was feasible to mitigate phosphorus loading.

Table 12. Management Techniques for Lake Classifications

	Lake Classification		
Management Techniques	**Enhanced**	**Moderate**	**Standard**
Vegetated Buffers	X	X	X
Shoreline Naturalization	X	X	X
Soil Protection	X	X	X
On-Site Storm Water Control	X	X	
Limit Impervious Surfaces	X	X	
Enhanced Septic Setback	XX	X	
Septic Abatement Technologies	X		
Full Servicing	X		
Site Specific Soils Investigation	X		
Enhanced Lot Sizes	X		
Limit Lot Creation	X		
Compliance Monitoring/Securities	X		
Monitoring Intensity	X		

6.3 Classification of CGS Lakes

Of the 354 CGS lakes with a surface area greater than 10 ha, a management classification of “Enhanced”, “Moderate” and “Standard” applies to 33, 142 and 179 lakes, respectively (Figure 14). Tables of lakes in each of the three categories, and of evaluation criteria results are provided in Appendix E.

Figure 14. Management classification for CGS lakes.

	P load ≥BG+50%	P load <BG+50%
High Responsiveness	Enhanced (33 lakes)	Moderate (112 lakes)
Low Responsiveness	Moderate (30 lakes)	Standard (179 lakes)

There are 8 CGS lakes with total phosphorus concentration that exceeds 20 µg/L (Trigger 1) (Section 3.2). These lakes should be considered for investigation by the City to evaluate the causes of the elevated phosphorus concentrations and to respond as required by amendments to policy or through lake-specific Watershed Management Plans that are being developed by the City and, if feasible, to lower the risk of further increases in phosphorus concentration due to human sources of phosphorus.

There are no lakes with a statistical increase in total phosphorus concentration based on an evaluation of trends in CGS lakes with measured data (Trigger 2) (Section 3.2). Only 10 of the lakes, however, have at least 10 years of data for confident evaluation of trends. Additional studies for management are not triggered for any of these lakes at this time.

The Sudbury & District Health Unit has documented occurrences of bluegreen algae blooms for 11 lakes that occur within the City of Greater Sudbury and were individually assessed in this investigation (Trigger 3) (Table 13). These lakes should be considered for investigation by the City to evaluate the causes of the blooms and to respond as required by amendments to policy or through lake-specific Watershed Management Plans that are being developed by the City to understand the causes of the blooms and, if feasible, to lower the risk of bloom activity due to human sources of phosphorus.

Table 13. CGS Lakes with Documented Bluegreen Algal Blooms

Lake	Management Class
Bethel Lake	Enhanced
Ella Lake - LV	Moderate
Hannah Lake	Enhanced
Little Panache Lake	Enhanced
Long Lake - P	Moderate
Makada Lake	Enhanced
McCharles	Moderate
McFarlane Lake	Moderate
Middle Lake	Enhanced
Ramsey Lake	Enhanced
Windy Lake - OR	Moderate

6.4 Lake Trout Lakes

The Provincial policy for lakes designated as “lake trout lakes” by the province requires that the mean volume-weighted hypolimnetic dissolved oxygen (MVWHDO) remain above 7 mg/L. Lake trout lakes with a measured MVWHDO ≤7 mg/L, or where development of existing vacant lots would reduce MVWHDO to 7 mg/L or less, are considered to be over capacity for new or more intense residential, commercial or industrial development within 300 m of the lake. Thirty four of the lakes included in this study are classified as natural lake trout lakes and two of the lakes are classified as “Put, Grow, Take” lake trout lakes (Table 14). Other lake trout lakes may exist in the CGS that have a surface area less than 10 ha. The Provincial policy for the protection of lake trout habitat in these lakes would apply regardless of the management classification. We recommend that the Ministry of Natural Resources (MNR) confirm the list of Lake Trout Lakes in Table 14 and provide the CGS with their evaluation of capacity for these lakes so that the City can address these lakes specifically this in their OP policies.

Table 14. Study Lakes in the CGS that are Designated Lake Trout Lakes (n=36)

Lake Trout Lakes		
Bassoon Lake	Hannah Lake	Nelson Lake
Bear Lake	Irish Lake	Norway Lake
Bell Lake	Kukagami Lake	Osbourne Lake
Bigwood Lake	Kumska Lake	Parkin Lake
Bonhomme Lake	Lake Panache	Roland Lake - NR 2
Chief Lake	Lake Wanapitei	Sam Martin Lake
Chiniguchi Lake	Laura Lake	Silvester Lake
Dewdney Lake	Long Lake – P (Put, Grow, Take)	Upper Mowat Lake
Evelyn Lake	Loon Lake (Put, Grow, Take)	Waddell Lake
Fairbank Lake	Marjorie Lake	West Morgan Lake
Fraleck Lake	Matagamasi Lake	Windy Lake – OR
Franks Lake	Morgan Lake	Wolf Lake

7. Water Quality Monitoring

Water quality monitoring is a key component of sound lake management. Monitoring data is used to track changes in water quality so that management efforts can be assessed and revised if necessary. Moreover, monitoring data can provide the necessary information to improve estimates of phosphorus loads from human and natural sources, including internal phosphorus loading, which can be used to refine the management classification of lakes.

We recommend that the CGS continue their spring phosphorus monitoring program with the following revisions:

1. That lakes be sampled every other year instead of annually, freeing up resources for the recommendations that follow.

2. That the program be expanded to include more lakes with a focus on headwater lakes and lakes with little to no development. This information would allow a better assessment of natural phosphorus loads, the calibration of the model and the movement of phosphorus to downstream lakes.

3. That spring sampling include dissolved organic carbon (DOC) to help assess nutrient dynamics. The LCM tends to underestimate phosphorus concentration in lakes with high DOC. Identification of high DOC lakes, therefore, may resolve some error in the model results.

4. That field parameters including water temperature, dissolved oxygen, pH, Secchi depth and conductivity be measured during sampling. These physical parameters can provide insight to a

wide range of lake conditions that may be influencing phosphorus concentrations and algal bloom activity and trends in some (water temperature, dissolved oxygen, Secchi depth) may provide insights into lake responses and the factors behind any observed changes or trends.

5. That the program be expanded to include special studies as resources permit, such as:

   a. Monthly phosphorus sampling over the ice-free season for lakes that 1) have displayed high variability in spring total phosphorus concentration, 2) are productive with high phosphorus concentration (>15 μg/L), 3) are shallow and do not stratify, or 4) have an internal load due to anoxia. Anoxic lakes should have samples taken from the epilimnion and at 1-meter off the lake bottom (1-mob). In all of these situations, the spring overturn phosphorus concentration may not accurately reflect ice-free concentrations for evaluation of the LCM results or against water quality objectives. These data would also help to refine estimates of phosphorus retention in shallow and anoxic lakes.

   b. Collection of physical data (lake depth, end-of-summer oxygen and temperature profiles) from lakes that have not been previously monitored to refine estimates of internal phosphorus loading.

   c. Stormwater quality monitoring to evaluate phosphorus loads from urban runoff. It is suspected that phosphorus export coefficients used for the LCM likely overestimate loads for several urban lakes in the CGS. Refined loading estimates for urban lands may be warranted as lakes with urban development may have more capacity for phosphorus loads from shoreline development of un-serviced lots than predicted for the management classification system.

8. Conclusions

The model did not produce defensible estimates of phosphorus concentrations in the study lakes. This may be a result of changing factors that have not yet been quantified for incorporation into the model and which are the current focus of investigations by the MOE and the Canada Water Network in Muskoka. These include:

1. Effects of a changing climate on hydrology, phosphorus export and internal lake processes,
2. Observed increases in Dissolved Organic Carbon in some PreCambrian Shield waters waters (Palmer et al., 2011) and resultant changes in phosphorus, temperature and light dynamics, and
3. Invading species and changes in the aquatic communities.

We therefore recommend a revised approach that can be supported from the model outcome. The recommended approach follows from the model review and builds on the CGS monitoring program. The following advantages and improvements were identified:

1. It produces three classification categories for lake management policies.
2. It eliminates the need to predict phosphorus concentrations, which are a source of model uncertainty.
3. It maintains the ability of the model to estimate loads and determine relative lake responsiveness.
4. It addresses model uncertainty with observations of water quality.
5. Modeled uncertainty is replaced with measured certainty
6. Planning action is triggered by the potential for a lake to exceed BG+50%, as it is based on loading.
7. The classification system considers potential phosphorus loading and an accepted definition of social crowding in determining lake responsiveness and so it addresses social and water quality concerns.
8. Measurements from the CGS monitoring program are assessed as statistically significant trends over ten years, in which one year's measurement will have less influence.

The lake classification system proposed here is intended as a screening tool that can be applied to help manage additional development on lakes within the City of Greater Sudbury. It does not replace or supercede the need for watershed management plans or lake specific management plans that are triggered by lake-specific investigations. Lake management should be lake focussed and address the specific issues that are present at each lake. Many of the CGS lakes are urban lakes and have been developed for decades, often to levels that could exceed the MOE threshold of "Background + 50%". Although some lakes are serviced by municipal sewers there are still concerns about water quality that can only be addressed through implementing lake specific management plans. The classification system provided herein is in intended to support, and not replace or supercede, existing and future lake management plans.

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Appendix A. CGS Area Lakes – Lake and Watershed Data

Lake #	10ha Lake Name	Sub Watershed Name	Sub Watershed Code	Upstream Lakes	Within City Limits	UTM Easting	UTM Northing	Lake Surface Area	Catchment Area	% Wetland in Catchment
								km^2	km^2	%
1	C 1	Cameron	C	3	Yes	461336	5148348	0.24	1.44	2.74
2	Cameron Lake	Cameron	C	1,4	Yes	463678	5147733	1.01	82.86	11.71
3	Ross Lake - C	Cameron	C	0	Yes	461870	5149539	0.36	2.00	2.91
4	West Cameron Lake	Cameron	C	0	Yes	456636	5149367	0.86	2.83	4.66
5	Alice Lake	East Wanapitei River	EWR	6,20,21	Yes	511132	5145005	0.32	23.47	8.79
6	Baby Lake	East Wanapitei River	EWR	0	Yes	510358	5145353	0.12	1.22	0.00
7	Bonanza Lake	East Wanapitei River	EWR	0	Yes	522785	5168309	0.54	2.04	3.27
8	Brodill Lake	East Wanapitei River	EWR	13,17	Yes	504647	5135028	1.16	6.08	5.75
9	Chief Lake	East Wanapitei River	EWR	15,16	Yes	498934	5134213	1.31	12.09	9.37
10	EWR 1	East Wanapitei River	EWR	0	Yes	503328	5138164	0.37	1.64	4.48
11	EWR 2	East Wanapitei River	EWR	10	Yes	504711	5138719	0.12	0.95	3.78
12	EWR 3	East Wanapitei River	EWR	0	Yes	509644	5146683	0.12	6.46	12.85
13	EWR 4	East Wanapitei River	EWR	9	Yes	502456	5134406	0.10	3.43	10.39
14	EWR 5	East Wanapitei River	EWR	0	Yes	506214	5139029	0.96	4.45	3.37
15	EWR6	East Wanapitei River	EWR	0	No	497238	5132937	0.31	1.90	8.39
16	EWR7	East Wanapitei River	EWR	22	Yes	496294	5133503	0.14	0.78	6.03
17	Kasten Lake	East Wanapitei River	EWR	0	Yes	502351	5134863	0.17	4.74	7.98
18	Little Raft Lake	East Wanapitei River	EWR	0	Yes	502407	5138547	0.19	1.19	0.00
19	Norway Lake	East Wanapitei River	EWR	0	Yes	514464	5156888	0.13	1.78	0.00
20	Raft Lake	East Wanapitei River	EWR	11,18	Yes	504205	5139573	1.09	1.69	3.54
21	T Lake	East Wanapitei River	EWR	14	Yes	507485	5137485	0.49	5.40	8.14
22	Wolfe Lake	East Wanapitei River	EWR	0	Yes	494804	5132323	0.27	1.21	3.63
23	EC 1	Emery Creek	EC	0	Yes	516848	5160378	0.29	5.30	5.11
24	EC 2	Emery Creek	EC	0	Yes	516211	5160191	0.46	3.50	0.00
25	EC 3	Emery Creek	EC	24	Yes	516865	5159379	0.16	0.28	0.00
26	Falcon Gold Lake	Emery Creek	EC	23,25	Yes	519398	5158352	0.18	21.49	21.32
27	Bass Lake N - FB	Fairbank	FB	0	Yes	472526	5145274	0.24	4.87	6.13
28	Bass Lake S - FB	Fairbank	FB	27,31,33	Yes	472050	5144213	0.36	3.58	5.95
29	Ethel Lake	Fairbank	FB	28,32	Yes	471143	5140404	0.33	10.01	6.23
30	Fairbank Lake	Fairbank	FB	0	Yes	467168	5145898	7.04	10.69	3.97
31	Little Fairbank Lake	Fairbank	FB	30	Yes	470302	5145695	0.15	0.55	2.57
32	Mond Lake	Fairbank	FB	0	Yes	470304	5141678	0.13	2.50	14.55
33	Skill Lake	Fairbank	FB	0	Yes	468894	5143780	1.11	4.37	11.34
34	Bad Lake	Kukagami	K	0	Yes	532997	5178475	0.21	2.27	13.12
35	Bassfin Lake	Kukagami	K	0	Yes	529153	5175030	0.45	2.27	3.79
36	Big Valley Lake	Kukagami	K	57,68	Yes	533280	5189888	0.65	2.39	3.75
37	Boot Lake	Kukagami	K	0	Yes	531110	5175966	0.22	0.87	2.41
38	Cathro Lake	Kukagami	K	0	Yes	528441	5179115	0.34	2.40	5.74
39	Chiniguchi Lake	Kukagami	K	51,64,73	No	524095	5197453	11.05	56.00	4.94
40	Dewdney Lake	Kukagami	K	39,43,53	Yes	526459	5191681	1.70	9.14	2.73
41	Doon Lake	Kukagami	K	0	Yes	532644	5180532	0.37	2.55	13.66
42	Evelyn Lake	Kukagami	K	48	No	531162	5193602	1.11	4.01	3.59
43	Franks Lake	Kukagami	K	0	Yes	527169	5192029	0.20	3.14	0.90
44	Houston Lake	Kukagami	K	0	Yes	530978	5184412	0.14	0.46	22.52
45	Irish Lake	Kukagami	K	42	Yes	532073	5191125	0.24	2.35	8.83
46	Jones Lake	Kukagami	K	0	Yes	528109	5187094	0.11	1.53	3.99
47	K 1	Kukagami	K	0	Yes	529952	5184670	0.13	1.10	8.10
48	K 10	Kukagami	K	62	No	531389	5195123	0.12	1.89	8.05
49	K 11	Kukagami	K	0	No	527459	5196662	0.15	0.49	1.15
50	K 12	Kukagami	K	0	No	528064	5195130	0.10	1.70	3.26
51	K 13	Kukagami	K	0	No	524052	5193298	0.16	1.89	4.60
52	K 2	Kukagami	K	0	Yes	528043	5181974	0.19	1.53	15.54
53	K 3	Kukagami	K	0	Yes	525000	5190868	0.29	1.71	3.42
54	K 4	Kukagami	K	0	Yes	529010	5186312	0.32	2.12	7.15
55	K 5	Kukagami	K	0	Yes	531019	5190863	0.11	1.16	2.95
56	K 6	Kukagami	K	0	Yes	532879	5190019	0.14	0.74	25.26
57	K 7	Kukagami	K	0	No	532548	5192543	0.11	0.42	5.85
58	K 8	Kukagami	K	0	No	533713	5183236	0.11	1.52	3.75
59	K 9	Kukagami	K	0	No	535723	5180709	0.17	0.88	1.35
60	Kukagami Lake	Kukagami	K	7,70	Yes	534282	5175626	18.79	33.81	3.86
61	Landry Lake	Kukagami	K	71	Yes	529149	5190726	0.17	7.50	6.58
62	Laura Lake	Kukagami	K	0	No	529994	5199102	2.40	11.76	3.43
63	Little Valley Lake	Kukagami	K	0	No	534540	5190085	0.27	2.88	1.71
64	Marjorie Lake	Kukagami	K	49,50	No	528846	5195397	0.76	5.52	2.93

Lake #	10ha Lake Name	Sub Watershed Name	Sub Watershed Code	Upstream Lakes	Within City Limits	UTM Easting	UTM Northing	Lake Surface Area km^2	Catchment Area km^2	% Wetland in Catchment %
65	Matagamasi Lake	Kukagami	K	4,46,47,51,54 ,63,66,69,74,	Yes	531352	5182691	13.08	55.74	7.70
66	McLaren Lake	Kukagami	K	0	Yes	530272	5170084	0.28	16.30	19.65
67	Norman Lake	Kukagami	K	0	Yes	533259	5183583	0.15	0.79	6.18
68	Owen Lake	Kukagami	K	0	No	533913	5191993	0.17	1.18	4.02
69	Pelo Lake	Kukagami	K	0	Yes	530105	5185882	0.31	2.47	13.10
70	Portage Lake	Kukagami	K	71	Yes	531933	5175186	0.20	0.46	0.00
71	Rat Lake	Kukagami	K	0	Yes	532149	5176103	0.12	1.27	7.52
72	Rathwell Lake	Kukagami	K	0	Yes	528896	5192503	0.21	2.39	6.78
73	Shed Lake	Kukagami	K	0	Yes	523180	5192322	0.92	2.72	3.14
74	Silvester Lake	Kukagami	K	78	Yes	527043	5187562	0.55	9.22	6.87
75	Thomas Lake	Kukagami	K	0	Yes	526666	5183449	0.23	2.52	5.17
76	Upper Thomas Lake	Kukagami	K	75	Yes	526797	5184058	0.12	3.55	8.76
77	Wessel Lake	Kukagami	K	55,56,45	Yes	531957	5188418	0.31	8.51	9.92
78	Wolf Lake	Kukagami	K	40,61	Yes	527835	5188927	0.87	3.20	4.53
79	Bass Lake - LJC	Lower Junction Creek	LJC	0	No	479451	5134088	0.22	1.17	6.65
80	Echo Lake	Lower Junction Creek	LJC	0	Yes	485648	5142184	0.12	4.24	3.35
81	Fly Lake	Lower Junction Creek	LJC	92	No	487966	5136566	0.51	3.15	4.68
82	Little Fly Lake	Lower Junction Creek	LJC	81	No	488599	5137421	0.31	2.92	11.00
83	LJC 1	Lower Junction Creek	LJC	85,86	Yes	488141	5143472	0.10	2.51	13.23
84	LJC 2	Lower Junction Creek	LJC	0	Yes	488662	5146593	0.34	1.21	11.40
85	Meatbird Lake	Lower Junction Creek	LJC	84,89	Yes	488762	5145442	2.15	3.37	9.24
86	Mud Lake - LJC 1	Lower Junction Creek	LJC	0	Yes	487256	5144857	0.12	2.23	14.18
87	Mud Lake - LJC 2	Lower Junction Creek	LJC	80,82,83,244	Yes	487854	5139016	0.60	40.87	5.17
88	Nemag Lake	Lower Junction Creek	LJC	79	No	481796	5135032	2.21	4.79	5.74
89	North Star Lake	Lower Junction Creek	LJC	0	Yes	487443	5145586	0.32	2.15	5.64
90	Simon Lake	Lower Junction Creek	LJC	87	Yes	484992	5138128	1.02	4.30	3.80
91	Wakemi Lake	Lower Junction Creek	LJC	88	No	483470	5136162	1.31	1.40	2.07
92	Whitefish Lake	Lower Junction Creek	LJC	91	No	485550	5136060	3.83	7.39	11.77
93	LSR 1	Lower Spanish River	LSR	0	Yes	463825	5135486	0.13	0.84	29.44
94	Perch Lake - LSR	Lower Spanish River	LSR	0	Yes	467730	5138084	0.24	6.66	11.77
95	St Pothier Lake	Lower Spanish River	LSR	0	Yes	471037	5136370	0.29	0.94	9.13
96	Anne Lake	Lower Vermilion	LV	120	Yes	465619	5128725	0.46	7.43	8.05
97	Beaver Lake E (Little)- LV	Lower Vermilion	LV	98	Yes	462311	5131822	0.16	5.68	13.44
98	Beaver Lake W (Big) - LV	Lower Vermilion	LV	0	Yes	461376	5131952	0.22	0.83	3.50
99	Bell Lake	Lower Vermilion	LV	0	Yes	457526	5131806	0.33	1.34	6.85
100	Ella Lake - LV	Lower Vermilion	LV	104	Yes	459517	5127035	3.27	9.67	5.16
101	Grassy Lake - LV	Lower Vermilion	LV	107,117	Yes	469536	5132305	0.78	28.00	10.27
102	Happys Lake	Lower Vermilion	LV	0	Yes	482337	5143740	0.13	18.57	10.64
103	Hock Lake	Lower Vermilion	LV	116	No	459171	5123986	1.21	8.25	10.17
104	Karstula Lake	Lower Vermilion	LV	103,105	Yes	459438	5125469	0.14	1.21	2.15
105	LIttle Ella Lake	Lower Vermilion	LV	0	Yes	460415	5126165	0.28	1.07	1.07
106	Little Rat Lake	Lower Vermilion	LV	0	Yes	473284	5128483	0.26	3.85	8.82
107	Louie Lake	Lower Vermilion	LV	115	Yes	470680	5130415	0.20	2.84	20.86
108	LV 1	Lower Vermilion	LV	0	Yes	477335	5148252	0.13	1.38	43.78
109	LV 2	Lower Vermilion	LV	123	Yes	475193	5141115	0.29	3.29	9.89
110	LV 3	Lower Vermilion	LV	0	Yes	475709	5143597	0.25	5.67	7.46
111	Margaret Lake	Lower Vermilion	LV	0	Yes	465879	5126709	0.66	3.38	6.99
112	McCharles Lake	Lower Vermilion	LV	19	Yes	480906	5136939	2.30	45.53	12.56
113	Monk Lake	Lower Vermilion	LV	0	Yes	473189	5140893	0.12	1.52	3.87
114	Northeast Lake	Lower Vermilion	LV	0	Yes	468465	5126080	0.23	4.22	15.90
115	Number Ten Lake	Lower Vermilion	LV	0	Yes	468163	5129511	0.11	0.49	0.00
116	Pistin Lake	Lower Vermilion	LV	118	No	461180	5124517	0.47	2.65	5.49
117	Rat/Kusk Lake	Lower Vermilion	LV	22	Yes	473864	5129696	1.39	58.19	13.26
118	Rickale Lake	Lower Vermilion	LV	0	Yes	462816	5124694	0.59	1.81	7.88
119	SU-235 Lake	Lower Vermilion	LV	125,129,339, 349,351,352	Yes	477941	5140596	0.40	397.32	13.31
120	Threecomer Lake	Lower Vermilion	LV	111	Yes	467426	5128766	0.29	2.75	6.15
121	Wabagishik Lake	Lower Vermilion	LV	101	Yes	454835	5126757	5.93	63.74	6.73
122	West Lake	Lower Vermilion	LV	114	Yes	471995	5128884	0.61	14.96	11.21
123	Zilch Lake	Lower Vermilion	LV	0	Yes	475729	5141577	0.18	1.24	2.49
124	Clear Lake - MV	Mid Vermilion	MV	131	Yes	476824	5163960	0.12	0.94	2.60
125	Gordon Lake	Mid Vermilion	MV	132	Yes	472796	5148954	1.83	7.52	6.17
126	MV 1	Mid Vermilion	MV	0	Yes	486264	5170039	0.10	0.49	1.06

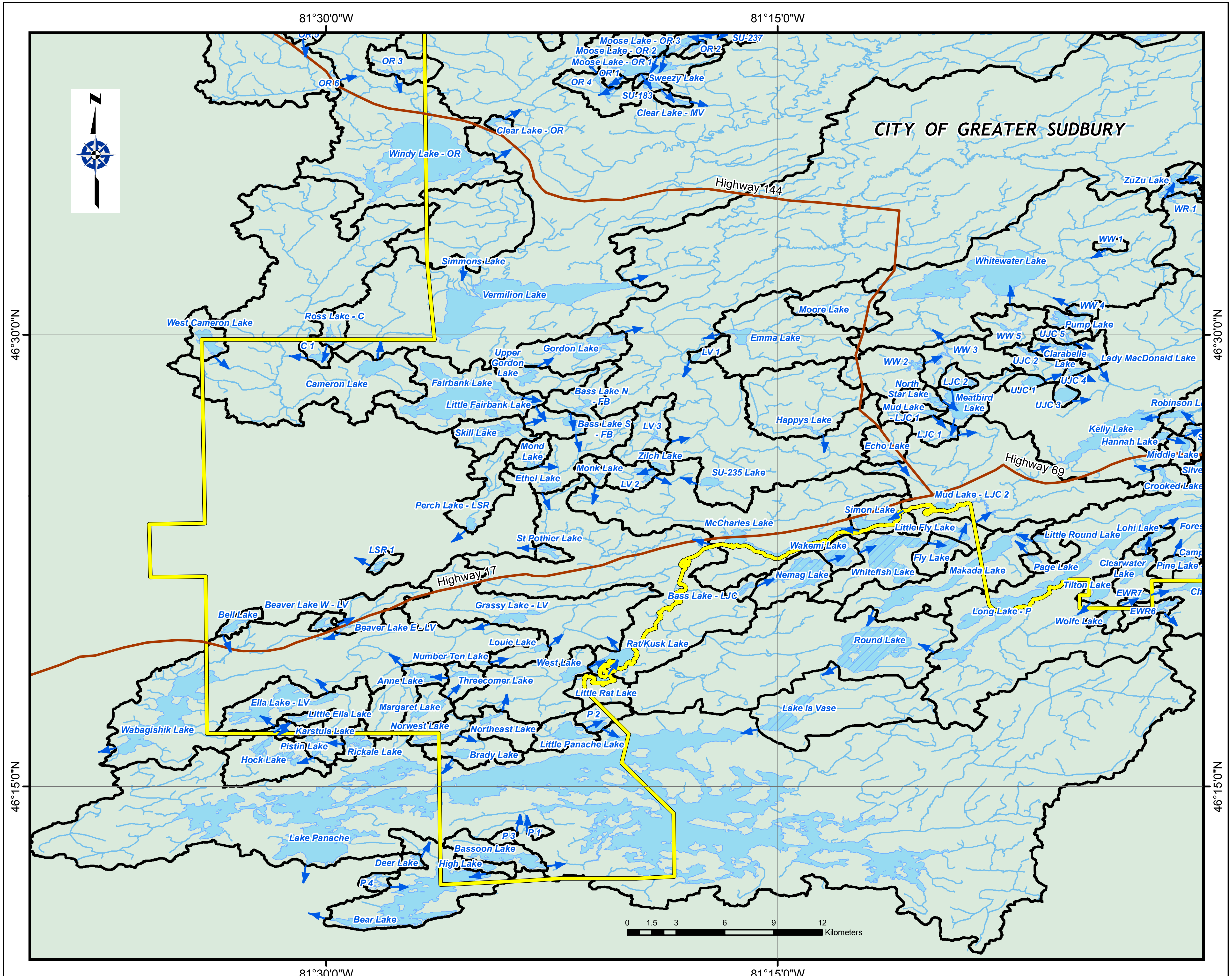
Lake #	10ha Lake Name	Sub Watershed Name	Sub Watershed Code	Upstream Lakes	Within City Limits	UTM Easting	UTM Northing	Lake Surface Area km^2	Catchment Area km^2	% Wetland in Catchment %
127	MV 2	Mid Vermilion	MV	126	Yes	486312	5170405	0.12	0.62	2.21
128	MV 3	Mid Vermilion	MV	0	Yes	496918	5168474	1.13	3.22	22.13
129	Simmons Lake	Mid Vermilion	MV	0	Yes	467902	5154317	0.36	20.94	15.78
130	Snider Lake	Mid Vermilion	MV	0	Yes	488184	5170296	0.16	0.53	4.27
131	SU-183	Mid Vermilion	MV	0	Yes	475537	5165006	0.23	0.78	0.00
132	Upper Gordon Lake	Mid Vermilion	MV	0	Yes	470152	5147134	0.56	4.80	21.19
133	Vermilion Lake	Mid Vermilion	MV	8,130,133-42,149,152-3,157-8,201,203,20	Yes	469269	5151713	11.08	1990.59	6.47
134	Foster Lake	Nelson River	NR	0	Yes	488490	5176959	0.12	1.10	10.48
135	Nelson Lake	Nelson River	NR	0	Yes	492709	5174905	3.12	8.57	5.62
136	NR 1	Nelson River	NR	0	Yes	490014	5174216	0.15	0.60	3.79
137	NR 2	Nelson River	NR	0	Yes	487272	5171969	0.18	0.97	3.32
138	NR 3	Nelson River	NR	0	Yes	490230	5182845	0.43	5.82	11.18
139	Roland Lake - NR 1	Nelson River	NR	0	Yes	488716	5179548	0.22	6.20	7.45
140	Roland Lake - NR 2	Nelson River	NR	0	Yes	489908	5175763	0.12	0.85	3.01
141	Toweman's Lake	Nelson River	NR	0	Yes	493780	5173567	0.23	0.36	0.00
142	Clear Lake - OR	Onaping River	OR	0	Yes	468886	5162802	0.19	0.71	4.36
143	Moose Lake - OR 1	Onaping River	OR	144,145,156	Yes	475191	5166076	1.30	5.69	0.95
144	Moose Lake - OR 2	Onaping River	OR	0	Yes	475799	5167205	0.40	3.65	0.64
145	Moose Lake - OR 3	Onaping River	OR	147,155	Yes	476885	5167576	0.45	1.74	0.76
146	OR 1	Onaping River	OR	143	Yes	474017	5165206	0.16	0.61	4.18
147	OR 2	Onaping River	OR	0	Yes	477409	5167340	0.11	0.95	0.00
148	OR 3	Onaping River	OR	0	Yes	465118	5165946	0.32	4.35	15.98
149	OR 4	Onaping River	OR	146	Yes	473505	5164852	0.32	4.97	1.65
150	OR 5	Onaping River	OR	0	No	461086	5168283	0.15	1.09	14.35
151	OR 6	Onaping River	OR	150	No	461841	5165323	0.15	22.76	15.60
152	Pike Lake - OR	Onaping River	OR	0	Yes	471570	5168921	0.25	2.95	3.88
153	Seal Lake	Onaping River	OR	0	Yes	470613	5173021	0.39	2.11	3.05
154	SU-1109	Onaping River	OR	0	Yes	479254	5168886	0.14	0.40	1.95
155	SU-237	Onaping River	OR	154	Yes	478659	5168294	0.10	1.05	1.71
156	Sweezy Lake	Onaping River	OR	0	Yes	475117	5165444	0.11	0.26	0.00
157	Webfoot Lake	Onaping River	OR	0	Yes	473076	5170411	0.10	0.47	5.68
158	Windy Lake - OR	Onaping River	OR	148,151	Yes	465882	5160627	11.40	45.41	5.83
159	Bassoon Lake	Panache	P	0	Yes	469357	5117475	1.33	4.01	11.28
160	Bear Lake	Panache	P	166,168,182	Yes	465365	5115051	6.98	13.52	5.36
161	Brady Lake	Panache	P	178	Yes	467212	5123950	0.43	5.25	2.65
162	Camp Lake	Panache	P	164	Yes	499888	5136525	0.21	1.00	8.21
163	Clearwater Lake	Panache	P	0	Yes	496118	5135206	0.76	3.08	2.32
164	Crowley Lake	Panache	P	171	Yes	501332	5136762	0.40	2.59	5.43
165	Daisy Lake	Panache	P	0	Yes	508722	5144217	0.44	3.01	1.20
166	Deer Lake	Panache	P	0	No	465292	5117365	0.22	0.62	13.39
167	Forest Lake	Panache	P	0	Yes	500291	5137655	0.17	0.70	1.78
168	High Lake	Panache	P	0	Yes	468192	5116985	0.29	1.42	16.05
169	Lake la Vase	Panache	P	186	No	481066	5126172	1.79	21.70	11.60
170	Lake Panache	Panache	P	179-81	Yes	472507	5120535	81.47	300.12	8.48
171	Linton Lake	Panache	P	0	Yes	501135	5135738	0.28	1.79	10.48
172	Little Panache Lake	Panache	P	0	Yes	471837	5125239	1.03	3.16	4.72
173	Little Round Lake	Panache	P	0	Yes	491990	5137068	0.20	2.03	8.76
174	Lohi Lake	Panache	P	163	Yes	496672	5137108	0.41	1.01	6.99
175	Long Lake - P	Panache	P	177,184,188	Yes	492640	5134499	8.73	74.41	8.76
176	Makada Lake	Panache	P	173,183	Yes	488023	5134814	3.57	16.55	8.78
177	McFarlane Lake	Panache	P	185,187	Yes	503156	5140413	1.70	14.92	7.81
178	Norwest Lake	Panache	P	0	Yes	466161	5124949	0.45	2.94	3.47
179	P 1	Panache	P	0	Yes	470321	5119157	0.12	0.47	6.87
180	P 2	Panache	P	172	Yes	473063	5125665	0.31	2.57	16.37
181	P 3	Panache	P	0	Yes	469229	5118929	0.12	0.68	21.94
182	P 4	Panache	P	0	No	463531	5116127	0.17	1.17	26.64
183	Page Lake	Panache	P	0	Yes	491725	5135758	0.21	1.00	3.47
184	Pine Lake - P	Panache	P	0	Yes	498064	5135843	0.19	1.74	8.78
185	Richard Lake	Panache	P	165	Yes	506512	5142747	0.80	3.86	5.27
186	Round Lake	Panache	P	175,176	No	484804	5130421	5.85	49.07	12.23
187	Silver Lake	Panache	P	0	Yes	498869	5141708	0.22	0.40	3.82

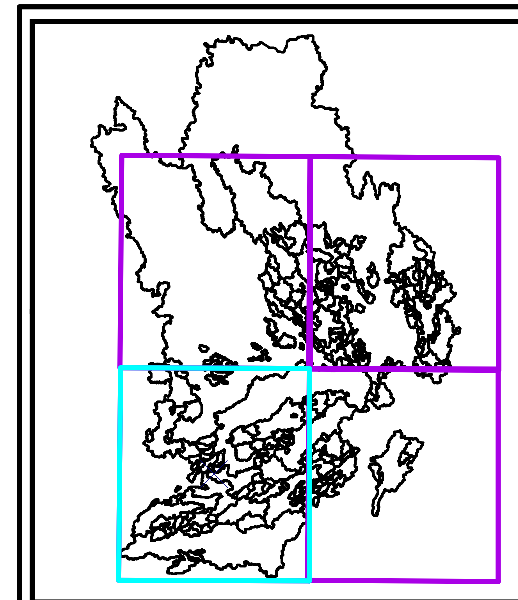
Lake #	10ha Lake Name	Sub Watershed Name	Sub Watershed Code	Upstream Lakes	Within City Limits	UTM Easting	UTM Northing	Lake Surface Area	Catchment Area	% Wetland in Catchment
								km^2	km^2	%
188	Tilton Lake	Panache	P	0	Yes	494462	5133710	0.52	2.06	4.20
189	Bennett Lake	Ramsey	R	0	Yes	502148	5144904	0.14	0.23	3.43
190	Bethel Lake	Ramsey	R	0	Yes	502921	5146438	0.32	0.66	4.72
191	Hannah Lake	Ramsey	R	0	Yes	497055	5143302	0.28	0.71	8.08
192	Lake Laurentian	Ramsey	R	196	Yes	503515	5144097	1.35	3.97	16.68
193	Lake Nepahwin	Ramsey	R	189	Yes	500850	5145008	1.26	5.40	2.30
194	Middle Lake	Ramsey	R	191	Yes	498095	5142823	0.29	1.72	7.57
195	Minnow Lake - R	Ramsey	R	0	Yes	503337	5148777	0.20	2.29	1.24
196	Perch Lake - R	Ramsey	R	0	Yes	505527	5143951	0.32	0.77	11.77
197	Ramsey Lake	Ramsey	R	190,192,195	Yes	503687	5147012	7.96	24.32	7.60
198	Robinson Lake	Ramsey	R	193,197,199	Yes	497688	5144691	0.34	5.59	6.48
199	St Charles Lake	Ramsey	R	194	Yes	498746	5143690	0.41	1.72	14.14
200	Dixon (Little Joe) Lake	Rapid River	RPR	0	Yes	500624	5175054	0.23	1.14	3.09
201	Joe Lake	Rapid River	RPR	'200,204,210	Yes	498876	5176038	1.97	3.19	5.16
202	Osbourne Lake	Rapid River	RPR	0	No	487997	5189889	0.98	10.35	9.48
203	Pigeon Lake	Rapid River	RPR	0	Yes	497125	5173254	0.19	0.96	0.93
204	RPR 1	Rapid River	RPR	0	Yes	498553	5174992	0.14	0.38	0.00
205	RPR 2	Rapid River	RPR	0	Yes	495040	5180567	0.14	0.72	7.06
206	RPR 3	Rapid River	RPR	0	Yes	495587	5181026	0.10	0.99	14.53
207	RPR 4	Rapid River	RPR	0	Yes	495817	5181592	0.10	2.66	10.70
208	RPR 5	Rapid River	RPR	202	Yes	494949	5181392	0.19	20.78	12.38
209	RPR 6	Rapid River	RPR	0	Yes	497281	5176593	0.13	0.60	2.72
210	Tank Lake	Rapid River	RPR	0	Yes	499587	5176545	0.20	0.94	0.70
211	Jumbo Lake	Red Deer	RD	0	Yes	517274	5141459	0.12	7.48	8.91
212	RD	Red Deer	RD	0	No	525746	5145065	0.11	14.39	8.06
213	Red Deer Lake	Red Deer	RD	211,214,215	Yes	520147	5137728	1.86	97.90	10.16
214	Southeast Baby Lake	Red Deer	RD	0	Yes	517999	5137963	0.23	2.10	1.47
215	SU-258	Red Deer	RD	212	Yes	523431	5143513	0.27	5.27	5.75
216	Bigwood Lake	Roberts River	RBR	222	No	492897	5187495	2.78	19.33	7.54
217	Copenhagen Lake	Roberts River	RBR	0	No	492422	5184967	0.21	1.61	3.44
218	Decair Lake	Roberts River	RBR	0	No	490560	5202073	0.19	0.72	4.15
219	Duck Lake	Roberts River	RBR	0	No	489555	5201758	0.14	1.40	1.75
220	Ironside Lake	Roberts River	RBR	216	Yes	495336	5186890	1.34	8.28	9.20
221	Kumska Lake	Roberts River	RBR	217,229	Yes	496303	5182747	1.44	9.39	10.58
222	Morton Lake	Roberts River	RBR	228	No	489614	5192253	1.30	9.71	9.60
223	RBR 1	Roberts River	RBR	0	Yes	497070	5189885	0.11	0.24	21.87
224	RBR 2	Roberts River	RBR	221,225,227	Yes	500120	5186003	0.11	37.57	10.78
225	RBR 3	Roberts River	RBR	220,226,231	Yes	497429	5188364	0.16	0.39	0.00
226	RBR 4	Roberts River	RBR	223	Yes	497384	5189295	0.12	0.15	0.00
227	RBR 5	Roberts River	RBR	0	Yes	498428	5183538	0.11	2.01	7.28
228	RBR 6	Roberts River	RBR	0	No	488775	5195255	0.14	6.22	10.64
229	RBR 7	Roberts River	RBR	0	No	494418	5184304	0.13	4.14	15.13
230	Roberts Lake	Roberts River	RBR	218	No	491829	5200764	0.82	4.33	1.34
231	Slide Lake	Roberts River	RBR	230,219	Yes	494219	5192412	0.22	49.10	6.34
232	Island Lake	Sandcherry Creek	SCC	233	Yes	475424	5170051	0.15	3.73	12.05
233	Longvack Lake	Sandcherry Creek	SCC	0	Yes	474677	5170972	0.13	0.62	3.04
234	Morgan Lake	Sandcherry Creek	SCC	0	Yes	477820	5168922	0.43	0.96	6.91
235	SCC 1	Sandcherry Creek	SCC	0	Yes	485455	5173075	0.15	1.21	15.24
236	SCC 2	Sandcherry Creek	SCC	0	Yes	484262	5173651	0.11	0.73	2.95
237	SU-345	Sandcherry Creek	SCC	0	Yes	483802	5170211	0.24	0.65	0.61
238	West Morgan Lake	Sandcherry Creek	SCC	0	Yes	476706	5168907	0.99	2.53	2.82
239	Ashigami Lake	Sturgeon River	SR	241	Yes	532748	5166868	4.32	14.65	8.88
240	MacDonald's Lake	Sturgeon River	SR	0	No	535430	5169617	0.13	1.07	0.58
241	SR	Sturgeon River	SR	240	No	535188	5168357	0.17	2.20	8.37
242	Clarabelle Lake	Upper Junction Creek	UJC	249,342	Yes	492971	5148769	0.40	1.74	3.17
243	Crooked Lake	Upper Junction Creek	UJC	0	Yes	497317	5140836	0.26	2.17	11.93
244	Kelly Lake	Upper Junction Creek	UJC	247,248	Yes	494972	5143576	3.45	132.75	5.80
245	Lady MacDonald Lake	Upper Junction Creek	UJC	242	Yes	494289	5148131	0.14	1.91	0.66
246	UJC 1	Upper Junction Creek	UJC	0	Yes	491639	5146724	0.46	0.77	1.22
247	UJC 3	Upper Junction Creek	UJC	0	Yes	493037	5145929	0.67	0.46	5.74
248	UJC 4	Upper Junction Creek	UJC	246	Yes	493460	5147382	0.22	0.60	0.04
249	UJC 5	Upper Junction Creek	UJC	0	Yes	493048	5149542	0.15	1.66	13.73
250	Baseline Lake	Upper Vermilion	UV	265	No	494646	5198958	0.33	32.46	5.77

Lake #	10ha Lake Name	Sub Watershed Name	Sub Watershed Code	Upstream Lakes	Within City Limits	UTM Easting	UTM Northing	Lake Surface Area	Catchment Area	% Wetland in Catchment
								km^2	km^2	%
251	Bass Lake - UV	Upper Vermilion	UV	257,261,267, 269,270	Yes	503856	5174215	0.21	43.95	8.72
252	Blueberry Lake	Upper Vermilion	UV	0	Yes	497968	5178921	0.11	1.36	15.81
253	Cache Lake	Upper Vermilion	UV	0	Yes	504448	5183388	0.14	9.11	40.51
254	Farm Lake	Upper Vermilion	UV	0	Yes	505494	5177673	0.12	5.02	6.76
255	Fraser Lake	Upper Vermilion	UV	250	Yes	503080	5186402	0.13	49.16	4.43
256	Frenchman Lake	Upper Vermilion	UV	0	Yes	501083	5173472	0.44	1.55	3.66
257	Grassy Lake - UV	Upper Vermilion	UV	0	Yes	506197	5180803	0.10	3.06	8.22
258	Graveyard Lake	Upper Vermilion	UV	0	No	488270	5205570	0.82	260.18	6.25
259	Greens Lake	Upper Vermilion	UV	262,263	Yes	505785	5170288	0.35	11.55	7.85
260	Hanmer Lake	Upper Vermilion	UV	256	Yes	502088	5173097	0.54	1.53	1.57
261	Hutton Lake	Upper Vermilion	UV	0	Yes	500451	5184378	0.72	5.09	5.11
262	Long Lake - UV	Upper Vermilion	UV	0	Yes	507446	5173699	0.12	1.00	0.00
263	Marshy Lake	Upper Vermilion	UV	251,260,266	Yes	505369	5172830	0.12	12.80	4.68
264	Onwatin Lake	Upper Vermilion	UV	259	Yes	504153	5170413	0.32	2.01	0.00
265	Proudfoot Lake	Upper Vermilion	UV	258	No	493228	5201213	0.44	12.71	4.41
266	Rockcut Lake	Upper Vermilion	UV	0	Yes	505679	5175925	0.20	3.76	8.45
267	Ross Lake - UV	Upper Vermilion	UV	255	Yes	503616	5184031	0.25	10.65	13.71
268	UV 1	Upper Vermilion	UV	0	Yes	499706	5181817	0.23	1.74	8.56
269	UV 2	Upper Vermilion	UV	0	Yes	500771	5178416	0.16	5.70	3.20
270	Wisner Lake	Upper Vermilion	UV	268	Yes	501162	5179683	0.27	3.14	11.54
271	Amy Lake	Wanapitei	W	286	Yes	511790	5173234	0.34	2.62	6.62
272	Bannagan Lake	Wanapitei	W	0	Yes	502115	5189164	0.17	0.95	4.76
273	Barnett Lake	Wanapitei	W	0	Yes	507413	5175821	0.11	0.76	7.24
274	Bass Lake - W	Wanapitei	W	0	Yes	512438	5188812	0.17	3.76	0.50
275	Beaver Lake - W	Wanapitei	W	285	Yes	510625	5200691	0.31	4.90	3.61
276	Bernard Lake	Wanapitei	W	272	Yes	502294	5189766	0.12	3.14	12.13
277	Blackthorn Lake	Wanapitei	W	323	Yes	525302	5182180	0.21	3.07	24.45
278	Blue Lake	Wanapitei	W	290	Yes	513573	5169417	1.30	4.85	5.07
279	Boland's Bay	Wanapitei	W	0	Yes	518046	5166881	0.14	2.32	0.00
280	Boland's Lake	Wanapitei	W	284	Yes	528257	5177637	0.50	0.83	0.00
281	Bonhomme Lake	Wanapitei	W	309	Yes	522009	5184924	0.35	10.78	12.34
282	Botom Lake	Wanapitei	W	0	Yes	525075	5183457	0.16	0.47	4.16
283	Bugg Lake	Wanapitei	W	328	Yes	528072	5168580	0.31	9.87	15.43
284	Bushy Lake	Wanapitei	W	0	Yes	528976	5177356	0.17	0.34	0.00
285	Camp Three Lake	Wanapitei	W	0	Yes	512322	5201570	0.10	2.27	4.31
286	Capre Lake	Wanapitei	W	0	Yes	512828	5170792	0.43	0.87	0.00
287	Caswell Lake	Wanapitei	W	305	Yes	522309	5189934	0.37	3.77	1.12
288	Connelly Lake	Wanapitei	W	311	Yes	502417	5191397	0.34	19.53	15.30
289	Dean Lake	Wanapitei	W	0	Yes	504130	5191071	0.26	2.96	11.98
290	Drill Lake	Wanapitei	W	0	Yes	514490	5171129	0.13	0.78	12.82
291	Eatlots Lake	Wanapitei	W	273,316	Yes	508869	5176257	0.11	2.49	3.96
292	Ella Lake - W	Wanapitei	W	335,337	Yes	510341	5172689	1.68	9.19	9.27
293	Fire Lake	Wanapitei	W	0	Yes	506983	5201315	0.68	2.24	26.97
294	Fraleck Lake	Wanapitei	W	322	Yes	508781	5195595	1.68	9.03	6.11
295	Framan Lake	Wanapitei	W	0	Yes	503952	5197451	0.73	13.50	4.79
296	Gipsy Lake	Wanapitei	W	0	Yes	503767	5200330	0.12	0.70	3.35
297	Goat Lake	Wanapitei	W	308	Yes	514809	5185696	0.23	3.81	1.44
298	Hagarty Lake	Wanapitei	W	303	Yes	513950	5167781	0.17	2.59	11.73
299	Horseshoe Lake	Wanapitei	W	307	Yes	513189	5174100	0.13	0.95	1.32
300	Irving Lake	Wanapitei	W	317	Yes	504675	5189124	0.30	1.34	11.42
301	Kolari Bay	Wanapitei	W	321	Yes	520029	5169679	0.37	6.66	6.93
302	Kosmerly Lake	Wanapitei	W	0	Yes	508922	5189289	0.24	1.23	59.50
303	Lac St Jean	Wanapitei	W	0	Yes	511173	5168745	0.82	3.10	15.51
304	Lake Wanapitei	Wanapitei	W	[illegible] 5,277- 83,287,292,2 97- 302,306,313- 5,319-20,324-	Yes	520233	5175923	132.49	2108.54	9.66
305	Lawlor Lake - W 1	Wanapitei	W	0	Yes	521738	5191354	0.34	2.59	5.97
306	Lawlor Lake - W 2	Wanapitei	W	0	Yes	519608	5190985	0.14	0.58	4.29
307	Little Amy Lake	Wanapitei	W	0	Yes	512456	5173040	0.12	1.15	0.00
308	Little Italy Lake	Wanapitei	W	0	Yes	514274	5186683	0.14	1.45	1.33
309	Little Otter Lake	Wanapitei	W	318	Yes	524388	5185297	0.17	0.35	0.00

Lake #	10ha Lake Name	Sub Watershed Name	Sub Watershed Code	Upstream Lakes	Within City Limits	UTM Easting	UTM Northing	Lake Surface Area	Catchment Area	% Wetland in Catchment
								km^2	km^2	%
310	Loon Lake	Wanapitei	W	0	No	515663	5194240	0.44	1.73	1.94
311	Lower Mowat Lake	Wanapitei	W	332	Yes	504739	5193615	0.12	0.87	14.48
312	Lynn Lake	Wanapitei	W	294	Yes	509125	5193395	0.20	4.59	4.11
313	Malbeuf Lake	Wanapitei	W	0	Yes	509806	5183803	0.34	2.03	7.39
314	McFie Lake	Wanapitei	W	0	Yes	508392	5186553	0.16	0.46	3.34
315	Minnow Lake - W	Wanapitei	W	0	Yes	512571	5174719	0.31	0.83	1.08
316	Moose Lake - W	Wanapitei	W	0	Yes	508333	5174378	0.21	1.23	3.41
317	Mowat Lake	Wanapitei	W	276,288,289	Yes	504041	5190067	0.68	2.46	18.56
318	Otter Lake	Wanapitei	W	0	Yes	524634	5186499	0.49	1.77	3.18
319	Overhead Lake	Wanapitei	W	293	Yes	509409	5199760	0.14	9.10	33.90
320	Parkin Lake	Wanapitei	W	312	Yes	510445	5191723	1.02	6.60	7.89
321	Pike Lake - W	Wanapitei	W	0	Yes	520707	5168773	0.12	0.50	0.08
322	Pine Lake - W	Wanapitei	W	295,296,331	Yes	506346	5197609	0.58	44.73	8.65
323	Rathbun Lake	Wanapitei	W	0	Yes	525757	5180342	0.91	5.46	10.21
324	Sam Martin Lake	Wanapitei	W	310	Yes	515717	5191097	1.44	6.76	4.69
325	Selwyn Lake	Wanapitei	W	291	Yes	509453	5178222	0.67	17.18	27.73
326	Skead Bay	Wanapitei	W	0	Yes	518730	5168433	0.31	1.43	0.00
327	Skynner Lake	Wanapitei	W	0	Yes	511090	5177573	0.19	0.70	6.30
328	Spar Lake	Wanapitei	W	0	Yes	527465	5168437	0.24	1.19	2.11
329	Stake Lake	Wanapitei	W	0	Yes	504767	5188208	0.10	0.80	11.48
330	Tower Lake	Wanapitei	W	0	Yes	512960	5190702	0.16	0.85	0.64
331	Upper Gipsy Lake	Wanapitei	W	0	Yes	504052	5201050	0.18	2.96	13.88
332	Upper Mowat Lake	Wanapitei	W	0	Yes	504347	5194445	0.74	3.11	4.59
333	W 1	Wanapitei	W	0	Yes	513629	5171830	0.10	1.27	14.69
334	W 2	Wanapitei	W	0	Yes	512707	5183935	0.11	3.13	6.01
335	W 3	Wanapitei	W	0	Yes	510943	5171707	0.13	0.89	8.89
336	W 4	Wanapitei	W	0	Yes	507756	5185989	0.17	1.14	33.71
337	Waddell Lake	Wanapitei	W	0	Yes	509853	5176216	0.70	3.11	6.43
338	Windy Lake - W	Wanapitei	W	0	Yes	513432	5172738	0.11	0.81	0.23
339	Emma Lake	Whitewater	WW	340	Yes	479225	5149619	0.58	19.63	16.14
340	Moore Lake	Whitewater	WW	343	Yes	482784	5151278	0.35	7.72	28.13
341	Pump Lake	Whitewater	WW	0	Yes	493107	5150571	0.59	1.40	6.53
342	UJC 2	Whitewater	UJC	0	Yes	491408	5148557	0.11	3.17	1.18
343	Whitewater Lake	Whitewater	WW	347,348	Yes	489335	5153154	9.50	64.61	11.36
344	WW 1	Whitewater	WW	0	Yes	494874	5155126	0.11	0.82	8.29
345	WW 2	Whitewater	WW	0	Yes	486666	5147749	0.19	8.03	15.34
346	WW 3	Whitewater	WW	345	Yes	487795	5148358	0.17	7.38	20.93
347	WW 4	Whitewater	WW	0	Yes	493524	5151098	0.17	0.81	8.10
348	WW 5	Whitewater	WW	0	Yes	490894	5150172	0.36	5.18	8.34
349	Garson Lake	Whitson River	WR	0	Yes	505986	5160383	1.27	12.00	15.04
350	McCrea Lake	Whitson River	WR	0	Yes	499835	5158776	0.17	1.85	2.03
351	Moose Lake - WR	Whitson River	WR	0	Yes	508065	5169131	0.36	3.30	28.02
352	Whitson Lake	Whitson River	WR	350,354	Yes	501972	5159189	5.13	14.83	7.85
353	WR 1	Whitson River	WR	0	Yes	497654	5158012	0.12	15.22	10.98
354	ZuZu Lake	Whitson River	WR	343	Yes	497592	5158792	0.45	2.47	7.21

Appendix B. Hydrological Connectivity of Greater Sudbury Lakes





Flow Direction
City Boundary
Primary Highway
Provincial Park
Water Areas
Subwatershed Boundary

Project Lead: Tammy Karst-Riddock
Neil Hutchinson
Prepared by: Stuart Paul
Data Source: City of Greater Sudbury
Data Source: Geological Association of Canada
Data Source: Canadian Council on Geomatics
Coordinate System: GCS North American 1983

C:\GIS_HESL\Projects\Sudbury Watershed Project\Report_Maps_2013_06_26\F2a Hydrological Connectivity Map 11x17L.mxd

Figure 2a: Hydrological connectivity of City of Greater Sudbury lakes

J110057

June, 2013

Hutchinson Environmental Sciences Ltd.

Appendix C. Spring Overturn Total Phosphorus Data

Spring Overturn Total Phosphorus Concentrations in CGS Lakes 2001-2012 (CGS data)

Note: Contaminated samples (pink highlight) are excluded from the mean. Outlier values are highlighted in yellow.

Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Ashigami	S	3	2005	12.3		**12.3**
Ashigami	S	3	2006	3.9	4.4	4.1
Ashigami	S	3	2007	5.7	5.0	5.3
Ashigami	S	A	2010	4.6	4.4	4.5
Ashigami	S	3	2012	4.2	4.2	4.2
Beaver (Big)	LV	1	2004	19.2	23.7	21.5
Beaver (Big)	LV	1	2006	11.9	12.0	11.9
Beaver (Big)	LV	1	2007	15.7	15.5	15.6
Beaver (Big)	LV	1	2011	11.8	11.3	11.5
Beaver (Big)	LV	3	2012	13.2	13.2	13.2
Beaver (Little)	LV	2	2004	26.1	30.5	28.3
Beaver (Little)	LV	2	2005	22.7		22.7
Beaver (Little)	LV	2	2006	22.1	21.4	21.7
Beaver (Little)	LV	2	2007	24.1	24.1	24.1
Beaver (Little)	LV	2	2011	22.7	23.5	23.1
Beaver (Little)	LV	4	2012	18.6	17.4	18.0
Bethel	R	3	2001	117.0	117.0	**117.0**
Bethel	R	3	2002	57.3	48.4	48.4
Bethel	R	3	2004	38.2	44.6	38.2
Bethel	R	3	2005	46.8	49.6	48.2
Bethel	R	3	2007	27.2	26.4	26.8
Bethel	R	3	2008	38.4	36.7	37.5
Bethel	R	3	2010	28.8	27.4	28.1
Bethel	R	3	2011	31.5	31.2	31.3
Broder (Wolf)		Broder 23	2001	4.9	3.8	4.4
Brodill	EWR		2001	5.9	6.5	6.2
Brodill	EWR	1	2002	7.6	8.5	8.1
Brodill	EWR	1	2005	20.1		**20.1**
Brodill	EWR	1	2006	4.7	4.1	4.4
Brodill	EWR	1	2007	7.8	6.1	6.9
Brodill	EWR	1	2008	3.3	6.3	3.3
Brodill	EWR	1	2011	4.3	4.3	4.3
Brodill	EWR	2	2012	4.6	5.8	5.2
Camp	P	1	2003	5.8	4.0	4.0
Camp	P	1	2005	4.3	3.3	3.3
Camp	P	1	2006	3.7	4.2	3.9

Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Camp	P	1	2007	2.6	3.5	2.6
Camp	P	1	2008	3.6	3.2	3.4
Camp	P	1	2011	3.2	3.3	3.3
Camp	P	3	2012	3.4	2.8	3.1
Chief	EWR	3	2003	4.0	3.4	3.7
Chief	EWR	3	2005	7.2		7.2
Chief	EWR	3	2006	3.2	3.2	3.2
Chief	EWR	3	2007	7.1	3.2	3.2
Chief	EWR	1	2011	13.0	12.0	12.5
Chief	EWR	3	2012	3.2	3.0	3.1
Clear	OR	1	2001	3.5	2.6	2.6
Clearwater	P	1	2004	4.5	3.0	3.0
Clearwater	P	1	2005	4.9	4.2	4.6
Clearwater	P	1	2006	3.6	3.2	3.4
Clearwater	P	1	2007	3.3		3.3
Clearwater	P	1	2010	2.6	2.4	2.5
Clearwater	P	1	2011	2.8	2.8	2.8
Crooked	UJC	2	2003	19.2	18.0	18.6
Crooked	UJC	2	2004	14.5		14.5
Crooked	UJC	3	2004	14.6	13.9	14.2
Crooked	UJC	3	2005	13.9		13.9
Crooked	UJC	3	2007	6.3	6.0	6.2
Crooked	UJC	3	2008	8.6	8.8	8.7
Crooked	UJC	3	2011	8.0	8.4	8.2
Crooked	UJC	1	2012	7.8	8.6	8.2
Crowley	P	1	2003	5.8	5.8	5.8
Crowley	P	1	2005	9.1		9.1
Crowley	P	1	2006	4.6	4.7	4.6
Crowley	P	1	2007	3.6	4.6	4.1
Crowley	P	1	2011	5.2	5.7	5.4
Crowley	P	1	2012	4.2	3.6	3.9
Daisy	P		2001	3.5	6.1	3.5
Daisy	P	1	2004	4.7	4.6	4.6
Dixon (Little Joe)	RPR	1	2001	4.1	4.3	4.2
Ella (Capreol)	W	3	2001	5.3	7.9	5.3
Ella (Capreol)	W	3	2002	7.7	7.3	7.5
Ella (Capreol)	W	3	2004	6.2	6.1	6.1
Ella (Capreol)	W	3	2007	3.6	4.3	3.9
Ella (Capreol)	W	3	2008	3.6	4.4	4.0
Ella (Capreol)	W	3	2010	5.0	4.8	4.9
Ella (Capreol)	W	1	2012	5.0	6.0	5.5

Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Ella (Lorne)	LV	1	2001	4.1	3.9	4.0
Ella (Lorne)	LV	1	2002	15.7	15.7	15.7
Ella (Lorne)	LV	1	2004	7.1	7.7	7.4
Ella (Lorne)	LV	1	2005	5.9		5.9
Ella (Lorne)	LV	1	2007	6.1	4.7	4.7
Ella (Lorne)	LV	1	2008	6.1	6.0	6.1
Ella (Lorne)	LV	2	2012	10.8	10.6	10.7
Fairbank	FB	3	2001	9.2	4.2	4.2
Fairbank	FB	3	2002	5.0	6.3	5.7
Fairbank	FB	4	2002	7.1	7.0	7.0
Fairbank	FB	1	2003	5.6	6.0	5.8
Fairbank	FB	3	2003	4.6	4.4	4.5
Fairbank	FB	2	2005	3.8		3.8
Fairbank	FB	2	2006	4.3	4.7	4.5
Fairbank	FB	3	2006	4.4	4.1	4.3
Fairbank	FB	2	2007	4.1	4.5	4.3
Fairbank	FB	3	2007	5.7	4.5	5.1
Fairbank	FB	2	2008	4.4	6.9	4.4
Fairbank	FB	3	2008	6.0	6.1	6.0
Fairbank	FB	2	2010	4.4	4.2	4.3
Fairbank	FB	3	2011	5.0	5.4	5.2
Fairbank	FB	9	2012	4.2	4.6	4.4
Forest	P	1	2004	4.5	4.3	4.4
Forest	P	1	2006	3.6	3.4	3.5
Forest	P	1	2007	3.7	3.8	3.7
Forest	P	1	2008	2.5	3.0	2.7
Forest	P	1	2011	3.3	3.4	3.3
Forest	P	1	2012	4.4	4.0	4.2
Frenchman	UV	2	2001	3.8	4.2	4.0
Frenchman	UV	2	2002	5.6	5.4	5.5
Frenchman	UV	2	2004	5.1	9.4	5.1
Frenchman	UV	2	2005	7.5		7.5
Frenchman	UV	2	2006	3.4	3.8	3.6
Frenchman	UV	2	2008	5.2	4.8	5.0
Frenchman	UV		2009	3.4		3.4
Frenchman	UV	2	2010	3.6	3.4	3.5
Frenchman	UV	2	2011	5.2		5.2
Garson	WR		2001	14.1	14.9	14.5
Garson	WR	1	2004	13.2	13.0	13.1
Gordon	MV	1	2003	13.6	12.0	12.8
Gordon	MV	1	2004	16.1	13.9	15.0

Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Gordon	MV	1	2006	8.2	8.5	8.3
Gordon	MV	1	2007	7.7	7.8	7.8
Gordon	MV	1	2008	10.2	10.3	10.2
Gordon	MV	1	2011	6.2	7.4	6.8
Gordon	MV	1	2012	5.2	5.0	5.1
Grassy	LV		2001	17.3	18.3	17.8
Grassy	LV	1	2004	14.0	14.6	14.3
Grassy	LV	1	2005	19.1		19.1
Grassy	LV	1	2006	16.3	16.7	16.5
Grassy	LV	1	2008	14.5	16.4	15.4
Grassy	LV	1	2011	16.8	15.1	16.0
Grassy	LV	1	2012	12.2	12.6	12.4
Greens	UV	1	2012	5.8	6.0	5.9
Hanmer	UV	5	2001	5.8	5.6	5.7
Hanmer	UV	5	2002	5.0	6.2	5.6
Hanmer	UV	5	2004	4.7	4.6	4.7
Hanmer	UV	3	2006	4.6	4.8	4.7
Hanmer	UV	1	2008	3.9	4.6	4.2
Hanmer	UV		2009	4.1		4.1
Hanmer	UV	3	2010	4.0	3.8	3.9
Hanmer	UV	3	2011	7.4	4.6	4.6
Hannah	R	3	2001	6.5	6.2	6.4
Hannah	R	1	2004	7.1	7.0	7.0
Hannah	R	1	2006	6.8	6.8	6.8
Hannah	R	3	2008	8.4	6.5	7.5
Hannah	R	1	2010	6.8	6.8	6.8
Hannah	R	1	2012	6.0	5.8	5.9
Ironside	RBR	1	2002	8.3	8.2	8.3
Ironside	RBR	3	2002	6.9	6.9	6.9
Ironside	RBR	3	2003	5.8	4.8	5.3
Ironside	RBR	3	2006	5.0	5.1	5.0
Ironside	RBR	3	2007	4.2	5.2	4.7
Ironside	RBR	3	2010	6.6	6.2	6.4
Ironside	RBR	2	2012	5.4	4.8	5.1
Joe	RPR	1	2001	11.5	2.7	2.7
Joe	RPR	2	2001	4.3	4.7	4.5
Joe	RPR	2	2002	4.8	4.2	4.5
Joe	RPR	1	2004	4.2	4.1	4.2
Joe	RPR	2	2004	4.3	3.1	3.1
Joe	RPR	2	2006	3.0	3.5	3.2
Joe	RPR	2	2008	4.1	4.0	4.1

Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Joe	RPR		2009	4.2		4.2
Joe	RPR	2	2010	4.8	5.6	5.2
Joe	RPR	2	2012	4.8	4.0	4.4
Kasten (Bibby)	EWR		2001	18.1	17.2	17.7
Kasten (Bibby)	EWR	1	2005	19.3	13.5	13.5
Kasten (Bibby)	EWR	1	2006	8.9	8.6	8.7
Kasten (Bibby)	EWR	1	2008	12.2	10.5	11.3
Kasten (Bibby)	EWR	1	2012	7.4	7.4	7.4
Kelly	UJC	LU stn 38	2001	16.4	16.2	16.3
Kelly	UJC	1	2001	31.0	31.6	31.3
Kelly	UJC	2	2001	20.8	22.8	21.8
Kelly	UJC	3	2001	21.4	21.8	21.6
Kelly	UJC	4	2001	20.8	20.2	20.5
Kelly	UJC	2	2002	7.8	8.1	**8.0**
Kelly	UJC	4	2002	7.3	8.2	**7.8**
Kelly	UJC	1	2008	24.9	25.5	25.2
Kukagami	K	2	2005	4.4		4.4
Kukagami	K	4	2005	14.6		**14.6**
Kukagami	K	4	2006	3.5	3.9	3.7
Kukagami	K	4	2007	3.2	3.5	3.4
Kukagami	K	4	2010	3.0	3.2	3.1
Kukagami	K	3	2012	3.0	3.0	3.0
Linton	P	1	2003	4.8	5.6	5.2
Linton	P	1	2004	7.0	6.5	6.8
Linton	P	1	2008	3.8	3.9	3.8
Linton	P	1	2011	4.8	4.4	4.6
Linton	P	1	2012	3.6	3.6	3.6
Little Panache	P	1	2001	22.9	22.0	22.5
Little Panache	P	3	2001	14.1	13.1	13.6
Little Panache	P	1	2002	19.7	28.6	19.7
Little Panache	P	3	2002	18.8	15.4	17.1
Little Panache	P	1	2003	14.8	15.4	15.1
Little Panache	P	3	2003	17.2	17.2	17.2
Little Panache	P	1	2004	12.8	12.8	12.8
Little Panache	P	3	2004	12.5	11.4	12.0
Little Panache	P	2	2006	8.3	8.7	8.5
Little Panache	P	3	2006	10.2	10.7	10.5
Little Panache	P	3	2007	14.3	21.3	14.3
Little Panache	P	2	2008	15.6	13.6	14.6
Little Panache	P	3	2008	13.7	13.3	13.5
Little Panache	P		2009	6.9		6.9

Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Little Panache	P		2009	7.8		7.8
Little Panache	P	2	2010	10.4	10.0	10.2
Little Panache	P	2	2011	8.3	7.9	8.1
Little Panache	P	3	2011	8.2	7.7	8.0
Little Panache	P	4	2012	8.0	7.4	7.7
Little Raft	EWR	1	2001	11.0	12.0	11.5
Little Raft	EWR	1	2004	4.0	2.8	**2.8**
Little Raft	EWR	1	2005	9.3	13.9	9.3
Little Raft	EWR	1	2006	9.8	10.2	10.0
Little Raft	EWR	1	2007	11.8		11.8
Little Raft	EWR	1	2010	8.8	8.8	8.8
Little Raft	EWR	1	2011	9.1	8.3	8.7
Little Raft	EWR	1	2012	7.2	7.2	7.2
Lohi	P	1	2001	4.0	8.0	4.0
Lohi	P	1	2002	8.0	7.8	7.9
Lohi	P	1	2003	5.6	6.2	5.9
Lohi	P	1	2005	7.3		7.3
Lohi	P	1	2006	4.3	4.0	4.1
Lohi	P	1	2007	5.1	3.9	3.9
Lohi	P	1	2010	6.4	3.8	3.8
Lohi	P	1	2011	3.8	4.1	4.0
Lohi	P	3	2012	4.8	4.6	4.7
Long	P	1	2001	10.4	9.5	10.0
Long	P	3	2001	7.8	7.3	7.6
Long	P	5	2001	5.5	5.8	5.7
Long	P	1	2002	6.9	7.8	7.3
Long	P	3	2002	7.0	6.8	6.9
Long	P	5	2002	10.2	10.3	10.3
Long	P	1	2004	10.0	10.0	10.0
Long	P	3	2004	8.0	6.7	7.3
Long	P	4	2004	5.2	5.4	5.3
Long	P	1	2005	7.2	10.0	7.2
Long	P	5	2005	4.9	8.2	4.9
Long	P	1	2007	6.5	6.3	6.4
Long	P	5	2007	9.3	10.0	9.7
Long	P	1	2008	9.4	9.8	9.6
Long	P	5	2008	5.9	5.3	5.6
Long	P	1	2010	8.8	8.6	8.7
Long	P	5	2010	4.8	5.6	5.2
Long	P	1	2011	5.1	5.3	5.2
Long	P	5	2011	7.2	6.8	7.0

Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Long	P	4	2012	6.2	6.8	6.5
Makada	P	1	2001	9.2	6.5	6.5
Makada	P	4	2001	5.4	6.9	6.2
Makada	P	2	2003	5.4	15.1	5.4
Makada	P	1	2005	6.8	5.2	5.2
Makada	P	4	2005	5.7	8.3	5.7
Makada	P	1	2006	4.6	4.7	4.6
Makada	P	1	2007	6.2	5.3	5.7
Makada	P	1	2010	6.6	6.4	6.5
Makada	P	1	2011	7.5	7.3	7.4
Makada	P	4	2012	5.8	6.0	5.9
Matagamasi	K	1	2005	6.3	6.6	6.5
Matagamasi	K	1	2006	2.9	3.1	3.0
Matagamasi	K	1	2007	3.6	3.5	3.6
Matagamasi	K	4	2012	2.6	2.8	2.7
McCharles	LV	1	2001	15.1	13.8	14.5
McCharles	LV	2	2001	25.5	24.7	25.1
McCharles	LV	4	2001	25.4	25.8	25.6
McCharles	LV	3	2002	26.9	26.9	26.9
McCharles	LV	1	2002	15.3	17.1	16.2
McCharles	LV	3	2003	22.6	21.8	22.2
McCharles	LV	1	2005	39.0		39.0
McCharles	LV	4	2005	70.9	85.2	70.9
McCharles	LV	4	2006	34.4	33.8	34.1
McCharles	LV	4	2007	38.0	40.5	39.3
McCharles	LV	4	2008	129.3	43.5	43.5
McCharles	LV		2009	23.4		23.4
McCharles	LV		2010	13.6	13.6	13.6
McCharles	LV	4	2011	9.1	9.7	**9.4**
McCharles	LV	4	2012	22.2	22.6	22.4
McCrea	WR		2001	10.5	9.9	10.2
McCrea	WR	1	2004	5.9	6.4	6.1
McCrea	WR	1	2005	7.9	11.0	7.9
McCrea	WR	1	2006	11.8	11.3	11.5
McCrea	WR	1	2007	11.7	12.1	11.9
McCrea	WR	1	2010	13.6	13.8	13.7
McCrea	WR	1	2011	36.9	34.2	**35.6**
McCrea	WR	3	2012	12.8	12.4	12.6
McFarlane	P	2	2001	11.1	11.5	11.3
McFarlane	P	2	2002	12.5	12.2	12.3
McFarlane	P	3	2002	12.7	13.5	13.1

Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
McFarlane	P	1	2003	15.4	13.6	14.5
McFarlane	P	3	2005	9.8	12.7	11.3
McFarlane	P	3	2005	9.8	9.4	9.6
McFarlane	P	2	2005	12.7	11.8	12.3
McFarlane	P	2	2006	8.6	9.4	9.0
McFarlane	P	3	2006	9.3	9.2	9.3
McFarlane	P	2	2007	9.7	10.1	9.9
McFarlane	P	2	2008	12.1	11.7	11.9
McFarlane	P		2009	10.3		10.3
McFarlane	P	2	2010	9.2	9.2	9.2
McFarlane	P	2	2011	8.9	9.2	9.1
McFarlane	P	6	2012	9.0	9.2	9.1
Middle	R	2	2001	4.7	5.7	5.2
Middle	R	2	2004	5.6	5.1	5.4
Middle	R	2	2005	10.3		**10.3**
Middle	R	2	2006	5.7	5.7	5.7
Middle	R	2	2008	7.6	6.9	7.2
Middle	R	2	2010	5.2	5.6	5.4
Middle	R	2	2011	5.8	5.9	5.8
Middle	R	2	2012	5.8	5.8	5.8
Minnow	R		2001	28.0	37.0	28.0
Minnow	R	1	2003	52.2	52.0	52.1
Minnow	R	1	2004	41.8	44.3	43.1
Minnow	R	1	2005	36.1	36.2	36.2
Minnow	R	1	2006	33.2	32.7	32.9
Minnow	R	1	2007	57.8	53.2	55.5
Minnow	R	1	2008	40.2	41.4	40.8
Minnow	R		2009	45.0		45.0
Minnow	R	1	2010	28.6	30.2	29.4
Minnow	R	1	2011	19.7	45.8	19.7
Minnow	R	1	2012	26.0	26.2	26.1
Mud	LJC	3	2001	33.3	31.2	32.3
Mud	LJC	3	2004	26.7	30.8	28.8
Mud	LJC	3	2005	38.4	39.8	39.1
Mud	LJC	3	2007	77.0	75.4	76.2
Mud	LJC	3	2008	44.1	48.3	46.2
Mud	LJC		2010	43.4	41.8	42.6
Mud	LJC	3	2011	63.9	61.4	62.7
Nelson	NR	1	2002	4.0	4.5	4.3
Nelson	NR	1	2004	4.5	4.2	4.3
Nelson	NR	1	2005	4.2		4.2

Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Nelson	NR	1	2006	3.2	3.3	3.2
Nelson	NR	1	2007	2.8	3.6	2.8
Nelson	NR	1	2011	3.8	4.7	4.2
Nelson	NR	2	2012	2.8	3.6	3.2
Nepahwin	R	1	2001	9.8	9.5	9.7
Nepahwin	R	1	2002	15.7	17.7	16.7
Nepahwin	R	4	2002	17.4	14.5	15.9
Nepahwin	R	2	2003	12.4	15.0	13.7
Nepahwin	R	3	2003	12.6	12.6	12.6
Nepahwin	R	mid	2005	14.3	13.4	13.9
Nepahwin	R	1	2006	8.3	8.6	8.5
Nepahwin	R	4	2006	9.6	10.5	10.1
Nepahwin	R	1	2007	11.6	11.4	11.5
Nepahwin	R	1	2008	11.4	12.2	11.8
Nepahwin	R		2009	8.3		8.3
Nepahwin	R	1	2010	17.0	16.0	16.5
Nepahwin	R	1	2011	10.8	11.2	11.0
Nepahwin	R	6	2012	14.0	13.6	13.8
Onwatin	UV	2	2002	7.2	7.5	7.3
Onwatin	UV	2	2004	8.2	9.0	8.6
Onwatin	UV	4	2004	8.0	7.2	7.6
Onwatin	UV	2	2007	7.2	8.6	7.9
Onwatin	UV	2	2008	7.2	7.9	7.5
Onwatin	UV		2010	8.2	7.8	8.0
Onwatin	UV	1	2012	6.4	6.6	6.5
Panache	P	2	2001	3.8	4.1	4.0
Panache	P	3	2001	4.3	5.4	4.9
Panache	P	1	2002	5.9	6.0	6.0
Panache	P	3	2002	5.1	6.9	5.1
Panache	P	1	2004	5.4	4.4	4.9
Panache	P	2	2004	4.8	5.6	5.2
Panache	P	3	2004	5.9	6.2	6.1
Panache	P	3	2006	3.7	3.7	3.7
Panache	P	2	2007	11.5	11.3	**11.4**
Panache	P	3	2007	7.8		7.8
Panache	P	3	2008	4.9	5.6	5.2
Panache	P		2009	3.7		3.7
Panache	P		2010	4.0	4.2	4.1
Panache	P	12	2012	4.0	4.0	4.0
Pine	P		2001	4.4	4.8	4.6
Pine	P	1	2003	4.0	4.2	4.1

Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Pine	P	1	2005	3.2	3.8	3.5
Pine	P	1	2008	5.4	3.8	3.8
Raft	EWR	2	2001	7.9	6.0	6.0
Raft	EWR	2	2002	8.4	10.4	9.4
Raft	EWR	1	2003	7.4	7.0	7.2
Raft	EWR	2	2005	9.8		9.8
Raft	EWR	2	2005	7.9	5.3	5.3
Raft	EWR	2	2006	5.4	5.2	5.3
Raft	EWR	2	2007	7.9		7.9
Raft	EWR	2	2010	6.8	6.6	6.7
Raft	EWR	2	2011	4.9	4.7	4.8
Raft	EWR	3	2012	4.0	4.0	4.0
Ramsey	R	1	2001	31.6	14.7	14.7
Ramsey	R	2	2001	11.3	18.3	11.3
Ramsey	R	3	2001	12.6	13.4	13.0
Ramsey	R	4	2001	11.8	11.6	11.7
Ramsey	R	1	2002	12.3	14.2	13.3
Ramsey	R	2	2002	16.6	14.9	15.8
Ramsey	R	3	2002	12.6	12.2	12.4
Ramsey	R	4	2002	30.8	15.0	15.0
Ramsey	R	5	2002	16.7	17.6	17.2
Ramsey	R	6	2002	19.9	18.2	19.0
Ramsey	R	1	2004	11.7	12.7	12.2
Ramsey	R	2	2004	15.1	10.7	10.7
Ramsey	R	4	2004	9.4	10.3	9.8
Ramsey	R	1	2005	13.7	15.7	14.7
Ramsey	R	4	2005	15.7		15.7
Ramsey	R	4	2007	11.3	11.7	11.5
Ramsey	R	4	2008	10.7	10.3	10.5
Ramsey	R		2009	7.7		7.7
Ramsey	R		2010	10.6	10.0	10.3
Ramsey	R	4	2011	5.7	6.5	6.1
Ramsey	R	4	2012	7.6	7.4	7.5
Rat (Kusk)	LV	1	2003	13.4	14.8	14.1
Rat (Kusk)	LV	1	2004	13.6	13.2	13.4
Rat (Kusk)	LV	1	2006	17.5	16.4	16.9
Rat (Kusk)	LV	1	2007	17.5	18.6	18.1
Rat (Kusk)	LV	1	2008	15.1	14.2	14.6
Rat (Kusk)	LV		2010	14.2	14.2	14.2
Rat (Kusk)	LV	1	2011	15.4	14.3	14.8
Rat (Kusk)	LV	2	2012	12.2	13.0	12.6

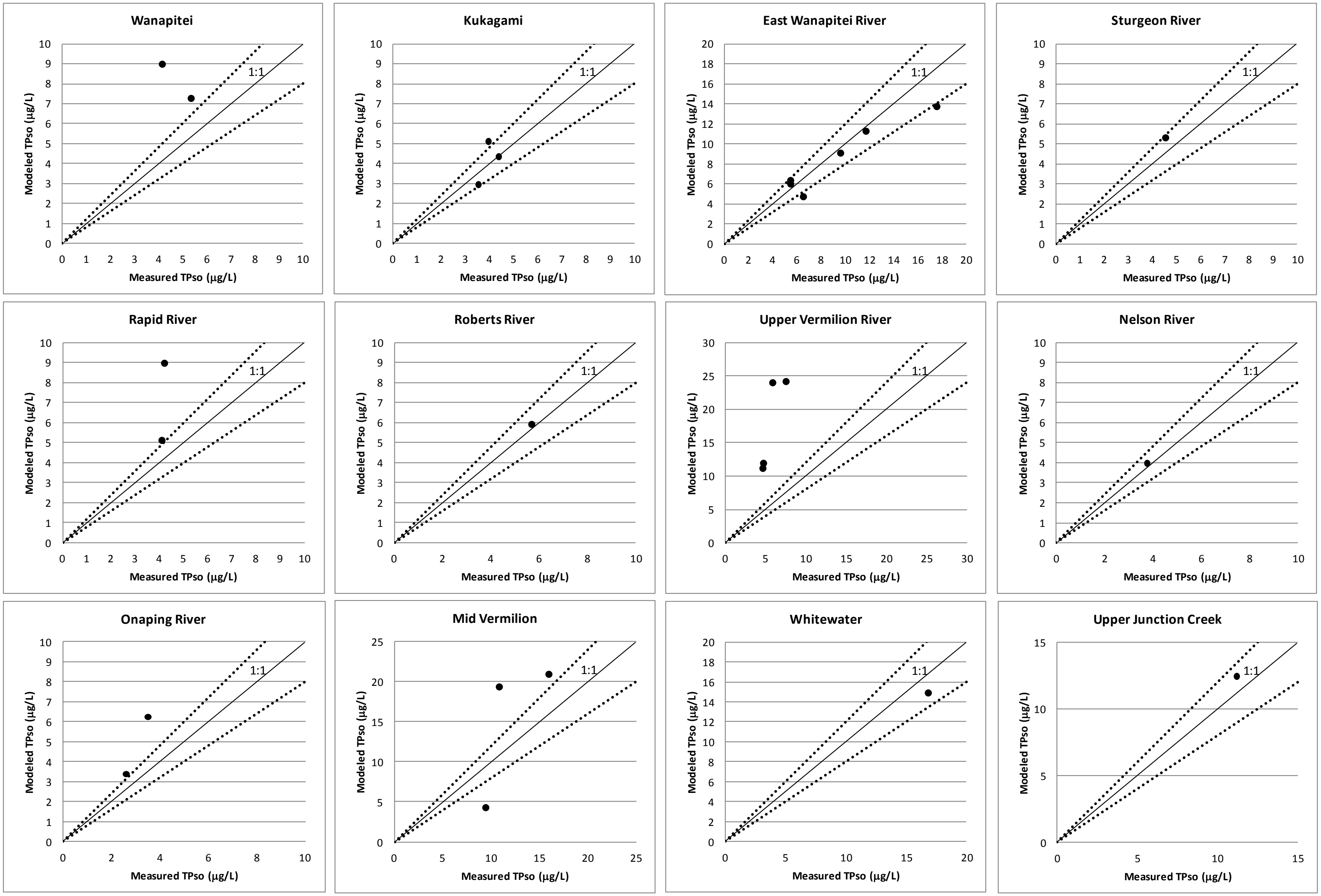
Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Red Deer	RD	2	2003	22.4	18.0	20.2
Red Deer	RD	1	2005	20.7	20.6	20.7
Red Deer	RD	3	2005	22.4	23.2	22.8
Red Deer	RD	3	2006	19.5	19.6	19.5
Red Deer	RD		2010	25.0	25.0	25.0
Red Deer	RD	2	2012	13.4	13.4	13.4
Reserve	RD		2001	15.6	14.9	15.3
Richard	P	2	2001	6.9	8.9	7.9
Richard	P	2	2002	10.7	11.4	11.0
Richard	P	2	2003	8.4		8.4
Richard	P	3	2003	8.0	9.0	8.5
Richard	P	3	2005	7.5	7.9	7.7
Richard	P	3	2006	7.3	8.0	7.6
Richard	P	3	2007	12.5	10.6	11.6
Richard	P	3	2008	11.2	10.4	10.8
Richard	P	3	2010	7.8	8.2	8.0
Richard	P	3	2011	9.2	8.8	9.0
Richard	P	4	2012	10.6	10.4	10.5
Robinson	R	2	2001	20.2	24.6	22.4
Robinson	R	2	2002	21.6	22.0	21.8
Robinson	R	2	2003	27.8	26.5	27.2
Robinson	R	2	2005	22.0	21.2	21.6
Robinson	R	2	2006	27.3	29.0	28.1
Robinson	R	2	2007	29.9	31.6	30.8
Robinson	R	2	2008	25.5	23.7	24.6
Robinson	R	2	2010	19.4	19.0	19.2
Robinson	R	2	2011	11.1	11.4	**11.2**
Robinson	R	2	2012	20.4	20.4	20.4
Silver	P		2001	4.0	3.5	3.8
Silver	P	3	2002	12.2	8.6	8.6
Silver	P	1	2003	5.2	5.0	5.1
Silver	P	3	2003	4.6	6.2	4.6
Silver	P	1	2004	5.4	5.7	5.5
Silver	P	1	2007	8.5	8.4	8.4
Silver	P	1	2008	6.9	7.5	7.2
Silver	P	A	2010	6.0	5.2	5.6
Silver	P	1	2011	4.7	4.8	4.7
Simmons	MV	1	2002	15.5	14.8	15.2
Simmons	MV	1	2008	15.9	17.6	16.8
Simon	LJC	3	2001	27.0	28.4	27.7
Simon	LJC	3	2002	27.7	27.3	27.5

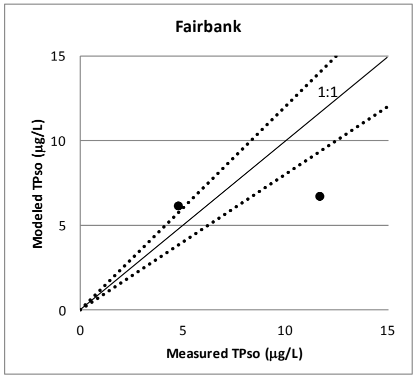
Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Simon	LJC	3	2003	32.2	29.6	30.9
Simon	LJC	3	2004	24.7	28.4	26.6
Simon	LJC	3	2005	40.5	39.2	39.9
Simon	LJC	3	2005	30.4	33.9	32.2
Simon	LJC	2	2007	51.4	49.0	50.2
Simon	LJC	4	2007	56.7	56.1	56.4
Simon	LJC	2	2008	26.5	24.5	25.5
Simon	LJC	4	2008	25.9	93.7	25.9
Simon	LJC		2009	33.8		33.8
Simon	LJC		2010	32.6	30.2	31.4
Simon	LJC	3	2011	45.2	44.3	44.7
Simon	LJC	3	2012	29.4	28.2	28.8
Skill	FB	4	2001	15.0	13.7	14.4
Skill	FB	2	2003	13.6	11.6	12.6
Skill	FB	1	2006	10.4	10.3	10.3
Skill	FB	1	2007	10.5	10.9	10.7
Skill	FB	1	2008	11.9	11.9	11.9
Skill	FB		2010	10.6	9.8	10.2
St. Charles	R	1	2001	11.4	14.7	13.1
St. Charles	R	2	2001	12.2	10.7	11.5
St. Charles	R	4	2001	9.4	10.0	9.7
St. Charles	R	4	2002	21.1	18.3	**19.7**
St. Charles	R	2	2003	12.0	14.0	13.0
St. Charles	R	4	2003	10.6	11.0	10.8
St. Charles	R	1	2005	11.7	15.1	13.4
St. Charles	R	1	2006	9.7	9.6	9.7
St. Charles	R	1	2007	8.5	9.0	8.8
St. Charles	R	1	2010	11.0	11.4	11.2
St. Charles	R	1	2011	10.4	10.5	10.5
St. Charles	R	5	2012	8.6	8.6	8.6
T (Dill)	EWR	2	2001	26.2	27.5	26.9
T (Dill)	EWR	2	2002	30.7	30.0	30.3
T (Dill)	EWR	1	2003	14.2		14.2
T (Dill)	EWR	2	2005	20.1		20.1
T (Dill)	EWR	2	2006	11.7	11.6	11.6
T (Dill)	EWR	2	2007	11.3	13.2	12.3
T (Dill)	EWR	2	2010	14.2	12.6	13.4
T (Dill)	EWR	2	2011	3.6	3.8	**3.7**
T (Dill)	EWR	3	2012	11.6	12.2	11.9
Tilton	P	1	2001	4.7	3.2	3.2
Tilton	P	1	2002	5.5	5.6	5.6

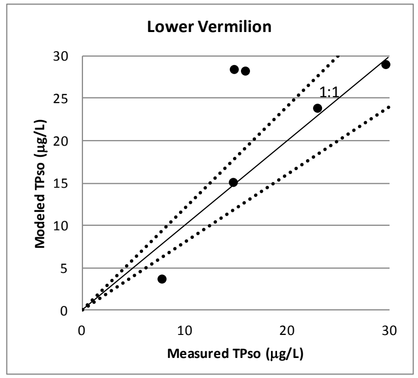
Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Tilton	P	3	2003	5.2	5.8	5.5
Tilton	P	1	2005	3.3	4.4	3.3
Tilton	P	1	2005	6.9	8.6	7.8
Tilton	P		2007	6.4	7.0	6.7
Tilton	P	1	2008	4.6	5.5	5.0
Tilton	P	A	2010	3.8	4.4	4.1
Tilton	P	3	2012	3.8	3.8	3.8
Vermilion	MV	3	2012	7.8	7.4	7.6
Vermilion	MV	3s	2001	12.4	11.2	11.8
Vermilion	MV	3	2002	13.9	12.8	13.4
Vermilion	MV	2	2004	11.2	12.9	12.1
Vermilion	MV	3	2004	11.4	13.3	12.4
Vermilion	MV	4	2004	7.3	7.8	7.5
Vermilion	MV	3	2006	12.3	12.6	12.4
Vermilion	MV	3	2007	10.8	9.6	10.2
Vermilion	MV	3	2008	42.7	11.8	11.8
Vermilion	MV		2010	9.2	8.6	8.9
Wanapitei	W	1	2001	3.5	3.2	3.4
Wanapitei	W	1	2002	6.2	5.5	**5.8**
Wanapitei	W		2010	3.2	3.2	3.2
Whitewater	WW	2	2001	24.4	22.7	23.6
Whitewater	WW	4	2001	35.4	36.1	35.8
Whitewater	WW	2	2002	20.2	21.8	21.0
Whitewater	WW	3	2002	24.4	26.8	25.6
Whitewater	WW	4	2003	15.8	18.8	17.3
Whitewater	WW	2	2005	12.4	13.7	13.1
Whitewater	WW	3	2005	10.8	10.9	10.9
Whitewater	WW	2	2006	12.8	12.2	12.5
Whitewater	WW	3	2006	13.9	13.6	13.8
Whitewater	WW	2	2007	11.8	12.4	12.1
Whitewater	WW	3	2007	12.7	11.3	12.0
Whitewater	WW	2	2008	17.8	17.4	17.6
Whitewater	WW	3	2008	15.2	14.6	14.9
Whitewater	WW		2009	13.3		13.3
Whitewater	WW	3	2010	20.4	19.2	19.8
Whitewater	WW	5	2012	11.2	12.0	11.6
Whitson	WR	3	2001	5.4	5.7	5.6
Whitson	WR	3	2002	29.1	28.6	**28.9**
Whitson	WR	3	2003	7.0	7.0	7.0
Whitson	WR	1	2004	8.4	7.6	8.0
Whitson	WR	3	2004	5.1	4.7	4.9

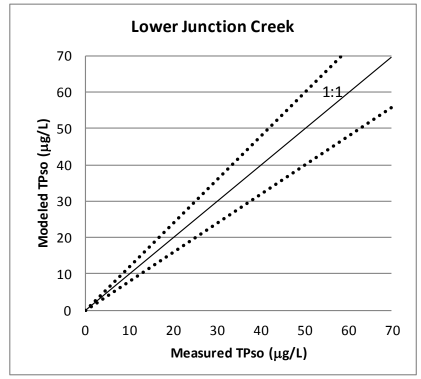
Lake	Subwatershed Code	CGS Station #	Year	TP1 (ug/L)	TP2 (ug/L)	Mean TP (ug/L)
Whitson	WR	3	2006	6.2	6.2	6.2
Whitson	WR	3	2007	4.3	5.0	4.6
Whitson	WR	3	2008	6.3	5.9	6.1
Whitson	WR		2010	6.4	6.2	6.3
Windy	OR	2	2001	2.9	2.3	2.6
Windy	OR	2	2002	4.4	4.4	4.4
Windy	OR	3	2003	5.4	3.4	3.4
Windy	OR	1	2005	3.3		3.3
Windy	OR	2	2006	3.3	3.1	3.2
Windy	OR	2	2007	4.4	5.0	4.7
Windy	OR	2	2010	2.8	3.2	3.0

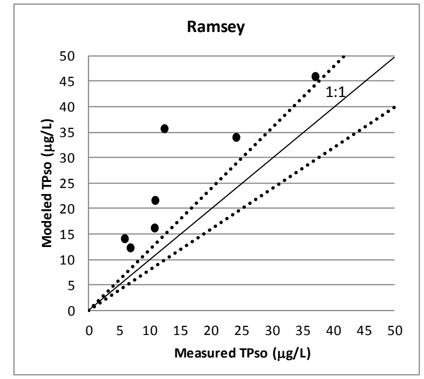
Appendix D. Modelled and Measured Total Phosphorus Concentrations by Subwatershed

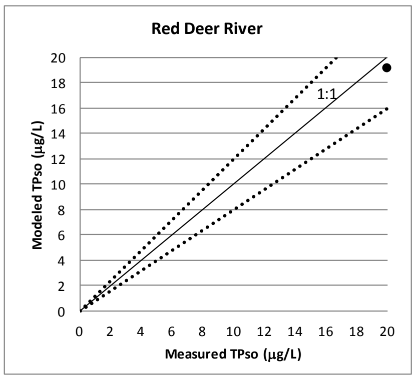

Wanapitei
Kukagami
East Wanapitei River
Sturgeon River
Rapid River
Roberts River
Upper Vermilion River
Nelson River
Onaping River
Mid Vermilion
Whitewater
Upper Junction Creek
1:1
Modeled TPso (µg/L)
Measured TPso (µg/L)

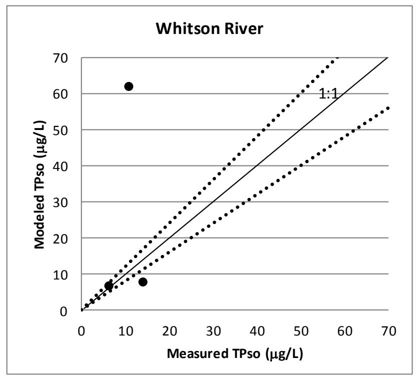

Fairbank
Modeled TPso (µg/L)
Measured TPso (µg/L)
1:1
0 5 10 15
0 5 10 15

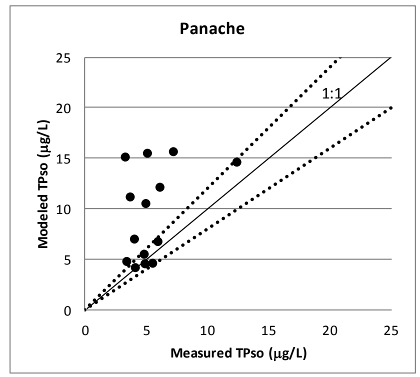

Lower Vermilion
Modeled TPso (µg/L)
Measured TPso (µg/L)
1:1
0 5 10 15 20 25 30
0 10 20 30


Lower Junction Creek
Modeled TPso (µg/L)
Measured TPso (µg/L)
1:1
0 10 20 30 40 50 60 70
0 10 20 30 40 50 60 70


Ramsey
Modeled TPso (µg/L)
Measured TPso (µg/L)
1:1
0 5 10 15 20 25 30 35 40 45 50
0 5 10 15 20 25 30 35 40 45 50


Red Deer River
Modeled TPso (µg/L)
Measured TPso (µg/L)
1:1
0 2 4 6 8 10 12 14 16 18 20
0 2 4 6 8 10 12 14 16 18 20


Whitson River
Modeled TPso (µg/L)
Measured TPso (µg/L)
1:1
0 10 20 30 40 50 60 70
0 10 20 30 40 50 60 70


Panache
Modeled TPso (µg/L)
Measured TPso (µg/L)
1:1
0 5 10 15 20 25
0 5 10 15 20 25

Appendix E. Management Classification of CGS Area Lakes

List of "Enhanced" Management Lakes (n=33). Lake Trout Lakes are in bold.

Ashigami Lake
Beaver Lake W (Big) - LV
Bethel Lake
Boland's Lake
Bushy Lake
Clearwater Lake
Dixon (Little Joe) Lake
Ella Lake - W
Fairbank Lake
Forest Lake
Frenchman Lake
Hanmer Lake
Hannah Lake
Joe Lake
Lake Nepahwin
Little Panache Lake
Little Raft Lake
Lohi Lake
Makada Lake
Middle Lake
Page Lake
Raft Lake
Ramsey Lake
RBR 4
Richard Lake
Roland Lake - NR 2
Silver Lake
Skead Bay
Skill Lake
St Pothier Lake
Tilton Lake
Toweman's Lake
Whitson Lake

List of "Moderate" Management Lakes (n=142). Lake Trout Lakes are in bold.

Bannagan Lake	**Kukagami Lake**	Onwatin Lake	Wakemi Lake
Barnett Lake	Lac St Jean	OR 2	Webfoot Lake
Bass Lake - LJC	Lake Laurentian	Otter Lake	West Cameron Lake
Bass Lake S - FB	**Lake Panache**	Owen Lake	**West Morgan Lake**
Bassfin Lake	**Laura Lake**	P 1	Whitefish Lake
Bassoon Lake	Lawlor Lake - W 2	P 2	Whitewater Lake
Bear Lake	LIttle Ella Lake	Perch Lake - R	**Windy Lake - OR**
Beaver Lake E (Little)- LV	Little Fairbank Lake	Pigeon Lake	Windy Lake - W
Bell Lake	Little Otter Lake	Pike Lake - W	Wolfe Lake
Bennett Lake	Little Round Lake	Pistin Lake	WW 1
Big Valley Lake	LJC 1	Portage Lake	
Blue Lake	LJC 2	Pump Lake	
Boland's Bay	**Long Lake - P**	Rat/Kusk Lake	
Bonanza Lake	Long Lake - UV	Rickale Lake	
Boot Lake	Longvack Lake	Roberts Lake	
Botom Lake	Loon Lake	Robinson Lake	
C 1	MacDonald's Lake	Ross Lake - C	
Capre Lake	Malbeuf Lake	Round Lake	
Cathro Lake	Margaret Lake	RPR 1	
Chiniguchi Lake	**Marjorie Lake**	RPR 2	
Clear Lake – OR	McCharles Lake	RPR 6	
Copenhagen Lake	McCrea Lake	**Sam Martin Lake**	
Crooked Lake	McFarlane Lake	SCC 2	
Daisy Lake	McFie Lake	Seal Lake	
Decair Lake	Meatbird Lake	Shed Lake	
Deer Lake	Minnow Lake - R	Simon Lake	
Ella Lake – LV	Minnow Lake - W	Skynner Lake	
Evelyn Lake	Moore Lake	Snider Lake	
EWR 1	Moose Lake - OR 3	Southeast Baby Lake	
EWR 5	Moose Lake - W	Spar Lake	
EWR6	**Morgan Lake**	St Charles Lake	
Gipsy Lake	Mud Lake - LJC 2	SU-1109	
Gordon Lake	MV 1	SU-183	
Grassy Lake - LV	MV 2	SU-345	
Greens Lake	MV 3	Sweezy Lake	
Houston Lake	**Nelson Lake**	T Lake	
Hutton Lake	Nemag Lake	Tank Lake	
K 11	Norman Lake	Tower Lake	
K 3	North Star Lake	UJC 1	
K 4	**Norway Lake**	UJC 3	
K 7	Norwest Lake	UJC 4	
K 9	NR 1	**Upper Mowat Lake**	
Kelly Lake	NR 2	Wabagishik Lake	
Kolari Bay	Number Ten Lake	**Waddell Lake**	

List of "Standard" Management Lakes (n=179). Lake Trout Lakes are in bold.

Alice Lake	EWR 3	**Lake Wanapitei**	Pike Lake - OR	W 1
Amy Lake	EWR 4	Landry Lake	Pine Lake - P	W 2
Anne Lake	EWR7	Lawlor Lake - W 1	Pine Lake - W	W 3
Baby Lake	Falcon Gold Lake	Linton Lake	Proudfoot Lake	W 4
Bad Lake	Farm Lake	Little Amy Lake	Rat Lake	Wessel Lake
Baseline Lake	Fire Lake	Little Fly Lake	Rathbun Lake	West Lake
Bass Lake - UV	Fly Lake	Little Italy Lake	Rathwell Lake	Wisner Lake
Bass Lake - W	Foster Lake	Little Rat Lake	RBR 1	**Wolf Lake**
Bass Lake N - FB	**Fraleck Lake**	Little Valley Lake	RBR 2	WR 1
Beaver Lake - W	Framan Lake	Louie Lake	RBR 3	WW 2
Bernard Lake	**Franks Lake**	Lower Mowat Lake	RBR 5	WW 3
Bigwood Lake	Fraser Lake	LSR 1	RBR 6	WW 4
Blackthorn Lake	Garson Lake	LV 1	RBR 7	WW 5
Blueberry Lake	Goat Lake	LV 2	RD	Zilch Lake
Bonhomme Lake	Grassy Lake - UV	LV 3	Red Deer Lake	ZuZu Lake
Brady Lake	Graveyard Lake	Lynn Lake	Rockcut Lake	
Brodill Lake	Hagarty Lake	Marshy Lake	Roland Lake - NR 1	
Bugg Lake	Happys Lake	**Matagamasi Lake**	Ross Lake - UV	
Cache Lake	High Lake	McLaren Lake	RPR 3	
Cameron Lake	Hock Lake	Mond Lake	RPR 4	
Camp Lake	Horseshoe Lake	Monk Lake	RPR 5	
Camp Three Lake	**Irish Lake**	Moose Lake - OR 1	SCC 1	
Caswell Lake	Ironside Lake	Moose Lake - OR 2	Selwyn Lake	
Chief Lake	Irving Lake	Moose Lake - WR	**Silvester Lake**	
Clarabelle Lake	Island Lake	Morton Lake	Simmons Lake	
Clear Lake - MV	Jones Lake	Mowat Lake	Slide Lake	
Connelly Lake	Jumbo Lake	Mud Lake - LJC 1	SR	
Crowley Lake	K 1	Northeast Lake	Stake Lake	
Dean Lake	K 10	NR 3	SU-235 Lake	
Dewdney Lake	K 12	OR 1	SU-237	
Doon Lake	K 13	OR 3	SU-258	
Drill Lake	K 2	OR 4	Thomas Lake	
Duck Lake	K 5	OR 5	Threecomer Lake	
Eatlots Lake	K 6	OR 6	UJC 2	
EC 1	K 8	**Osbourne Lake**	UJC 5	
EC 2	Karstula Lake	Overhead Lake	Upper Gipsy Lake	
EC 3	Kasten Lake	P 3	Upper Gordon Lake	
Echo Lake	Kosmerly Lake	P 4	Upper Thomas Lake	
Emma Lake	**Kumska Lake**	**Parkin Lake**	UV 1	
Ethel Lake	Lady MacDonald Lake	Pelo Lake	UV 2	
EWR 2	Lake la Vase	Perch Lake - LSR	Vermilion Lake	

Management Criteria and Classification of CGS Area Lakes (n=354)

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	63	291	145	209	33	30	112	179		8	10
% of Lakes:	18	82	41	59	9	8	32	51		2	3
Alice Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Amy Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Anne Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Ashigami Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Baby Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Bad Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Bannagan Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Barnett Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Baseline Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Bass Lake - LJC	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Bass Lake - UV	N	Y	N	Y	N	N	N	Y	Standard	N	N
Bass Lake - W	N	Y	N	Y	N	N	N	Y	Standard	N	N
Bass Lake N - FB	N	Y	N	Y	N	N	N	Y	Standard	N	N
Bass Lake S - FB	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Bassfin Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Bassoon Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Bear Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Beaver Lake - W	N	Y	N	Y	N	N	N	Y	Standard	N	N
Beaver Lake E (Little)- LV	Y	N	N	Y	N	Y	N	N	Moderate	Y	N
Beaver Lake W (Big) - LV	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Bell Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Bennett Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	63	291	145	209	33	30	112	179		8	10
% of Lakes:	18	82	41	59	9	8	32	51		2	3
Bernard Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Bethel Lake	Y	N	Y	N	Y	N	N	N	Enhanced	Y	Y
Big Valley Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Bigwood Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Blackthorn Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Blue Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Blueberry Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Boland's Bay	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Boland's Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Bonanza Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Bonhomme Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Boot Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Botom Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Brady Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Brodill Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Bugg Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Bushy Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
C 1	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Cache Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Cameron Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Camp Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Camp Three Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Capre Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Caswell Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Cathro Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	63	291	145	209	33	30	112	179		8	10
% of Lakes:	18	82	41	59	9	8	32	51		2	3
Chief Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Chiniguchi Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Clarabelle Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Clear Lake - MV	N	Y	N	Y	N	N	N	Y	Standard	N	N
Clear Lake - OR	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Clearwater Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Connelly Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Copenhagen Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Crooked Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Crowley Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Daisy Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Dean Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Decair Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Deer Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Dewdney Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Dixon (Little Joe) Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Doon Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Drill Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Duck Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Eatlots Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
EC 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
EC 2	N	Y	N	Y	N	N	N	Y	Standard	N	N
EC 3	N	Y	N	Y	N	N	N	Y	Standard	N	N
Echo Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Ella Lake - LV	N	Y	Y	N	N	N	Y	N	Moderate	N	Y

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	63	291	145	209	33	30	112	179		8	10
% of Lakes:	18	82	41	59	9	8	32	51		2	3
Ella Lake - W	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Emma Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Ethel Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Evelyn Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
EWR 1	N	Y	Y	N	N	N	Y	N	Moderate	N	N
EWR 2	N	Y	N	Y	N	N	N	Y	Standard	N	N
EWR 3	N	Y	N	Y	N	N	N	Y	Standard	N	N
EWR 4	N	Y	N	Y	N	N	N	Y	Standard	N	N
EWR 5	N	Y	Y	N	N	N	Y	N	Moderate	N	N
EWR6	N	Y	Y	N	N	N	Y	N	Moderate	N	N
EWR7	N	Y	N	Y	N	N	N	Y	Standard	N	N
Fairbank Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Falcon Gold Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Farm Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Fire Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Fly Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Forest Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Foster Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Fraleck Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Framan Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Franks Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Fraser Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Frenchman Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Garson Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Gipsy Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	**63**	**291**	**145**	**209**	**33**	**30**	**112**	**179**		**8**	**10**
% of Lakes:	**18**	**82**	**41**	**59**	**9**	**8**	**32**	**51**		**2**	**3**
Goat Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Gordon Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Grassy Lake - LV	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Grassy Lake - UV	N	Y	N	Y	N	N	N	Y	Standard	N	N
Graveyard Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Greens Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Hagarty Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Hanmer Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Hannah Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	Y
Happys Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
High Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Hock Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Horseshoe Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Houston Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Hutton Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Irish Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Ironside Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Irving Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Island Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Joe Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Jones Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Jumbo Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
K 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
K 10	N	Y	N	Y	N	N	N	Y	Standard	N	N
K 11	N	Y	Y	N	N	N	Y	N	Moderate	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	63	291	145	209	33	30	112	179		8	10
% of Lakes:	18	82	41	59	9	8	32	51		2	3
K 12	N	Y	N	Y	N	N	N	Y	Standard	N	N
K 13	N	Y	N	Y	N	N	N	Y	Standard	N	N
K 2	N	Y	N	Y	N	N	N	Y	Standard	N	N
K 3	N	Y	Y	N	N	N	Y	N	Moderate	N	N
K 4	N	Y	Y	N	N	N	Y	N	Moderate	N	N
K 5	N	Y	N	Y	N	N	N	Y	Standard	N	N
K 6	N	Y	N	Y	N	N	N	Y	Standard	N	N
K 7	N	Y	Y	N	N	N	Y	N	Moderate	N	N
K 8	N	Y	N	Y	N	N	N	Y	Standard	N	N
K 9	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Karstula Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Kasten Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Kelly Lake	Y	N	N	Y	N	Y	N	N	Moderate	Y	N
Kolari Bay	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Kosmerly Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Kukagami Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Kumska Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Lac St Jean	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Lady MacDonald Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Lake la Vase	N	Y	N	Y	N	N	N	Y	Standard	N	N
Lake Laurentian	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Lake Nepahwin	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Lake Panache	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Lake Wanapitei	N	Y	N	Y	N	N	N	Y	Standard	N	N
Landry Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	63	291	145	209	33	30	112	179		8	10
% of Lakes:	18	82	41	59	9	8	32	51		2	3
Laura Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Lawlor Lake - W 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
Lawlor Lake - W 2	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Linton Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Little Amy Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
LIttle Ella Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Little Fairbank Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Little Fly Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Little Italy Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Little Otter Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Little Panache Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	Y
Little Raft Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Little Rat Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Little Round Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Little Valley Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
LJC 1	Y	N	N	Y	N	Y	N	N	Moderate	N	N
LJC 2	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Lohi Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Long Lake - P	Y	N	N	Y	N	Y	N	N	Moderate	N	Y
Long Lake - UV	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Longvack Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Loon Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Louie Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Lower Mowat Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
LSR 1	N	Y	N	Y	N	N	N	Y	Standard	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	**Criteria Met Yes (Y) or No (N)**				**Management Classification**					**Trigger1**	**Trigger3**
	Load ≥ BG+50%	**Load < BG+50%**	**Resp. = H**	**Resp. = L**	**Enhanced Load ≥BG+50% Resp. = H**	**Moderate 1 Load ≥BG+50% Resp. = L**	**Moderate 2 Load <BG+50% Resp. = H**	**Standard Load <BG+50% Resp. = L**	**Summary**	**[TP] > 20 mg/L**	**algal bloom?**
Count:	**63**	**291**	**145**	**209**	**33**	**30**	**112**	**179**		**8**	**10**
% of Lakes:	**18**	**82**	**41**	**59**	**9**	**8**	**32**	**51**		**2**	**3**
LV 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
LV 2	N	Y	N	Y	N	N	N	Y	Standard	N	N
LV 3	N	Y	N	Y	N	N	N	Y	Standard	N	N
Lynn Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
MacDonald's Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Makada Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	Y
Malbeuf Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Margaret Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Marjorie Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Marshy Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Matagamasi Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
McCharles Lake	Y	N	N	Y	N	Y	N	N	Moderate	Y	Y
McCrea Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
McFarlane Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	Y
McFie Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
McLaren Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Meatbird Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Middle Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	Y
Minnow Lake - R	Y	N	N	Y	N	Y	N	N	Moderate	Y	N
Minnow Lake - W	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Mond Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Monk Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Moore Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Moose Lake - OR 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
Moose Lake - OR 2	N	Y	N	Y	N	N	N	Y	Standard	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	**63**	**291**	**145**	**209**	**33**	**30**	**112**	**179**		**8**	**10**
% of Lakes:	**18**	**82**	**41**	**59**	**9**	**8**	**32**	**51**		**2**	**3**
Moose Lake - OR 3	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Moose Lake - W	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Moose Lake - WR	N	Y	N	Y	N	N	N	Y	Standard	N	N
Morgan Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Morton Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Mowat Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Mud Lake - LJC 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
Mud Lake - LJC 2	Y	N	N	Y	N	Y	N	N	Moderate	Y	N
MV 1	N	Y	Y	N	N	N	Y	N	Moderate	N	N
MV 2	N	Y	Y	N	N	N	Y	N	Moderate	N	N
MV 3	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Nelson Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Nemag Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Norman Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
North Star Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Northeast Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Norway Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Norwest Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
NR 1	N	Y	Y	N	N	N	Y	N	Moderate	N	N
NR 2	N	Y	Y	N	N	N	Y	N	Moderate	N	N
NR 3	N	Y	N	Y	N	N	N	Y	Standard	N	N
Number Ten Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Onwatin Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
OR 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
OR 2	N	Y	Y	N	N	N	Y	N	Moderate	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	63	291	145	209	33	30	112	179		8	10
% of Lakes:	18	82	41	59	9	8	32	51		2	3
OR 3	N	Y	N	Y	N	N	N	Y	Standard	N	N
OR 4	N	Y	N	Y	N	N	N	Y	Standard	N	N
OR 5	N	Y	N	Y	N	N	N	Y	Standard	N	N
OR 6	N	Y	N	Y	N	N	N	Y	Standard	N	N
Osbourne Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Otter Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Overhead Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Owen Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
P 1	N	Y	Y	N	N	N	Y	N	Moderate	N	N
P 2	Y	N	N	Y	N	Y	N	N	Moderate	N	N
P 3	N	Y	N	Y	N	N	N	Y	Standard	N	N
P 4	N	Y	N	Y	N	N	N	Y	Standard	N	N
Page Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Parkin Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Pelo Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Perch Lake - LSR	N	Y	N	Y	N	N	N	Y	Standard	N	N
Perch Lake - R	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Pigeon Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Pike Lake - OR	N	Y	N	Y	N	N	N	Y	Standard	N	N
Pike Lake - W	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Pine Lake - P	N	Y	N	Y	N	N	N	Y	Standard	N	N
Pine Lake - W	N	Y	N	Y	N	N	N	Y	Standard	N	N
Pistin Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Portage Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Proudfoot Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	**63**	**291**	**145**	**209**	**33**	**30**	**112**	**179**		**8**	**10**
% of Lakes:	**18**	**82**	**41**	**59**	**9**	**8**	**32**	**51**		**2**	**3**
Pump Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Raft Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Ramsey Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	Y
Rat Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Rat/Kusk Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Rathbun Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Rathwell Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
RBR 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
RBR 2	N	Y	N	Y	N	N	N	Y	Standard	N	N
RBR 3	N	Y	N	Y	N	N	N	Y	Standard	N	N
RBR 4	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
RBR 5	N	Y	N	Y	N	N	N	Y	Standard	N	N
RBR 6	N	Y	N	Y	N	N	N	Y	Standard	N	N
RBR 7	N	Y	N	Y	N	N	N	Y	Standard	N	N
RD	N	Y	N	Y	N	N	N	Y	Standard	N	N
Red Deer Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Richard Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Rickale Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Roberts Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Robinson Lake	Y	N	N	Y	N	Y	N	N	Moderate	Y	N
Rockcut Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Roland Lake - NR 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
Roland Lake - NR 2	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Ross Lake - C	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Ross Lake - UV	N	Y	N	Y	N	N	N	Y	Standard	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	63	291	145	209	33	30	112	179		8	10
% of Lakes:	18	82	41	59	9	8	32	51		2	3
Round Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
RPR 1	N	Y	Y	N	N	N	Y	N	Moderate	N	N
RPR 2	N	Y	Y	N	N	N	Y	N	Moderate	N	N
RPR 3	N	Y	N	Y	N	N	N	Y	Standard	N	N
RPR 4	N	Y	N	Y	N	N	N	Y	Standard	N	N
RPR 5	N	Y	N	Y	N	N	N	Y	Standard	N	N
RPR 6	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Sam Martin Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
SCC 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
SCC 2	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Seal Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Selwyn Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Shed Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Silver Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Silvester Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Simmons Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Simon Lake	Y	N	N	Y	N	Y	N	N	Moderate	Y	N
Skead Bay	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Skill Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Skynner Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Slide Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Snider Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Southeast Baby Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Spar Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
SR	N	Y	N	Y	N	N	N	Y	Standard	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	63	291	145	209	33	30	112	179		8	10
% of Lakes:	18	82	41	59	9	8	32	51		2	3
St Charles Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
St Pothier Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Stake Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
SU-1109	N	Y	Y	N	N	N	Y	N	Moderate	N	N
SU-183	N	Y	Y	N	N	N	Y	N	Moderate	N	N
SU-235 Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
SU-237	N	Y	N	Y	N	N	N	Y	Standard	N	N
SU-258	N	Y	N	Y	N	N	N	Y	Standard	N	N
SU-345	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Sweezy Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
T Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Tank Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Thomas Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Threecomer Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Tilton Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Toweman's Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Tower Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
UJC 1	N	Y	Y	N	N	N	Y	N	Moderate	N	N
UJC 2	N	Y	N	Y	N	N	N	Y	Standard	N	N
UJC 3	N	Y	Y	N	N	N	Y	N	Moderate	N	N
UJC 4	N	Y	Y	N	N	N	Y	N	Moderate	N	N
UJC 5	N	Y	N	Y	N	N	N	Y	Standard	N	N
Upper Gipsy Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Upper Gordon Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Upper Mowat Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	Criteria Met Yes (Y) or No (N)				Management Classification					Trigger1	Trigger3
	Load ≥ BG+50%	Load < BG+50%	Resp. = H	Resp. = L	Enhanced Load ≥BG+50% Resp. = H	Moderate 1 Load ≥BG+50% Resp. = L	Moderate 2 Load <BG+50% Resp. = H	Standard Load <BG+50% Resp. = L	Summary	[TP] > 20 mg/L	algal bloom?
Count:	63	291	145	209	33	30	112	179		8	10
% of Lakes:	18	82	41	59	9	8	32	51		2	3
Upper Thomas Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
UV 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
UV 2	N	Y	N	Y	N	N	N	Y	Standard	N	N
Vermilion Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
W 1	N	Y	N	Y	N	N	N	Y	Standard	N	N
W 2	N	Y	N	Y	N	N	N	Y	Standard	N	N
W 3	N	Y	N	Y	N	N	N	Y	Standard	N	N
W 4	N	Y	N	Y	N	N	N	Y	Standard	N	N
Wabagishik Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Waddell Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Wakemi Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Webfoot Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Wessel Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
West Cameron Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
West Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
West Morgan Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Whitefish Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Whitewater Lake	Y	N	N	Y	N	Y	N	N	Moderate	N	N
Whitson Lake	Y	N	Y	N	Y	N	N	N	Enhanced	N	N
Windy Lake - OR	N	Y	Y	N	N	N	Y	N	Moderate	N	Y
Windy Lake - W	N	Y	Y	N	N	N	Y	N	Moderate	N	N
Wisner Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Wolf Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
Wolfe Lake	N	Y	Y	N	N	N	Y	N	Moderate	N	N
WR 1	N	Y	N	Y	N	N	N	Y	Standard	N	N

10ha Lake Name (Lake Trout Lakes are in bold text)	**Criteria Met Yes (Y) or No (N)**				**Management Classification**					**Trigger1**	**Trigger3**
	Load ≥ BG+50%	**Load < BG+50%**	**Resp. = H**	**Resp. = L**	**Enhanced Load ≥BG+50% Resp. = H**	**Moderate 1 Load ≥BG+50% Resp. = L**	**Moderate 2 Load <BG+50% Resp. = H**	**Standard Load <BG+50% Resp. = L**	**Summary**	**[TP] > 20 mg/L**	**algal bloom?**
Count:	**63**	**291**	**145**	**209**	**33**	**30**	**112**	**179**		**8**	**10**
% of Lakes:	**18**	**82**	**41**	**59**	**9**	**8**	**32**	**51**		**2**	**3**
WW 1	Y	N	N	Y	N	Y	N	N	Moderate	N	N
WW 2	N	Y	N	Y	N	N	N	Y	Standard	N	N
WW 3	N	Y	N	Y	N	N	N	Y	Standard	N	N
WW 4	N	Y	N	Y	N	N	N	Y	Standard	N	N
WW 5	N	Y	N	Y	N	N	N	Y	Standard	N	N
Zilch Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N
ZuZu Lake	N	Y	N	Y	N	N	N	Y	Standard	N	N