WATER QUALITY SUMMARY REPORT
FOR THE GREATER VICTORIA DRINKING WATER SYSTEM
December 2019 to May 2020

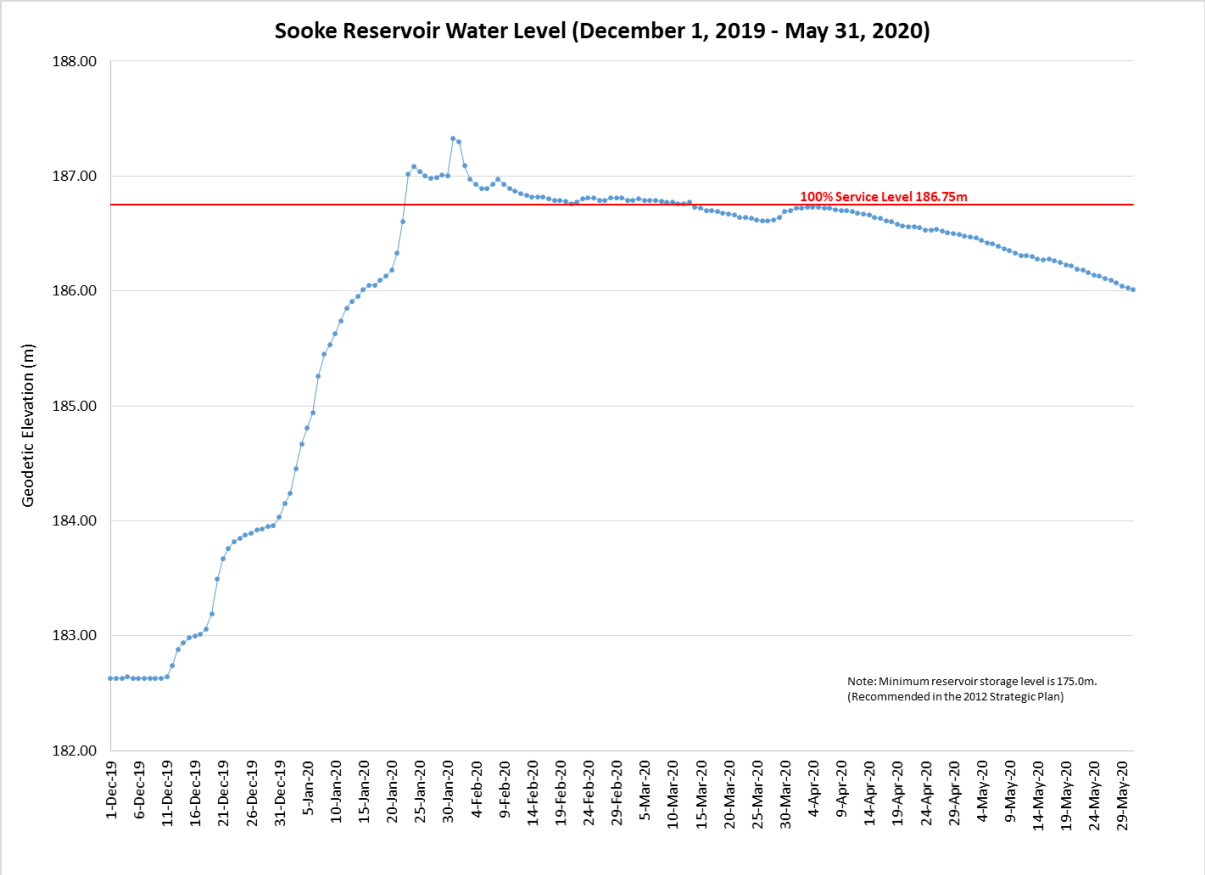
September 2020

SOURCE WATER – SOOKE LAKE RESERVOIR

Physical Parameters

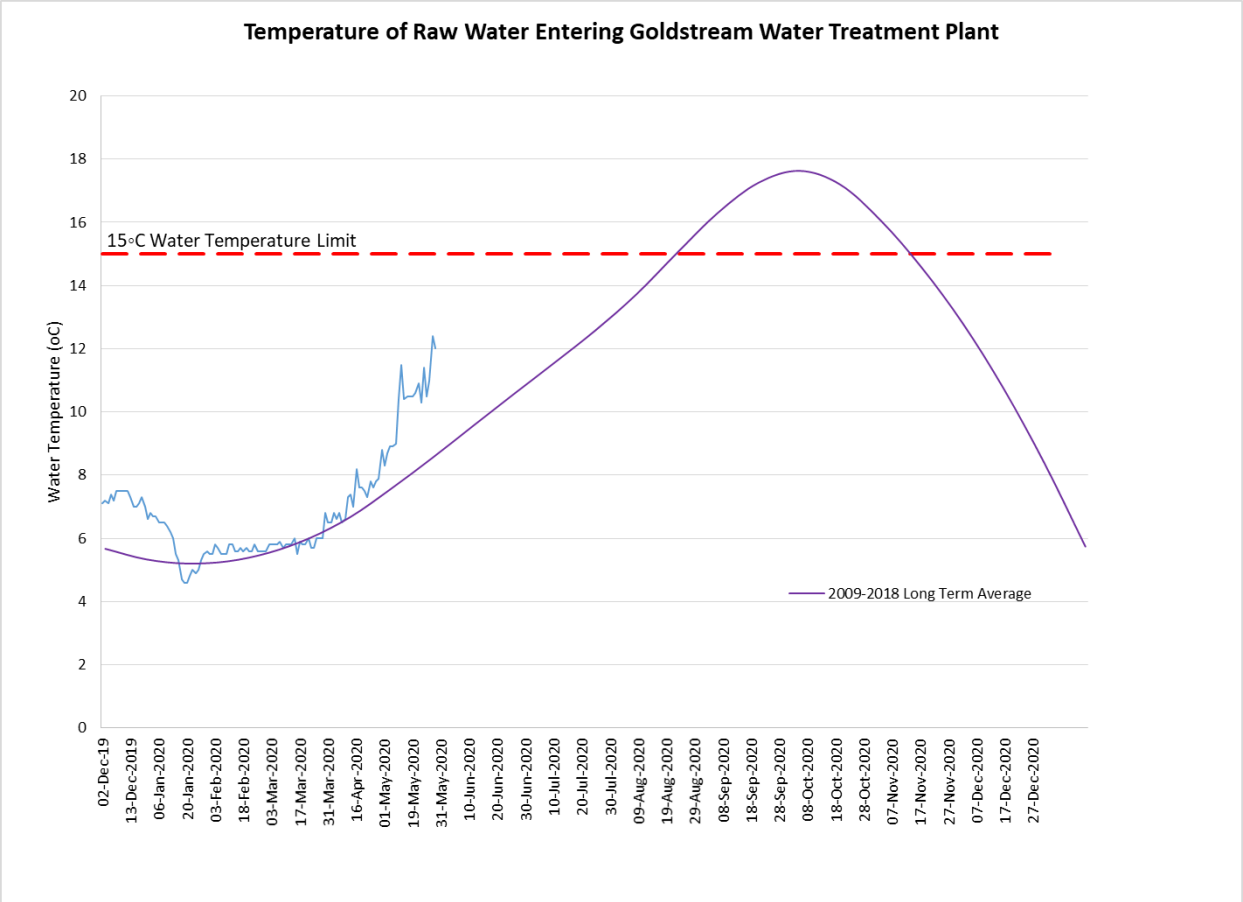
Water Levels. Sooke Lake Reservoir was at 69% of full capacity at the start of this reporting period on December 1, 2019 (Figure 1). November and December 2019 were unusually dry in comparison to previous years when Sooke Lake Reservoir was typically filled by year's end. Reservoir levels began rising quickly on the last day of December and all through January 2020 until it reached the full service level on January 23, 2020. The last year the reservoir filled that late was 2013.

Figure 1



Water Temperature. The raw water temperature measured at the Goldstream Water Treatment Plant remained low until the end of April (Figure 2) and rose quickly to about 12ºC at the end of May with the onset of the seasonal thermal stratification in the Sooke Lake south basin. The accelerated warming of the water during May was more profound than in a typical year but still within what is considered normal.

Figure 2



Turbidity. Turbidity in the lake near the intake tower remained well below the 1.0 Nephelometric Turbidity Unit (NTU) limit for the entire reporting period (Table 1). Heavy rainfall and runoff events in January and February, including a relatively rare extreme rain event on January 31, had no measurable impact on the raw water turbidity. This demonstrates the robustness of the Sooke Lake Reservoir in terms of turbidity impacts. The low turbidity of the raw water allows the UV disinfection stage to remain effective at inactivating bacteria and parasites.

Table 1

Sooke Reservoir, South Basin (1m) - SOL-00-01					
	Samples Collected	Unit of Measure	Minimum	Maximum	Mean
Turbidity	15	NTU	0.25	0.45	0.31

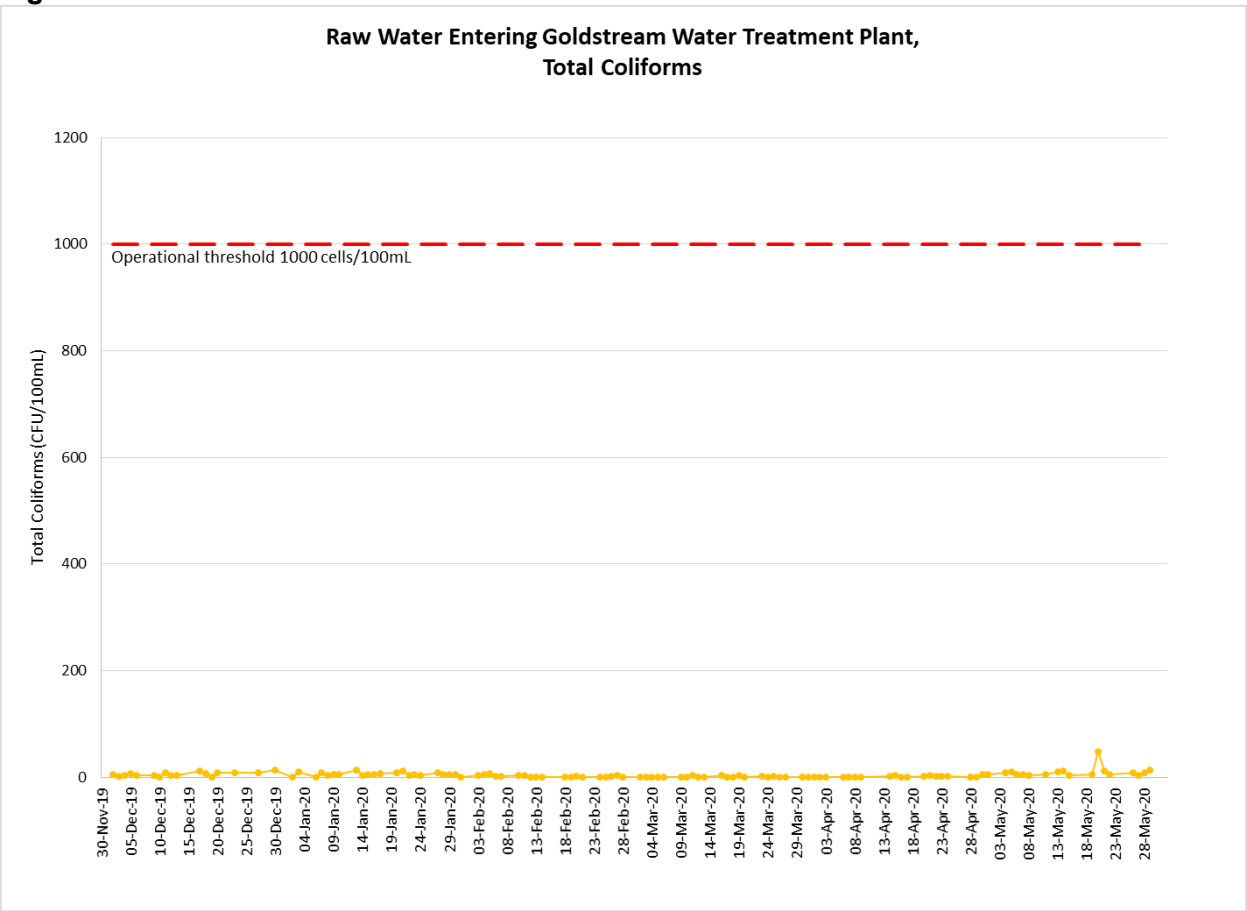
Water Transparency. The transparency of the lake water measured with the Secci Disc in the lake was high (between 7 and 9 m) and consistent with the long-term average.

Dissolved Oxygen. The dissolved oxygen concentrations at three lake sampling stations have been consistently between 9-10 mg/L from surface to bottom. This well-oxygenated state prevents internal nutrient loading or metal releases from lake sediments during summer lake stratification, and is another indicator of the oligotrophic status of Sooke Lake.

Bacteria

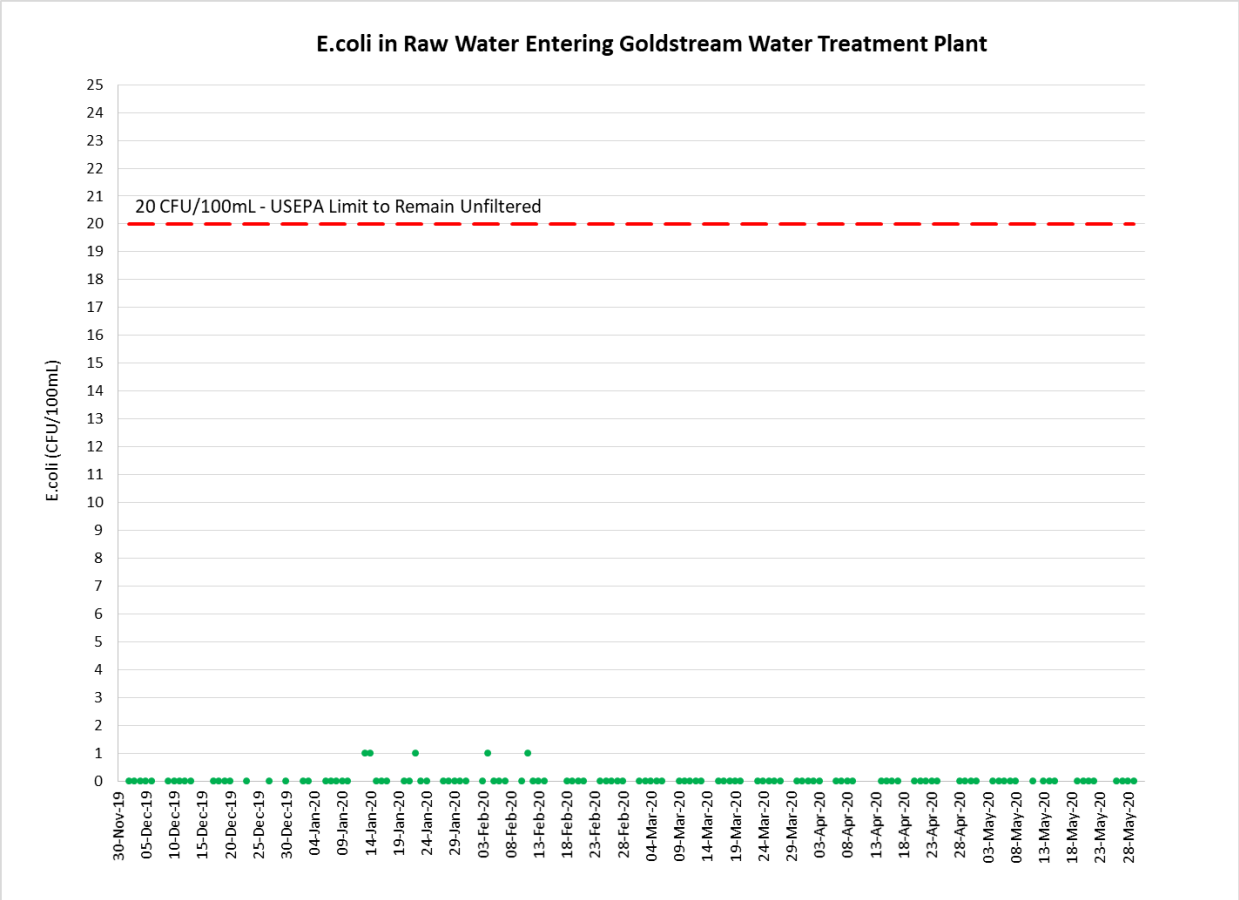
Total Coliform Bacteria and E. Coli The total coliform concentrations in the raw source water entering the Goldstream Water Treatment Plant remained very low throughout the entire reporting period (Figure 3).

Figure 3



E. coli concentrations during the reporting period were mostly non-detected or extremely low and therefore consistently well under the limit for meeting the United States Environmental Protection Agency filtration exemption criteria for surface water used for drinking water supply (Figure 4). These results are very typical for Sooke Lake Reservoir during the winter and spring season.

Figure 4



Nutrients

In general, the nutrient concentrations during the reporting period confirmed the ultra-oligotrophic status of Sooke Lake Reservoir, which is indicative of very low productivity in an upland lake with a virtually undisturbed catchment. This lake status is demonstrated by very low overall nutrient concentrations with a high nitrogen:phosphorus ratio and dissolved organic nitrogen being the dominant constituent of the total nitrogen. These conditions allow only limited biological activity in the lake, thus ensuring a good quality source for unfiltered drinking water. Significant rainfall events during the winter months did result in some measurable nutrient loads entering the lake, especially in the North Basin where the main tributaries discharge into. In particular, phosphorus concentrations exhibited some spikes following rainfall and runoff events. These naturally-added nutrients were then quickly consumed by aquatic organisms, which is an indication of a healthy and functioning food chain in the lakes ecosystem (Table 2 and 3).

Table 2

Sooke Reservoir, South Basin (1m) - SOL-00-01					
	Samples Collected	Unit of Measure	Minimum	Maximum	Mean
Total Nitrogen	7	ug/L	99	137	116
Total Phosphorus	10	ug/L	<1	4.10	2.21

Table 3

Sooke Reservoir, North Basin (1m) - SOL-04-01					
	Samples Collected	Unit of Measure	Minimum	Maximum	Mean
Total Nitrogen	7	ug/L	91	152	114
Total Phosphorus	6	ug/L	<1	2.80	1.65

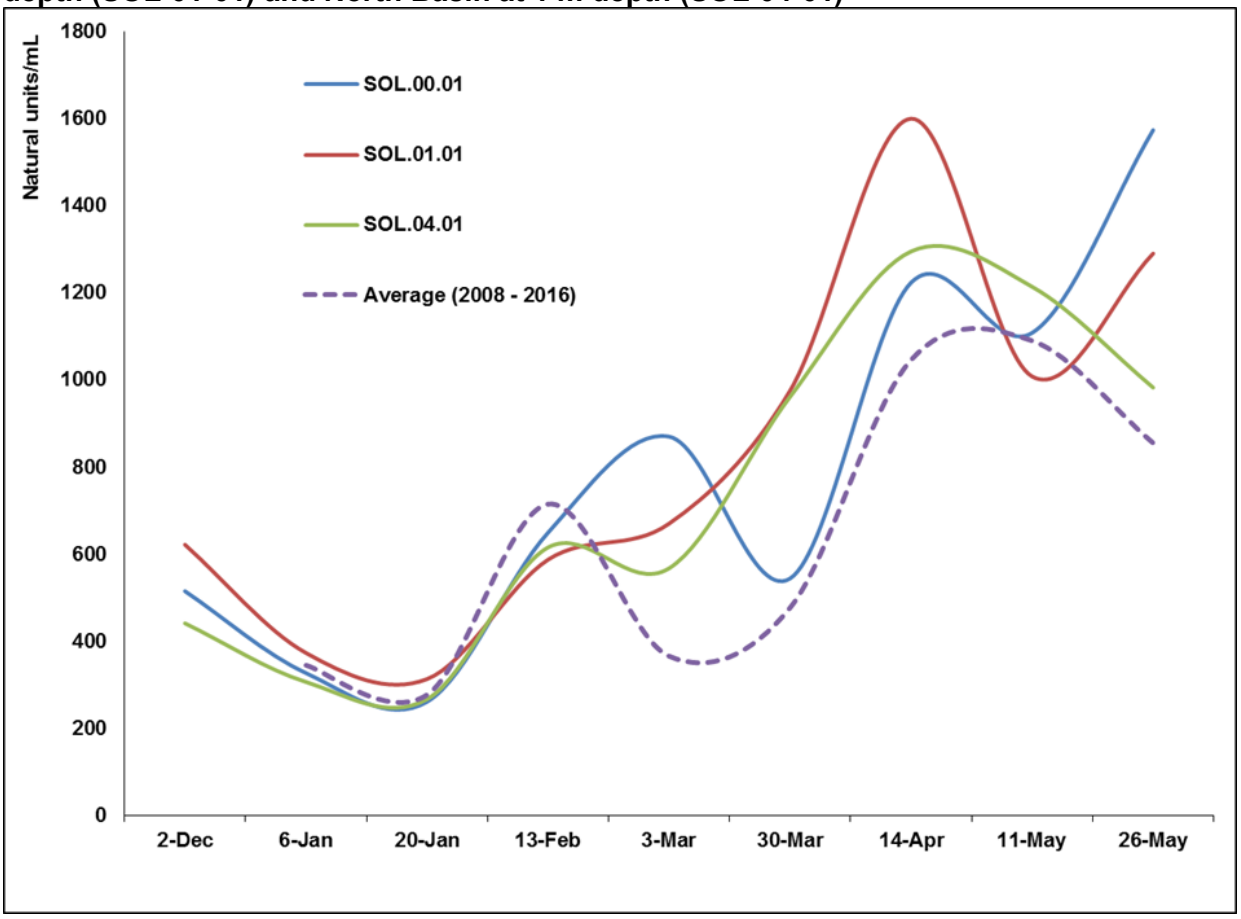
Protozoan Parasites

In five tests during this reporting period in the raw water entering the Goldstream Water Treatment Plant, no *Cryptosporidium* oocysts and no *Giardia* cysts were found.

Algae

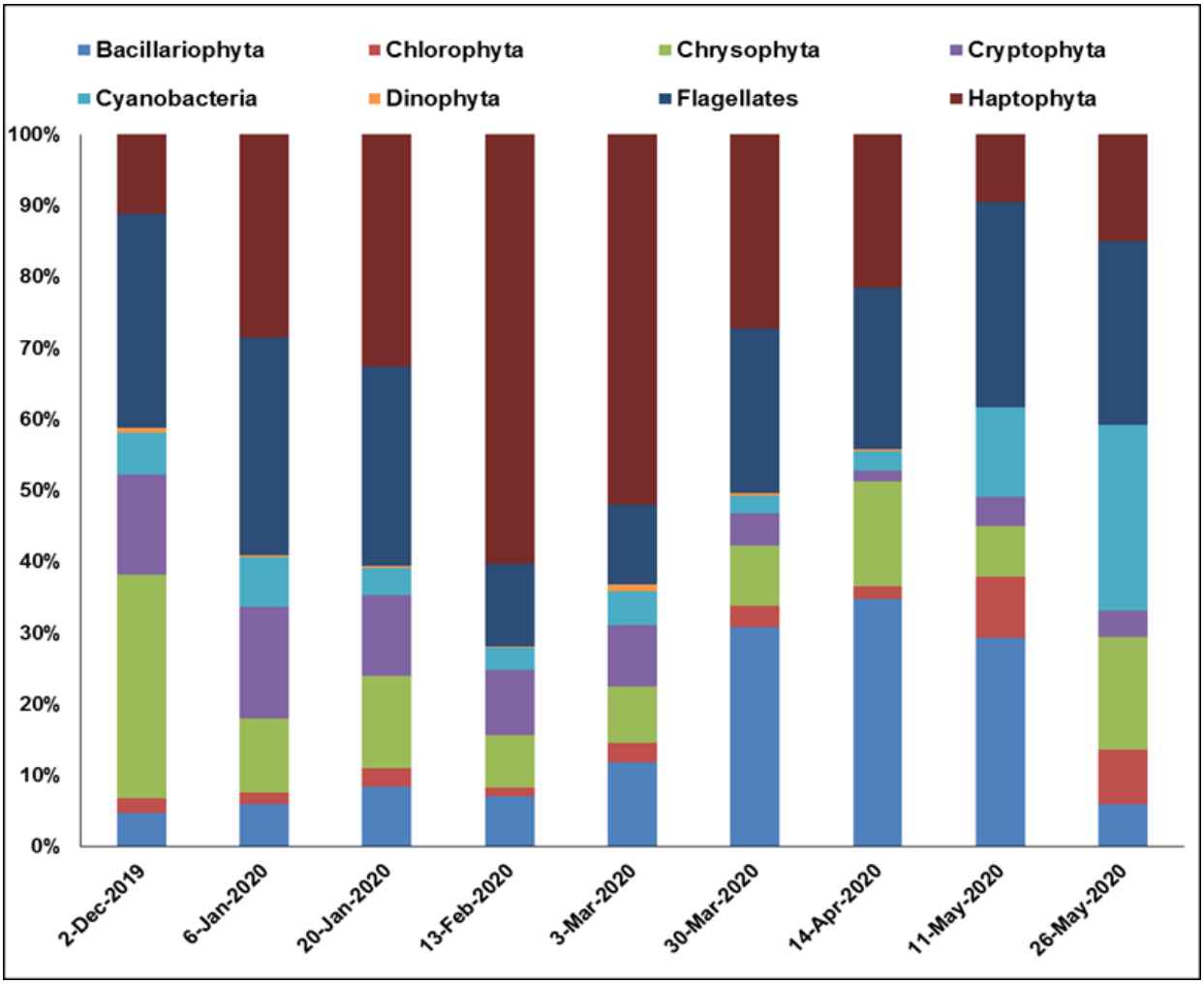
From December 2019 to May 2020, we observed that the algal abundance (natural unit counts) was quite similar to the long-term trend (Figure 5).

Figure 5: Total algal concentration (natural units/mL) from December 2019 to May 2020, Sooke Lake Reservoir, Intake Location at 1 m depth (SOL-00-01), South Basin at 1 m depth (SOL-01-01) and North Basin at 1 m depth (SOL-04-01)



In general, algal abundance started to increase in winter and peaked in the spring. Although algal groups varied in abundance patterns, the abundance of each algal group was quite similar to those observed in previous years (Figure 6). For instance, the diatoms *Asterionella* sp., *Cyclotella* spp., *Urosolenia* sp. increased their numbers in winter and peaked in the middle of spring. The fluctuating abundance of golden algae, e.g., *Dinobryon* spp. showed the same pattern as the diatoms. On the other hand, Picocyanobacteria (cell size around 2 microns), e.g., *Cyanodictyon* spp., *Aphanothece* spp., *Aphanocapsa* spp., increased in spring and would peak in the summer.

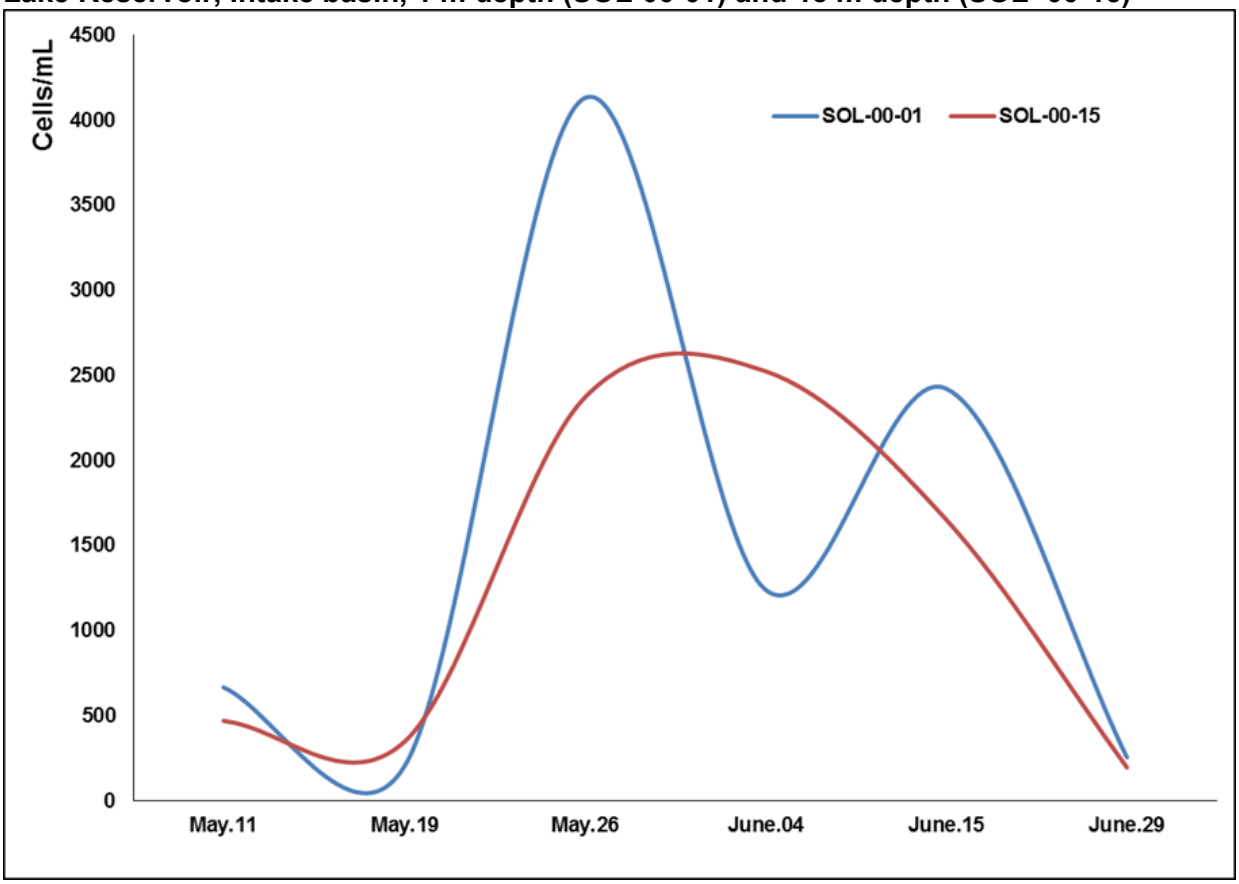
Figure 6: Abundance percent of different algal groups from December 2019 to May 2020, Sooke Lake Reservoir



We recorded a bloom event of a colonial golden alga, *Uroglena* sp., in Sooke Lake Reservoir (SOL) from early of May to late June 2020 (Figure 7). That bloom was responsible for some taste and odour complaints from customers (approximately 20 complaints) during that period and a public advisory was issued between June 2 and 9, 2020. When in a bloom state, *Uroglena* sp. can cause a fishy smell or metallic-fishy taste. Taste and odour, however, are aesthetic issues and cause no health concern. Studies showed that phosphorus is the limiting factor for *Uroglena* sp. growth. However, as it is a mixotrophic alga, i.e., they carry out photosynthesis and/or feed on bacteria and micro-particles, it is able to bloom in water bodies with very low phosphorus concentration, such as Sooke Lake Reservoir. *Uroglena* blooms are not common in Sooke Lake

Reservoir. Interestingly, a number of southern BC surface waters experienced *Uroglena* blooms this summer, which indicates that favourable environmental conditions, such as frequent rainfalls, well into July were likely the cause for these events.

Figure 7: Concentration (cells/mL) of *Uroglena* sp. from May 11 to June 29, 2020, Sooke Lake Reservoir, Intake basin, 1 m depth (SOL-00-01) and 15 m depth (SOL -00-15)



Overall, from December 2019 to May 2020, algal dynamics were in line with well-established long-term trends in Sooke Lake Reservoir. Except for the short-term taste and odour episode from the aforementioned *Uroglena* bloom, there were no water quality concerns from an algal perspective.

WATER TREATMENT PLANTS

Goldstream Water Treatment Plant (formerly called Japan Gulch Disinfection Facility)

Turbidity The raw water entering the Goldstream Disinfection Facility was generally well below 1 NTU during the reporting period (Table 4). On May 5, 2020, the turbidity exceeded 1 NTU slightly for about one hour, likely due to operational activities at the plant.

Table 4

Goldstream Water Treatment Plant Turbidity - Raw Water	
Samples Collected	138
Minimum	0.2 NTU
Maximum	1.3 NTU
Mean	0.3 NTU

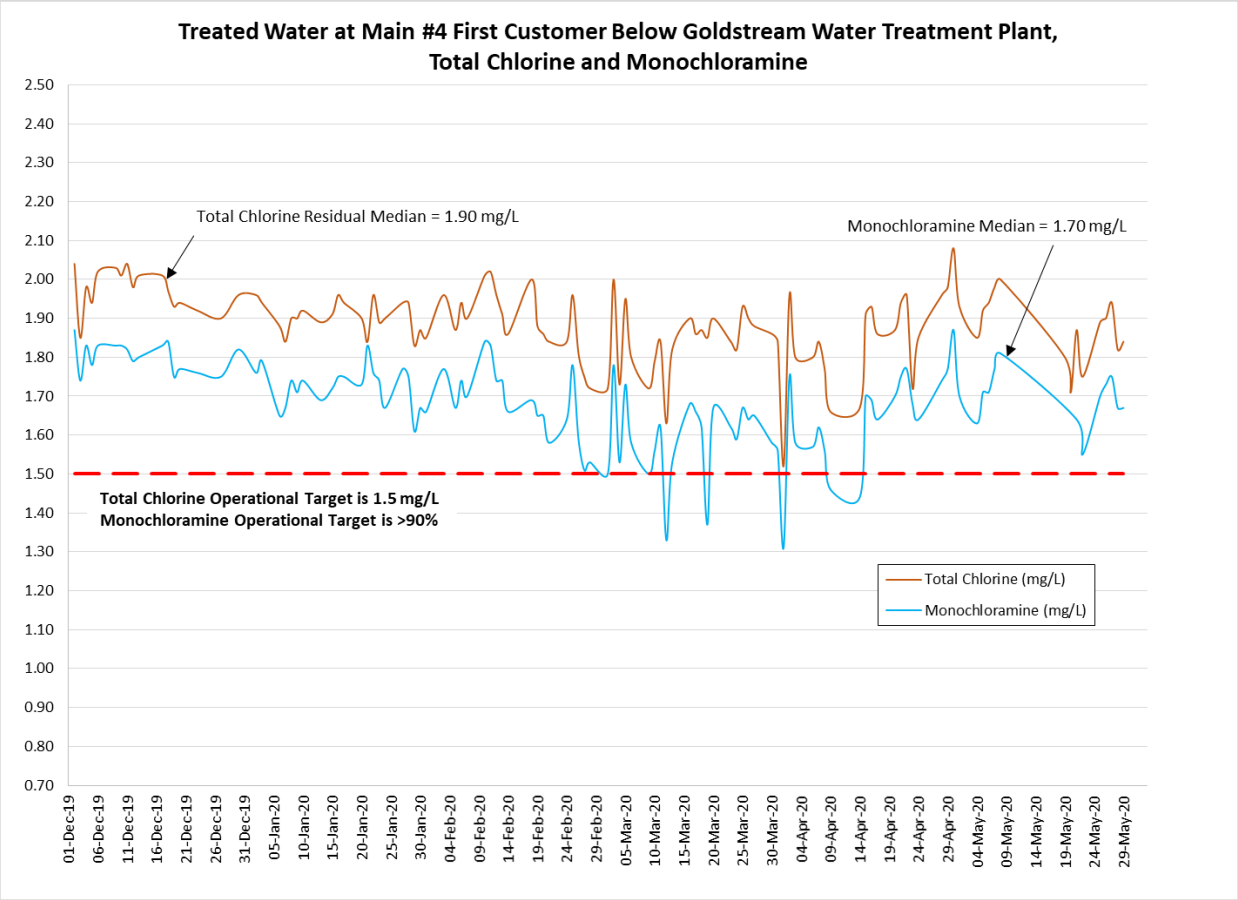
Main #4 First Customer Sampling Station Total Coliform Bacteria and E. Coli
At the Main #4 First Customer Sampling Station immediately downstream of the Goldstream Water Treatment Plant, no samples tested positive for total coliform bacteria during the entire reporting period.

Main #5 First Customer Sampling Station Total Coliform Bacteria and E. Coli
At the Main #5 First Customer Sampling Station immediately downstream of the Goldstream Water Treatment Plant, two samples in May tested positive for total coliform bacteria. Staff suspected that the sampling line and sampling tap were contaminated and after flushing and cleaning the sampling installations, retesting yielded total coliform free results. No *E.coli* bacteria were found in any samples collected from this site.

These results demonstrate the efficacy of the disinfection process at the Goldstream Water Treatment Plant.

Secondary Disinfection Figure 7 shows the total chlorine and monochloramine concentrations at the Main #4 First Customer Sampling Station. The target concentration of 1.5 mg/L for total chlorine was consistently achieved. The target ratio of 90% monochloramine was not consistently achieved due to the operation of the old chlorine-gas facility during this reporting period. However, adequate and effective secondary disinfection across the entire system was provided.

Figure 7



Sooke River Road Water Treatment Plant

Turbidity The raw water entering the Sooke River Road Water Treatment Plant was consistently well under 1 NTU (Table 5).

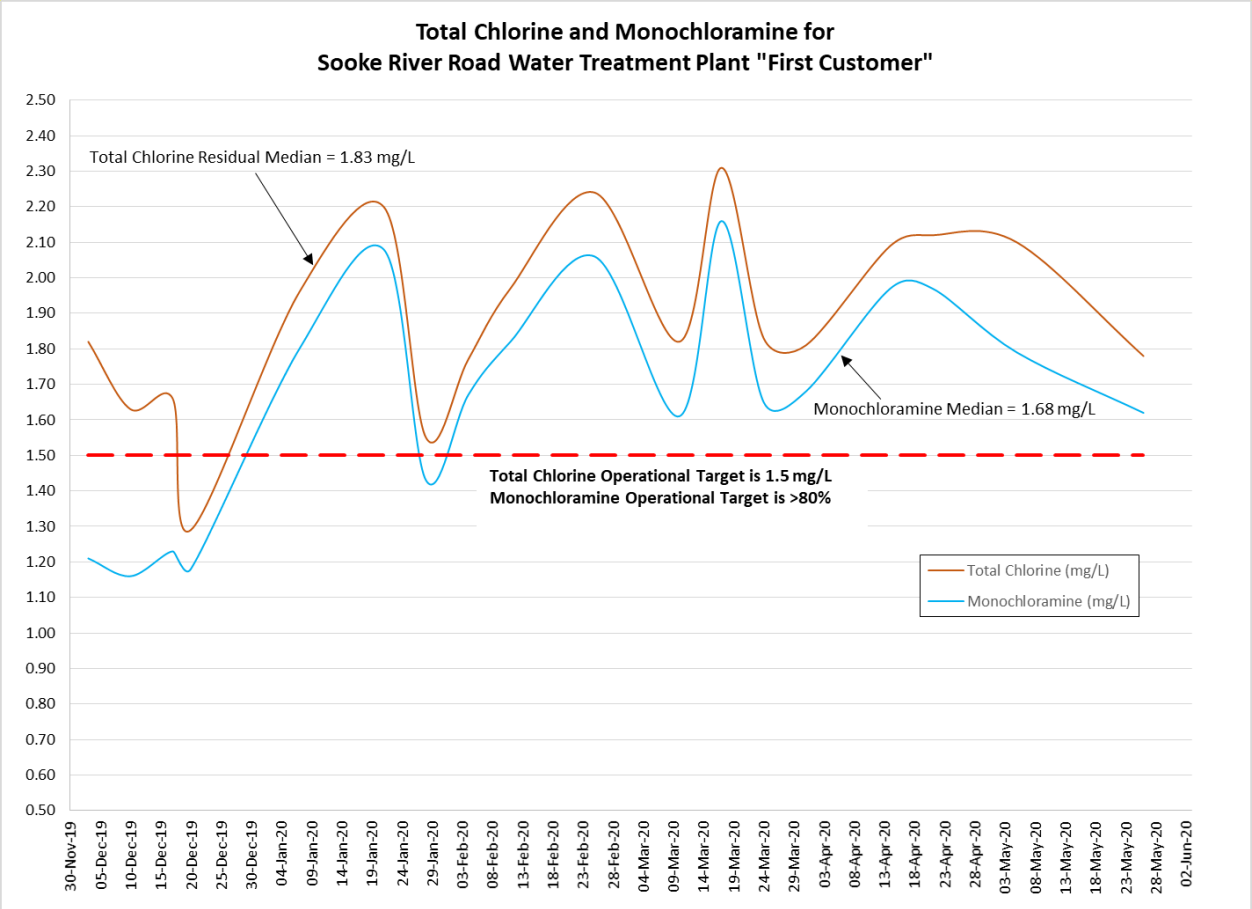
Table 5

Sooke River Road Water Treatment Plant Turbidity - Raw Water	
Samples Collected	19
Minimum	0.20 NTU
Maximum	0.55 NTU
Mean	0.30 NTU

Sooke First Customer Sampling Station Total Coliform Bacteria and E. Coli
At the Sooke First Customer Sampling Station immediately downstream of the Sooke Water Treatment Plant, total coliform or *E.coli* bacteria were not found in any samples collected from this site. These results demonstrate the efficacy of the disinfection process at the Sooke Water Treatment Plant.

Secondary Disinfection Figure 8 shows the total chlorine and monochloramine concentrations at the Sooke First Customer Sampling Station. The target concentration of 1.5 mg/L for total chlorine was consistently achieved during the reporting period except for a short period in December 2019. The slightly lower target ratio of 80% monochloramine for this facility was consistently achieved after mid December 2019. The residual concentrations were adequate to provide effective secondary disinfection across this much smaller distribution system.

Figure 8



DISTRIBUTION SYSTEMS
Goldstream (Japan Gulch) Service Area

Table 6

Month/Year	Samples Collected	Total Coliforms (CFU/mL)				E.coli (CFU/100mL)	Turbidity		Chlorine Residual	Water Temp.
		Samples TC > 0	Percent TC > 0	Resamples TC > 0	Samples TC > 10	Samples > 0	Samples Collected	Adverse > 1 NTU	Median mg/L as CL2	Median °C
Dec-19	326	1	0.3	0	5	0	51	0	1.44	8.0
Jan-20	369	0	0.0	0	0	0	57	0	1.47	7.6
Feb-20	318	1	0.3	0	1	0	52	0	1.54	7.5
Mar-20	350	0	0.0	0	0	0	59	0	1.48	7.9
Apr-20	350	3	0.9	0	0	0	51	0	1.47	9.9
May-20	339	9	2.7	0	1	0	57	0	1.49	12.8
Total:	2052	14	0.7	0	7	0	327	0	1.48	8.0

Total Coliform Bacteria and E. Coli
Only 14 out of 2,052 distribution system samples, or 0.7% of all bacteriological samples during the reporting period, tested positive for total coliform bacteria. In all of these cases, the resample was free of total coliform bacteria, indicating that no actual water contamination was the cause of these coliform hits. No *E.coli* bacteria were found (Table 6).

Turbidity
None of the 327 turbidity samples registered higher than 1 NTU (Table 6). This is an indication of good drinking water quality.

Total Chlorine Residual
A median total chlorine residual concentration of 1.48 mg/L across the system indicates an effective secondary disinfection protecting the potability of the treated drinking water as it flows throughout the system (Table 6).

Water Temperature
The temperature of the drinking water in the system during this reporting period was well within the aesthetic objective in the Canadian Drinking Water Quality Guidelines, which contributed to the excellent quality of the drinking water supplied to customers.

Water Chemistry
The average pH of the drinking water in the Goldstream Service Area was 7.11 during the reporting period. The pH ranged from 6.7 to 7.7, which is typically when operating the chlorine-gas disinfection facility. The average alkalinity was 13.3 mg/L. During the previous reporting period, the new hypochlorite plant was in operation which resulted in a generally higher pH and higher alkalinity throughout the system.

Disinfection Byproducts
The three typically monitored disinfection byproducts in a drinking water system have all been well below the Health Canada established health limits in the Goldstream Service Area (Table 7).

Table 7

Disinfection Byproducts - Greater Victoria Distribution System						
Parameter	**Samples Collected**	**Unit of Measure**	**Minimum**	**Maximum**	**Mean**	**MAC (Maximum Acceptable Concentration)**
Haloacetic Acids (HAAs)	12	ug/L	18.5	22.0	16.1	80
Trihalomethanes (THMs)	12	ug/L	17.0	21.0	16.8	100
NDMA	12	ng/L	<1.9	<1.9	<1.9	40

Metals
A comprehensive metals analysis was conducted every second month at four different locations in the Goldstream Service Area: (1) where treated water enters the Victoria/Esquimalt System, (2) the Oak Bay System, (3) one in Langford and (4) one in North Saanich. Out of the 32 tested metals, four are monitored particularly closely: iron, manganese, lead and copper. All metal concentrations were below the respective Health Canada maximum acceptable concentration or the aesthetic objective. The sampling station where the Oak Bay System is supplied continued to produce elevated lead and copper concentrations, as compared to everywhere else in the system. Extra investigations have concluded that this is a localized issue likely related to the plumbing material used for this particular sampling station, which does not cause any health concerns for downstream customers in Oak Bay. Changes to this installation are planned.

Sooke Service Area

Table 8

Month/Year	Samples Collected	Total Coliforms (CFU/mL)				E.coli (CFU/100mL)	Turbidity		Chlorine Residual	Water Temp.
		Samples TC > 0	Percent TC > 0	Resamples TC > 0	Samples TC > 10	Samples > 0	Samples Collected	Adverse > 1 NTU	Median mg/L as CL2	Median °C
Dec-19	40	0	0.0	0	0	0	7	0	1.13	7.6
Jan-20	39	0	0.0	0	0	0	5	0	1.08	7.5
Feb-20	30	0	0.0	0	0	0	4	0	1.18	7.0
Mar-20	40	0	0.0	0	0	0	4	0	1.12	7.6
Apr-20	24	0	0.0	0	0	0	4	0	1.36	10.3
May-20	29	1	3.4	0	0	0	4	0	1.38	13.5
Total:	202	2	0.6	0	0	0	28	0	1.16	7.6

Total Coliform Bacteria and E. Coli
In all 202 bacteriological samples during the reporting period, only one sample tested positive for total coliform bacteria and a prompt resample did not confirm any actual water contamination. No sample contained *E.coli* bacteria (Table 8).

Turbidity
All 28 turbidity samples registered below 1 NTU (Table 8). This is an indication of good drinking water quality.

Total Chlorine Residual
A median total chlorine residual concentration of 1.16 mg/L across the system indicates an effective secondary disinfection protecting the potability of the treated drinking water as it flows throughout the system (Table 8).

Water Temperature
The temperature of the drinking water in the system during this reporting period was well within the aesthetic objective in the Canadian Drinking Water Quality Guidelines contributed to the excellent quality of the drinking water supplied to customers.

Water Chemistry
The average pH of the drinking water in the Sooke Service Area was 7.48 during the reporting period. The pH ranged from 7.0 to 8.1 and is typically very stable and consistent across this system. The average alkalinity was 16.13 mg/L.

Disinfection Byproducts
The three typically monitored disinfection byproducts in a drinking water system have all been well below the Health Canada established health limits in the Sooke Service Area (Table 9).

Table 9

Disinfection Byproducts - Sooke Distribution System						
Parameter	**Samples Collected**	**Unit of Measure**	**Minimum**	**Maximum**	**Mean**	**MAC (Maximum Acceptable Concentration)**
Haloacetic Acids (HAAs)	2	ug/L	26.0	29.0	27.5	80
Trihalomethanes (THMs)	2	ug/L	36.0	43.0	39.5	100
NDMA	2	ng/L	<1.9	<1.9	<1.9	40

Metals
A comprehensive metals analysis was conducted every second month in one location in the Sooke Service Area: at the end of the distribution system near Whiffen Spit. Out of the 32 tested metals, four are monitored particularly closely: iron, manganese, lead and copper. All metal concentrations were well below the respective Health Canada maximum acceptable concentration or the aesthetic objective.

CONCLUSION

During this winter/spring reporting period (December 2019-May 2020), all parameters from source water to treated water indicate stable conditions and good water quality. All trends are in line with historic data and confirm the adequacy of existing water treatment and performance of all major infrastructure components. The multi-barrier approach applied to the Greater Victoria Drinking Water System ensures the excellent drinking water quality achieved during the reporting period.