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Comox Lake: Water Quality Objectives Attainment (2015 – 2016)

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EXECUTIVE SUMMARY

Water Quality Objectives (WQOs) were approved for Comox Lake in 2011 (Epps and Phippen, 2011). Attainment monitoring was conducted by the BC Ministry of Environment and Climate Change Strategy (ENV) from August 2015 through March 2016. This report presents attainment data and documents any changes that have occurred in the watershed between 2011 and 2016 that may influence water quality within Comox Lake.

Data demonstrated that water quality in the lake was generally good but WQOs were occasionally exceeded for three parameters: *Escherichia coli* (*E. coli)*, water temperature, and Chlorophyll *a*. This report recommends that the ENV collaborate with the Comox Valley Regional District (CVRD) and Timberwest (now Mosaic Forest Management) to monitor and continue to protect water quality while focusing on issues related to recreational use. Initiatives should include public outreach and education, as well as monitoring and microbial source tracking *of E. coli.*

1. INTRODUCTION

As part of the Province of British Columbia Ministry of Environment and Climate Change Strategy's (ENV) mandate to manage and protect water bodies, water quality assessments and Water Quality Objective (WQO) reports have been created for numerous lakes, rivers and marine surface waters. These reports provide a list of objectives to protect water quality that are tailored to the specific water body for which they have been created, considering natural local water quality, water uses, water movement, and waste discharges. While the WQOs currently have no legal standing, they can direct resource managers aiming to protect the water body in question and are used as a standard against which to measure any changes in the water quality of that water body. The science-based information and trends identified help inform local government on drinking water, liquid waste and land use planning, water quality targets and effective monitoring of those plans. Once objectives have been developed, periodic monitoring (approximately every three to five years) is undertaken to determine whether they are being met.

Comox Lake is located on the east coast of Vancouver Island near Comox BC and is part of the Puntledge River system. The lake provides drinking water to the Comox Valley Regional District (CVRD) and has important fisheries values (Epps and Phippen, 2011). Factors that could potentially affect water quality include expanding recreational use, residential cabins, timber harvesting, natural erosion, and presence of wildlife.

Objectives, based on data collected between 2005 and 2008, were set for Comox Lake in 2011 (Epps and Phippen, 2011) to protect drinking water, irrigation, primary-contact recreation, and protection of wildlife and aquatic life (Table 1). Water quality monitoring to determine objectives attainment occurred between August 2015 and March 2016. This report examines 2015-2016 attainment monitoring data and presents changes in the watershed from 2011-2016. The data are summarized in Appendix A.

Table 1. Water Quality Objectives for Comox Lake (Epps and Phippen, 2011).

Variable	Objective Value
Secchi depth	Annual average ≥ 8 m
***E. coli* Bacteria**	≤10 CFU/100 mL (90^{th} percentile) with a minimum 5 weekly samples collected over a 30-day period
Turbidity	≤ 2 NTU maximum
Total phosphorus	≤6 µg/L average during spring overturn
Chlorophyll *a*	≤ 1.5 µg/L
Water temperature	≤ 15°C summer maximum hypolimnetic temperature (>10m depth)
Dissolved oxygen	≥ 5 mg/L at any depth throughout the year

2. CHANGES AND ACTIVITIES IN THE WATERSHED SINCE OBJECTIVES DEVELOPMENT

The following notable changes or activities occurred in the watershed between 2011 and 2016:

- The CVRD has substantially developed their water quality monitoring program. It now includes: two continuous turbidity monitoring devices on Cruikshank and Perseverance Creeks and sampling for chlorophyll *a*, bacteriology, nitrogen, and phosphorous (Norcross-Nu'u, pers comm., 2017).
- The CVRD focuses on decreasing turbidity in the lake since Island Health mandates that water providers issue boil water advisories when turbidity exceeds 1.0 NTU (Norcross-Nu'u, pers comm., 2017). Perseverance Creek is a significant source of turbidity in Comox Lake due to an eroding bank of fine sediments within the watershed. The eroding bank is located on a spillway that is part of the Cumberland water system. It becomes active during high flows when the Cumberland water system dam overflows into the tributary (Aqua-Tex, 2016). The CVRD has encouraged Cumberland to join their water system and remove the dam but the cost of such a merger has been a barrier (Norcross-Nu'u, pers comm., 2017).
- In 2016, the CVRD completed the Comox Lake Watershed Protection Plan. The comprehensive plan presents a large amount of information about the watershed, details threats to water quality in the lake, and makes 54 watershed management recommendations (Aqua-Tex, 2016).
- Recreational use of Comox Lake by boaters, swimmers, mountain bikers, campers, and lakeside cabin owners is believed to be increasing in the summer (Barraclough, pers comm., 2017). Additional users may increase the potential for contamination of the lake with bacterial and other types of pollution.
- To decrease the amount of particulate transported to the lake from existing logging areas, Timberwest completed a road resurfacing and repair project from 2012 to 2014. They also have an ongoing maintenance program including road inspections for plugged culverts and surface erosion (Cole, pers. comm., 2017).
- Timberwest, now Mosaic Forest Management, which owns 95% of the forested land in the Comox Lake watershed, has maintained consistent harvest levels since 2011. The company is focused on long term sustainable harvest and annually cuts approximately 1.5% of the land area (Cole, pers. comm., 2017).
- Local observations suggest that the elk population is increasing in the Cruikshank River watershed; such an increase could contribute to bacterial contamination from wildlife (Cole, pers. comm., 2017).
- Timberwest conducted a mandatory inventory of sewer systems in place at the 54 cabins that exist on Timberwest property surrounding the lake. This information may help managers to understand if these cabins are a source of potential bacteriological contributions to the lake. Timberwest (Mosaic) grants leases to cabin owners on an annual basis (Cole, pers. comm., 2017).

3. SAMPLING AND ANALYTICAL METHODS

As part of the WQO attainment monitoring recommended in Epps and Phippen (2011), ENV sampled nine sites around Comox Lake during 2015 and 2016. Seven sites are located along the shoreline, one is near the CVRD water intake, and another is a deep basin site at the east end of the lake (Map 1; Table 2). Sampling and site selection followed the methods recommended in the Comox Lake Technical Report (Epps and Phippen., 2011) with these exceptions: one deep lake station was sampled instead of the recommended three; the water intake site five weekly samples in 30 days did not include all parameters (as per Table 2, some were collected on two separate dates).

The sampling program was conducted by three teams; the ENV sampled at the deep lake site E259499 - Comox Lake Outlet Basin - Mid Lake, CVRD sampled the Puntledge River at the CVRD Water Intake E303170, and the Courtenay and District Fish and Game Protective Association sampled the perimeter sites (E303171 to E303177). Water quality data collected weekly through most of the year by the CVRD were also reviewed and summarized for the study period for comparison purposes but were not used in this report to determine if WQOs were met.

Figure 1. Water quality attainment sampling sites within the Comox Lake watershed (2015-2016).

Table 2: Comox Lake 2015-2016 water quality sampling program summary.

Site (EMS ID and Site Name)	Frequency and timing	Parameters
Deep Station: E259499 - Comox Lake Outlet Basin - Mid Lake	Quarterly sampling (once each season, including spring overturn; 2015: Jun 28, Aug 12, Oct 20, 2016: Mar 3)	• Profile (every metre): temperature, pH, dissolved oxygen, specific conductivity • Secchi depth • Chlorophyll *a* (surface only) • At surface, 10m and 1 m from bottom: Residue non-filterable/total suspended solids (TSS), turbidity, colour, total organic carbon (TOC), dissolved organic carbon (DOC), total phosphorous, total nitrogen, total and dissolved metals (March sample only) • Phytoplankton and zooplankton (August and March sample only)
Shoreline Sites 1-7: E303171 to E303177 (perimeter sites) and E303170 - Puntledge River at CVRD water intake	5 weekly samples in 30 days Summer sampling: August 5 to September 1, 2015 Fall sampling: October 13, to November 9, 2015	All Sites (surface samples): • *E. coli* representative of near shore areas and intake site (all sites, all dates) Site E303170 only: • Temperature, turbidity, pH, dissolved oxygen, specific conductivity (all dates) • Residue non-filterable/TSS, total and dissolved metals (Aug 18 and Oct 27, 2015) • TOC, total phosphorous (Aug 4 and Sept 1, 2015)

4. RESULTS AND OBJECTIVES ATTAINMENT

Most parameters met or were below WQOs during most sampling events. Results are summarized in Table 3 and discussed below. Appendix A contains detailed water quality results. Zooplankton and phytoplankton sample results are summarized in Appendix A, Tables A-4 and A-5. Site-specific raw data can be obtained at ENVs Environmental Monitoring System website: https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/environmental-monitoring-system.

Table 3: Summary of water quality objectives for Comox Lake.

Variable	Objective Value	Objective Met?
Secchi depth	Annual average ≥ 8 m	Yes
E. coli	≤10 CFU/100 mL (90th percentile) with a minimum 5 weekly samples collected over a 30-day period	No. One *E. coli* sampling event exceeded the objective in August 2015 at site E303175 with a 90th percentile value of 91.6 CFU/100mL.
Turbidity	≤ 2 NTU maximum	Yes
Total phosphorus	≤6 µg/L average during spring overturn	Yes
Chlorophyll *a*	≤ 1.5 µg/L	No. Chlorophyll *a* levels exceeded the objective with a value of 2.41 ug/L on 2015/05/28 at site E259499.
Water temperature	≤ 15°C summer maximum hypolimnetic temperature (>10m depth)	No. Temperatures remained above 15°C until a depth of 15m on 2015/08/12 at site E259499.
Dissolved oxygen	≥ 5 mg/L at any depth throughout the year	Yes

E. coli

E. coli levels measured were mostly low but exceeded the WQO of ≤10 CFU/100 mL (90th percentile) for the five weekly samples in 30 days sampling completed in August 2015 with a value of 91.6 CFU/100mL. The sample collected on August 25, 2015 at site E303175 contained 150 CFU/100mL of *E. coli.* The site is in front of one of the most heavily populated areas on the lake, with several cabins and docks nearby. Field notes for that day indicate that three gulls were present at the site during sampling. In a few other cases individual samples were higher than 10 CFU/100mL, but no other the five weekly samples in 30 days sampling period had 90th percentile values that exceeded the objective. Appendix A, Table A-1 contains a summary of all *E.coli* sampling.

The CVRD sampling program sampled *E. coli* weekly for most of the year at surface, 20m, and 30m depths, at the location of their water intake. Individual values never exceeded 10 CFU/100 mL. Using source tracking analysis, the CVRD determined that hosts of the *E. coli* bacteria found included: wolves, dogs, gulls, coyote, cows, elk, bears, marmots, and humans (CVRD, 2017). It is likely that the coyote result is erroneous given there are no coyotes on Vancouver Island (Barraclough, pers comm., 2017)

Chlorophyll *a*

Chlorophyll *a* exceeded the objective of ≤ 1.5 µg/L in one of the four samples collected with a value of 2.41 ug/L on May 28th, 2015 at E259499 - Comox Lake Outlet Basin, Mid Lake. Though higher than the objective of 1.5 µg/L (the objective is based on surface samples only), these values were still within the range of values considered normal for a low productivity (oligotrophic) lake such as Comox Lake, and thus are not of concern.

For comparison, CVRD weekly sampling at their water intake showed three individual values exceeding 1.5 µg/L in July of 2015. Two exceedances occurred on July 7, 2015. On this day the surface sample contained 1.81 µg/L, and the 9m depth sample had a value of 1.77 µg/L. Another exceedance occurred on July 27, 2015 with result of 1.56 µg/L. Weekly sampling by the CVRD began in 2015 in January but was not continued past July in that year. The CVRD sampled during most weeks in 2016 and showed no exceedances for Chlorophyll *a* (CVRD, 2017).

Water Temperature

Most water temperature values met the WQO of maximum hypolimnetic (>10m depth) temperature of ≤ 15°C. However, temperature exceeded the objective on August 12th, 2015 at site E259499, with a temperature of 20.37 °C at 11m depth (Figure 2). Water temperature remained cooler than the objective at depths deeper than 15m only. Air temperatures were on average 1.8 degrees higher than normal for July 2015 and 0.8 degrees higher in August 2015 (Environment Canada, 2017). This warmer than average summer likely contributed to the higher temperatures found in the lake.

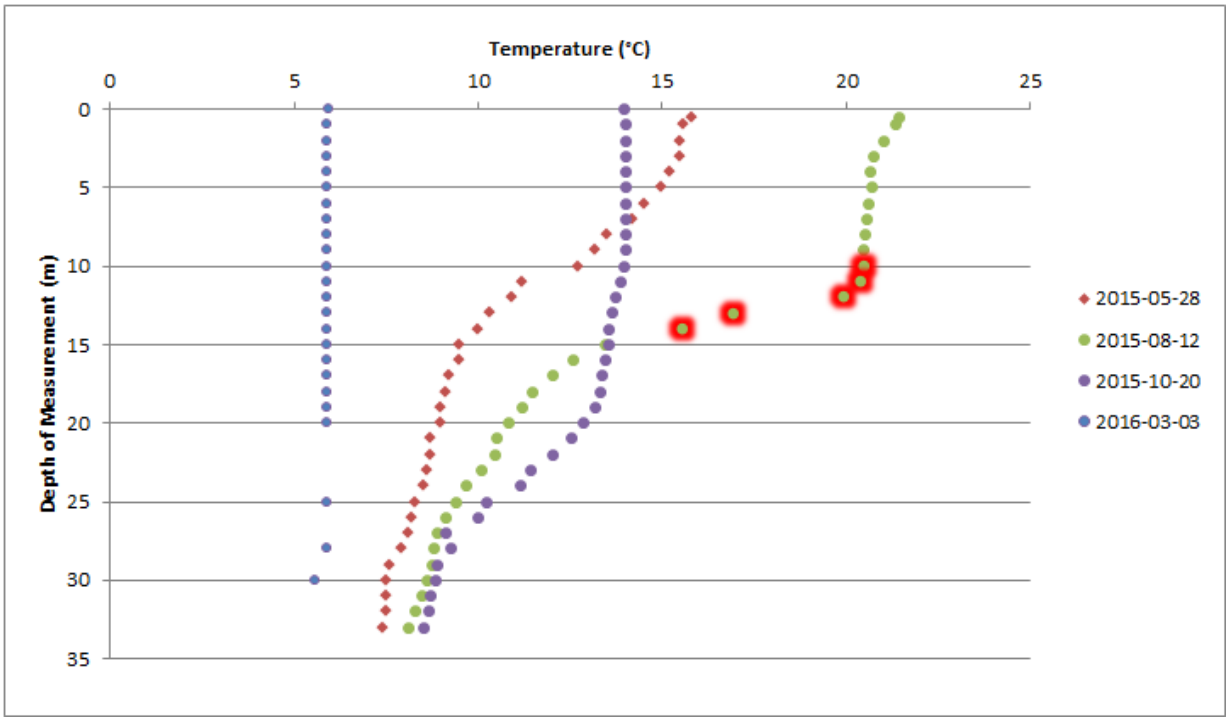

Figure 2: Temperature profile at site E259499 - Comox Lake outlet basin, mid Lake. Red shadow indicates values exceeding objective.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Water quality in Comox Lake is good but continued efforts to maintain and improve it are necessary to sustain water quality for its users. Recreational use of the watershed by boaters, swimmers, mountain bikers, campers, and lakeside cabin owners should be monitored and managed to protect the lake's role as a drinking water source. Diligent water quality monitoring combined with education of users is required to ensure a high level of water quality. Source tracking of *E.coli* samples, combined with Timberwest's sewer and septic inventory could be used to determine possible locations of inputs of *E. coli.*

The CVRD and Timberwest (now Mosaic Forest Management) collaborate to conduct water quality monitoring, education, and remediation programs in and around Comox Lake. It is recommended that a partnership is formed between them and the ENV to avoid overlap of monitoring programs and enhance protection and understanding of the lake.

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APPENDIX A: WATER QUALITY MONITORING RESULTS

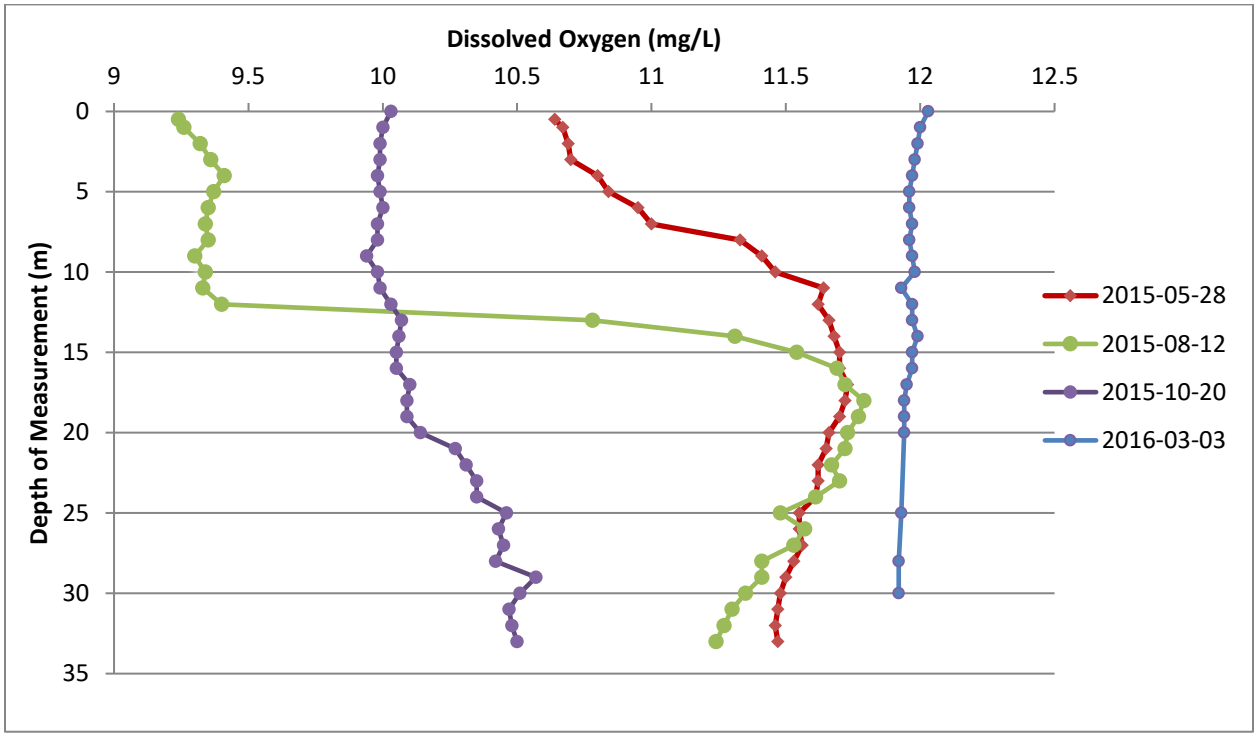

Figure A-1: Dissolved oxygen profile at site E259499 - Comox Lake Outlet Basin, Mid Lake.

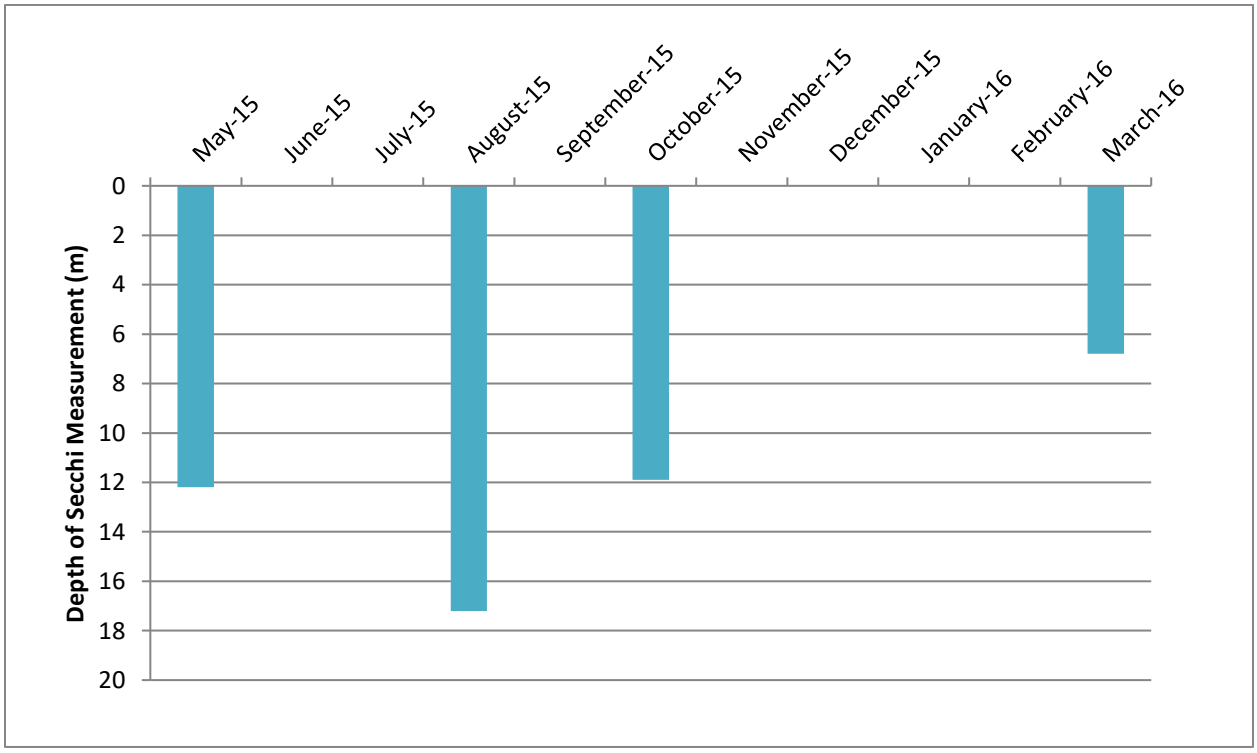

Figure A-2: Secchi depths site E259499 - Comox Lake Outlet Basin, Mid Lake.

Table A-1: 90th percentile for E. coli *from five in 30 sampling for Comox Lake sites.*

EMS ID	Location Name	Dates	90th percentile *E. coli* (CFU/100mL)
E303170	PUNTLEDGE RIVER AT CVRD WATER INTAKE	Aug 4-Sept 1, 2015	3
E303170	PUNTLEDGE RIVER AT CVRD WATER INTAKE	Oct 15-Nov 9, 2015	3.8
E303171	COMOX LAKE PERIMETER SITE #1	Aug 5-Sept 1, 2015	1
E303171	COMOX LAKE PERIMETER SITE #1	Oct 13-Nov 9, 2015	1
E303172	COMOX LAKE PERIMETER SITE #2	Aug 5-Sept 1, 2015	1.6
E303172	COMOX LAKE PERIMETER SITE #2	Oct 13-Nov 9, 2015	1
E303173	COMOX LAKE PERIMETER SITE #3	Aug 5-Sept 1, 2015	1.6
E303173	COMOX LAKE PERIMETER SITE #3	Oct 13-Nov 9, 2015	1
E303174	COMOX LAKE PERIMETER SITE #4	Aug 5-Sept 1, 2015	3.4
E303174	COMOX LAKE PERIMETER SITE #4	Oct 13-Nov 9, 2015	3.2
E303175	COMOX LAKE PERIMETER SITE #5	Aug 5-Sept 1, 2015	91.6
E303175	COMOX LAKE PERIMETER SITE #5	Oct 13-Nov 9, 2015	1.6
E303176	COMOX LAKE PERIMETER SITE #6	Aug 5-Sept 1, 2015	9.6
E303176	COMOX LAKE PERIMETER SITE #6	Oct 13-Nov 9, 2015	1
E303177	COMOX LAKE PERIMETER SITE #7	Aug 5-Sept 1, 2015	8.8
E303177	COMOX LAKE PERIMETER SITE #7	Oct 13-Nov 9, 2015	1

Table A-2: Summary statistics for E259499: COMOX LAKE OUTLET BASIN, MID LAKE (2015-2016). Shaded cells indicate values below minimum detection limits.

Parameter	Minimum	Maximum	Average	Standard Deviation	Number of Samples
Ag-D (mg/L)	0.000005	0.000005	0.000005	0	3
Ag-T (mg/L)	0.000005	0.000005	0.000005	0	3
Al-D (mg/L)	0.0113	0.0132	0.0121	0.000985	3
Al-T (mg/L)	0.025	0.0341	0.028233	0.00509	3
As-D (mg/L)	0.000083	0.00009	8.67E-05	3.51E-06	3
As-T (mg/L)	0.000096	0.000104	0.0001	4.04E-06	3
Ba-D (mg/L)	0.000409	0.000463	0.000429	2.98E-05	3
Ba-T (mg/L)	0.000443	0.000482	0.000461	1.97E-05	3
B--D (mg/L)	0.0117	0.0142	0.013167	0.001305	3
Be-D (mg/L)	0.00001	0.00001	0.00001	0	3
Be-T (mg/L)	0.00001	0.00001	0.00001	0	3
Bi-D (mg/L)	0.000005	0.000005	0.000005	0	3
Bi-T (mg/L)	0.000005	0.000005	0.000005	0	3
B--T (mg/L)	0.0116	0.0119	0.011767	0.000153	3
Ca-D (mg/L)	5.61	5.86	5.713333	0.130512	3
Carbon Dissolved Organic (mg/L)	0.93	7.41	1.753333	1.803881	12
Carbon Total Organic (mg/L)	0.87	1.39	1.147778	0.18424	9
Ca-T (mg/L)	5.85	6.21	6.073333	0.195021	3
Cd-D (mg/L)	0.000005	0.000005	0.000005	0	3
Cd-T (mg/L)	0.000005	0.000005	0.000005	0	3
Chlorophyll A (mg/L)	0.00019	0.00241	0.000904	0.001021	4

Parameter	Minimum	Maximum	Average	Standard Deviation	Number of Samples
Co-D (mg/L)	1.01E-05	1.47E-05	1.28E-05	2.39E-06	3
Color True (Col. Unit)	5	6.2	5.166667	0.36265	12
Co-T (mg/L)	2.33E-05	3.39E-05	2.81E-05	5.37E-06	3
Cr-D (mg/L)	0.00014	0.00016	0.000153	1.15E-05	3
Cr-T (mg/L)	0.00015	0.00018	0.000163	1.53E-05	3
Cu-D (mg/L)	0.000465	0.00125	0.000752	0.000433	3
Cu-T (mg/L)	0.00054	0.00063	0.000594	4.78E-05	3
Diss Oxy (mg/L)	9.24	12.03	10.98048	0.888292	126
Secchi Depth (m)	12.2	17.2	14.7	3.535534	2
Fe-D (mg/L)	0.0061	0.0084	0.0072	0.001153	3
Fe-T (mg/L)	0.0281	0.0409	0.032633	0.00717	3
Hardness (Dissolved) (mg/L)	17.8	18.3	18	0.264575	3
Hardness Total (T) (mg/L)	18.7131	19.66555	19.20762	0.47728	3
K--D (mg/L)	0.0411	0.0477	0.044033	0.003361	3
K--T (mg/L)	0.0415	0.0494	0.0465	0.004349	3
Li-D (mg/L)	0.0005	0.0005	0.0005	0	3
Li-T (mg/L)	0.0005	0.0005	0.0005	0	3
Mg-D (mg/L)	0.895	0.921	0.904667	0.014224	3
Mg-T (mg/L)	0.938	1.01	0.981667	0.038371	3
Mn-D (mg/L)	0.000749	0.00117	0.000968	0.000211	3
Mn-T (mg/L)	0.00211	0.0028	0.00235	0.00039	3
Mo-D (mg/L)	0.00005	0.00005	0.00005	0	3
Mo-T (mg/L)	0.00005	0.00005	0.00005	0	3
Na-D (mg/L)	0.744	0.818	0.782667	0.037112	3
Na-T (mg/L)	0.815	0.845	0.833	0.015875	3
Ni-D (mg/L)	0.00005	0.000057	5.37E-05	3.51E-06	3
Ni-T (mg/L)	0.000056	0.000083	0.000066	1.48E-05	3
Nitrogen Total (mg/L)	0.03	0.127	0.06475	0.034421	8
ORP (mV)	100	146	113.7917	12.77899	24
Pb-D (mg/L)	5.2E-06	2.18E-05	1.15E-05	8.97E-06	3
Pb-T (mg/L)	6.5E-06	1.45E-05	1.09E-05	4.05E-06	3
pH (pH units)	6.49	7.5	6.941	0.231389	130
P--T (mg/L)	0.002	0.005	0.0025	0.000914	18
Residue Non-filterable (mg/L)	1	5.8	1.4	1.385641	12
Sb-D (mg/L)	0.00002	0.00002	0.00002	0	3
Sb-T (mg/L)	0.00002	0.00002	0.00002	0	3
Se-D (mg/L)	0.00004	0.000041	4.03E-05	5.77E-07	3
Se-T (mg/L)	0.000046	0.000058	0.000053	6.24E-06	3
Si-D (mg/L)	2.15	2.22	2.193333	0.037859	3
Si-T (mg/L)	2.32	2.51	2.41	0.095394	3
Sn-D (mg/L)	0.00001	0.00001	0.00001	0	3
Sn-T (mg/L)	0.00001	0.00001	0.00001	0	3
Specific Conductance (uS/cm)	35	40	37.27302	1.275267	126
Sr-D (mg/L)	0.00765	0.0085	0.008013	0.000438	3
Sr-T (mg/L)	0.00774	0.00822	0.007927	0.000257	3
Temp (Degrees C)	5.58	21.43	11.22365	4.425657	126

Parameter	Minimum	Maximum	Average	Standard Deviation	Number of Samples
Tl-D (mg/L)	0.000002	0.000002	0.000002	0	3
Tl-T (mg/L)	0.000002	0.000002	0.000002	0	3
Turbidity (NTU)	0.18	0.63	0.3375	0.147963	12
U--D (mg/L)	0.000002	0.000002	0.000002	0	3
U--T (mg/L)	0.000002	0.000002	0.000002	0	3
V--D (mg/L)	0.00039	0.00041	0.0004	1E-05	3
V--T (mg/L)	0.00049	0.00055	0.000517	3.06E-05	3
Zn-D (mg/L)	0.00046	0.00077	0.00064	0.000161	3
Zn-T (mg/L)	0.00047	0.00089	0.000673	0.00021	3

Table A-3: Summary statistics for E303170: PUNTLEDGE RIVER AT CVRD WATER INTAKE (2015-2016). Shaded cells indicate values below minimum detection limits.

Parameter	Minimum	Maximum	Average	Standard Deviation	Number of Samples
Ag-D (mg/L)	0.000005	0.000005	0.000005	0	2
Ag-T (mg/L)	0.000005	0.000005	0.000005	0	2
Al-D (mg/L)	0.00428	0.00463	0.004455	0.000247	2
Al-T (mg/L)	0.00789	0.00798	0.007935	6.36E-05	2
As-D (mg/L)	0.0001	0.000123	0.000112	1.63E-05	2
As-T (mg/L)	0.000113	0.000123	0.000118	7.07E-06	2
Ba-D (mg/L)	0.000376	0.000523	0.00045	0.000104	2
Ba-T (mg/L)	0.000413	0.000471	0.000442	4.1E-05	2
B--D (mg/L)	0.0109	0.0138	0.01235	0.002051	2
Be-D (mg/L)	0.00001	0.00001	0.00001	0	2
Be-T (mg/L)	0.00001	0.00001	0.00001	0	2
Bi-D (mg/L)	0.000005	0.000005	0.000005	0	2
Bi-T (mg/L)	0.000005	0.000005	0.000005	0	2
B--T (mg/L)	0.0116	0.013	0.0123	0.00099	2
Ca-D (mg/L)	6.23	6.56	6.395	0.233345	2
Carbon Total Organic (mg/L)	0.88	1.03	0.955	0.106066	2
Ca-T (mg/L)	6.84	7	6.92	0.113137	2
Cd-D (mg/L)	0.000005	0.000005	0.000005	0	2
Cd-T (mg/L)	0.000005	0.000005	0.000005	0	2
Co-D (mg/L)	0.000005	2.17E-05	1.34E-05	1.18E-05	2
Co-T (mg/L)	8.3E-06	1.19E-05	1.01E-05	2.55E-06	2
Cr-D (mg/L)	0.00014	0.00014	0.00014	0	2
Cr-T (mg/L)	0.00012	0.00013	0.000125	7.07E-06	2
Cu-D (mg/L)	0.000377	0.000404	0.000391	1.91E-05	2
Cu-T (mg/L)	0.000423	0.000454	0.000439	2.19E-05	2
Dissolved Oxygen-Field (mg/L)	8.24	10.7	9.44	1.119464	10

Parameter	Minimum	Maximum	Average	Standard Deviation	Number of Samples
E Coli (CFU/100mL)	1	5	2.153846	1.57301	13
Fe-D (mg/L)	0.0051	0.0091	0.0071	0.002828	2
Fe-T (mg/L)	0.0132	0.018	0.0156	0.003394	2
Hardness (Dissolved) (mg/L)	19.5	20.4	19.95	0.636396	2
Hardness Total (T) (mg/L)	21.32102	21.67936	21.50019	0.253385	2
K--D (mg/L)	0.0369	0.0582	0.04755	0.015061	2
K--T (mg/L)	0.0409	0.0549	0.0479	0.009899	2
Li-D (mg/L)	0.0005	0.0005	0.0005	0	2
Li-T (mg/L)	0.0005	0.0005	0.0005	0	2
Mg-D (mg/L)	0.952	0.967	0.9595	0.010607	2
Mg-T (mg/L)	1.02	1.03	1.025	0.007071	2
Mn-D (mg/L)	0.00125	0.00232	0.001785	0.000757	2
Mn-T (mg/L)	0.00183	0.00254	0.002185	0.000502	2
Mo-D (mg/L)	0.000051	0.000056	5.35E-05	3.54E-06	2
Mo-T (mg/L)	0.00005	0.000066	0.000058	1.13E-05	2
Na-D (mg/L)	0.926	0.933	0.9295	0.00495	2
Na-T (mg/L)	0.857	0.974	0.9155	0.082731	2
Ni-D (mg/L)	0.00005	0.00006	0.000055	7.07E-06	2
Ni-T (mg/L)	0.00005	0.00005	0.00005	0	2
Pb-D (mg/L)	0.000005	0.000005	0.000005	0	2
Pb-T (mg/L)	0.000005	0.000005	0.000005	0	2
P--T (mg/L)	0.002	0.002	0.002	0	3
Residue Non-filterable (mg/L)	1	1	1	0	4
Sb-D (mg/L)	0.00002	0.000022	0.000021	1.41E-06	2
Sb-T (mg/L)	0.00002	0.000021	2.05E-05	7.07E-07	2
Se-D (mg/L)	0.00004	0.000041	4.05E-05	7.07E-07	2
Se-T (mg/L)	0.00004	0.00004	0.00004	0	2
Si-D (mg/L)	1.97	2.88	2.425	0.643467	2
Si-T (mg/L)	2.17	3.05	2.61	0.622254	2
Sn-D (mg/L)	0.00001	0.00001	0.00001	0	2
Sn-T (mg/L)	0.00001	0.00001	0.00001	0	2
Specific Conductivity-Fld (uS/cm)	0.0262	291	74.24942	111.7659	10
Sr-D (mg/L)	0.0082	0.00832	0.00826	8.49E-05	2
Sr-T (mg/L)	0.00757	0.00793	0.00775	0.000255	2
Temp (mg/L)	10.7	20.7	16.91	4.225965	10
Tl-D (mg/L)	0.000002	0.000002	0.000002	0	2
Tl-T (mg/L)	0.000002	0.000002	0.000002	0	2
Turbidity (NTU)	0.19	0.43	0.252	0.071926	10

Parameter	Minimum	Maximum	Average	Standard Deviation	Number of Samples
U--D (mg/L)	0.000002	0.000002	0.000002	0	2
U--T (mg/L)	0.000002	0.000002	0.000002	0	2
V--D (mg/L)	0.00046	0.00054	0.0005	5.66E-05	2
V--T (mg/L)	0.00048	0.00058	0.00053	7.07E-05	2
Zn-D (mg/L)	0.00035	0.00036	0.000355	7.07E-06	2
Zn-T (mg/L)	0.0002	0.00025	0.000225	3.54E-05	2

Table A-4: Summary of zooplankton species at site E259499 - Comox Lake Outlet Basin, Mid Lake. UID = unidentified due to lack of size and/or missing morphological characters.

	August 12, 2015			March 3, 2016		
Type	Stage	Total organisms/ sample	Percentage of Sample	Stage	Total organisms/ sample	Percentage of Sample
Sub-class: Copepoda						
Order: Cyclopoida						
Diacyclops thomasi	adult	20	1	adult	44	15
UID				copepodid	3	1
Order: Calanoida						
Family: Diaptomidae						
Skistodiaptomus oregonensis	adult	143	5	adult	19	7
UID	copepodid	306	10			
UID Calanoida /Cyclopoida	nauplii	102	3	nauplii	63	22
Order: Cladocera						
Bosmina longirostris / longispina	adult	796	27	adult	29	10
Bosmina sp.				juvenile	3	1
Daphnia longiremis				adult	8	3
Daphnia pulicaria				adult	3	1
Daphnia rosea	adult	204	7			
Daphnia sp.	juvenile	20	1			
Holopedium gibberum	adult	224	7	adult	8	3
Simocephalus vetulus	adult	367	12			
Phylum: Rotifera						
Kellicottia longispina		122	4		3	1
Keratella cochlearis		326	11		86	30
Notholca sp.					3	1
Keratella quadrata		41	1			
Polyarthra sp.		163	5		6	2
Testudinella sp.		102	3			
UID		61	2		6	2
TOTAL		2,997	100		284	100

Table A-5: Summary phytoplankton at site: E259499, Comox Lake Outlet Basin, Mid Lake

Type	August 12, 2015		March 3, 2016	
	Total cells/mL	Percentage of sample	Total cells/mL	Percentage of sample
Order: Centrales				
Cyclotella cf bodanica			1.4	3.125
Cyclotella cf glomerata	<1.4		5.6	12.5
Order: Cryptomonadales				
Chroomonas acuta	<1.4		29.4	65.625
Cryptomonas ovata / erosa	5.6	50.0	<1.4	
Order: Dinokontae				
Peridinium cf inconspicuum	5.6	50.0		
Order: Pennales				
Achnanthes minutissima	<1.4		2.8	6.25
Asterionella formosa			4.2	9.375
Fragilaria crotonensis			1.4	3.125
Total	11.2	100	44.8	100