

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 leaders in stewardship give us hope that our water resources will not be the limiting factor in the health of our environment.

If you would like to use data in this report for your own purposes, please contact ALMS to access the raw data files.

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. Special thanks to Brenda Madge and Bill Post, who aided in the 2018 sampling of Burnstick Lake. We would also like to thank Alanna Robertson, Lindsay Boucher and Shona Derlukewich, who were summer technicians in 2018. Executive Director Bradley Peter and Program Coordinator Laura Redmond were instrumental in planning and organizing the field program. This report was prepared by Caitlin Mader and Bradley Peter.

BURNSTICK LAKE

Located in the southern half of the province, Burnstick Lake is a moderately small water body tucked into the Boreal Foothills southwest of Caroline. Its primary inflow is West Stony Creek at the southwest end, although other streams may contribute intermittently when conditions are wet enough. Outflow is via East Stony Creek at the lake's easternmost point, which eventually flows into the James River as part of the Red Deer River Basin.



Bathymetric map of Burnstick Lake (Angler's Atlas)

The surrounding landscape is primarily native vegetation occurring in a mix of forests and wetlands. The area is also home to the regionally uncommon round-leafed bog-orchid (*Habernaria orbiculata*). The lake supports an active sport fishery for northern pike, yellow perch and walleye, the perch having been introduced in the 1970s¹. Extensive marshy and ponded areas around the lake provide excellent nesting sites for a variety of waterfowl and amphibians. Bald eagles have been known to nest along the lakeshore for multiple years¹. Land ownership throughout the watershed is primarily crown with private near-lake properties. Most crown land is under lease as cattle grazing reserves. Private lands consist of a municipal campground at the lake's east end, the Summer Village of Burnstick Lake midway along the north shore, and the Burnstick Lake Resort on the south shore across the lake from the summer village¹. Burnstick Lake is located on Treaty 6 land.

The watershed area for Burnstick Lake is 52.46 km² and the lake area is 4.70 km². The lake to watershed ratio of Burnstick Lake is 1:11. A map of the Burnstick Lake watershed area can be found at <http://alms.ca/wp-content/uploads/2016/12/Burnstick.pdf>.

¹ Alberta Environment Report. (1996). Burnstick Management Plan.

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 Innotech, 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.

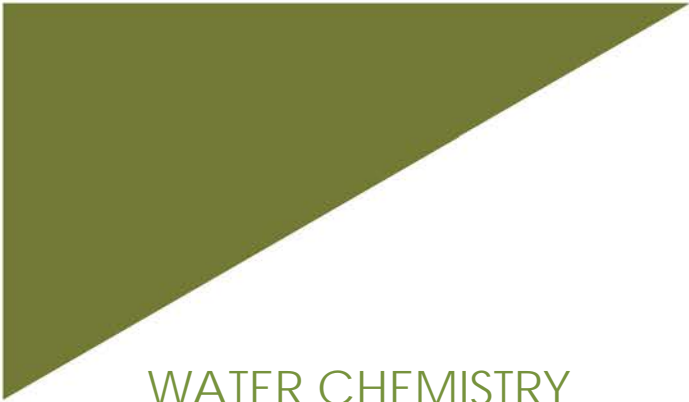
¹ R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.

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.



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OUT [A BRIEF INTRODUCTION TO
LIMNOLOGY](#) AT [ALMS.CA/REPORTS](#)

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 2 for a complete list of parameters.*

The average total phosphorus (TP) concentration for Burnstick Lake was 17.5 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. This value reflects a greater TP concentration than has previously been reported at Burnstick lake, but is only slightly higher than the 1994 average of 16 µg/L. TP spiked in early August, with a concentration of nearly 50 µg/L – this spike may be due to sample contamination and does not appear to be due to a bloom of algae or cyanobacteria (Figure 1).

Average chlorophyll-*a* concentrations in 2018 was 2.82 µg/L (Table 2), falling into the oligotrophic, or low productivity trophic classification. Chlorophyll-*a* concentrations remained consistent over the course of the sampling season.

Finally, the average TKN concentration was 0.35 mg/L (Table 2) with concentrations varying but generally decreasing over the course of the sampling season.

Average pH was measured as 8.25 in 2018, buffered by moderate alkalinity (142 mg/L CaCO₃) and bicarbonate (172 mg/L HCO₃). Calcium was the dominant ion contributing to a low conductivity of 274 µS/cm (Table 2).

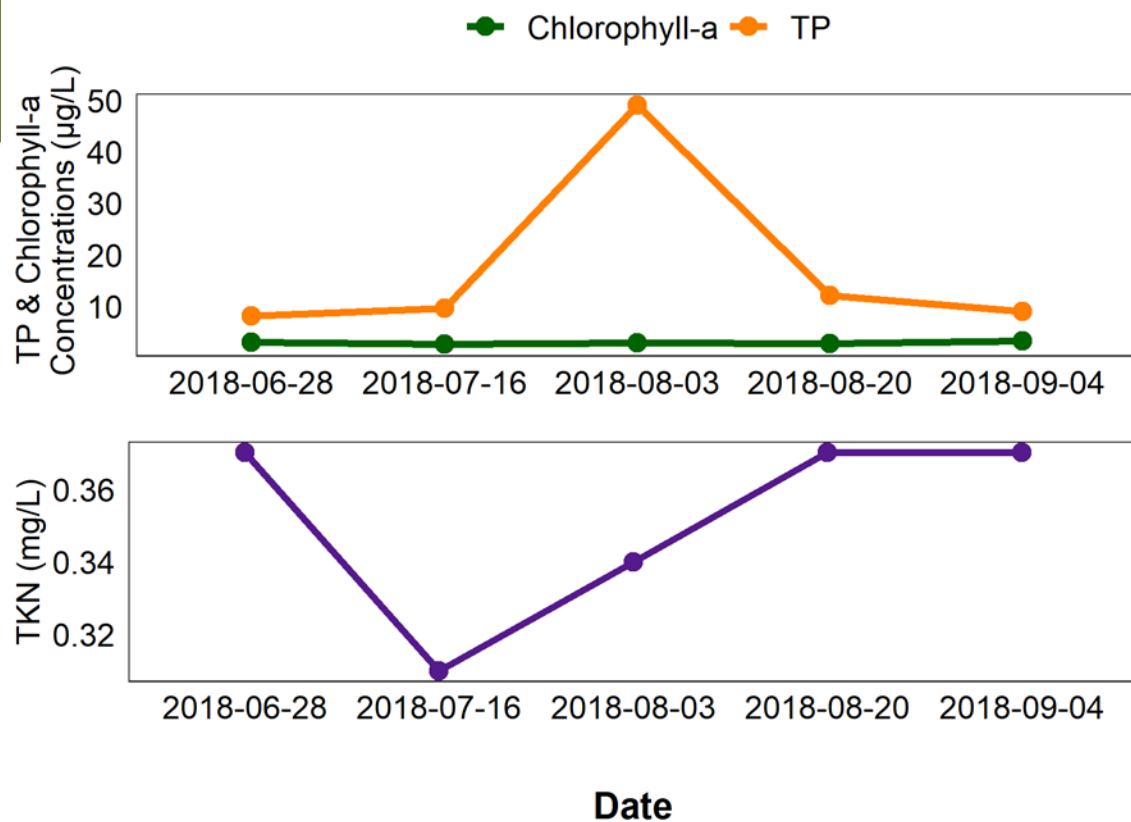


Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Burnstick Lake.

METALS

Samples were analyzed for metals once throughout the summer (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.

Metal concentrations were not measured at Burnstick Lake in 2018. In previous years, surface metal measurements were taken once per season, and all measured values fell within their respective guidelines (Table 3).

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 Burnstick Lake in 2018 was 4.98 m (Table 2). Secchi depth increased but remained relatively consistent over the sampling season. The lower Secchi depth at the beginning of the summer may be attributed to higher turbidity during spring melt.

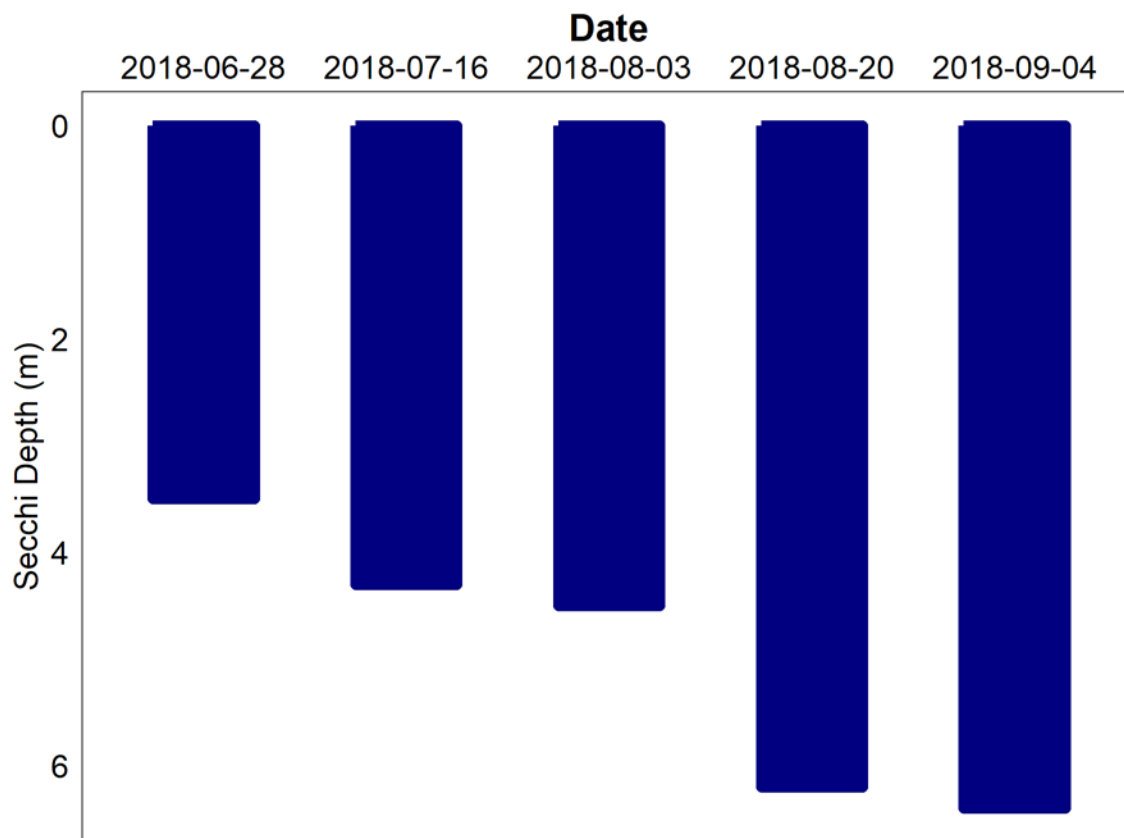


Figure 2 – Secchi depth values measured five times over the course of the summer at Burnstick Lake in 2018.

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 Burnstick Lake varied throughout the summer, with a maximum temperature of 21.13°C measured at the surface on July 16 (Figure 3a). The lake was strongly stratified on all sampling visits, with the thermocline deepening over the course of the summer.

Burnstick 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). Burnstick Lake reached anoxia at lake bottom on all sampling dates. This was associated with the thermal stratification that kept oxygenated waters separated from bottom waters.

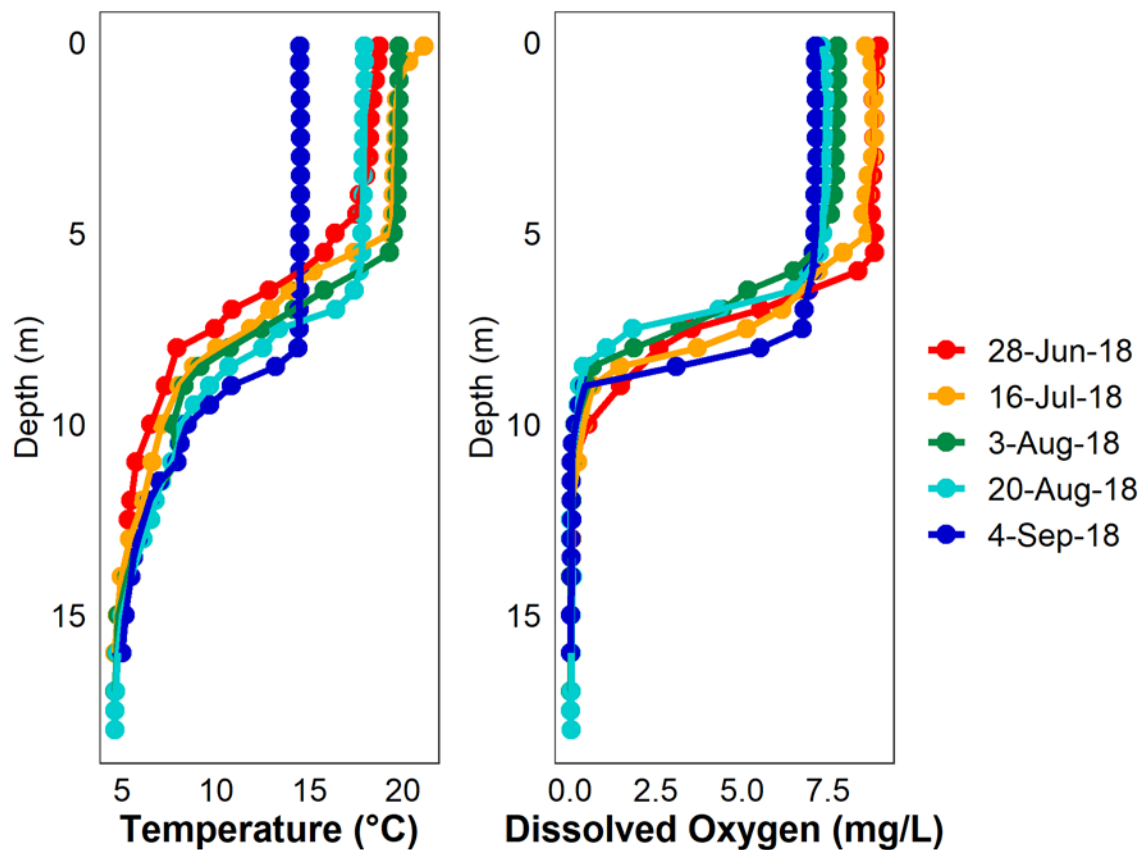


Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Burnstick Lake measured five times over the course of the summer of 2018.



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 Burnstick Lake fell below the recreational guideline for the entire sampling period of 2018 (Table 1).

Table 1 – Microcystin concentrations measured five times at Burnstick Lake in 2018.

Date	Microcystin Concentration (µg/L)
28-Jun-18	0.11
16-Jul-18	0.10
03-Aug-18	0.13
20-Aug-18	0.15
04-Sep-18	0.12
Average	0.12

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 Burnstick 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.

Currently, no water quantity data is available for Burnstick Lake.

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

Parameter	1993	1994	1999	2004	2016	2017	2018
TP (µg/L)	15	16	14	11	9	11	17.5
TDP (µg/L)	/	/	5.4	4.2	4	3.5	11.08
Chlorophyll- <i>a</i> (µg/L)	2.3	2.7	2.6	2.9	3.9	3.2	2.82
Secchi depth (m)	6.50	5.80	6.10	5.60	4.86	3.72	4.98
TKN (mg/L)	/	/	0.5	0.4	0.36	0.39	0.352
NO ₂ -N and NO ₃ -N (µg/L)	8.4	9.8	8.4	9	6.22	2.32	4.2
NH ₃ -N (µg/L)	/	/	15	17	38.4	5.5	15.8
DOC (mg/L)	/	/	/	/	4.46	5.1	5.14
Ca (mg/L)	30.6	33.5	30.3	28.5	40.6	39.4	37.6
Mg (mg/L)	11.4	11.7	11.3	10.4	13.8	13.2	12.6
Na (mg/L)	2.8	3.2	2.5	2.8	3.2	3.14	3.12
K (mg/L)	0.5	0.5	0.5	0.7	0.6	0.626	0.622
SO ₄ ²⁻ (mg/L)	<3	<3	3.4	8	2.32	2.32	1.9
Cl ⁻ (mg/L)	0.5	<0.5	3	0.4	0.5	0.68	1
CO ₃ (mg/L)	/	/	<5	4.0	0.25	0.376	1.3
HCO ₃ (mg/L)	156.4	167.3	157.6	151.7	182	180	172
pH	8.2	8.2	8.2	8.3	8.25	8.29	8.25
Conductivity (µS/cm)	239.2	253.8	244.0	217.0	280	274	274
Hardness (mg/L)	/	/	/	/	160	154	148
TDS (mg/L)	124.6	133.2	126.0	122.7	158	158	148
Microcystin (µg/L)	/	/	/	/	0.07	0.11	0.122
Total Alkalinity (mg/L CaCO ₃)	/	/	/	/	150	150	142

Table 3: Concentrations of metals were last measured measured in Burnstick Lake on August 16, 2017. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	2004	2016	2017	Guidelines
Aluminum µg/L	18.7	4.2	5	100 ^a
Antimony µg/L	0.0	0.059	0.031	/
Arsenic µg/L	0.3	0.3	0.37	5
Barium µg/L	126.0	157	153	/
Beryllium µg/L	<0.003	0.018	0.0015	100 ^{c,d}
Bismuth µg/L	<0.001	0.03	0.0015	/
Boron µg/L	4.4	6.6	4.9	1500
Cadmium µg/L	<0.002	0.023	0.005	0.26 ^b
Chromium µg/L	0.1	0.1	0.05	/
Cobalt µg/L	0.0	0.001	0.049	1000 ^d
Copper µg/L	0.9	0.32	0.34	4 ^b
Iron µg/L	4.0	26.6	10.2	300
Lead µg/L	0.1	0.026	0.007	7 ^b
Lithium µg/L	2.0	2.3	2.2	2500 ^e
Manganese µg/L	11.4	12.9	4.66	200 ^e
Molybdenum µg/L	0.2	0.427	0.383	73 ^c
Nickel µg/L	<0.005	0.004	1.32	150 ^b
Selenium µg/L	<0.1	0.07	0.1	1
Silver µg/L	0.0347	0.02	5.00E-04	0.25
Strontium µg/L	73.3	86.1	84.9	/
Thallium µg/L	0.0008	0.117	0.002	0.8
Thorium µg/L	0.0053	0.0541	0.015	/
Tin µg/L	0.13	0.014	0.03	/
Titanium µg/L	1	1.08	1.32	/
Uranium µg/L	0.19	0.266	0.267	15
Vanadium µg/L	0.104	0.1	0.187	100 ^{d,e}
Zinc µg/L	14.7	0.6	0.3	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.