Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Gleniffer Lake

2017

Lakewatch is made possible
with support from:

ALBERTA LAKE MANAGEMENT SOCIETY'S LAKEWATCH PROGRAM

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.

ALMS is happy to discuss the results of this report with our stakeholders. If you would like information or a public presentation, contact us at info@alms.ca.

ACKNOWLEDGEMENTS

Gleniffer Lake

Gleniffer Lake is a clear water lake located 20 km west of Innisfail. It is a reservoir that was created in 1983 by the construction of Dickson Dam and the impoundment of the Red Deer River. The dam levels fluctuate seasonally, and at its highest level it is 11 km long and 2 km wide.

Gleniffer is a popular lake for recreational fishing and boating, and supports sport fisheries including Walleye, Trout, Mountain Whitefish and Pike. There are six day use areas on the lake and boat launches at North Dyke, South Dyke and Cottonwood day-use areas. There is one public campsite and two commercially operated campgrounds. There are also two subdivisions on the lake. Gleniffer Lake Resort and Golf Course is on the northwest shore and Carefree Resort is on the southeast shore.

Gleniffer Lake—photo by Paradise Realty

Fluctuating water levels in Gleniffer Lake make for an interesting biological community, where a littoral zone with aquatic plants is less likely to develop. The lake is historically oligotrophic, or has low productivity. The water is clear but has seasonal high turbidity due to suspended sediment in the spring or after heavy rainfall.

University of Alberta - Atlas of Alberta Lakes. "Gleniffer Lake". Archived from the original on 2009-05-23. Retrieved 2017-10-31.

METHODS

Profiles: Profile data is measured at the deepest spot in the main basin of the lake. At the profile site, temperature, dissolved oxygen, pH, conductivity and redox potential are measured at 0.5- 1.0 m intervals. Additionally, Secchi depth is measured at the profile site and used to calculate the euphotic zone. On one visit per season, metals are collected at the profile site by hand grab from the surface and at some lakes, 1 m off bottom using a Kemmerer.

Composite samples: At 10-sites across the lake, water is collected from the euphotic zone and combined across sites into one composite sample. This water is collected for analysis of water chemistry, chlorophyll-a, nutrients and microcystin. Quality control (QC) data for total phosphorus was taken as a duplicate true split on one sampling date. ALMS uses the following accredited labs for analysis: Routine water chemistry and nutrients are analyzed by Maxxam Analytics, chlorophyll-*a* and metals are analyzed by Alberta Innovates Technology Futures (AITF), and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF). In lakes where mercury samples are taken, they are analyzed by the Biogeochemical Analytical Service Laboratory (BASL).

Invasive Species: Monitoring for invasive quagga and zebra mussels involved two components: monitoring for juvenile mussel veligers using a 63 μm plankton net at three sample sites and monitoring for attached adult mussels using substrates installed at each lake.

Data Storage and Analysis: Data is stored in the Water Data System (WDS), a module of the Environmental Management System (EMS) run by Alberta Environment and Parks (AEP). Data goes through a complete validation process by ALMS and AEP. Users should use caution when comparing historical data, as sampling and laboratory techniques have changed over time (e.g. detection limits). For more information on data storage, see AEP Surface Water Quality Data Reports at aep.alberta.ca/water.

Data analysis is done using the program R.[1] Data is reconfigured using packages tidyr [2] and dplyr [3] and figures are produced using the package ggplot2 [4]. Trophic status for each lake is classified based on lake water characteristics using values from Nurnberg (1996)[5]. The Canadian Council for Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life are used to compare heavy metals and dissolved oxygen measurements. Pearson's Correlation tests are used to examine relationships between TP, chlorophyll-*a,* TKN and Secchi depth, providing a correlation coefficient (r) to show the strength (0-1) and a p-value to assess significance of the relationship.

[1] R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

[2] Wickman, H. and Henry, L. (2017). tidyr: Easily Tidy Data with 'spread ( )' and 'gather ( )' Functions. R package version 0.7.2. https://CRAN.R-project.org/package=tidyr.

[3] Wickman, H., Francois, R., Henry, L. and Muller, K. (2017). dplyr: A Grammar of Data Manipulation. R package version 0.7.4. http://CRAN.R-project.org/package=dplyr.

[4] Wickham, H. (2009). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

[5] Nurnberg, G.K. (1996). Trophic state of clear and colored, soft- and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management 12: 432-447.

WATER CHEMISTRY

ALMS measures a suite of water chemistry parameters. Phosphorus, 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.

The average total phosphorus (TP) concentration for Gleniffer Lake was 4.0 µg/L (Table 2), falling into the oligotrophic, or unproductive trophic classification. TP remained relatively consistent over the course of the sampling season but was highest on July 12th, the first sampling visit.

Average chlorophyll-*a* concentration in 2017 was 0.95 µg/L (Table 2), also putting Gleniffer Lake into the oligotrophic classification. Chlorophyll-*a* concentrations remained relatively constant over the four sampling visits.

Finally, the average TKN concentration was 0.124 mg/L (Table 2), and the maximum concentration was measured on July 12th.

Average pH was measured as 8.38 in 2017, buffered by moderate alkalinity (155 mg/L $CaCO_3$) and bicarbonate (182.5 mg/L HCO_3). Calcium and sulphate were the dominant ions contributing to a low conductivity of 365 µS/cm (Table 2).

METALS

Samples were analyzed for metals (Table 3). In total, 27 metals were sampled for. It should be noted that many metals are naturally present in aquatic environments due to the weathering of rocks and may only become toxic at higher levels.

Metals were measured once on August 21 on Gleniffer Lake at the surface. In 2017, all metals were measured below their respective guidelines (Table 3).
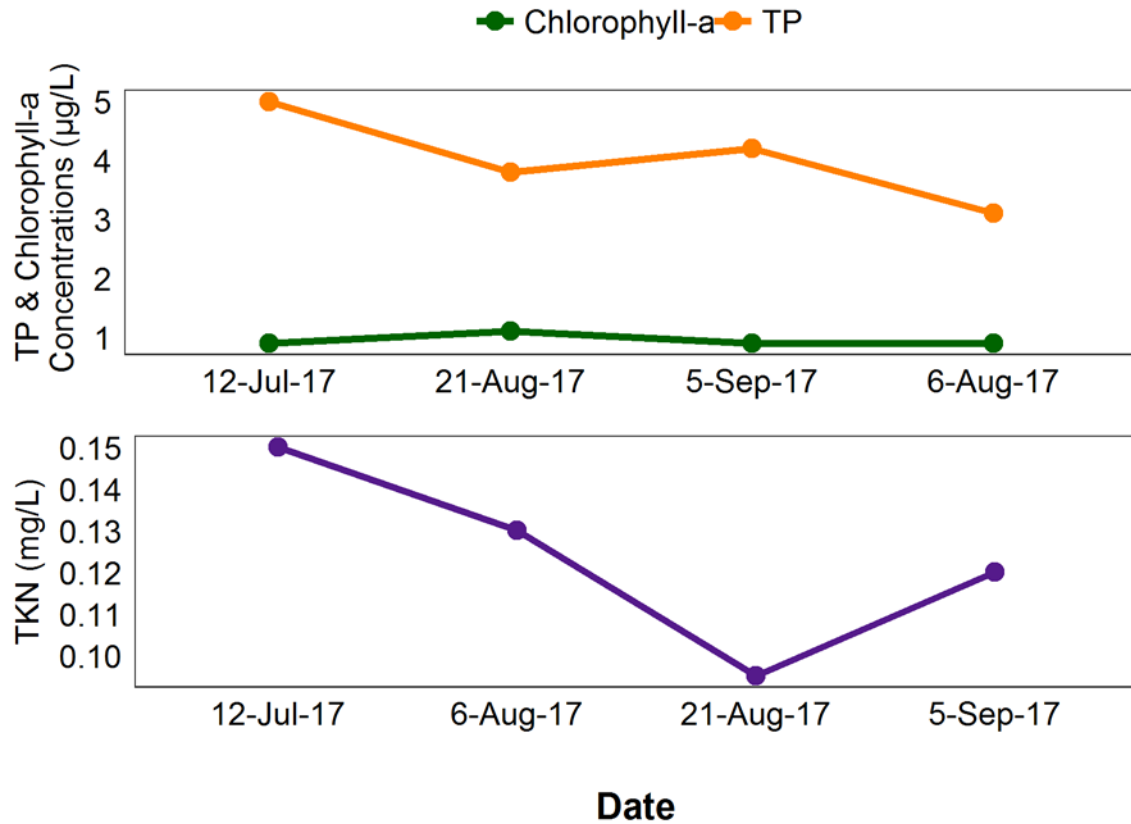
Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Gleniffer Lake.

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 depth. Two times the Secchi depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.

The average Secchi depth of Gleniffer Lake in 2017 was 5.7 m (Table 2). Secchi depth was consistently deep and therefore water clarity was high on all four sampling dates.
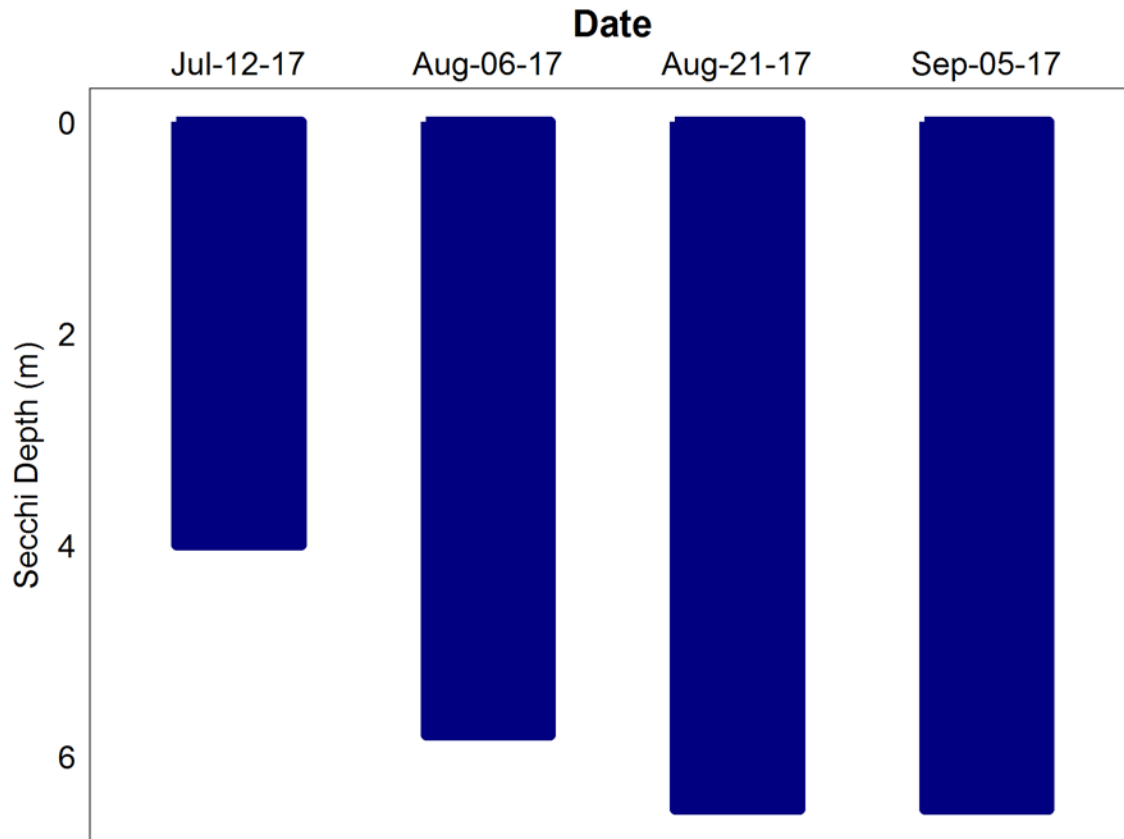
Figure 2– Secchi depth values measured four times over the course of the summer at Gleniffer Lake in 2017.

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.

Temperatures of Gleniffer Lake varied over the course of the summer, with a maximum temperature of 21.3°C measured at the surface on July 12 (Figure 3a). The lake was thermally stratified on July 12, but the entire water column was mixed for the remainder of the sampling season. Given that Gleniffer Lake is a reservoir of Red Deer River, the lake is flushed often and frequent mixing occurs.

Gleniffer Lake remained well oxygenated at the surface throughout the summer, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). Given the lack of thermal stratification, oxygen was mixed to the bottom on each sampling visit.
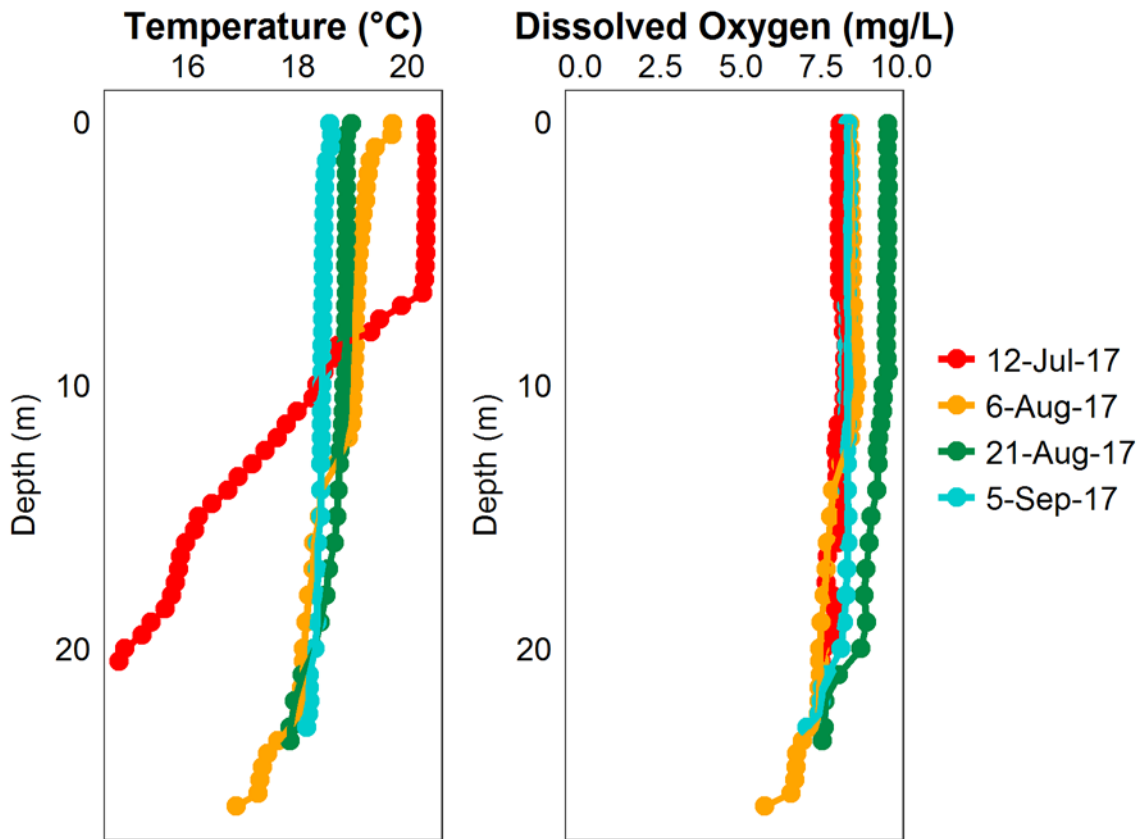
Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Gleniffer Lake measured four times over the course of the summer of 2017.

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. Blue-green algae advisories are managed by Alberta Health Services. Recreating in algal blooms, even if microcystin concentrations are not above guidelines, is not recommended.

Microcystin levels in Gleniffer Lake fell below the recreational guideline for the entire sampling period of 2017 (Table 1).

Table 1 – Microcystin concentrations measured four times at Gleniffer Lake in 2017.

Date	Microcystin Concentration (µg/L)
Jul-12-17	<0.1
Aug-06-17	<0.1
Aug-21-17	<0.1
Sep-05-17	<0.1
Average	<0.1

INVASIVE SPECIES MONITORING

Dreissenid mussels pose a significant concern for Alberta because they impair the function of water conveyance infrastructure and adversely impact the aquatic environment. These invasive mussels have been linked to creating toxic algae blooms, decreasing the amount of nutrients needed for fish and other native species, and causing millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities.

Monitoring involved two components: monitoring for juvenile mussel veligers using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. No mussels have been detected in Gleniffer Lake.

WATER LEVELS

There are many factors influencing water quantity. Some of these factors include the size of the lake's drainage basin, precipitation, evaporation, water consumption, ground water influences, and the efficiency of the outlet channel structure at removing water from the lake. Requests for water quantity monitoring should go through Alberta Environment and Parks Monitoring and Science division.

Water levels at Gleniffer Lake fluctuate with dam controls throughout the year. On average, water levels increase from May to October and decrease in the winter months. The average maximum is typically in October, and the average minimum is in May. For information on up to date water levels of Gleniffer Lake, visit: https://rivers.alberta.ca/
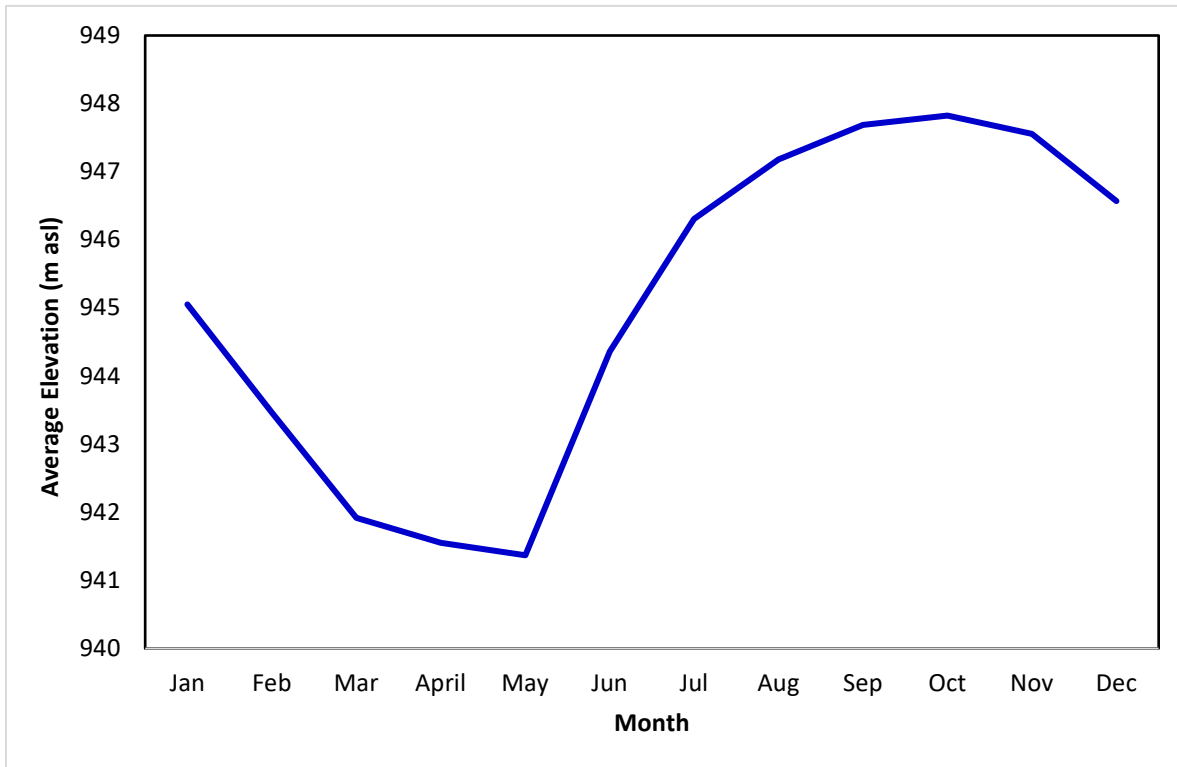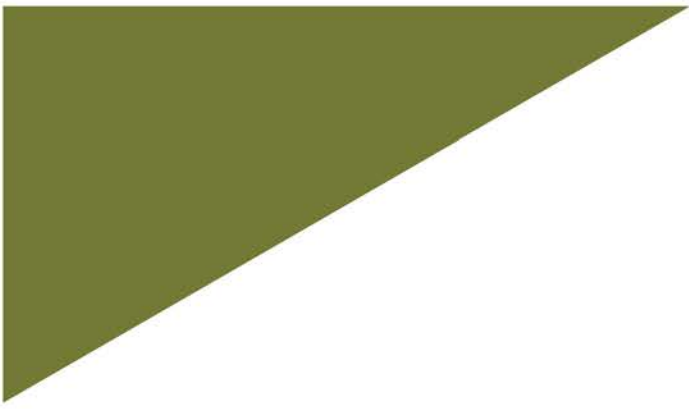
Figure 4- Average water levels of Gleniffer Lake throughout the year. Averages are calculated from water levels measured from 1983-2016. Data retrieved from Environment Canada.

Table 2: Average Secchi depth and water chemistry values for Gleniffer Lake.

Parameter	2017 Average
TP (µg/L)	4.025
TDP (µg/L)	1.95
Chlorophyll-a (µg/L)	0.95
Secchi depth (m)	5.7
TKN (mg/L)	0.124
NO_2-N and NO_3-N (µg/L)	23.3
NH_3-N (µg/L)	5.5
DOC (mg/L)	2.55
Ca (mg/L)	50.75
Mg (mg/L)	16.5
Na (mg/L)	3.825
K (mg/L)	0.99
SO_4^{2-} (mg/L)	42.5
Cl^- (mg/L)	0.8
CO_3 (mg/L)	2.3575
HCO_3 (mg/L)	182.5
pH	8.38
Conductivity (µS/cm)	365
Hardness (mg/L)	192.5
TDS (mg/L)	212.5
Microcystin (µg/L)	<0.1
Total Alkalinity (mg/L $CaCO_3$)	155

Table 3: Concentrations of metals measured in Gleniffer Lake on August 21. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	Average	Guidelines
Aluminum µg/L	9.2	100[a]
Antimony µg/L	0.075	/
Arsenic µg/L	0.39	5
Barium µg/L	94	/
Beryllium µg/L	0.0015	100[c,d]
Bismuth µg/L	0.0015	/
Boron µg/L	9.7	1500
Cadmium µg/L	0.005	0.26[b]
Chromium µg/L	0.05	/
Cobalt µg/L	0.059	1000[d]
Copper µg/L	0.81	4[b]
Iron µg/L	4.6	300
Lead µg/L	0.022	7[b]
Lithium µg/L	4.49	2500[e]
Manganese µg/L	0.63	200[e]
Molybdenum µg/L	0.947	73[c]
Nickel µg/L	2.21	150[b]
Selenium µg/L	0.5	1
Silver µg/L	0.001	0.25
Strontium µg/L	355	/
Thallium µg/L	0.006	0.8
Thorium µg/L	0.01	/
Tin µg/L	0.03	/
Titanium µg/L	0.71	/
Uranium µg/L	0.527	15
Vanadium µg/L	0.259	100[d,e]
Zinc µg/L	0.5	30

Values represent means of total recoverable metal concentrations.
[a] Based on pH ≥ 6.5
[b] Based on water hardness > 180mg/L (as CaCO3)
[c] CCME interim value.
[d] Based on CCME Guidelines for Agricultural use (Livestock Watering).
[e] Based on CCME Guidelines for Agricultural Use (Irrigation).
A forward slash (/) indicates an absence of data or guidelines.