

Horse Lake Water Quality Review

Horse Lake is located 8 km southeast of 100 Mile House, in the Cariboo Regional District. The lake is narrow relative to its length, and is oriented in an approximate west to east direction. Horse Lake is one of many inter-connected lakes that make up the Bridge Creek watershed. Bridge Creek is the main water supply source for 100 Mile House; therefore, Horse Lake's water quality influences the quality of drinking water for the community.

Horse Lake has several major inflowing tributaries including Bridge Creek, 93 Mile Creek, Attwood Creek, Fawn Creek, and Longbow Creek. The lake drains out through Bridge Creek, at the west end of the lake. The lake has a total surface area of 11.6 km², with a perimeter of approximately 31 km (Habitat Wizard 2016). The lake has a recorded maximum depth of 34 m, and the littoral depth of the lake is approximately 6 m, (Zirnhelt et al. 1997). Maps of the lake bathymetry are located in Appendix A.

Land uses around Horse Lake include roads, forestry, residential development, and agriculture, while uses in the lake include fishing, swimming, and water skiing (Zirnhelt et al. 1997).

**Table Error! No text of specified style in document.-1
Key watershed and lake information for Horse Lake**

Watercourse Name	Horse Lake
Watershed area	12,154 km ²
Watershed Code	129-360400-23900-98400-9950-6263
UTM Coordinates	10 629889E 5716967N
Lake surface area	12.2 km ²
Perimeter length	31 km
Maximum depth	34 m
Mean depth	15.2 m
Flushing Rate Class (Modelled)	4 (High)

Source: iMapBC 2016

Water Quality

The District of 100 Mile House obtains its drinking water from a deep production well located near Little Bridge Creek (District of 100 Mile House 2016). Until the District established this well as its main source, Bridge Creek downstream of Horse Lake was the primary drinking water supply for the community.

Water quality assessments for physical, chemical, and biological parameters were conducted at Horse Lake from 1993 to 1997 (Zirnhelt et al. 1997; Zirnhelt and Petch 1997). The trophic status of the lake was characterized as being borderline mesotrophic to mesotrophic based on total phosphorus and total nitrogen concentrations respectively. It appeared that biological production was both phosphorus limited and nitrogen limited. The average flushing rate was calculated to be 3.5 years, indicating that the lake has average ability to assimilate nutrients (Zirnhelt and Petch 1997). Based on the biophysical characteristics and the relatively high number of permanent residents, the lake was rated as having "High Sensitivity" to future development.

At the time of that assessment, phosphorus loading in Horse Lake primarily came from inflow from Bridge Creek (77% of the total phosphorus). The catchment size for Bridge Creek, in relation to the other tributaries, is likely the reason the proportion of phosphorus loading from Bridge Creek is high. As of 1997, phosphorus concentrations appeared to have increased when compared to samples collected by the Ministry of Environment, Lands and Parks during the 1970s, although this may be attributed to natural fluctuation within the lake. Secchi depth readings¹ taken in 1979 and 1994 show no changes in lake clarity during this time, indicating lake quality had not deteriorated during this period (Zirnhelt et al 1997). Overall, the authors concluded that water quality in Horse Lake was “very good”. However, they recommended on-going monitoring and additional work to characterize the nutrient budget.

To assess how the lake water quality may have changed since the 1997 report, a search of the provincial EMS databases was completed on July 28, 2016. The results indicate that the lake was sampled about 20-30 times between 1994 and 2016 (depending on the parameter), from three different EMS sites. The EMS site with the most data is Horse Lake at Deepest Point (EMS # 603100), which is located near the centre of the lake. Table X-1 shows the average, median, and range of concentrations of key water quality variables at the site.

Table X-1
Average, median, and range of concentrations for key water quality variables from 1994 – 2016
(EMS Site # 603100, Horse Lake at Deepest Point)

Parameter	<i>n</i>	Average	Median	Minimum	Maximum
pH	161	8.13	8.20	5.84	8.60
EC (µs/cm)	161	279	298	1	320
Turbidity (NTU)	161	0.65	0.50	0.05	3.22
TDS (mg/L)	146	169	176	10	280
Total nitrogen (mg/L)	189	0.30	0.36	<0.02	0.60
Orthophosphate (mg/L)	180	0.012	0.005	<0.001	0.16
Total phosphorus (mg/L)	210	0.021	0.018	<0.002	0.19
Chlorophyll <i>a</i> (mg/L)	40	0.0025	0.0020	0.0005	0.0092

n = number of measurements. Pools duplicates and depths for the site to illustrate complete range. Results below detection were taken to be at the detection limit. For chlorophyll *a*, over 50% of the results were below the detection limit.

Total phosphorus and total nitrogen concentrations have remained relatively consistent over time, suggesting lake quality has not changed appreciably. There is some indication that chlorophyll *a* has increased since the 1990s, but it has only been tested sporadically. The total phosphorus data indicates that the lake is mostly in the mesotrophic to meso-eutrophic range, based on Canadian Council of Ministry of Environment (2004) trigger ranges (i.e. mesotrophic is 0.010 mg/L to 0.020 mg/L total P;

¹ Secchi discs are used to measure water clarity. Lakes that are more productive will have more algal growth, resulting in reduced water clarity. Secchi discs are black and white discs that are lowered into the water. The depth at which the disc is no longer visible is then recorded.

meso-eutrophic is 0.020 mg/L to 0.035 mg/L total P). However, there are occasional measurements in the eutrophic range (0.035 mg/L to 0.100 mg/L). This indicates that the “sensitive” rating assigned to Horse Lake in 1997 still applies.

Aquatic Habitat

A search of iMap BC’s database (DataBC 2016) indicates 11 species of fish occur in Horse Lake (Table 4-1).

Records indicate Horse Lake was stocked with kokanee and rainbow trout, between 1933 and 2006. Largemouth bass, native to eastern North America, is an invasive species in British Columbia and has been found in Horse Lake (Habitat Wizard 2016).

**Table Error! No text of specified style in document.-2
Fish species present in Horse Lake**

Common name	Species Name
Burbot	<i>Lota lota</i>
Kokanee	<i>Oncorhynchus nerka</i>
Lake Chub	<i>Couesius plumbeus</i>
Lake Trout	<i>Salvelinus namaycush</i>
Largemouth Bass	<i>Micropterus salmoides</i>
Largescale Sucker	<i>Catostomus macrocheilus</i>
Longnose Sucker	<i>Catostomus</i>
Northern Pike-minnow	<i>Ptychocheilus oregonensis</i>
Peamouth Chub	<i>Mylocheilus caurinus</i>
Rainbow Trout	<i>Oncorhynchus mykiss</i>
Redside Shiner	<i>Richardsonius balteatus</i>

Source: Habitat Wizard 2016

Riparian Habitat

Horse Lake is located within the Interior Douglas Fir biogeoclimatic zone, Fraser Dry Cool variant (IDFdk3), which is characterized by warm, dry summers, a long growing season, and cool winters (Steen and Coupe 1997). Open conifer forests and extensive grasslands are the most common ecosystems. As such, Horse Lake and other lakes and associated riparian areas provide important biological diversity in the generally dry landscape. Riparian areas also function to maintain and improve water quality because they trap sediment, reduce erosion, provide shade, and store nutrients and contaminants. Based on interpretation of a 2013 aerial photograph (Google Earth), it appears that approximately 50-60 percent of the riparian zone around Horse Lake is in a natural or close to natural condition, with most of the developed residential areas located on the south side and at the west end of the lake. The riparian zone includes some areas where there is a sharp transition to non-riparian forest, but there are also several low-gradient wetlands, notably at the mouth of Bridge Creeks and at a bay in the eastern part of the lake, that contribute to the biodiversity of the area around the lake.

Planning Approaches to Lake Management

Horse Lake was rated by Zirnhelt and Petch (1997) as having high sensitivity to land use activities that could introduce nutrients and other compounds into the lake. Water quality monitoring data since then indicates that the lake remains sensitive, with nutrient measurements indicating that the trophic status ranges from mesotrophic to occasionally eutrophic. Therefore, there are a number of planning options that should be considered to maintain and enhance the values and ecological services that Horse Lake provides. A number of these options are either already in place elsewhere in Cariboo Regional District, or are considered “best practices” for lakes in British Columbia. These options are:

1. Establish riparian setbacks standards for the lake shore and for tributaries through Development Permit Areas (DPAs), consistent with the Cariboo Regional District shoreland management policy. The BC Riparian Areas Regulation (RAR) establishes a 30 m distance from the high water mark as the default setback. Although RAR does not currently apply to lands in the Cariboo Regional District, 30 m is recommended as the setback for Horse Lake for consistency. Like RAR, landowners should be able to propose an alternative, subject to an assessment from a qualified professional to determine that riparian function would be maintained.
2. New and upgraded on-site private wastewater systems (e.g. septic systems) must meet the requirements of the B.C. Sewerage System Regulation under the *Public Health Act*, and be designed and constructed according to the most recent version of the Sewerage System Standard Practice Manual². The Regional District may wish to consider the value of an on-site wastewater system bylaw for the Horse Lake area to augment the Sewerage System Regulation³. The bylaw would stipulate maintenance schedules and/or minimum lot sizes and setbacks from property lines and waterbodies. Alternatives to a bylaw include implementing an education and awareness program⁴.
3. Consider the incorporation of Best Management Practices for land development outlined in existing provincial and federal guideline documents including:
 - a. Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia (MOE 2014);
 - b. Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993); and
 - c. Standards and Best Practices for Instream Works (WLAP 2004).
4. Establish stormwater and rainwater management standards for new development, reflecting local climate and soil conditions.
5. Establish best management practices for boating on Horse Lake, including measures to prevent the spread of non-native aquatic plants and animals, and measures to prevent fuel spills.

² Available at <http://www2.gov.bc.ca/gov/content/environment/waste-management/sewage/onsite-sewage-systems/sewage-system-standard-practice-manual>

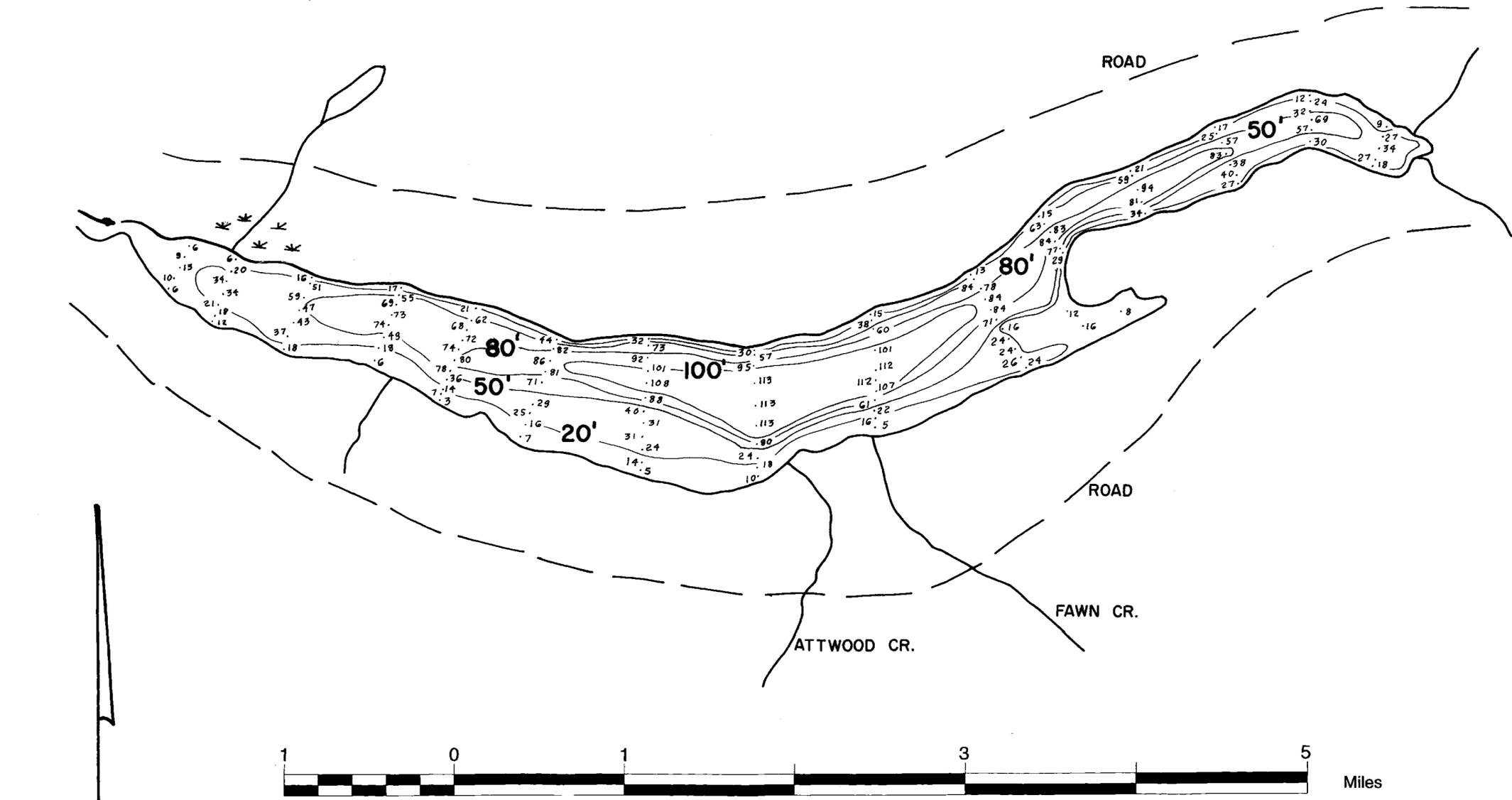
³ For an example of such a bylaw, see <https://www.crd.bc.ca/service/sewers-wastewater-septic/septic-systems/certifying-septic-maintenance>

⁴ For an example from another Regional District see <http://www.rdn.bc.ca/cms.asp?wpID=1159>.

References

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- Zirnhelt, N. and R. Petch. 1997. Water quality, lake sensitivity rating, and septic seepage survey of six lakes in the Bridge Creek Basin. BC Ministry of Environment and Environment Canada. Fraser River Action Plan. DOE FRAP 1997-46.
- Zirnhelt, N., et al. 1997. Hose Lake – Bridge Creek Water Quality Assessment. Ministry of Environment, Lands and Parks. Williams Lake. On-line at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/monitorwaterquality/cariboo-skeena-omineca-wq-docs/wq_car_horse_lake_bridge_cr_1997.pdf

CAUTION: DO NOT USE THIS MAP FOR NAVIGATIONAL PURPOSES
 This map may not reflect current conditions. Uncharted hazards may exist.



SURVEYED BY: T.G.N. DATE: JN. 10-11, 52
 SHORE OUTLINE FROM: OLD SURVEY MAP

STATISTICS AT TIME OF SURVEY

1. ELEVATION 3000'
2. SURFACE AREA 2872 ACRES
3. VOLUME 143,600 ACRE FT.
4. EST. ANNUAL FLUCTUATION
5. MEAN DEPTH 50'
6. MAX. DEPTH 113'
7. PERIMETER 98,736'

FISH AND GAME BRANCH
 DEPARTMENT OF RECREATION AND CONSERVATION

HORSE LAKE

DATE:	DRAWN:	SCALE: 1" = 2640'
	CHECK:	
APPROVED:		DWG. No. 92 P111
DIVISION ENGINEER:		CHIEF BIOLOGIST: