

WATER QUALITY SUMMARY REPORT FOR THE GREATER VICTORIA DRINKING WATER SYSTEM June to November 2019

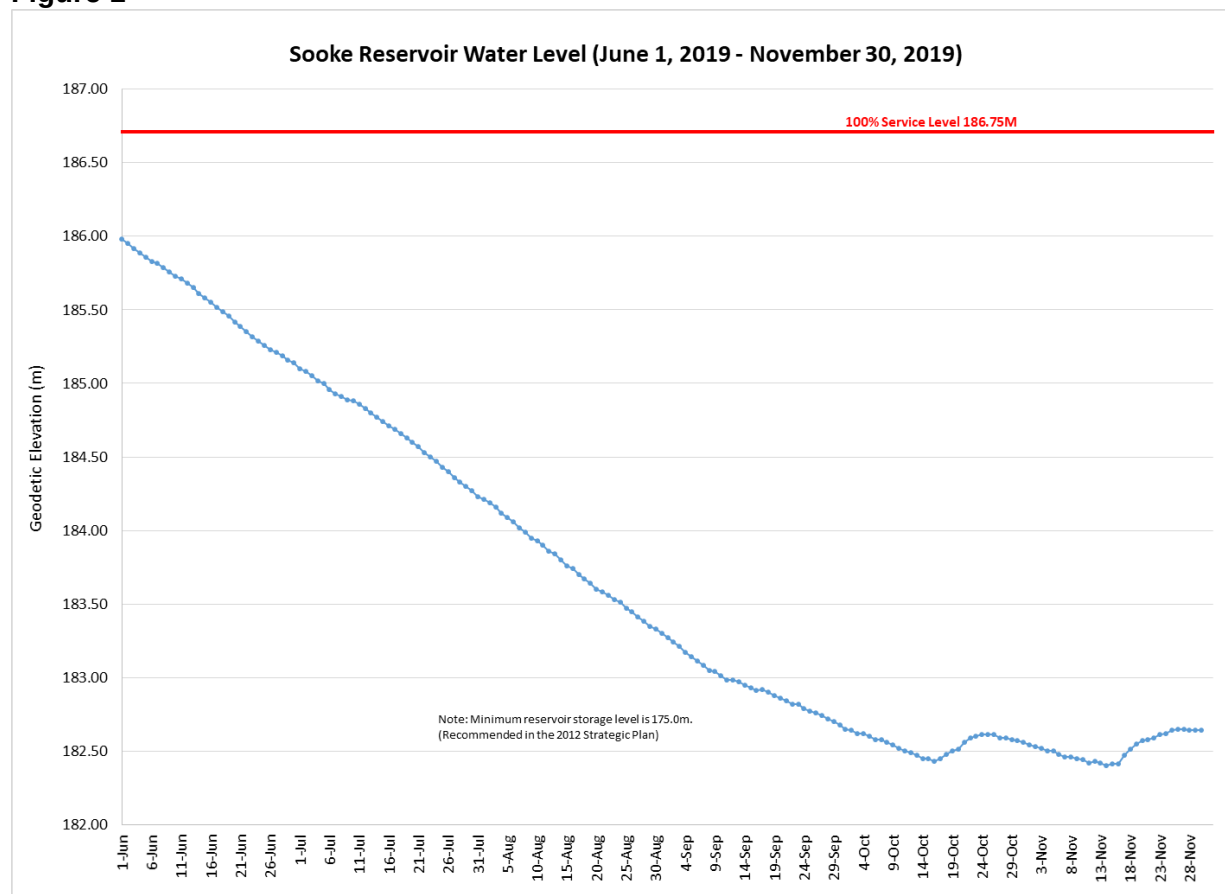
January 2020

SOURCE WATER – SOOKE LAKE RESERVOIR

Physical Parameters

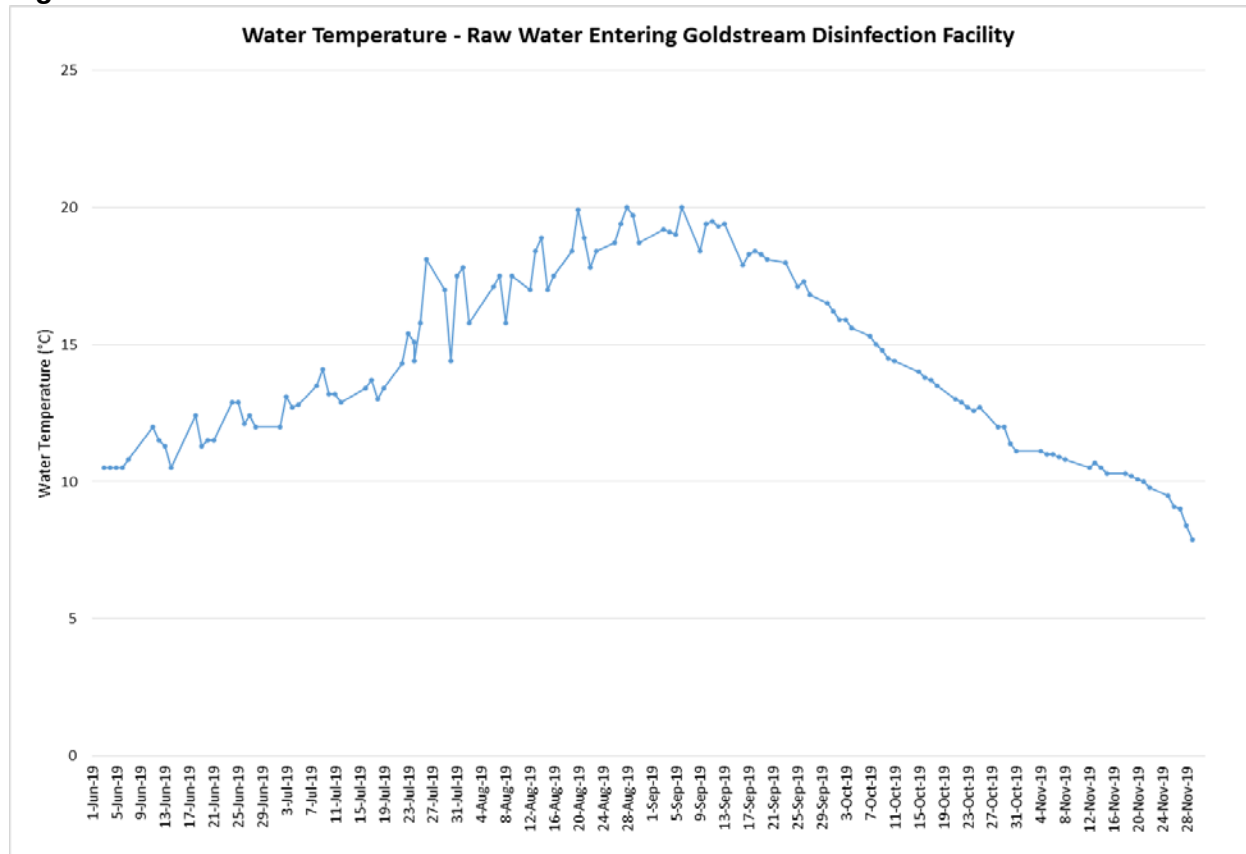
Water Levels. Sooke Lake Reservoir was at 94% of full capacity at the start of this reporting period on June 1, 2019 (Figure 1). While there were rainfall events during each month this summer, these rainfall events did not generate any measurable reservoir recharge. Reservoir levels continuously decreased at approximately the same rate as in recent years during the high summer water demands. The reservoir reached its lowest level on October 16, with 67.6% of capacity. With an unusually dry fall, the reservoir level has only increased by 1.5% by November 30. Since the last raising of Sooke Lake Dam in 2004, there have been only a few years with similar or even lower reservoir levels by November 30.

Figure 1



Water Temperature. The raw water temperature measured at the Goldstream Disinfection Facility reached the aesthetic limit of 15°C by the end of July (Figure 2) and remained above 15°C until early October. During August and September the raw water temperature reached 20°C on several days. Water temperatures in excess of 15°C can lead to higher chlorine consumption due to faster chemical reaction rates and increased bacterial growth in water infrastructure components.

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). Sporadic heavy rainfall and runoff events in September through November 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	12	NTU	0.25	0.35	0.29

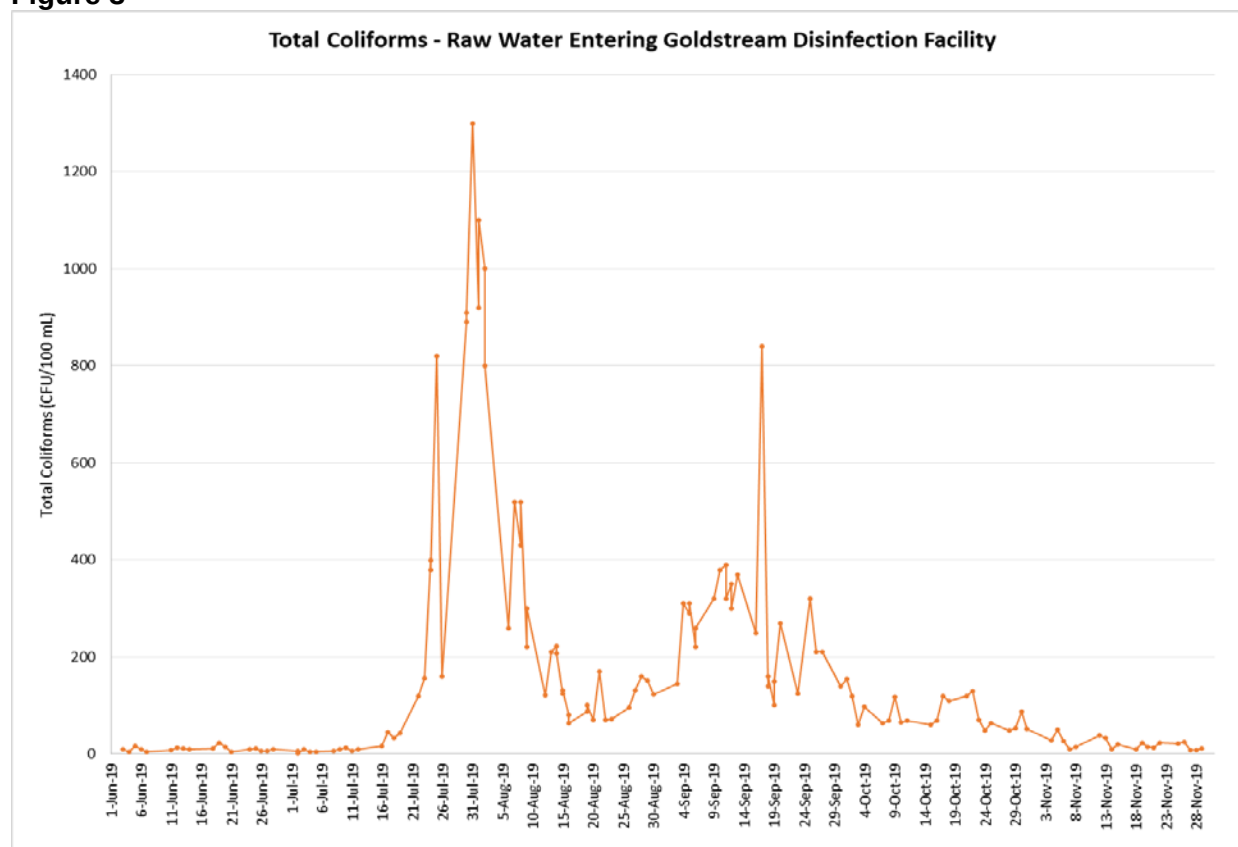
Water Transparency. The transparency of the lake water measured with the Secchi Disc in the lake was high and consistent with the long-term average.

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 metals 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 Disinfection Facility increased between May and August and then again for a period of time during September (Figure 3). This summer pattern is typical for Sooke Lake Reservoir and no exception compared to historical data. Individual short-term higher total coliform concentration spikes during the summer and fall season could be an indication of internal seiches, a natural physical phenomenon that has been recognized to occur in Sooke Lake.

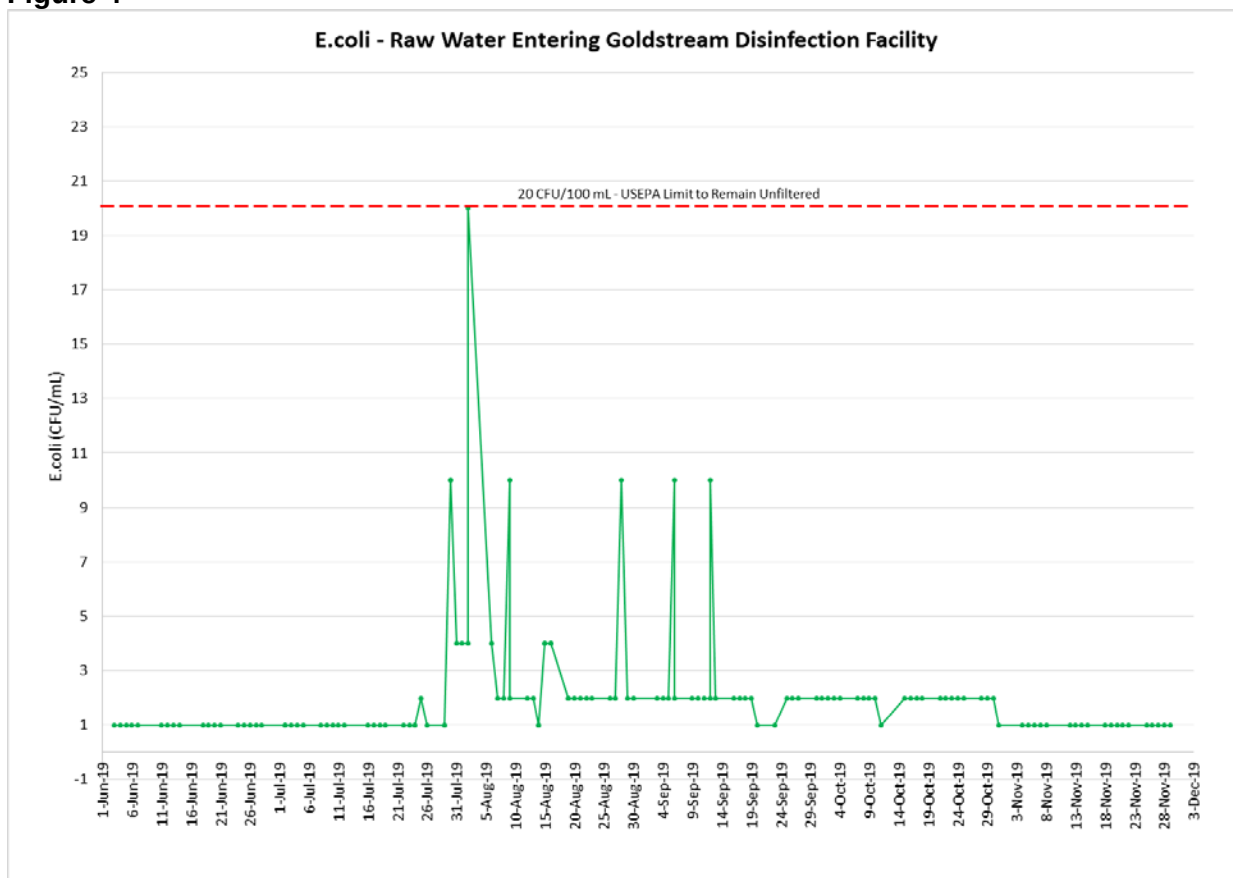
Figure 3



E. coli concentrations during the reporting period were consistent with previous years with the exception of a few more days with elevated *E.coli* concentrations (Figure 4). On August 2, 20 CFU/100mL *E.coli* bacteria were detected. This is the limit for meeting the United States Environmental Protection Agency filtration exemption criteria for surface water used for drinking water supply. This is a fairly unusual occurrence in Sooke Lake and further monitoring will determine whether this event was a statistical outlier or the beginning of a trend. Some of the

E.coli concentration spikes, including the August 2 event, correlate with significant summer rainfall events. In particular, summer runoff events can transport accumulated animal feces to the Sooke Lake tributaries and eventually into the lake resulting in short-term spikes of *E.coli* concentrations.

Figure 4



Nutrients

In general, the nutrient concentrations during the reporting period confirmed an 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 summer 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	6	ug/L	102	138	116.8
Total Phosphorus	7	ug/L	non-detect	10	10

Table 3

Sooke Reservoir, Lake North Basin (1m) - SOL-04-01					
	Samples Collected	Unit of Measure	Minimum	Maximum	Mean
Total Nitrogen	7	ug/L	82	138	111.1
Total Phosphorus	6	ug/L	non-detect	37	15

Protozoan Parasites

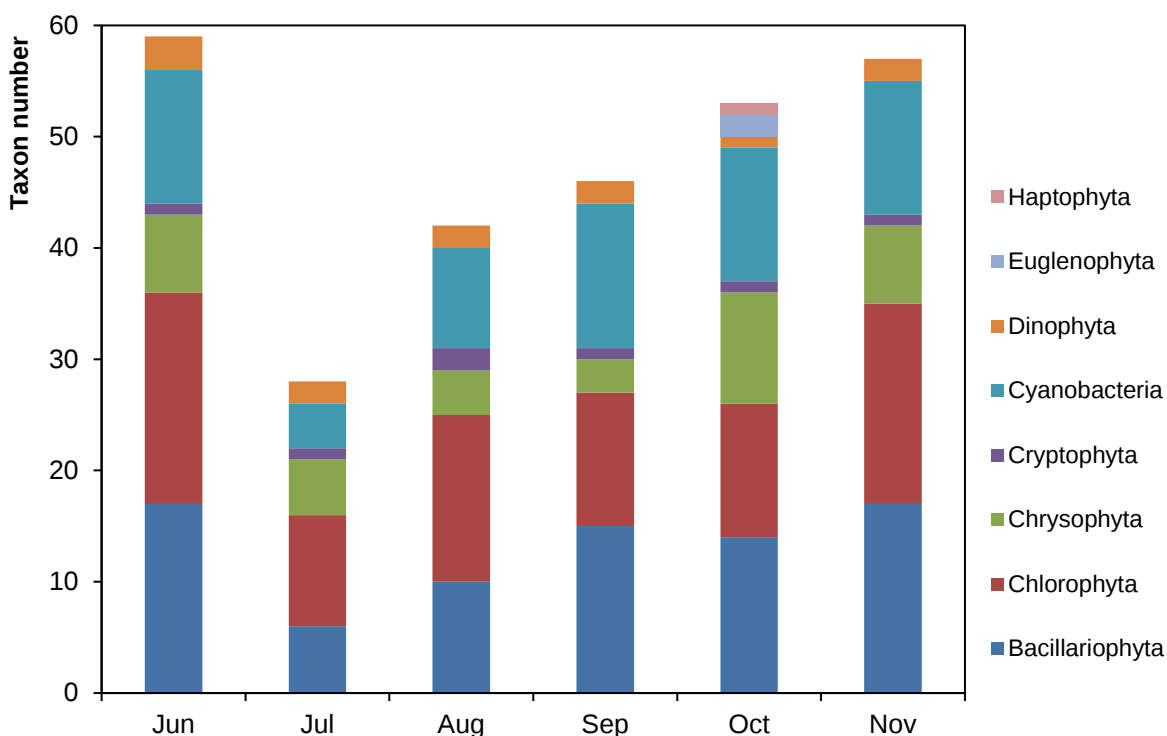
In three tests during this reporting period in the raw water entering the Goldstream Disinfection Facility, no *Cryptosporidium* oocysts and no *Giardia* cysts were found.

Algae

Staff recorded a total number of 126 algal taxa, including 43 Chlorophyta, 31 Bacillariophyta, 28 Cyanobacteria, 16 Chrysophyta, 3 Dinophyta, 2 Cryptophyta, 2 Euglenophyta and 1 Haptophyta in Sooke Lake Reservoir from June to November 2019. Three groups of Chlorophyta, Bacillariophyta and Cyanobacteria contributed up to 81% of the total taxa. The two most frequent dominant species during this period were *Dinobryon* spp. in summer and *Asterionella formosa* in autumn. A similar pattern has been observed in previous years. Both of these taxa can cause taste and odour issues when in bloom conditions. Staff observed considerably high abundances of some picocyanobacteria taxa (with cells < 2 microns), e.g., *Aphanothece*, *Cyanodictyon*, and *Aphanocapsa*, in August. The dominance of cyanobacteria in August was also recorded in previous years, 2014 and 2018. Some of these species are considered potential cyanotoxin producers under bloom conditions. However, low nutrient conditions in Sooke Lake have so far prevented any cyanobacteria blooms.

Samples analyzed from the South Basin near the intake tower consisted primarily of three main algal groups, e.g., Bacillariophyta, Chlorophyta and Cyanobacteria (Figure 5). The number of algal species overall decreased in July. Diatoms noticeably declined possibly due to the depletion of the silica source following a strong presence of diatoms in previous months and due to the effects of stratification. High grazing pressure by zooplankton in the summer may have also contributed to the decline of diatoms and other edible algae.

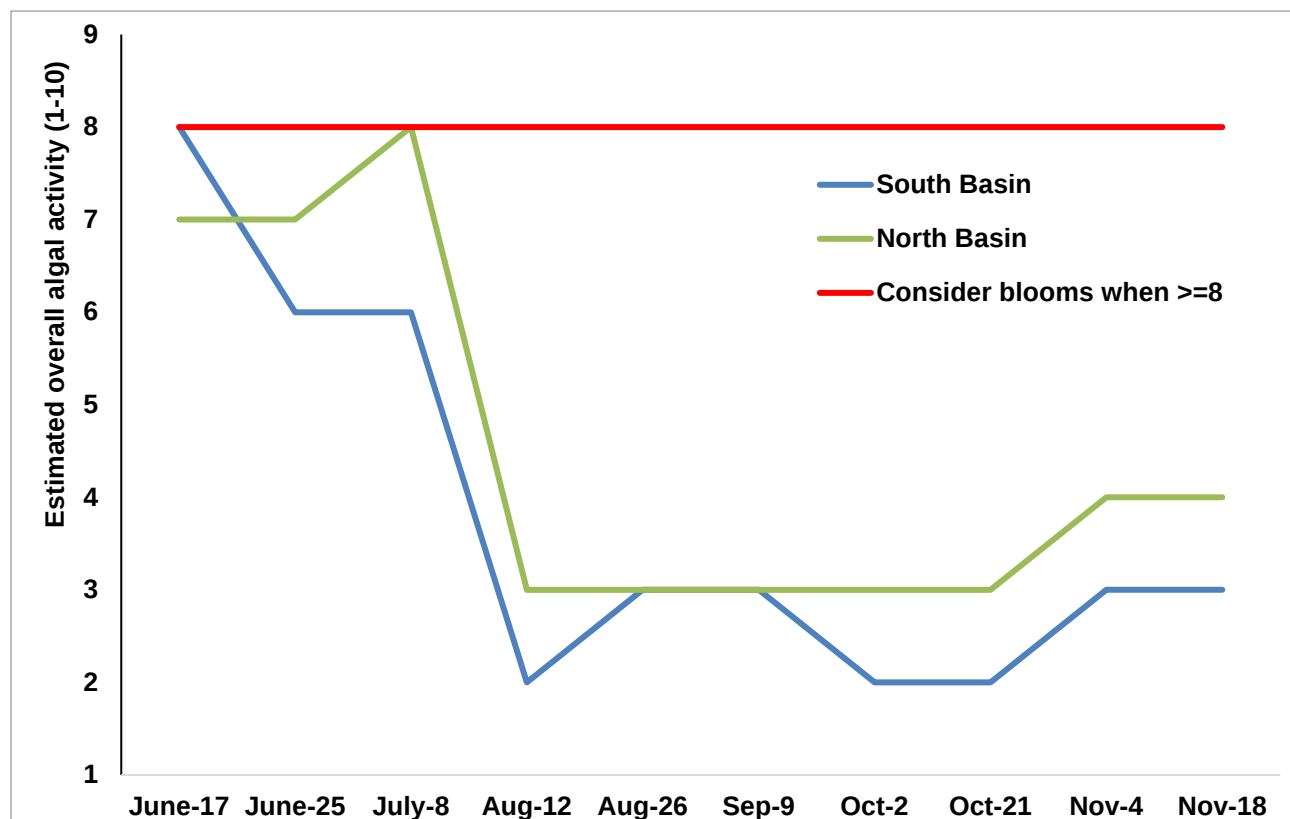
Figure 5: Taxon composition of algae in the South Basin recorded from June to November, 2019



The overall algal activity ranged from 1 (lowest density) to 10 (highest density), for the samples collected near the intake tower, and is shown in Figure 6. Samples from the South Basin were slightly lower in algal activity compared to the North Basin where there is a larger open water area and a longer occurrence of summer lake stratification. The strong growth of the golden algae, *Dinobryon* spp. (continuing from the previous period), was likely the main cause for the algal activity score to reach 8/10 in June, which constitutes a low level algae bloom. However, there were no taste and odour complaints or other potentially associated water quality issues related to this algal event. Springtime or early summer algal blooms are not uncommon in Sooke Lake Reservoir and usually do not have noticeable adverse drinking water quality impacts. The algal activity scores declined in the following months but increased in autumn due to the nutrient influx from more regular rainfall and runoff. This latest increase in algal activity was characterized by a dominance of the diatom *Asterionella formosa*. Based on typical Sooke Lake patterns, we expect this species to thrive for several weeks over the winter before it may be replaced by other Haptophyte species in February.

The large open water area coupled with the summer stratification in Sooke Lake Reservoir provides a suitable range of habitat for a diverse taxa of algae. The seasonal change of the algal taxon composition observed was similar to the historical patterns and did not cause any water quality concerns during this reporting period.

Figure 6: Overall algal activity in the South and North Basins from June to November, 2019



DISINFECTION FACILITIES

Goldstream Disinfection Facility (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). During a few peak demand times on high volume watering days (typically Wednesday) in June the turbidity exceeded 1 NTU slightly for a few hours. This was a result of pipe sediments being mobilized upstream of the Goldstream Disinfection Facility by the high flow rates during watering times. CRD flushes these pipe sections each year to minimize this effect.

Table 4

Turbidity Goldstream DF – Raw	
Minimum	0.2
Maximum	2.7
Mean	0.41

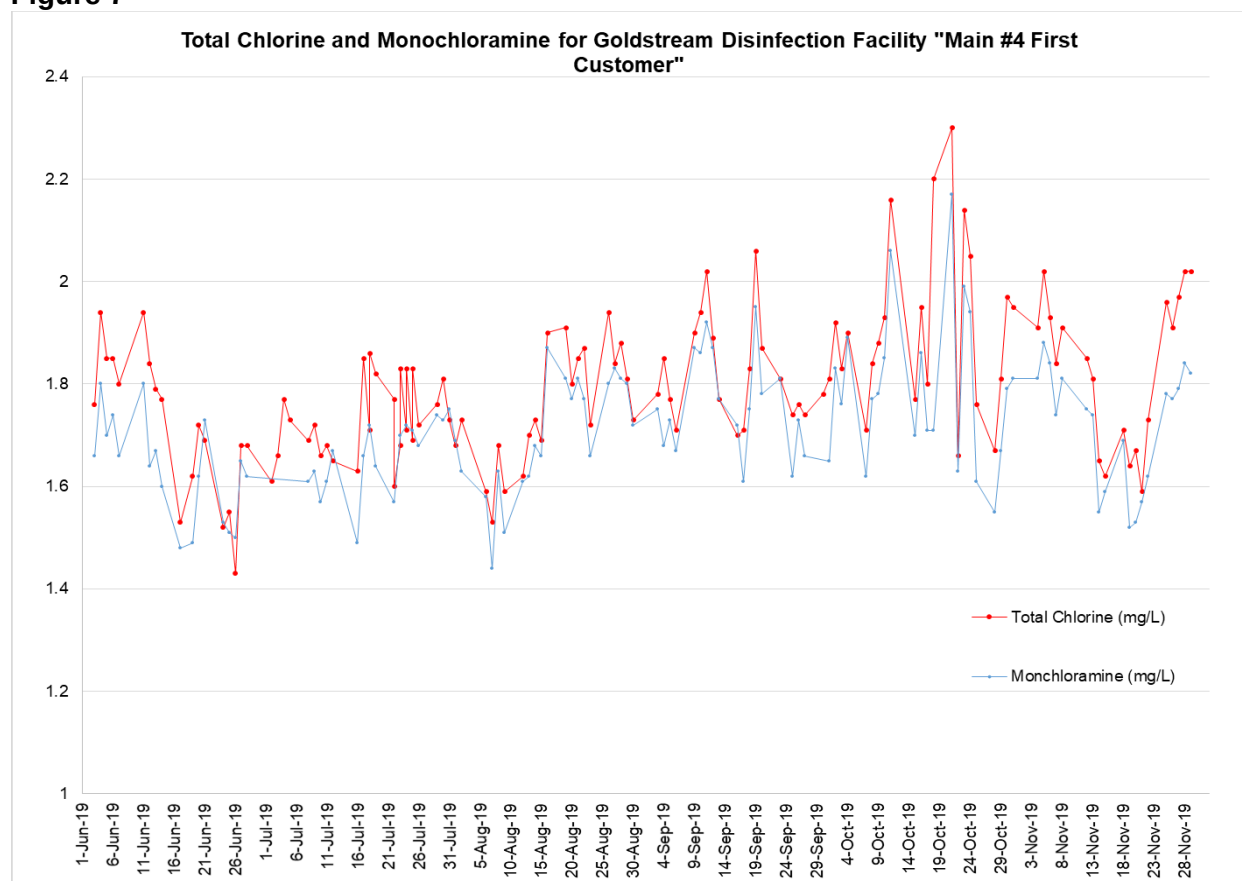
Main #4 First Customer Sampling Station Total Coliform Bacteria and E. Coli.

At the Main #4 First Customer Sampling Station immediately downstream of the Goldstream Disinfection Facility only one sample during the entire reporting period tested positive for total

coliform bacteria. Resampling and retesting could not confirm a true water contamination. No *E.coli* bacteria were found in any sample collected from this site. These results demonstrate the efficacy of the disinfection process.

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 except for a very short time period on June 26. The target ratio of 90% monochloramine was also consistently achieved and therefore provided a long-lasting and effective disinfectant across the entire system.

Figure 7



Sooke River Road Disinfection Facility

Turbidity The raw water entering the Sooke River Road Disinfection Facility (SRRDF) was consistently well under 1 NTU and did not experience the same elevated turbidity events on high demand water days (Table 5).

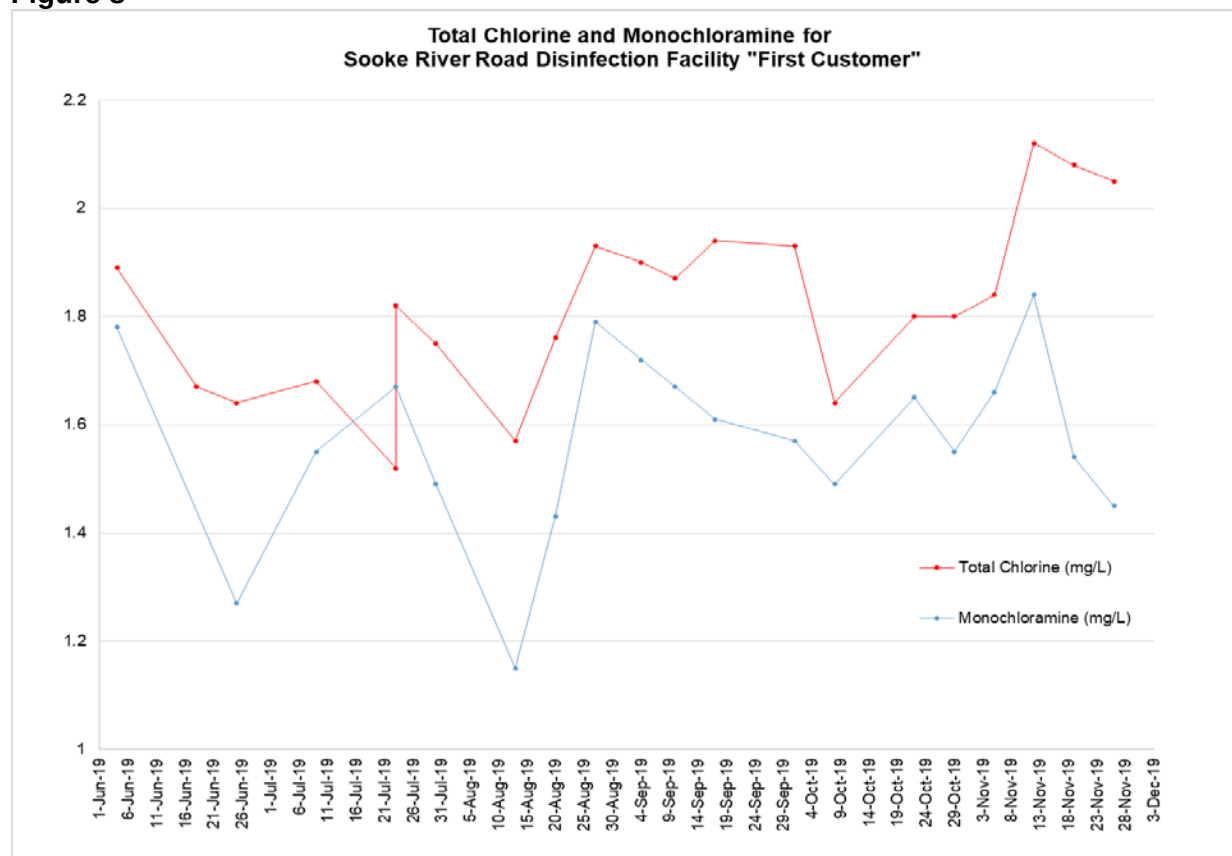
Table 5

Raw Water Turbidity SRRDF	
Minimum	0.2
Maximum	0.4
Mean	0.29

Sooke First Customer Sampling Station Total Coliform Bacteria and E. Coli At the Sooke First Customer Sampling Station immediately downstream of the SRRDF 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.

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. The slightly lower target ratio of 80% monochloramine for this facility was not consistently achieved. However, 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	Samples Collected	Total Coliforms (CFU/100mL)				<i>E.coli</i> (CFU/100mL)	Turbidity		Chlorine Residual	Water Temp.
		Samples TC > 0	Percent TC>0	Resamples TC > 0	Samples TC > 10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L as CL2	Median ° C
JUN	340	10	2.9	0	1	0	57	1	1.39	14.8
JUL	352	7	2.0	0	3	0	49	1	1.38	17.0
AUG	334	6	1.8	0	1	0	52	2	1.42	19.4
SEP	341	1	0.3	0	0	0	57	0	1.39	18.7
OCT	362	4	1.1	0	0	0	57	0	1.40	14.5
NOV	326	1	0.3	0	0	0	48	0	1.42	11.6
Total:	2055	29	1.4	0	5	0	320	4	1.40	16.0

Total Coliform Bacteria and E. Coli.

Only 29 out of 2,055 distribution system samples, or 1.4% 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 hits. No *E.coli* bacteria were found (Table 6).

Turbidity

Only 4 out of 320 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 1.4 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 peaked in late August and reached almost 20°C (Table 6). This is an exceedance of the aesthetic objective in the Canadian Drinking Water Quality Guidelines and is not only an unpleasant experience for the customers but also an issue for water system operations. It is an inevitable result of the current configuration of the water supply infrastructure at Sooke Lake Reservoir.

Water Chemistry

The average pH of the drinking water in the Goldstream Service Area was 8.1 during the reporting period. The pH ranged from 6.8 to 8.9 and is typically stable and consistent across this system. The average alkalinity was 16.6 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 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)	8	ug/L	< 5	18	9	80
Trihalomethanes (TTHMs)	8	ug/L	15	23	16.3	100
NDMA	8	ng/L	< 1.9	2.6	2.1	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 32 tested metals, four are monitored particularly close: 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 existing metering infrastructure which does not cause any health concerns for downstream customers in Oak Bay. Investigations regarding this issue are ongoing.

Sooke Service Area

Table 8

Month	Samples Collected	Total Coliforms (CFU/100mL)				<i>E.coli</i> (CFU/100mL)	Turbidity		Chlorine Residual	Water Temp.
		Samples TC > 0	Percent TC > 0	Resamples TC > 0	Samples TC > 10		Samples Collected	Samples > 1 NTU	Median mg/L as CL2	Median ° C
JUN	28	0	0.0	0	0	0	4	0	1.15	14.7
JUL	36	0	0.0	0	0	0	5	0	0.81	16.9
AUG	28	0	0.0	0	0	0	5	0	0.40	18.3
SEP	30	0	0.0	0	0	0	8	0	0.43	17.4
OCT	35	0	0.0	0	0	0	8	0	0.69	13.7
NOV	34	0	0.0	0	0	0	8	0	0.71	10.9
Total:	191	0	0.0	0	0	0	38	0	0.70	15.3

Total Coliform Bacteria and *E. Coli*.

In all 191 bacteriological samples during the reporting period, no total coliform and no *E.coli* bacteria were found (Table 8).

Turbidity

All 38 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 0.7 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 peaked in late August and reached almost 19°C (Table 8). This is only slightly lower than in the Goldstream Service Area and has the same effects.

Water Chemistry

The average pH of the drinking water in the Sooke Service Area was 7.8 during the reporting period. The pH ranged from 7.4 to 8.3 and is typically very stable and consistent across this system. The average alkalinity was 16.9 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	24	27	25.5	80
Trihalomethanes (TTHMs)	2	ug/L	32	34	33	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 32 tested metals, four are monitored particularly close: iron, manganese, lead and copper. All metal concentrations were well below the respective Health Canada maximum acceptable concentration or the aesthetic objective. A Sooke sampling station at Henlyn Pump Station that registered high lead concentrations in the past was successfully mitigated by changing the pump operation mode. Mid-to long term, this aging pump station will eventually be rebuilt or abandoned.