THE ALBERTA LAKE MANAGEMENT SOCIETY
VOLUNTEER LAKE MONITORING PROGRAM

2014 Touchwood Lake Report

LAKEWATCH IS MADE POSSIBLE WITH SUPPORT FROM:

Beaver River Watershed Alliance

Alberta Government

LICA
Lakeland Industry & Community Association

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LakeWatch has several important objectives, one of which is to collect and interpret water quality data on Alberta Lakes. Equally important is educating lake users about their aquatic environment, encouraging public involvement in lake management, and facilitating cooperation and partnerships between government, industry, the scientific community and lake users. LakeWatch Reports are designed to summarize basic lake data in understandable terms for a lay audience and are not meant to be a complete synopsis of information about specific lakes. Additional information is available for many lakes that have been included in LakeWatch and readers requiring more information are encouraged to seek those sources.

ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the LakeWatch program. These people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health of our environment.

Acknowledgements

The LakeWatch program is made possible through the dedication of its volunteers. We would like to thank Megan, Matt, and Braden, who were summer technicians with the County of Lac la Biche for their assistance with sampling Touchwood Lake in 2014. We would also like to thank Jackson Woren, Brittany Kereliuk, and Kara MacAulay who were summer technicians with ALMS in 2014. Program Coordinator Bradley Peter was instrumental in planning and organizing the field program. Mike Bilyk was involved in the training aspects of the program. Lisa Reinbolt was responsible for data management. This report was prepared by Jackson Woren and Bradley Peter. Alberta Environment, the Beaver River Watershed Alliance (BRWA), the Lakeland Industry and Community Association (LICA), and Environment Canada, were major sponsors of the program.

TOUCHWOOD LAKE:

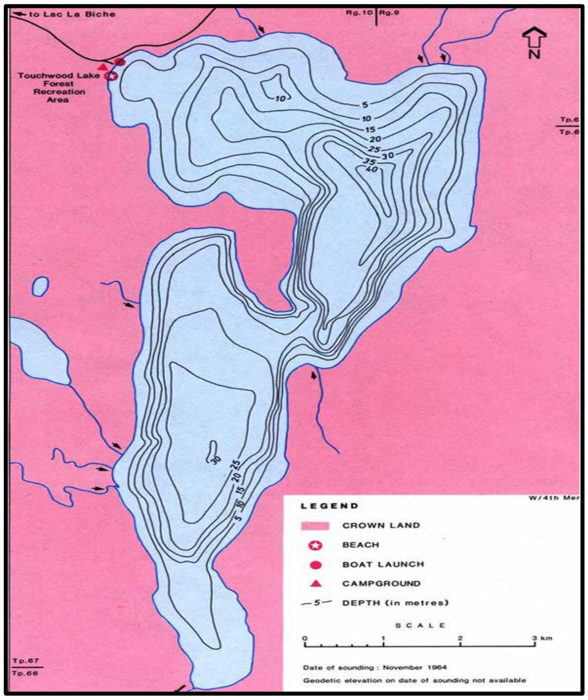

Figure 1 – Bathymetric map of Touchwood Lake (Mitchell and Prepas 1990).

Touchwood Lake is a beautiful wilderness lake set in heavily forested, rolling hills. It is located in Lakeland County, 265 km northeast of Edmonton and 45 km east of the town of Lac La Biche, which is the closest large population centre. Touchwood Lake falls within the boundaries of the Lakeland Recreation Area, positioned between the Lakeland Provincial Park to the west and the Cold Lake Air Weapons Range to the east. It is a popular recreational lake for camping, fishing, and boating.

The word “touchwood” refers to birch punk, which was used to start fires with flint and steel. The Cree called Touchwood Lake *Nameygos Sakahegan*, which means Trout Lake, in reference to the abundant, large lake trout found there (Chipeniuk 1975). By the late 1920’s, however, the trout population was decimated by the commercial fishery industry. Today, walleye and northern pike are the main species caught by the popular sport fishery. The lake also supports commercial and domestic fisheries for lake whitefish. Concentrations of algae in Touchwood Lake are low throughout the open-water period, so the water is transparent. The density of aquatic vegetation is sparse to moderate, with many un-vegetated areas along the lakeshore.

Touchwood Lake is one of the largest bodies of water in the Lakeland region (surface area = 29.0 km^2, mean depth = 15.0 m). It is separated into two basins by a large peninsula. The north basin, with a maximum depth of 40.0 m, is the deeper of the two. Touchwood Lake is a headwater lake. It drains quite a large area (111 km^2), but the drainage basin is less than four times the size of the lake. The outlet stream flows to Pinehurst Lake, six km to the south, and eventually to the Beaver River via Punk Creek and Sand River.

The drainage basin is part of the Boreal Mixwood Ecoregion (Strong and Leggat 1981). The dominant trees are an association of trembling aspen, balsam poplar, and lodgepole pine on moderately well-drained Gray Luvisols. Other species present are jack pine, white spruce, black spruce, willows, and sedges.

WATER QUANTITY:

There are many factors influencing water quantity. Some of these factors include the size of the lakes drainage basin, precipitation, evaporation, water consumption, ground water influences, and the efficiency of the outlet channel structure at removing water from the lake.

Unlike many other lakes in Alberta, water levels at Touchwood Lake have shown an increasing trend since Alberta Environment began monitoring the lake in 1969 (Figure 2). In recent years, water levels remained relatively stable, fluctuating between 631.8 meters above sea level (m asl) and 632.0 m asl. The maximum water level was reached in 1997 (632.2 m asl), which was one of the wettest years on record.

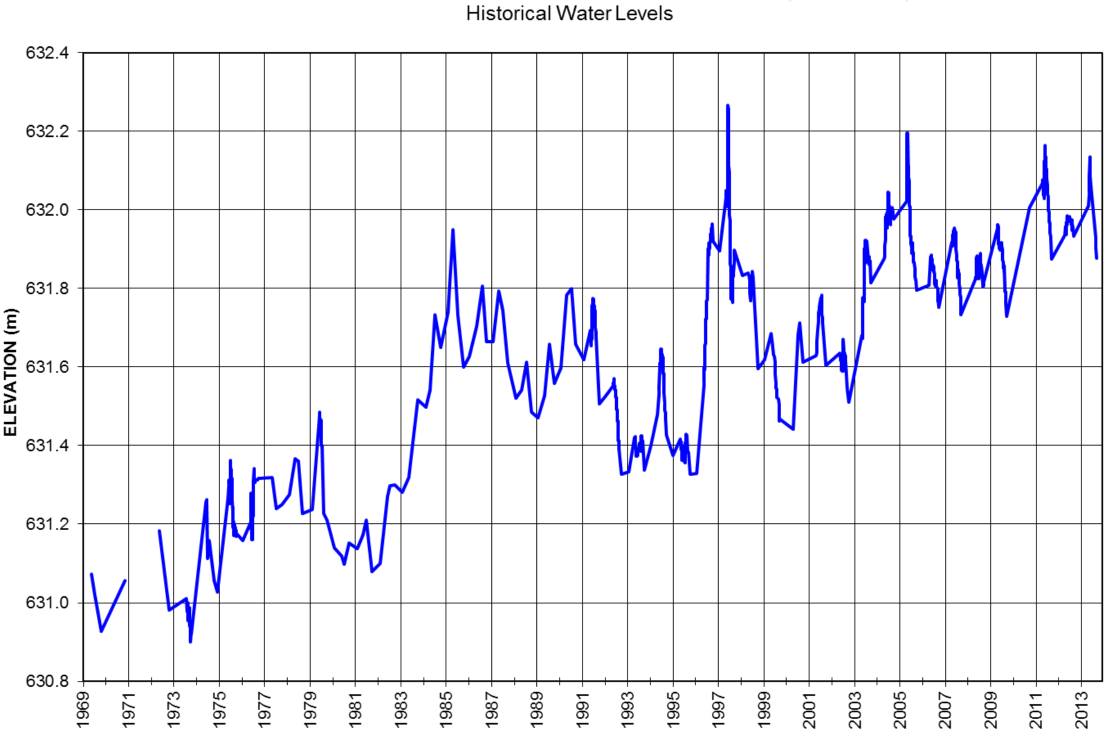

Figure 2 – Water level data in meters above sea level (m asl) for Touchwood Lake obtained from Alberta Environment.

WATER CLARITY AND SECCHI DEPTH:

Water clarity is influenced by suspended materials, both living and dead, as well as dissolved colored compounds in the water column. During the melting of snow and ice in spring, lake water can become turbid (cloudy) from silt transported into the lake. Lake water usually clears in late spring but then becomes more turbid with increased algal growth as the summer progresses. The easiest and most widely used measure of lake water clarity is the Secchi disk depth.

Average Secchi depth at Touchwood Lake in 2014 was 5.55 m (Table 1). Secchi disc depth has stayed relatively stable since 1986. A maximum secchi disc depth of 6.60 m was seen on July 18th as well as September 19th (Figure 3). Higher Secchi depths are common early in the season when water temperatures and nutrients are not high enough to promote large algal blooms. A minimum Secchi depth of 4.50 m was measured on August 28th.

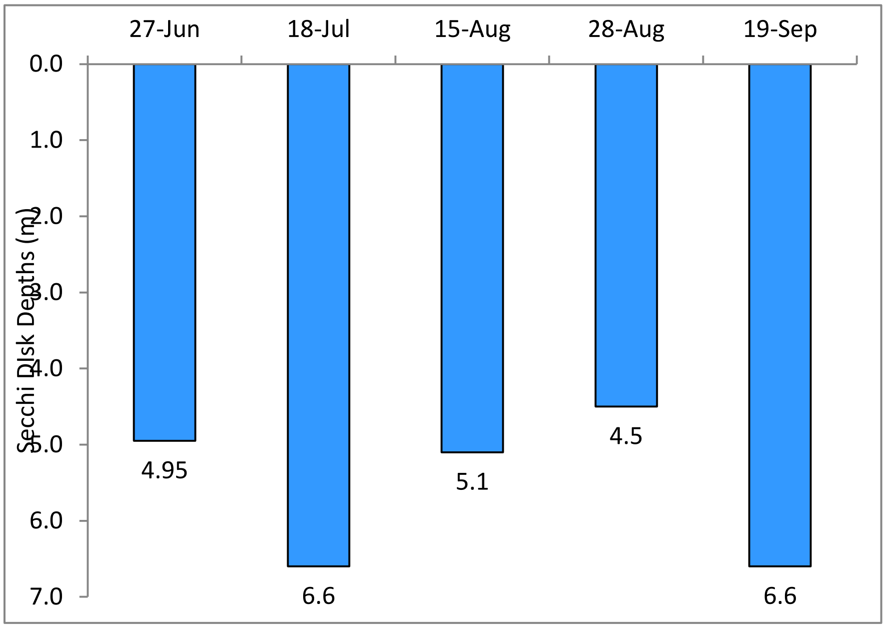

Figure 3 – Secchi disk depths measured at the profile spot at Touchwood Lake, 2014.

WATER TEMPERATURE AND DISSOLVED OXYGEN

Water temperature and dissolved oxygen profiles in the water column can provide information on water quality and fish habitat. The depth of the thermocline is important in determining the depth to which dissolved oxygen from the surface can be mixed. Please refer to the end of this report for descriptions of technical terms.

Due to the depth of Touchwood Lake, strong thermal stratification is able to form in the water column (Figure 4a). In late-June, surface water temperature was 17.33 °C while bottom temperature was 4.38 °C. In mid-July, surface water temperature had increased to 20.48 °C, resulting in stronger stratification between 6.0 m and 9.0 m. Temperatures at the lakebed remained relatively constant throughout the summer, fluctuating between 4.38 °C and 5.24 °C. On August 15th, surface temperature had increased to its seasonal maximum of 22.71 °C and thermal stratification was present between 6.5 m and 8.0 m. On September 19th, surface temperatures decreased dramatically to 13.47 °C and thermal stratification began to weaken, present between 10.0 m and 11.0 m.

Dissolved oxygen concentrations in the upper layers of the water column were sufficient for fish survival, but there was substantial dissolved oxygen depletion in the deeper waters (Figure 4b). Surface dissolved oxygen ranged between a minimum of 8.90 mg/L on August 28th and 9.85 mg/L on June 27th. On June 27th, the water column was still fairly well mixed, as oxygen was still above anoxia at 4.56 mg/L at a depth of 31.0 m. In July, August, and early September, however, dissolved oxygen decreased steadily and anoxia was observed between 30.0 m and 31.0 m. This is common in most lakes as decomposition at the lakebed consumes oxygen and particularly common at deeper lakes where the wind is unable to mix atmospheric oxygen to lower depths. Dissolved oxygen remained above the Canadian Council for Ministers of the Environments (CCME) Guidelines for the Protection of Aquatic Life (PAL) of 6.5 mg/L until an earliest of 11.0 m on August 28th and September 19th.

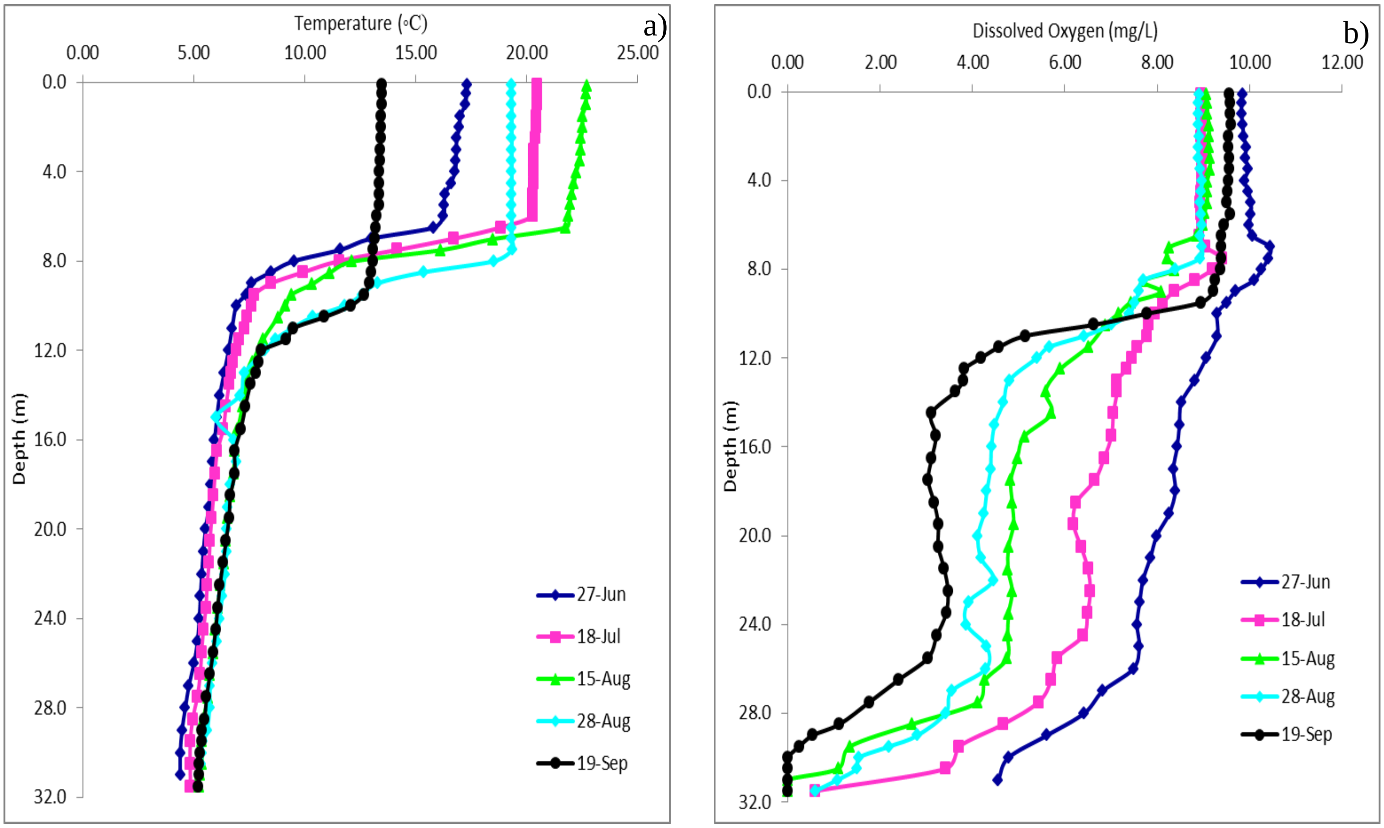

Figure 4 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles measured during the summer of 2014 at Touchwood Lake.

WATER CHEMISTRY:

ALMS measures a suite of water chemistry parameters. Phosphorous, nitrogen, and chlorophyll-a are important because they are indicators of eutrophication, or excess nutrients, which can lead to harmful algal/cyanobacteria blooms. One direct measure of harmful cyanobacteria blooms are Microcystins, a common group of toxins produced by cyanobacteria. See Table 1 for a complete list of parameters.

Based on average total phosphorus measured in 2014 (14.1 µg/L), Touchwood Lake is considered mesotrophic, or moderately productive. Compared to previous years, 14.1

μg/L is within the normal phosphorus range for Touchwood Lake (Table 1). A seasonal minimum of 0.5 μg/L was recorded on June 27th, and a seasonal maximum of 20 μg/L was recorded on July 18th, August 28th, and September 19th (Figure 5).

Chlorophyll-*a* remained stable throughout the summer and averaged 1.94 μg/L, one of the lowest observed in recent years, besides 2010. Chlorophyll-*a* measured a minimum of 1.3 μg/L on August 28th and a seasonal maximum of 2.4 μg/L on August 15th (Figure 5). If chlorophyll-*a* was used as the indicator of trophic status, Touchwood Lake would be considered oligotrophic, or of low-productivity.

Finally, total Kjeldahl nitrogen increased a few times throughout the summer, with an average of 588 μg/L (Table 1). The lowest concentration was measured on June 27th at 350 μg/L and then a seasonal maximum was observed on July 18th at 720 μg/L (Figure 5).

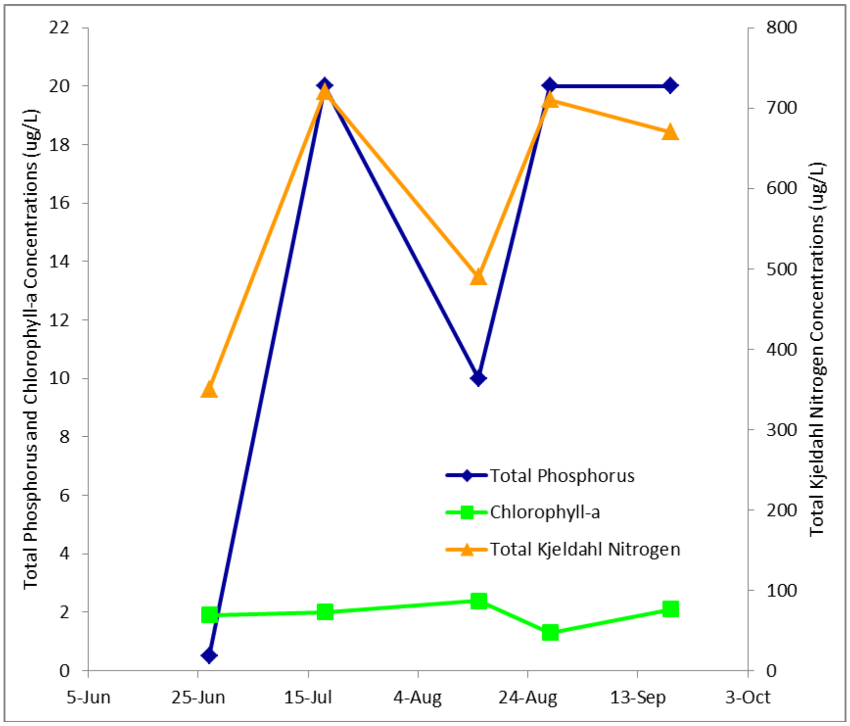

Figure 5 – Total phosphorous (μg/L), total Kjeldahl nitrogen (mg/L), and chlorophyll-*a* (μg/L) measured five times over the course of the summer at Touchwood Lake.

Average pH at Touchwood Lake was well above neutral at 8.212 (Table 1). High alkalinity (142.8 mg/L $CaCO_3$) and bicarbonate (174.6 mg/L HCO_3) likely helps to buffer the lake against changes to pH. Calcium (29.63 mg/L), magnesium (13.13 mg/L) and sodium (9.58 mg/L) are the dominant ions in Touchwood Lake contributing to a conductivity of 269.2 μS/cm. In comparison to previous years, water chemistry parameters have changed very little and are all within a normal range.

Metals were measured twice during the summer of 2014, and all fell within their recommended guidelines (Table 2).

MICROCYSTIN:

Microcystins are toxins produced by cyanobacteria (blue-green algae) which, when ingested, can cause severe liver damage. Microcystins are produced by many species of cyanobacteria which are common to Alberta's Lakes, and are thought to be the one of the most common cyanobacteria toxins. In Alberta, recreational guidelines for microcystin are set at 20 µg/L.

In 2014, concentrations of microcystin reached an observed maximum of 0.07 µg/L on June 27th, August 28th, and September 19th. Field observations suggest that there were no noticeable cyanobacteria in the water column until August 15th, however, it could not be determined what species it was. No large blooms were observed on the lake. Caution should always be taken when recreating in waters experiencing cyanobacteria blooms.

INVASIVE SPECIES:

Quagga and Zebra mussels are invasive species which, if introduced to our lakes, will have significant negative ecological, economical, and recreational impacts. ALMS collects water samples which are analyzed for mussel veligers (juveniles) and monitors substrates for adult mussels. In order to prevent the spread of invasive mussels, always clean, drain, and dry your boat between lakes. To report mussel sightings or mussel-fouled boats, call the confidential Alberta hotline at 1-855-336-BOAT.

In 2014, no zebra or quagga mussels were detected in Touchwood Lake.

Table 1 – Average secchi depth and water chemistry values for Touchwood Lake. Previous years averages are provided for comparison.

Parameter	**1986**	**2003**	**2004**	**2010**	**2014**
TP (µg/L)	22	15	19	16.8	14.1
TDP (µg/L)	/	9.2	1.5	8	5.9
Chlorophyll-*a* (µg/L)	4.6	3.5	3.7	1.9	1.94
Secchi depth (m)	4.9	3.8	4.5	4.65	5.55
TKN (µg/L)	770	590	600	650	588
NO_2 and NO_3 (µg/L)	10	9.1	3.7	6.5	28
NH_3 (µg/L)	26	16	9.2	14.8	16.8
DOC (mg/L)	11.1	/	10.2	10.8	19.13
Ca (mg/L)	33	29	31	27.3	29.63
Mg (mg/L)	11	12	12	13.5	13.13
Na (mg/L)	7.3	8.1	8	8.83	9.58
K (mg/L)	2.5	2.7	2.6	2.73	2.59
SO_4^{2-} (mg/L)	2.5	3	1.5	6.67	1.5
Cl^- (mg/L)	0.5	0.4	0.3	0.7	0.5
CO_3 (mg/L)	2.5	5.3	5.5	3	0.1
HCO_3 (mg/L)	170	165	166	176	174.6
pH	8.3	8.6	8.4	8.35	8.212
Conductivity (µS/cm)	267		271	272	269.2
Hardness (mg/L)	/	122	128	124	128
TDS (mg/L)	/	184	144	148	145.33
Microcystin (ug/L)	/	/	/	/	0.066
Total Alkalinity (mg/L $CaCO_3$)	143	144	146	146	142.8

Note: TP = total phosphorus, TDP = total dissolved phosphorus, Chl-*a* = chlorophyll-*a*, TKN = total Kjeldahl nitrogen. NO_{2+3} = nitrate+nitrite, NH_3 = ammonia, DOC = dissolved organic carbon, Ca = calcium, Mg = magnesium, Na = sodium, K = potassium, SO_4 = sulphate, Cl = chloride, CO_3 = carbonate, HCO_3 = bicarbonate, TDS= total dissolved solids. A forward slash (/) indicates an absence of data.

Table 2 - Concentrations of metals measured in Touchwood Lake on August 15th and September 19th 2014. Values shown for 2014 are an average of those dates. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	**2003**	**2004**	**2010**	**2014**	**Guidelines**
Aluminum µg/L	15	29	21.2	15.05	100
Antimony µg/L	0.007	0.029	0.0211	0.0237	6
Arsenic µg/L	0.56	0.6	0.644	0.646	5
Barium µg/L	33	36	36.05	35.55	1000
Beryllium µg/L	0.079	0.0015	0.00595	0.004	100
Bismuth µg/L	0.004	0.0005	0.00195	0.0005	/
Boron µg/L	32	37	31.45	34	5000
Cadmium µg/L	0.01	0.003	0.0033	0.0025	0.085
Chromium µg/L	0.28	0.13	0.063	0.196	/
Cobalt µg/L	0.021	0.014	0.01065	0.001	1000
Copper µg/L	0.59	0.26	0.208	0.364	4
Iron µg/L	15	22	21.15	9.75	300
Lead µg/L	0.23	0.05	0.0215	0.0274	7
Lithium µg/L	9.4	11	9.76	9.53	2500
Manganese µg/L	9.4	12	5.305	5.56	200
Molybdenum µg/L	0.11	0.11	0.114	0.08995	73
Nickel µg/L	0.03	0.0025	0.0486	0.004	150
Selenium µg/L	0.4	0.09	0.05	0.03	1
Silver µg/L	0.0025	0.0011	0.00515	0.002	0.1
Strontium µg/L	127	130	125.5	130	/
Thallium µg/L	0.003	0.0014	0.00315	0.00045	0.8
Thorium µg/L	0.004	0.0042	0.00635	0.014805	/
Tin µg/L	0.05	0.037	0.015	0.008225	/
Titanium µg/L	0.9	0.74	0.684	0.537	/
Uranium µg/L	0.103	0.98	0.1255	0.124	100
Vanadium µg/L	0.147	0.16	0.1375	0.126	100
Zinc µg/L	1.6	1.7	0.2855	0.8585	30

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5; calcium ion concentrations [Ca^{+2}] ≥ 4 mg/L; and dissolved organic carbon concentration [DOC] ≥ 2 mg/L.

[b] Based on water Hardness of 300 mg/L (as $CaCO_3$)

[c] Based on water hardness > 180mg/L (as $CaCO_3$)

[d] CCME interim value.

[e] Based on Canadian Drinking Water Quality guideline values.

[f] Based on CCME Guidelines for Agricultural use (Livestock Watering).

[g] Based on CCME Guidelines for Agricultural Use (Irrigation).

A forward slash (/) indicates an absence of data or guidelines.

A BRIEF INTRODUCTION TO LIMNOLOGY

INDICATORS OF WATER QUALITY:

Water samples are collected in Lakewatch to determine the chemical characteristics that characterize general water quality. Though not all encompassing, the variables collected in Lakewatch are sensitive to human activities in watersheds that can cause degraded water quality. For example, nutrients such as phosphorus and nitrogen are important determinants of lake productivity. The concentrations of these nutrients in a lake are impacted (typically elevated) by land use changes such as increased crop production or livestock grazing. Elevated nutrient concentrations can cause increases in undesirable algae blooms resulting in low dissolved oxygen concentrations, degraded habitat for fish and noxious smells. A large increase in nutrients over time may also indicate sewage inputs which in turn may result in other human health concerns associated with bacteria or the protozoan *Cryptosporidium*.

TEMPERATURE AND MIXING:

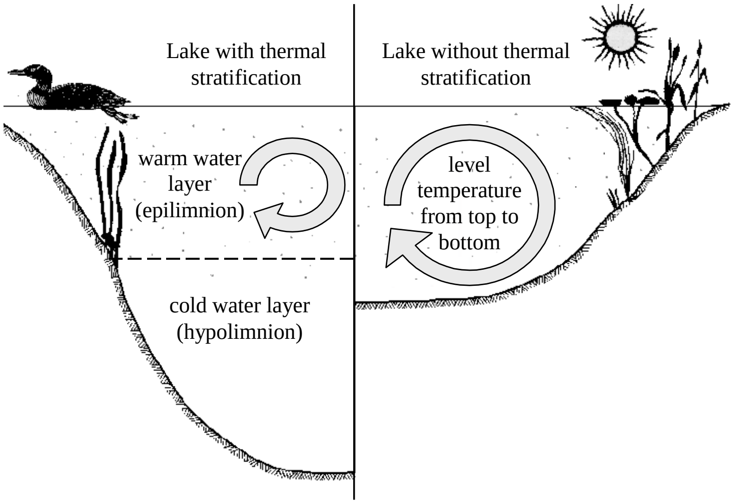

Figure A: Difference in the circulation of the water column depending on thermal stratification.

Water temperature in a lake dictates the behavior of many chemical parameters responsible for water quality. Heat is transferred to a lake at its surface and slowly moves downward depending on water circulation in the lake. Lakes with a large surface area or a small volume tend to have greater mixing due to wind. In deeper lakes, circulation is not strong enough to move warm water to depths typically greater than 4 or 5 m and as a result cooler denser water remains at the bottom of the lake. As the difference in temperature between warm surface and cold deeper water increases, two distinct layers are formed. Limnologists call these layers of water the **epilimnion** at the surface and the **hypolimnion** at the bottom. The layers are separated by a transition layer known as the **metalimnion** which contains the effective wall separating top and bottom waters called a **thermocline**. A thermocline typically occurs when water temperature changes by more than one degree within one meter depth. The hypolimnion and epilimnion do not mix, nor do elements such as oxygen supplied at the surface move downward into the hypolimnion. In the fall, surface waters begin to cool and eventually reach the same temperature as hypolimnetic water. At this point the water mixes from top to bottom in what is often called a **turnover** event. Surface water cools further as ice forms and again a thermocline develops this time with 4° C water at the bottom and near 0° C water on the top.

In spring another turnover event occurs when surface waters warm to 4° C. Lakes with this mixing pattern of two stratification periods and two turnover events are called **dimictic** lakes. In shallower lakes, the water column may mix from top to bottom most of the ice-free season with occasional stratification during periods of calm warm conditions. Lakes that mix frequently are termed **polymictic** lakes. In our cold climate, many shallow lakes are **cold monomictic** meaning a thermocline develops every winter, there is one turnover event in spring but the remainder of the ice free season the lake is polymictic.

DISSOLVED OXYGEN:

Oxygen enters a lake at the lake surface and throughout the water column when produced by photosynthesizing plants, including algae, in the lake. Oxygen is consumed within the lake by respiration of living organisms and decomposition of organic material in the lake sediments. In lakes that stratify (see temperature above), oxygen that dissolves into the lake at the surface cannot mix downward into the hypolimnion. At the same time oxygen is depleted in the hypolimnion by decomposition. The result is that the hypolimnion of a lake can become **anoxic**, meaning it contains little or no dissolved oxygen. When a lake is frozen, the entire water column can become anoxic because the surface is sealed off from the atmosphere. Winter anoxic conditions can result in a fish-kill which is particularly common during harsh winters with extended ice-cover. Alberta Surface Water Quality Guidelines suggest dissolved oxygen concentrations (in the epilimnion) must not decline below 5 $mg \bullet L^{-1}$ and should not average less than 6.5 $mg \bullet L^{-1}$ over a seven-day period. However, the guidelines also require that dissolved oxygen concentrations remain above 9.5 $mg \bullet L^{-1}$ in areas where early life stages of aquatic biota, particularly fish, are present.

GENERAL WATER CHEMISTRY:

Water in lakes always contains substances that have been transported by rain and snow or have entered the lake in groundwater and inflow streams. These substances may be dissolved in the water or suspended as particles. Some of these substances are familiar minerals, such as sodium and chloride, which when combined form table salt, but when dissolved in water separate into the two electrically charged components called **ions**. Most dissolved substances in water are in ionic forms and are held in solution due to the polar nature of the water molecule. **Hydrophobic** (water-fearing) compounds such as oils contain little or no ionic character, are non-polar and for this reason do not readily dissolve in water. Although hydrophobic compounds do not readily dissolve, they can still be transported to lakes by flowing water. Within individual lakes, ion concentrations vary from year to year depending on the amount and mineral content of the water entering the lake. This mineral content can be influenced by the amount of precipitation and other climate variables as well as human activities such as fertilizer and road salt application.

PHOSPHORUS AND NITROGEN:

Phosphorus and nitrogen are important nutrients limiting the growth of algae in Alberta lakes. While nitrogen usually limits agricultural plants, phosphorus is usually in shortest supply in lakes. Even a slight increase of phosphorus in a lake can, given the right conditions, promote algal blooms causing the water to turn green in the summer and impair recreational uses. When pollution originating from livestock manure and human sewage enters lakes not only are the concentrations of phosphorus and nitrogen increased but nitrogen can become a limiting nutrient which is thought to cause blooms of toxic algae belonging to the cyanobacteria. Not all cyanobacteria are toxic, however, the blooms can form decomposing mats that smell and impair dissolved oxygen concentrations in the lake.

CHLOROPHYLL-*A*:

Chlorophyll *a* is a photosynthetic pigment that green plants, including algae, possess enabling them to convert the sun's energy to living material. Chlorophyll *a* can be easily extracted from algae in the laboratory. Consequently, chlorophyll *a* is a good estimate of the amount of algae in the water. Some highly productive lakes are dominated by larger aquatic plants rather than suspended algae. In these lakes, chlorophyll *a* and nutrient values taken from water samples do not include productivity from large aquatic plants. The result, in lakes like Chestermere which are dominated by larger plants known as macrophytes, can be a lower trophic state than if macrophyte biomass was included. Unfortunately, the productivity and nutrient cycling contributions of macrophytes are difficult to sample accurately and are therefore not typically included in trophic state indices.

SECCHI DISK TRANSPARENCY :

Lakes that are clear are more attractive for recreation, whereas those that are turbid or murky are considered by lake users to have poor water quality. A measure of the transparency or clarity of the water is performed with a Secchi disk with an alternating black and white pattern. To measure the clarity of the water, the Secchi disk is lowered down into the water column and the depth where the disk disappears is recorded. The Secchi depth in lakes with a lot of algal growth will be small while the Secchi depth in lakes with little algal growth can be very deep. However, low Secchi depths are not caused by algal growth alone. High concentrations of suspended sediments, particularly fine clays or glacial till, are common in plains or mountain reservoirs of Alberta. Mountain reservoirs may have exceedingly low Secchi depths despite low algal growth and nutrient concentrations.

The euphotic zone or the maximum depth that light can penetrate into the water column for actively growing plants is calculated as twice the Secchi depth. Murky waters, with shallow Secchi depths, can prevent aquatic plants from growing on the lake bottom. Conversely, aquatic plants can ensure lakes have clear water by reducing shoreline erosion and stabilizing lake bottom sediments. In Alberta, many lakes are shallow and bottom sediments contain high concentrations of nutrients. Without aquatic plants, water quality may decline in these lakes due to murky, sediment laden water and excessive algal blooms. Maintaining aquatic plants in certain areas of a lake is often essential for ensuring good water clarity and a healthy lake as many organisms, like aquatic invertebrates and insects, depend on aquatic plants for food and shelter.

TROPHIC STATE:

Trophic state is classification of lakes into four categories of fertility and is a useful index for rating and comparing lakes. From low to high nutrient and algal biomass (as chlorophyll) concentrations, the trophic states are; **oligotrophic**, **mesotrophic**, **eutrophic** and **hypereutrophic (Table 2)**.

A majority of lakes in Alberta contain naturally high levels of chlorophyll *a* (8 to 25 µg/L) due to our deep fertile soils. These lakes are usually considered fertile and are termed eutrophic. The nutrient and algal biomass concentrations that define these categories are shown in the following table, a figure of Alberta lakes compared by trophic state can be found on the ALMS website.

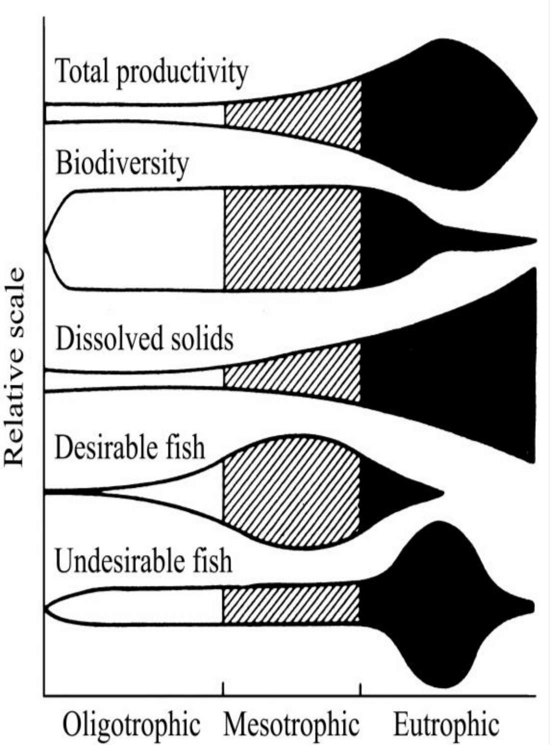

Figure B: Suggested changes in various lake characteristics with eutrophication. From “Ecological Effects of Wastewater”, 1980.

Table A - Trophic status classification based on lake water characteristics.

Trophic state	Total Phosphorus ($\mu g \bullet L^{-1}$)	Total Nitrogen ($\mu g \bullet L^{-1}$)	Chlorophyll *a* ($\mu g \bullet L^{-1}$)	Secchi Depth (m)
Oligotrophic	< 10	< 350	< 3.5	> 4
Mesotrophic	10 – 30	350 - 650	3.5 - 9	4 - 2
Eutrophic	30 – 100	650 - 1200	9 - 25	2 - 1
Hypereutrophic	> 100	> 1200	> 25	< 1

Note: These values are from a detailed study of global lakes reported in Nurnberg 1996. Alberta Environment uses slightly different values for TP and CHL based on those of the OECD reported by Vollenweider (1982). The AENV and OECD cutoffs for TP are 10, 35 and 100; for CHL are 3, 8 and 25. AENV does not have TN or Secchi depth criteria. The corresponding OECD exists for Secchi depth and the cutoffs are 6, 3 and 1.5 m.