

APPENDIX D

# ENVIRONMENTAL ASSESSMENT



CITY OF  
**COURTENAY**

CITY OF COURTENAY

# INTEGRATED RAINWATER MANAGEMENT PLAN

EXISTING ENVIRONMENTAL CONDITIONS



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## EXECUTIVE SUMMARY

The need for an Integrated Rainwater Management Plan (IRMP) has been identified by the City of Courtenay to focus future land-use planning for the City's growing population and expanding development footprint in a measured way that provides enhanced protection of aquatic and riparian habitat and private and municipal property. This document prepared by Current Environmental Ltd., sub-contractor to Urban Systems, describes existing environmental conditions, within the City of Courtenay as they pertain to the ongoing management of rainwater infrastructure and in support of an overarching IRMP. Overall, the purpose of this study is to identify key areas of environmental impact resulting from existing rainwater management and propose measures to improve the existing systems under the City's authority or recommend new ones.

The study area was established according to 2019 City of Courtenay municipal boundaries with environmental aspects divided at watershed level to reflect specific conditions encountered in each aquatic system as they are each subject to unique land-use factors. The following watersheds and aquatic receptors (in the case of the marine environment of Comox Harbour) are detailed in this study:

1. Puntledge River
2. Tsolum River (inc. Portuguese Creek sub-basin)
3. Morrison Creek
4. Millard/Piercy Creek
5. Glen Urquhart Creek
6. Courtenay River Estuary

At-risk drainage catchments have been identified based on an assessment of the following study components with field data collection completed summer/fall 2019 and winter 2020:

1. Overview, Information Gathering and Mapping
2. Riparian Corridor Assessment (fish presence and watershed impervious area)
3. Aquatic Species and Habitat Inventory – Freshwater & Estuarine/Marine
4. Species at Risk
5. Terrestrial Species and Habitat Assessment
6. Benthic Community Assessment
7. Water Quality Assessment

Results represent a baseline assessment of existing conditions in these watersheds, that although treated separately in order to help identify discrete issues that may be affecting them individually, are connected by the common threads of broad City management practices and their ultimate downstream discharge into the ecologically sensitive receiving waters of the Courtenay River and Comox Harbour.

### Riparian Corridor

The urban environment poses a series of additional challenges that most commonly include perched culverts at road crossings and extended lengths of underground pipe. Fish presence as a percentage of total available stream length was impaired in all but the Courtenay and Puntledge Rivers.

The objective of impervious surface coverage analysis is to identify those systems most at risk of impacts from urban rainwater, and where impacts have occurred, to mitigate those impacts to the greatest extent practicable, considering costs and benefits, using effective rainwater management techniques. Percent impervious surfaces correlate to habitat quality for fish habitat, aquatic insects, and plant and amphibian density and are rated on a descriptive scale. Most of the study watersheds are considered *Non-supporting*, while only Little River and Tsolum River are considered *Impacted*, and Millard/Piercy is rated *Sensitive*.

### Benthic Species

Benthic species analysis includes the 10 Metric benthic index of biological integrity (B-IBI) which contains seven categories of taxa richness and three categories of % life history strategies (Dominance, Tolerant, Predator). The metric is organized into a scoring matrix that provides a description of stream health ranging from *Very Poor* to *Excellent*. All of the sample sites in this study received an I-BIB rating of *Poor* or *Very Poor* for benthic diversity as an indicator of ecosystem health.

### Water Quality

Hand-meter data and laboratory analysis of water quality samples collected through summer (Sept. – Oct. 2019) and winter (Jan. – Feb. 2020) periods are intended to reflect chronic (30-day average) and acute (single event exceedance) conditions during low- and high-flow conditions affecting the urban watersheds in and around the City of Courtenay. Hand-meter data included collection of pH, specific conductivity, temperature, dissolved oxygen, and turbidity. Results from hand-meter water quality collection indicate that chronically high turbidity conditions may exist at the stormwater outlet into Morrison Creek while acute (single event) elevated temperature and turbidity events were observed periodically at all sites; apart from Piercy Creek which remained within water quality guidelines for all parameters.

In laboratory analysis, acute (short-term) and chronic (long-term) elevated concentrations of copper, iron, and zinc may be associated with vehicle pollutants entering rainwater systems and suggests that a heightened responsibility may exist between the City and private landowners/ developers to improve treatment facilities and best management practices to better remove/detain heavy metals from runoff before they are allowed to enter natural waters. Similar efforts would also benefit elevated turbidity levels, such as those entering Morrison Creek, at an outfall with effluent entering onto a notable salmon spawning reach.

*E. coli* and fecal coliform concentrations are well in exceedance of acceptable limits and indicate a chronic, City wide matter compelling corrective action. Storm/sanitary cross-connections in older neighbourhoods can oftentimes be responsible for elevated bacteriological activity and is within the purview of the City to amend.

### Conclusion

Overall, each of the study watersheds have demonstrated some limitations to ecological function. However, priority treatment watersheds have been identified according to the maturity of their development status, future opportunities for the avoidance or mitigation of impacts, and feasibility of habitat enhancement to already impacted systems. The following table represents a summary of all study parameters (Section 5.1 - 5.4) categorized by watershed sampling location (Section 4.3.1) with recommendations for priority management provided in Section 6.

Summary of all study parameter results categorized by watershed sampling location and overall priority sites selected for City management.											
Watershed	Courtenay River	Glen Urquhart Creek	Little River	Millard/Piercy Creek	Morrison Creek	Portuguese Creek	Puntledge River	Brooklyn Creek	Tsolum River	City of Courtenay	
% Fish Bearing Stream Channels (w/n City limits)	100	56	83	91	87	12	100	0	68	74.6 (Average)	
% Watershed Covered in Impervious Surfaces and Predicted Stream Quality (Scheuler 1994)	Non-supporting	Non-supporting	Impacted	Sensitive	Non-supporting	Non-supporting	Non-supporting	Non-supporting	Impacted	Majority Non-supporting	
Benthic index of biological integrity (B-IBI) Stream Health Score (Page et al. 2008)	Very Poor	Poor	n/a	Very Poor	Poor	n/a	Poor	Very Poor	n/a	Very Poor/Poor	
Water Quality Handmeter Exceedance of BC Standards (Summer)	Acute	Temp./Turbidity	Temp./Turbidity	n/a	No	Temperature	n/a	Temp./Turbidity	Temperature	n/a	Temp./Turbidity
	Chronic	No	No	n/a	No	Turbidity	n/a	No	No	n/a	Turbidity
Water Quality Handmeter Exceedance of BC Standards (Winter)	Acute	Turbidity	No	n/a	Turbidity	Turbidity	n/a	No	Turbidity	n/a	Turbidity
	Chronic	No	No	n/a	No	No	n/a	No	No	n/a	No
Water Quality Laboratory Exceedance of BC Standards (Summer)	Acute	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, E. coli, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, Zinc, E. coli, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, E. coli, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform
	Chronic	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Zinc, Ttl. Coliform	n/a	Copper, Zinc, Ttl. Coliform	Copper, Zinc, E. coli, Ttl. Coliform	n/a	Copper, Zinc, E. coli, Ttl. Coliform	Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform
Water Quality Laboratory Exceedance of BC Standards (Winter)	Acute	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, E. coli, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform
	Chronic	Copper, Zinc, Ttl. Coliform	Copper, Zinc, E. coli, Ttl. Coliform	n/a	Copper, Zinc, E. coli, Ttl. Coliform	Copper, Zinc, Ttl. Coliform	n/a	Copper, Zinc, E. coli, Ttl. Coliform	Copper, Zinc, Ttl. Coliform	n/a	Copper, Zinc, E. coli, Ttl. Coliform
Management Priority	MODERATE	HIGH	MODERATE	HIGH	HIGH	LOW	MODERATE	LOW	LOW		

Sites labelled "n/a" were not assessed for handmeter or laboratory water quality parameters according to budget/scope of study.

The City of Courtenay is not an outlier in the health of its watersheds described in this study, nor the management challenges that exist in moving towards achieving balance between municipal works and the health of the City's natural environments. Many municipalities across Vancouver Island and beyond are endeavouring to comprehend and amend the impacts associated with their activities by undertaking similar studies and enacting measures to reduce their impacts

A comprehensive, multi-disciplinary approach will be necessary to move the City of Courtenay into compliance with water quality guidelines and return degraded ecosystems back to a healthy condition with the implementation of best management practices for natural systems in urban environments. Many achievable opportunities exist to improve the City's interface with its natural systems and establish the City of Courtenay as a leader in progressive urban environmental stewardship.

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## 1.0 INTRODUCTION

Historically, many natural stream systems located in proximity to growing urban centers have been utilized as a means of transporting “storm water” away from urban areas into the environment (Walsh et al. 2004). As a result, many of these natural systems have been degraded by erosive forces associated with “flashy” flow conditions and high peak flows; reduced dry-season water availability and impaired climate change resilience as wetlands have been replaced by impermeable surfaces and streams have been channelized and hardened; and the introduction of pollutants associated with vehicle use, land use practices associated with agriculture and commercial/industrial properties, and disposal of household contaminants into drains and catch basins lethal to aquatic life.

Human interactions with the environment are, however: predictable, and in many cases our activities can be moderated, modified, or eliminated to result in mitigation, or in the best-case scenario, avoidance of impacts. Best management practices (BMP) for rainwater management have been evolving for many years. In 1992, Fisheries and Oceans Canada and the BC Ministry of Environment jointly produced *Land Development Guidelines for the Protection of Aquatic Habitat* (Chilibeck et al. 1992), followed in 2002 with *Stormwater Planning: A Guidebook for British Columbia* (MWLAP 2002) among many other documents. These BMP guidelines have been produced with the intention of providing, in part, a basis for and options to achieve integrated rainwater management and planning.

Locally, the City of Courtenay has been proactive in bringing the concepts of improved rainwater stewardship and climate action to the forefront by signing on to the Climate Action Charter in 2007, implementation of a Climate Action Strategy beginning in 2009, ongoing publicly available reporting on the Climate Action Revenue Incentive Program (CARIP) from 2013-2019, *City State of the Environment* Reporting (2013-2014), and partnering with other local municipal governments in a *Guide to Water Wise Land Development in the Comox Valley* (2016) produced to inform and direct small and large scale developers in their water management responsibilities.

The BC *Local Government Act* has obligated municipalities with the responsibility of managing their drainage infrastructure and with that, the liability for drainage patterns resulting in downstream impacts (MWLAP 2002). Legislatively, the City has produced formal strategies, bylaws, and environmental development permit areas with the focus of enacting many of the BMPs introduced in recent times and expanding upon laws and regulations developed by senior government, including the federal *Fisheries Act* and provincial *Riparian Areas Protection Regulation*.

Currently, the need for Integrated Rainwater Management Planning (IRMP) has been identified by the City to focus future land-use planning for the City’s growing population and expanding development footprint in a measured way that provides enhanced protection of aquatic and riparian habitat and private and municipal property.

## 2.0 BACKGROUND

This document prepared by Current Environmental Ltd., sub-contractor to Urban Systems, describes existing environmental conditions surrounding the City of Courtenay as they pertain to the ongoing management of rainwater infrastructure and in support of an overarching Integrated Rainwater Management Plan (IRMP). At-risk drainage catchments have been identified based on an assessment of the following study components:

1. Overview, Information Gathering and Mapping
2. Riparian Corridor Assessment
3. Aquatic Species and Habitat Inventory – Freshwater & Estuarine/Marine
4. Species at Risk
5. Terrestrial Species and Habitat Assessment
6. Benthic Community Assessment
7. Water Quality Assessment

Based on the specific characteristics of at-risk catchments and limiting factors to productivity, recommendations for improving degraded habitat conditions have been provided where relevant. Overall, the purpose of this study is to identify key areas of environmental impact resulting from existing rainwater management and propose measures to improve the existing systems under the City's authority or recommend new ones.

## 3.0 METHODOLOGY (OVERVIEW, INFORMATION GATHERING, AND MAPPING)

Information gathering on the various species and habitats encountered within City of Courtenay municipal boundaries has been derived from various online and printed resources available from municipal, provincial, and federal databases and libraries.

In general, existing information gathered on study parameters have been obtained from the following sources:

1. City of Courtenay Environmental Publications;<sup>1</sup>
2. BC Conservation Data center (CDC);
3. Wildlife Tree Stewardship Atlas (WiTS);
4. Sensitive Ecosystem Inventory (SEI);
5. Sensitive Habitat Inventory and Mapping (SHIM);
6. Comox Valley Regional District iMap;
7. Species at Risk Act (SARA) database;
8. Species at Risk & Local Government database;
9. Ministry of Environment BC Species and Ecosystems Explorer;
10. Fisheries Inventory Data Query (FIDQ);
11. Aerial photographs.

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<sup>1</sup> <https://www.courtenay.ca/EN/main/community/environment/publications.html>;  
<https://www.courtenay.ca/EN/main/community/environment.html>

### 3.1 STUDY BOUNDARIES

The overall study area was established according to 2019 City of Courtenay municipal boundaries (Figure 2). Within the study area environmental aspects have been divided at watershed level to reflect specific conditions encountered in each aquatic system as they are each subject to unique land-use factors. As a result, the following watersheds and aquatic receptors (in the case of the marine environment of Comox Harbour) are detailed in this study:

1. Puntledge River
2. Tsolum River (inc. Portuguese Creek sub-basin)
3. Morrison Creek
4. Millard/Piercy Creek
5. Glen Urquhart Creek
6. Courtenay River Estuary
7. Comox Harbour<sup>2</sup>

A description of specific sampling locations for benthic invertebrates and water quality within these catchment areas are detailed in Section 4.3.1.

### 3.2 RIPARIAN CORRIDOR

The City of Courtenay has been active in expanding their management of trees within internal operations and private development proposals with enactment of the *City's Tree Protection and Management Bylaw No. 2850 (2016)*, adopting an *Urban Forest Strategy* land-use concept (2019), as well as enrolling in a 2018 pilot project with the Municipal Natural Assets Initiative (MNAI) for the application of natural assessment management in the City.

This riparian corridor assessment considers factors supporting ecosystem health and integrity and includes a discussion of the influences that urban development has on them. Fish presence and impervious surface area per rainwater catchment are included as indicators of watershed health.

In addition to a watershed level analysis of impacts, each stream riparian area in the study area has been assessed based on urban impacts vs. retained natural settings within a 30 m riparian assessment corridor; based in part on provincial *Riparian Areas Protection Regulation* assessment methods and the City's Environmental Development Permit areas. Results provide percent impervious areas, as well as qualitative categorization (Section 4.1.2) leading to a discussion of recommended management practices and resource objectives (Section 5).

Confirmed and Unconfirmed Fish Presence data is available for streams within the study area accessed from the Comox Valley Regional District (via Project Watershed mapping initiative).<sup>3</sup> This data has been used to calculate percentage available mainstem and tributary habitat (excluding ditches) of watersheds within the study area. This metric provides an indication of physical, urban constraints (e.g. perched culverts) limiting fish access to otherwise potentially beneficial aquatic habitats implicated in reductions of fish productivity in Courtenay's watersheds (Section 4.1.1).

<sup>2</sup> Study parameters for Comox Harbour are limited to species inventories (aquatic/terrestrial/at-risk) as no saline water quality or benthic species assessments were within the scope of this assessment.

<sup>3</sup> <https://www.comoxvalleyrd.ca/about/about-cvrd/imap>

Analysis of fish presence has been calculated using a percentage of fish-bearing stream length (m) by watershed within the City limits using ArcGIS software and CVRD Sensitive Habitat Atlas (SHA)–Watercourse information. Percent impervious surface area within City watershed boundaries has been calculated from satellite imagery and analyzed using desktop programs Geomatica Focus and ArcGIS to create a classification map separating and identifying land cover types (Figure 2).

### 3.3 AQUATIC HABITATS AND SPECIES

Criteria for determining and describing aquatic areas and potential urban influences on identified features have been based primarily on the BC *Riparian Areas Protection Regulation Technical Assessment Manual v. 1.1*<sup>4</sup>, the Resources Inventory Committee of British Columbia *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures* Version 1.1<sup>5</sup>, City of Courtenay Environmental Development Permit Areas<sup>6</sup>, and from the project biologist’s previous experience in liaising with local government and Federal and Provincial agency staff.

### 3.4 TERRESTRIAL HABITATS AND SPECIES

Survey methods for terrestrial elements or ESA’s included those outlined in *Environmental Objectives, Best Management Practices and Requirements for Land Developments*<sup>7</sup>, *Environmental Best Management Practices for Urban and Rural Land Development in British Columbia*<sup>8</sup>, and the *Field Manual for Describing Terrestrial Ecosystems*<sup>9</sup>.

### 3.5 SPECIES AT RISK

An office-based assessment of Species at Risk occurrences on the subject property was completed using the *CDC Mapped Known Locations of Species and Ecological Communities at Risk*<sup>10</sup>, *BC Species and Ecosystems Explorer*<sup>11</sup>, and the *Federal Species at Risk Public Registry*<sup>12</sup>.

### 3.6 BENTHIC SPECIES

Benthic invertebrates are species that colonize the bottom substrates and water column of streams. The richness (diversity) and types of species present can be used as reliable indicators of ecosystem health. Benthic samples were collected between Sept. – Oct. 2019, following Metro Vancouver’s Monitoring and Adaptive Management Framework (MAMF)<sup>13</sup> protocols and guidance from Page, N. *et al.* (2008)<sup>14</sup>.

Benthic sampling coincided with summer (low flow) water quality sample collection efforts described in Section 3.7 at WQ/Benthic sample locations shown in Figure 1 and detailed in Section

<sup>4</sup> [https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/fish-fish-habitat/riparian-areas-regulations/rapr\\_assessment\\_methods\\_manual\\_for\\_web\\_11.pdf](https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/fish-fish-habitat/riparian-areas-regulations/rapr_assessment_methods_manual_for_web_11.pdf)

<sup>5</sup> Resource Information Standards Committee. (1999). *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures*. Retrieved from <<http://www.ilmb.gov.bc.ca/risc/pubs/aquatic/sitecard/sitecard.pdf>>.

<sup>6</sup> <https://www.courtenay.ca/EN/main/departments/development-services/planning-division/development-permits.html>

<sup>7</sup> BC Ministry of Environment Lands and Parks, 2001

<sup>8</sup> BC Ministry of Environment, Draft 2005

<sup>9</sup> BC Ministry of Environment Lands and Parks and BC Ministry of Forests - Research Branch, 1998

<sup>10</sup> <http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/conservation-data-centre/explore-cdc-data/known-locations-of-species-and-ecosystems-at-risk>

<sup>11</sup> <http://a100.gov.bc.ca/pub/eswp/>

<sup>12</sup> [http://www.sararegistry.gc.ca/species/default\\_e.cfm](http://www.sararegistry.gc.ca/species/default_e.cfm)

<sup>13</sup> Metro Vancouver. (2014). *Monitoring and Adaptive Management Framework for Stormwater*. Accessed from <[http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/Monitoring\\_Adaptive\\_Management\\_Framework\\_for\\_Stormwater.pdf](http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/Monitoring_Adaptive_Management_Framework_for_Stormwater.pdf)>.

<sup>14</sup> Page, N. A., L. S. Fore, M. Eymann, and C. Johnston. (2008). *Assessment of the use of B-IBI in Greater Vancouver streams (2003–2006)*. Report prepared for Metro Vancouver. 58 pp. + appendices.

4.3.1. Benthic sampling consisted of 3 Surber placements (3 jars with 3 replicates per jar) collected using a 500-micron Surber sampler. Samples were shipped to Biologica Environmental Services in Victoria, BC and were processed on Oct. 11, 2019 with analysis results received in January 2020 that include:

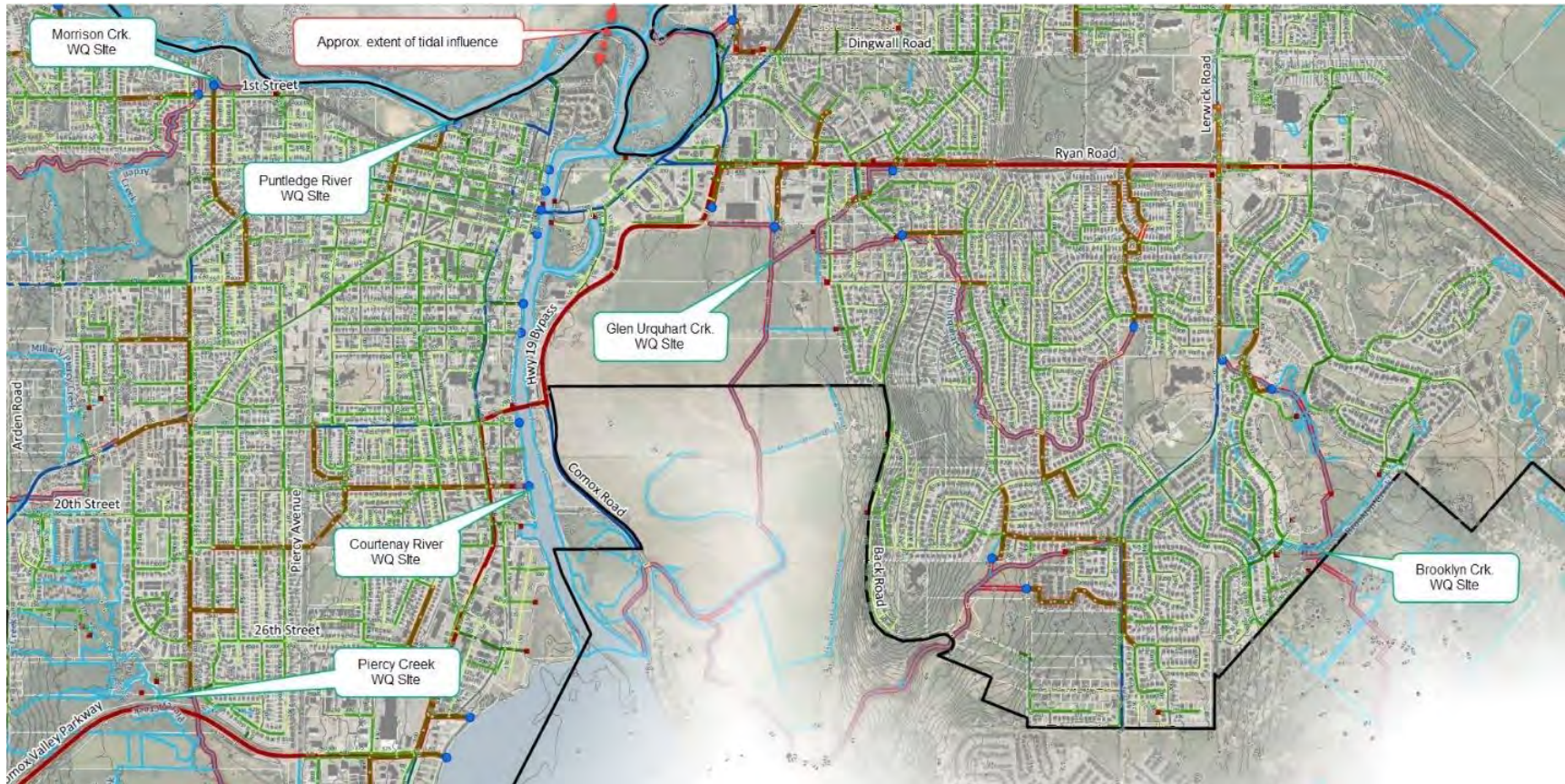
1. Samples identified to lowest practical taxonomic level (Washington 1996 standard) as indicators of small urban watershed health including human disturbances.
2. A 10-metric Benthic Index of Biological Integrity (B-IBI) score calculated for each sample. The B-IBI “combines measures of taxa richness and relative abundance for key groups of benthic invertebrates such as tolerant taxa, predator taxa, and long-lived taxa. B-IBI is used as an indicator of stream condition.”<sup>14</sup>

According to lab results from Biologica Environmental Services Ltd. (Appendix D) laboratory methods included:

Data were compiled in an excel spreadsheet. Incidental organisms (e.g., pupae, Collembola, terrestrial insects) were reported separately. These data were entered into Biologica’s database and completely double-checked for entry errors.

The multi-metric benthic index of biological integrity (B-IBI) was calculated based on the following metrics after Karr and Chu (1999), Morely (2002) and Page et al. (2008):

- Total number of unique taxa
- Total number of unique mayfly (Ephemeroptera) taxa
- Total number of unique stonefly (Plecoptera) taxa
- Total number of unique caddisfly (Trichoptera) taxa
- Number of long-lived taxa (organisms living a minimum of 2-3 years in the immature state)
- Number of intolerant taxa
- Percent of predatory individuals
- Number of clinger taxa
- Percent dominance: the percent of individuals in the three most dominant taxa.



**Figure 1. Water quality and benthic invertebrate sample locations collected in the City of Courtenay in Sept.-Oct. 2019 to characterize water quality and aquatic stream health conditions in support of the City's Integrated Rainwater Management Plan.**

### 3.7 WATER QUALITY

Both hand-meter data and laboratory analysis of water quality were collected through summer (Sept. – Oct. 2019) and winter (Jan. – Feb. 2020) periods to reflect low- and high-flow conditions, respectively. In some cases, target summer sampling sites did not begin to flow until the first freshet in early September, which was set as the point of commencement for the sampling program.

#### 3.7.1 Laboratory analysis

BC Approved Water Quality Guidelines (BCWQG) for long-term chronic (i.e. “average”) conditions “are intended to protect the most sensitive species and life stage against sub-lethal and lethal effects for indefinite exposures”.<sup>15</sup> The long-term BCWQG approach allows for fluctuations above and below established standards provided that acute (“short-term”) levels are not exceeded and long-term chronic levels are met over the study period. The standard BCWQG frequency of 5 samples over 30 days has been targeted for both summer and winter sampling periods to establish long-term seasonal averages, and to identify possible acute exceedances at 6 rainwater effluent sites into the 6 primary freshwater streams within the study area (Figure 1; Section 4.3.1). A discussion of results for both chronic and acute analyses is provided in Section 5.4.2.

Water quality sample collection for lab analysis has followed Metro Vancouver’s Monitoring and Adaptive Management Framework (MAMF)<sup>13</sup>, that has included the following tasks:

1. Collection and measurement of 5 WQ samples from 6 streams over a 30-day period in both summer 2019 (low flow) and winter 2020 (high flow) periods.
2. Lab analyses have been carried out for *E. coli*, fecal coliform, nitrate, and total metals.<sup>16</sup>
3. Hand-meter field measurements have been collected for water temperature, dissolved oxygen, pH, conductivity, and turbidity.<sup>17</sup>
4. Results have been compared against Provincial *Water Quality Guidelines for Aquatic Life* or where provincial standards are not available, federal Canadian Council of Minister of the Environment (CCME) *Water Quality Guidelines for the Protection of Aquatic Life*.<sup>18</sup>

#### 3.7.2 Hand-meter data collection

Hand-meter sample parameters were selected based on effects to salmonid and other environmentally sensitive organisms that included temperature (°C), dissolved oxygen (mg/L), pH, turbidity (NTU), and specific conductivity (µS/cm). The instruments used to collect this data include an *Oxyguard Handy Polaris* meter for Dissolved Oxygen (mg/L), *Eutech Instruments pHTestr 30* for pH and Temperature (°C); a *Hanna Combo* meter for Conductivity (µS/cm); and a *LaMotte 2020e* Turbidity<sup>17</sup> (NTU) meter.

The following is a brief description of how these parameters affect the health of aquatic organisms according to limits prescribed by *RISC Guidelines for Interpreting Water Quality Data*<sup>19</sup>:

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<sup>15</sup> [https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg\\_summary\\_aquaticlife\\_wildlife\\_agri.pdf](https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf)

<sup>16</sup> With total iron, cadmium, copper, lead, and zinc being of interest to benthic and other aquatic organism health.

<sup>17</sup> During the period of Sept. 12- Oct. 1 the hand-meter was unavailable and turbidity analysis was completed by ALS laboratories from unpreserved nitrate sample bottles prior to nitrate analysis. The *LaMotte 2020e* Turbidity meter was used for subsequent measurements.

<sup>18</sup> <http://st-ts.ccme.ca/en/index.html?chems=all&chapters=1&pdf=1>

<sup>19</sup> Resource Information Standards Committee. Guidelines for Interpreting Water Quality Data. Accessed from <<http://www.ilmb.gov.bc.ca/risc/pubs/aquatic/interp/index.htm>>.

- **Temperature** affects the solubility of many chemical compounds and can therefore influence the effect of pollutants on aquatic life. Increased temperatures, in conjunction with reduced oxygen solubility, elevate the metabolic oxygen demand of many species, and in effect cause suffocation. Temperatures in excess of 18-19 °C when averaged over 7 days are considered lethal to salmonids.
- **Dissolved Oxygen** is essential to respiratory metabolism of most aquatic organisms. It affects the solubility and availability of nutrients, and therefore the productivity of aquatic ecosystems. Bacterial mediated decay of excess organic material in water consumes oxygen and can lead to eutrophic conditions. Levels below an instantaneous minimum of 5 mg/L and 30-day mean of 8 mg/L may be lethal to salmonids.
- **pH** Most freshwater systems have a natural pH range of 6 to 8 and minimum critical limits for aquatic life occur at 4.5 and a maximum of 9.5 units. When pH approaches or goes below 5, fish populations can begin to die-off and undesirable growth of plankton and semi-aquatic plants can occur that also cause decreased oxygen availability through the process of eutrophication. In an acidic environment, metal ions can also be leached into the water (e.g. Al<sup>3+</sup>) that have negative health effects on fish. Conversely, high alkalinity can damage fish gills, eyes, and scales, and eventually result in death of fish and aquatic invertebrates. High pH can also enhance the toxic effects of other substances in the environment (e.g. NH<sub>3</sub>).
- **Turbidity** is a measurement of the suspended particulate matter in a water body. Physiological effects of turbidity on salmonids include gill trauma, increased blood glucose, plasma glucose, plasma cortisol, and osmoregulatory ability<sup>20</sup>. Physiological stress in salmonids may decrease immunological competence, growth, and reproductive success. In addition, high turbidity impairs photosynthesis of aquatic primary producers that may in turn suppress fish productivity. Criteria for conditions affecting freshwater aquatic life occur with an 8 NTU increase at any time for 24 hrs., a 5 NTU change when background is 8-50 NTU, or a 10% increase when background is > 50 NTU.
- **Specific Conductivity** may be used to estimate the total ion concentration of the water and is often used as an alternative measure of dissolved solids. As such, it is generally used as a broad-scope tool to detect changes to water chemistry. In general, natural waters are found to vary between 50 and 1500 µS/cm, and coastal streams in BC have specific conductivity values of about 100 µS/cm.<sup>21</sup>

## 4.0 RESULTS

The following summary of results represents a baseline assessment of existing conditions in six select sub-basins that makeup much of the City of Courtenay land-base. These watersheds, although treated separately in order to help identify discrete issues that may be affecting them individually, are connected by the common threads of overarching City management practices and their ultimate downstream discharge into the ecologically sensitive receiving waters of the Courtenay River and Comox Harbour.

<sup>20</sup> Bach, J., Berman, C., & Bolton, S. (2001). Effects of Turbidity and Suspended Solids on Salmonids. Centre for Streamside Studies. University of Washington. Pp 10. Retrieved on Feb 14, 2011 from <[http://www.krisweb.com/biblio/gen\\_uofw\\_bashetal\\_2001.pdf](http://www.krisweb.com/biblio/gen_uofw_bashetal_2001.pdf)>.

<sup>21</sup> Resource Information Standards Committee (1998). Guidelines for Interpreting Water Quality Data. Land use task force. Prepared by Ministry of Environment, Land Data BC, Geographic Data BC. Retrieved on Feb 14, 2011 from <<http://www.ilmb.gov.bc.ca/risc/pubs/aquatic/interp/index.htm>>.

A condition or impact highlighted in one watershed does not necessarily mean that other watersheds are not vulnerable to similar fates, but instead is intended to be an indicator of conditions that could develop in other areas of the system if left unmonitored.

Multi-season field data collection covers summer/fall 2019 and winter 2020 for all watershed health indicators introduced in the previous section. Discussion and interpretation of these results is provided in Section 5 with recommendations and conclusions described in Sections 6.

#### **4.1 RIPARIAN CORRIDOR**

Within urban environments riparian corridors provide critical habitat functions for myriad terrestrial and aquatic species as well as ecosystem services for humans. A healthy riparian corridor contains a high level of native species diversity and intact canopy and understory cover. Riparian corridors are preferentially used by many nesting bird species; migrating mammals including deer, bear, cougars, amongst many others; while aquatic life proliferates in streams surrounded by intact riparian vegetation.

Riparian corridors are not limited to streams alone but also include areas of wetland. Land-use changes associated with urbanization have particularly detrimental effects on wetlands because of their locations in relatively flat low-land positions hydrologically linked with other ecosystems, and because of their exposure to downstream effects from habitat alteration in the wider watershed (Faulkner 2004). Wetlands are important buffers against urban impacts as they have the capacity to help absorb peak flows and pollutants associated with impermeable cover (i.e. hard surfaces such as roads and buildings).

Streams receiving water from areas of impervious surfaces experience elevated water temperatures (Walsh et al. 2004). Furthermore, clearing of native riparian vegetation and subsequent replacement with impervious surfaces removes shading that can exacerbate already higher temperatures and often leads to the introduction of invasive species. As introduced in Section 3.7.2, increased water temperatures enhance the impacts of pollutants on aquatic life and decrease oxygen solubility that can lead to lethal conditions for fish.

##### **4.1.1 Fish Presence**

Fish presence is a measure of stream health as it indicates that aquatic and riparian conditions are sufficiently healthy to maintain a population of fish sensitive to substantial changes in watershed condition. The absence of fish can be the result of barriers to migration such as improperly placed culvert crossings or extensive areas of stream converted into underground pipes, or the presence of water quality conditions that do not support life including higher temperatures or presence of pollutants described in the previous section.

The following Table 1 and Figures in Appendix B show percent availability of urban stream channels (i.e. within City of Courtenay boundaries<sup>22</sup>) to fish migration. Stream channels where fish presence is unconfirmed are often the result of human-made barriers to fish migration by way of perched culverts or other stream bed modifications (e.g. Photo 1).

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<sup>22</sup> Note that stream lengths and subsequent % Fish Bearing status is limited by study area boundaries within the confines of the City of Courtenay and are not meant to provide a comprehensive percentage of overall stream lengths that may continue into other jurisdictions.

**Table 1. Fish presence/absence by channel length used as an indicator of watershed health in the City of Courtenay.**

Existing Conditions: Watershed Health as Represented by Fish Presence			
All Systems (including tributaries but not ditches)			
Watercourse	Sensitive Habitat Atlas	Confirmed Fish Presence	% Fish Bearing
	Length (m)	Length (m)	
Brooklyn Creek	5,680	0	0
Courtenay River	7,222	7,222	100
Glen Urquhart Creek	7,247	4,047	56
Little River	16,593	13,705	83
Millard Piercy Creek	24,983	22,832	91
Morrison Creek	5,533	4,825	87
Portuguese Creek	7,394	866	12
Puntledge River	3,271	3,271	100
Tsolum River	5,146	3,485	68



**Photo 1. Example of a perched culvert installation (Glen Urquhart Creek at 10<sup>th</sup> St. E.) acting as a barrier to fish migration and contributing to limited fish productivity in urban stream channels.**

Major fluvial systems free of barriers to fish passage, within study area boundaries, are considered 100% fish bearing and include the Courtenay River, and Puntledge River. Three systems: Little River, Millard/Piercy, and Morrison Creek have confirmed fish presence in 80-95 % of their lengths in the study area. Glen Urquhart and Tsolum River (influenced heavily by its tributaries) are in the 50-70 % range for fish passage. Portuguese Creek and Brooklyn Creek are in the lowest range at 12% and 0%, respectively. Brooklyn Creek is shown at the low end as a result of only the heavily modified headwaters channels on Crowne Isle being within the City boundaries. Although Brooklyn Creek is listed as 0 % fish bearing it is known that the mainstem channel east of Parry Place within the Town of Comox is fish bearing throughout its remaining ~6 km length.

#### 4.1.2 Watershed Impervious Area

Both total impervious area and riparian corridor impervious area are important measures of watershed health as the total area relates water catchment from rainwater infrastructure that is ultimately conveyed to natural streams, while impervious surfaces within riparian corridors relate to both direct rainwater inputs as well as overall ecosystem health.

As described in Section 3.2, satellite imagery has been analyzed using GIS and Geomatica Focus desktop applications to calculate the percentage of impervious surface area used to characterize the level of general urban impacts within municipalities, watersheds, and user defined geographic areas (i.e. *RAPR* assessment and City EDP areas).

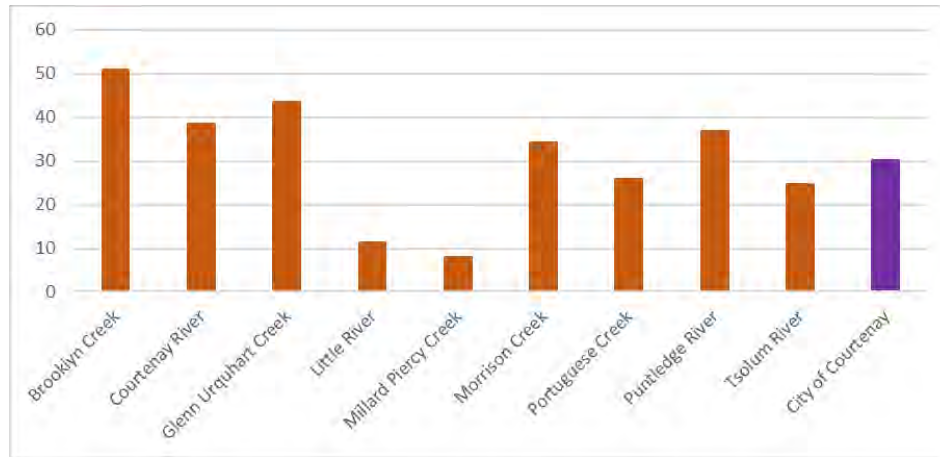
Scheuler (1994) has proposed a stream quality index based on percent impervious surfaces that correlate to habitat quality for fish habitat, aquatic insects, and plant and amphibian density according to the matrix in Table 2.

**Table 2. Stream quality index based on percent impervious surfaces and recommended management strategies to achieve resource objectives (adapted from Scheuler 1994).**

Stream classification based on impervious cover and recommended management strategies to meet resource objectives (Scheuler 1994)			
% Watershed Covered in Impervious Surface	Predicted Stream Quality	Resource Objective	Management Strategy
1-10	Sensitive	Pre-development stream quality at risk of impact. Protective measures for riparian corridors and strict management of development and City stormwater practices required.	Strict zoning, site impervious restrictions, stream buffers and stormwater practices are applied to maintain pre-development stream quality.
11-25	Impacted	Above the threshold for maintenance of pre-development stream quality and can be expected to experience some degradation after development (i.e., less stable channels and some loss of diversity).	Mitigate Impacts to the greatest extent possible, using effective stormwater management practices.
26-100	Non-supporting	Pre-development channel stability and biodiversity cannot be fully maintained, even when stormwater practices or retrofits are fully applied.	Protect downstream water quality by removing urban pollutants. Employ intensive stream restoration techniques.

**Table 3. Impervious surface area calculations by watershed in the City of Courtenay.**

Existing Conditions: Impervious Cover within City Watersheds				
Watershed	Watershed Area w/n City of Courtenay (ha)	Impervious Surfaces (ha)	% Watershed Covered in Impervious Surface	Predicted Stream Quality (Scheuler 1994)
Brooklyn Creek	161.6	82.2	50.9	Non-supporting
Courtenay River	836.3	321.6	38.5	Non-supporting
Glenn Urquhart Creek	568.2	247.3	43.5	Non-supporting
Little River	646.4	72.7	11.3	Impacted
Millard Piercy Creek	475.7	38.0	8.0	Sensitive
Morrison Creek	134.9	46.2	34.2	Non-supporting
Portuguese Creek	230.3	59.5	25.8	Non-supporting
Puntledge River	227.2	83.5	36.8	Non-supporting
Tsolum River	353.3	87.0	24.6	Impacted
City of Courtenay	3,376.4	1,018.4	30.2	Non-supporting



**Chart 1. Impervious surface area calculations by watershed in the City of Courtenay.**

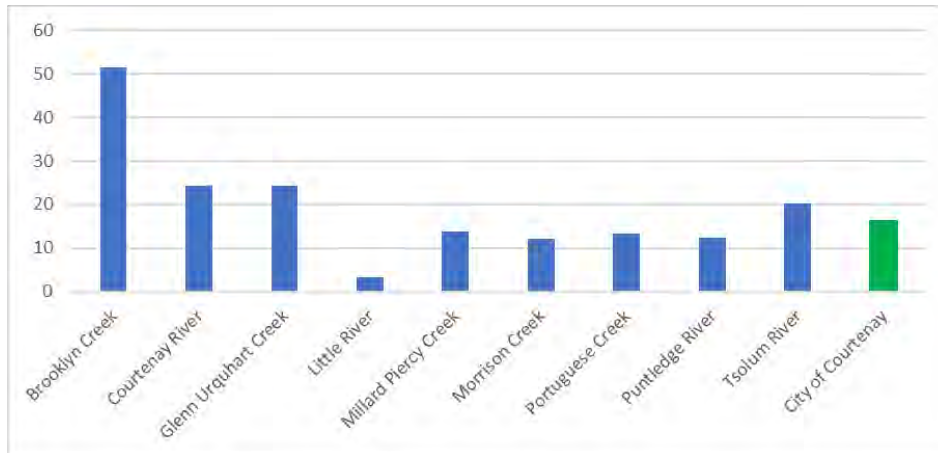
Overall, the City contains approximately 30.2 % impervious cover at slightly over 1,000 ha, and within riparian corridors the City contains 16.1 % impervious cover or 70 ha. The watershed with the highest percentage of impermeable surfaces by total land area in the City is Brooklyn Creek at 50.9 % and the lowest is Millard/Piercy at 8.0 %. Based on the Scheuler (1994) stream quality index, the majority of the study watersheds are considered *Non-supporting*, while only Little River and Tsolum River are considered *Impacted*, and Millard/Piercy is *Sensitive* (Table 3).

Analysis of impervious surfaces within riparian corridors show that Brooklyn Creek also has the highest percent impervious cover at 51.57 % and Little River the lowest at 3.22 % (Table 4). The balance of the study watersheds resides in the 12-24 % range of cover converted to impervious area.

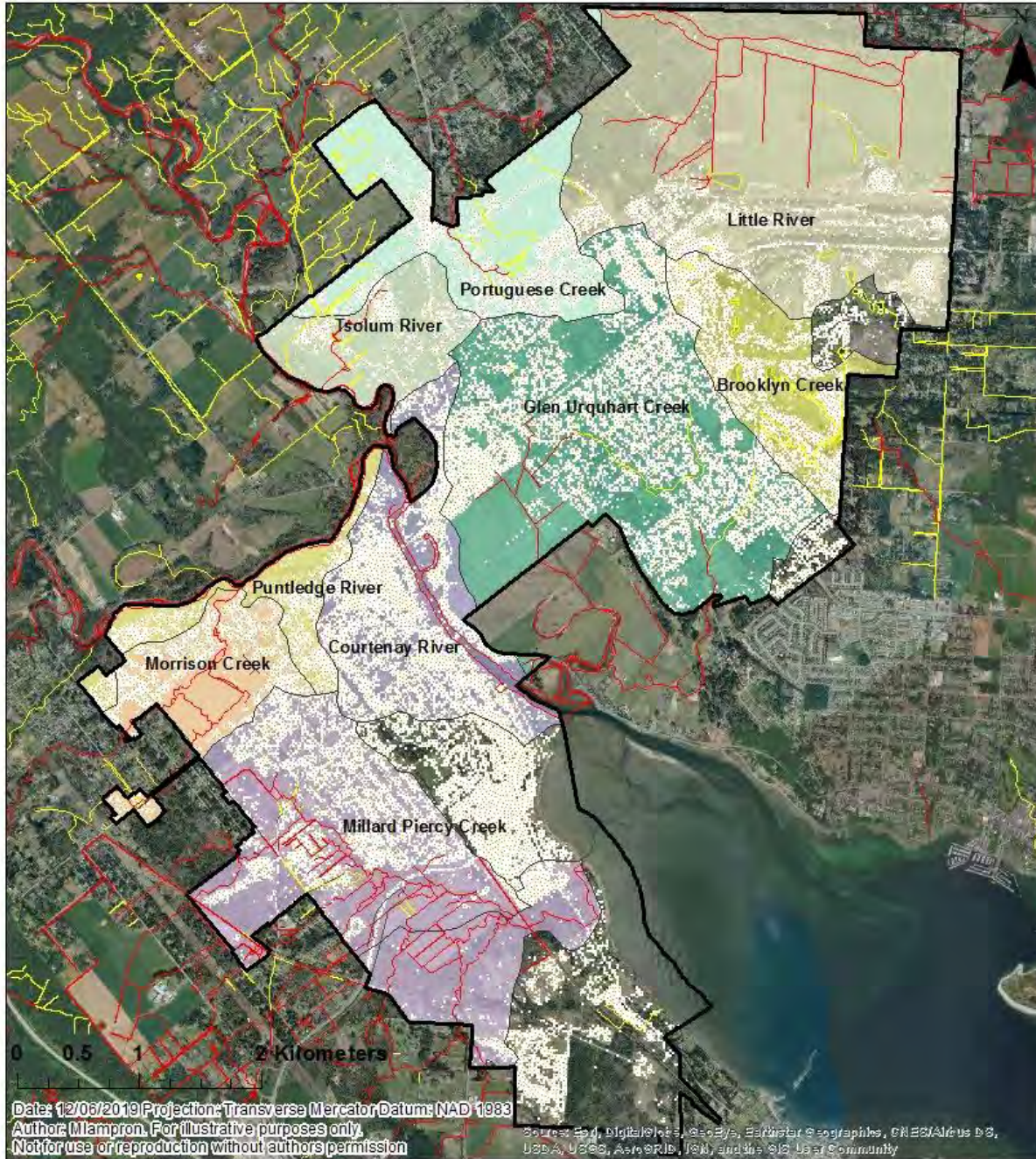
**Table 4. Impervious surface cover area calculations by stream riparian corridor (w/n 30 m from stream banks) in the City of Courtenay.**

Existing conditions: Impervious cover within Riparian Corridors			
Watercourse	Total Riparian Corridor Area (ha)*	Total Impervious Cover (ha)	% Impervious Cover
Brooklyn Creek	28.7	14.8	51.57
Courtenay River	36.6	8.9	24.32
Glenn Urquhart Creek	42.8	10.4	24.30
Little River	93.1	3	3.22
Millard Piercy Creek	126.3	17.5	13.86
Morrison Creek	26.5	3.2	12.08
Portuguese Creek	40	5.3	13.25
Puntledge River	15.5	1.9	12.26
Tsolum River	26.1	5.3	20.31
City of Courtenay	435.6	70.3	16.1

\*Note that Puntledge River, Tsolum River, and Courtenay River have been separated from tributary channels (e.g. Tsolum River and Portuguese Crk.)



**Chart 2. Impervious surface cover area calculations by stream riparian corridor (w/n 30 m from stream banks) in the City of Courtenay.**



### Impervious surface and fish passage assessment of major watersheds in the City of Courtenay



- Legend**
- City of Courtenay Boundary
  - Confirmed Fishbearing Watercourses
  - Unconfirmed Fishbearing Watercourses
  - Ditches
  - Impervious Surface
  - Portuguese Creek Watershed
  - Tsolum River Watershed
  - Millard Piercy Creek Watershed
  - Morrison Creek Watershed
  - Puntledge River Watershed
  - Little River Watershed
  - Brooklyn Creek Watershed
  - Courtenay River Watershed
  - Glen Urquhart Creek Watershed

**Figure 2. Overview site map of watersheds within the City of Courtenay including confirmed (red line) vs. unconfirmed (yellow line) fish presence attributed in part to anthropogenic barriers (e.g. perched culverts), and impervious surface analysis (white shading).**

#### 4.1 AQUATIC HABITATS AND SPECIES

BC Fish Inventory Data Queries (FIDQ) provide individual watershed fish presence data based on provincial and federal enhancement and management records, escapement data, and summaries of fish observations. These data have been summarized in the following tables for each subject stream in the City of Courtenay study area. Comments on provincial/federal Species at Risk (SAR) status have been provided for each species where relevant, while a separate, comprehensive SAR table is provided in Appendix A.

Known terrestrial, aquatic and species at risk for each watershed in the City can also be found in Appendix A. Due to the extremely high diversity of marine invertebrate species in the Comox Harbour, the tables below include only at-risk marine invertebrates and most common, charismatic species, as per the *Courtenay River Estuary Management Plan (2000)*.<sup>23</sup>

#### 4.2 TERRESTRIAL HABITATS AND SPECIES

Terrestrial species presence is based in part on likelihood of species occurrences within the Coastal Western Hemlock maritime subzones, encompassing all of the rivers and estuarine/ harbour habitats within the study area (Appendix A). To avoid repetition, all species which are exclusively marine are listed in the Comox Harbour tables under the previous heading.

The Coastal Western Hemlock Eastern Very Dry Maritime (CWHxm1) biogeoclimatic zone variant is restricted to elevations between sea level and 900 m in areas subject to the rainshadow of Vancouver Island and the Olympic Range, and is characterized by warm, dry summers with temperatures moderated by proximity to the ocean; and mild, wet winters with very little snowfall. According to Pojar, Klinka, & Demarchi (1991)<sup>24</sup>, CWH forest cover is dominated by mixtures of western hemlock and western red cedar with increases in the frequency of Douglas fir south of roughly 53°N latitude. As well, there are occurrences of grand fir and big leaf maple in the warmer, and drier, southern areas of the zone such as those found in and around the City of Courtenay. Regionally common but globally rare red alder/slough sedge/skunk cabbage wetlands<sup>25</sup> cover many of the semi-aquatic areas in the study area that are not inhabited by terrestrial forest stands. Other floristic features of this CWH ecosystem include a sparse herb layer and predominance of several moss species.

Although coastal western hemlock is often the dominant species in this BGC zone the forest inhabiting non-riparian areas in and around the study area are often dominated by Douglas fir and grand fir, typical of drier maritime subzones. Aspects of the south-eastern Vancouver Island CDFmm variant are also represented in the Courtenay region with the sporadic presence of arbutus, Garry oak, and Douglas fir ecosystems.

#### 4.3 BENTHIC SPECIES

As described above, benthic species collection was completed in the 6 indicator streams around the City of Courtenay where existing urban rainwater inputs are expected to have a pronounced effect on species health and diversity. Analysis results were obtained from Biologica Environmental Services Ltd. in January 2020. Additional parameters collected in conjunction with benthic

<sup>23</sup> <https://waves-vagues.dfo-mpo.gc.ca/Library/314594.pdf>

<sup>24</sup> <https://www.for.gov.bc.ca/hfd/pubs/docs/Srs/Srs06/chap6.pdf>

<sup>25</sup> *Alnus rubra/Carex obnupta* Ecological Community. Provincially red-listed (B.C. List Status) and Globally Critically Imperiled (Global Conservation Status). Retrieved from <<http://a100.gov.bc.ca/pub/eswp/search.do>>

sampling included water quality (both laboratory and grab sample; Section 4.4) and physical site descriptions, the latter as shown in the below table.

### 4.3.1 Sample Site Description

As mentioned, water quality and benthic sampling sites shared common locations (Figure 1). These sites were selected based on their position at the interface between “natural”<sup>26</sup> stream channels and City stormwater infrastructure. These sites are intended to represent the condition of stream habitats at the point of impact from flows exposed to the impermeable surfaces, storm infrastructure, and land-uses of the immediate catchment area funneling into the sample locations.

Sample sites are intended to be an indicator of stream health that can potentially be traced to upstream point sources or land-use types and specific recommendations to remediate any identified issues connected with limiting factors are provided in Section 6. Table 5 below provides a site by site description of sample site physical characteristics while the following sub-sections provide additional context of the catchments providing flow into these areas.

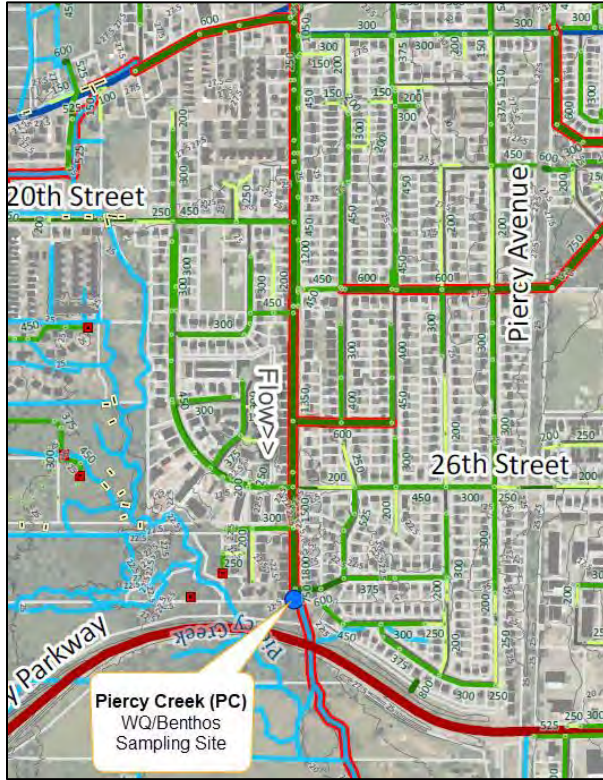
**Table 5. Physical site conditions during summer (Sept. 25 – Oct. 9, 2019) benthic sampling.**

Summer Benthos (Sep. 25 - Oct. 9, 2019)						
Sample Location	PC	CR	MC	PR	GU	BC
Date	01-Oct-19	01-Oct-19	25-Sep-19	01-Oct-19	09-Oct-19	09-Oct-19
BFW (m)	4.2	5.1	9.1	13.4 (sidechannel)	3.3	4
Wetted Width (m)	3.4	3.1	9.1	13.4	2.2	3.1
Riffle Depth (cm)	9; 12; 12	10; 13; 13	14; 10; 8; 6	35; 53; 48	7; 6; 16	4; 4; 4
Embeddedness (%)	0 (loose gravel) Loose	10 (cobble/boulder) 50 (gravel)	50 (gravel)	30-100 (cobble) 50 (gravel)	0 (loose gravel) to 100 cobbles at dst end	0-100 (loose gravel and cobble veneer w/ fully embedded gravel below)
Substrate	100% gravel	50% cobble 40% gravel 10% fines	50% gravel 50% fines	cobble, gravel, sand	40% sand 30% cobble 30% gravel	50% hardpan 10% gravel 20% cobble 10% fines 10% boulder
Canopy	90% (deciduous)	80-90% (deciduous)	80-90% (deciduous)	only on RB 10.3 m depth of overhang	40 % LB only RB cleared lawn	100 % deciduous understory w/ coniferous canopy
Photos x 4	DS	DS	DS	DS	DS	DS
GPS	394 - 440	395 - 445	-	441 - 442	453-454	455-456

<sup>26</sup> Because of proximity to storm infrastructure and urban modifications many of the sample site streams have been modified or impacted by human activity over long periods of time and do not represent an undisturbed condition but do show characteristics of “natural” stream systems with the presence of stream bed and bank substrates, riparian vegetation cover, and wildlife access.

4.3.1.1 Piercy Creek (PC)

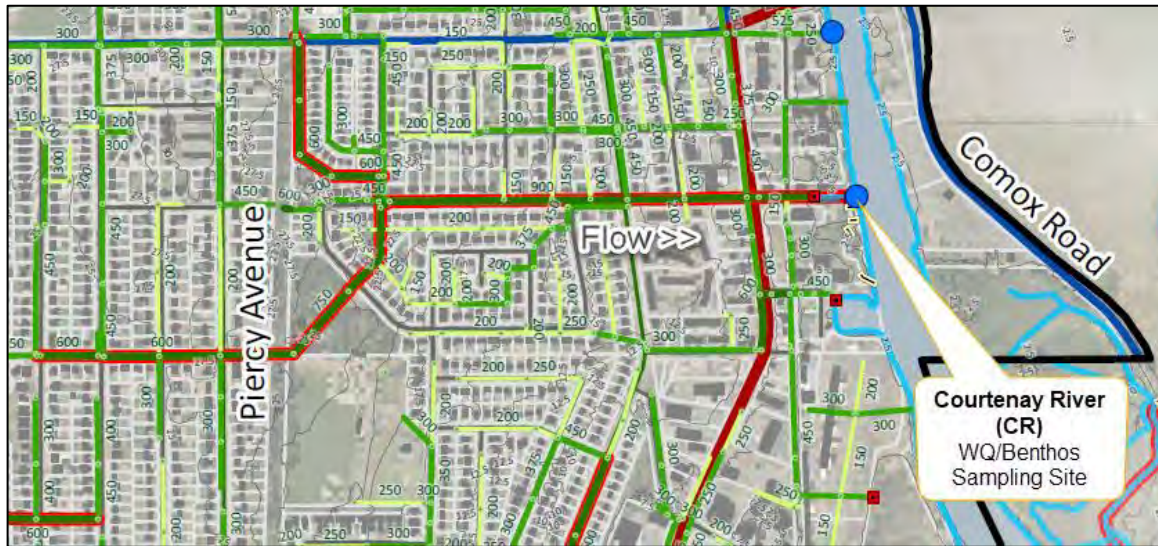
The Piercy Creek sample site is located at the south end of Marsden Road at the downstream discharge point of the storm catchment area extending approximately from 20<sup>th</sup> St. in the north to parts of Piercy Ave. and 26<sup>th</sup> St. in the east and the industrial/commercial area of Cousins Road to the west (Inset 1).



**Inset 1. City map of stormwater infrastructure (above) showing character of approximate upstream catchment area and photos of the Piercy Creek sample site looking upstream (top right) and downstream (bottom right) on Jan. 10, 2020.**

4.3.1.2 Courtenay River (CR)

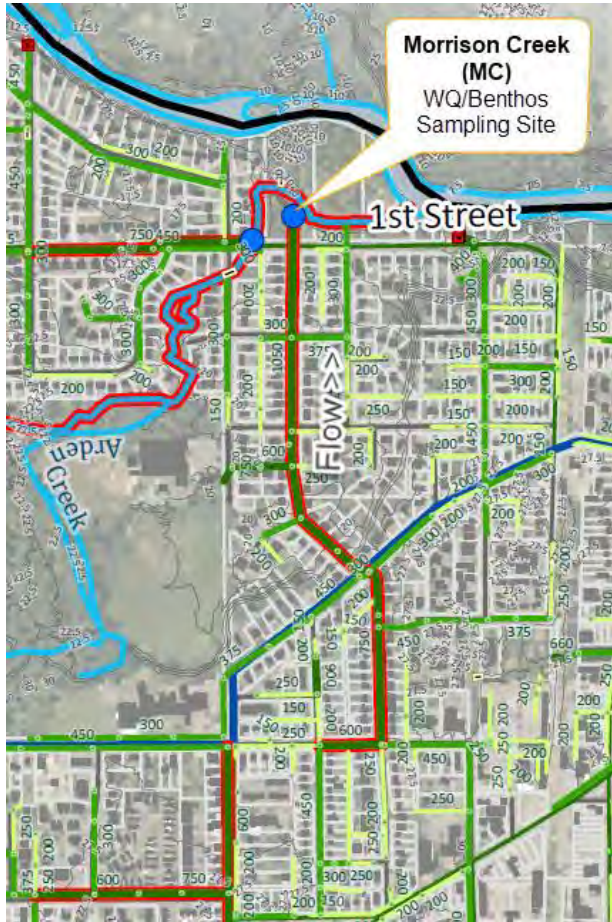
The Courtenay River sample site is located at the east end of 19<sup>th</sup> St. at the downstream discharge point of the storm catchment area extending approximately from Marsden Road in the west, 16<sup>th</sup> St. in the north, and 21<sup>st</sup> St. in the south (Inset 2).



**Inset 2. City map of stormwater infrastructure (top) showing approximate upstream catchment area and photos of the Courtenay River sample site at 19<sup>th</sup> St. looking upstream (above left) and downstream (above right) on Jan. 10, 2020.**

4.3.1.3 Morrison Creek (MC)

The Morrison Creek sample site is located at the north end of Woods Ave. in Puntledge Park at the downstream discharge point of the storm catchment area extending approximately from Lake Trail Road in the south, Willemar in the west, and Menzies Ave. in the east (Inset 3).



**Inset 3. City map of stormwater infrastructure (left) showing approximate upstream catchment area and photos of the Morrison Creek sample site north of Woods Ave. looking downstream (above right) on Jan. 10, 2020.**

#### 4.3.1.4 Puntledge River (PR)

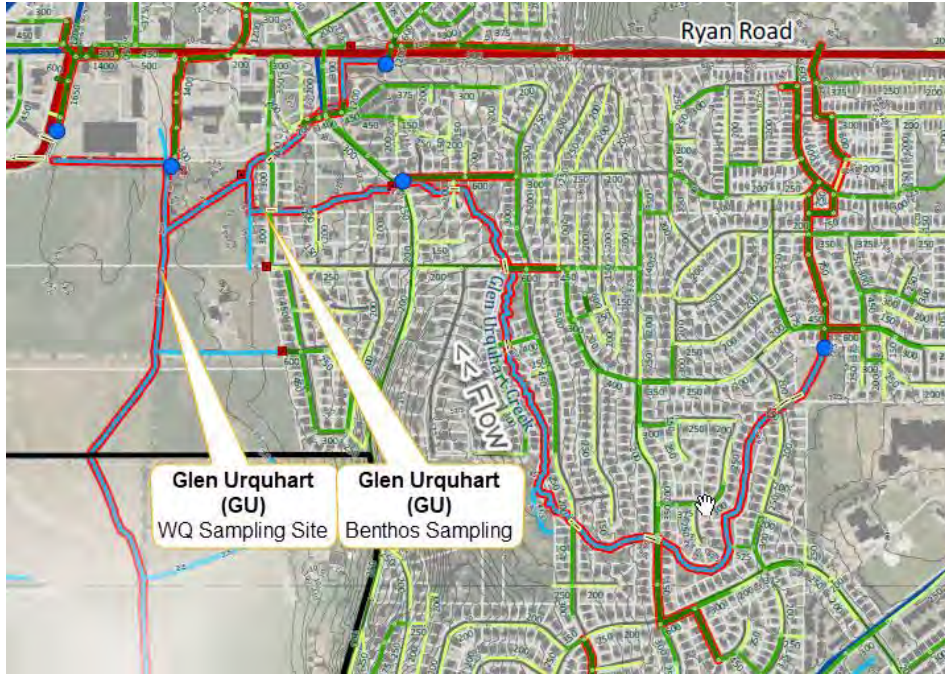
The Puntledge River sample site is located at the north end of Fitzgerald Ave. at the downstream discharge point of the storm catchment area extending approximately from McPhee Ave. in the west, 8<sup>th</sup> St. in the south, and England Ave. in the east (Inset 4).



**Inset 4. City map of stormwater infrastructure (left) showing approximate upstream catchment area and photos of the Puntledge River sample site north of Fitzgerald Ave. looking downstream (above right) on Jan. 10, 2020.**

**4.3.1.5 Glen Urquhart Creek (GU)**

The Glen Urquhart Creek sample site is located on Comox Bay Farm at the downstream discharge point of the storm catchment area extending approximately from south of the commercial area near Ryan Road and west of Lerwick Road and Valley View Drive (Inset 5).

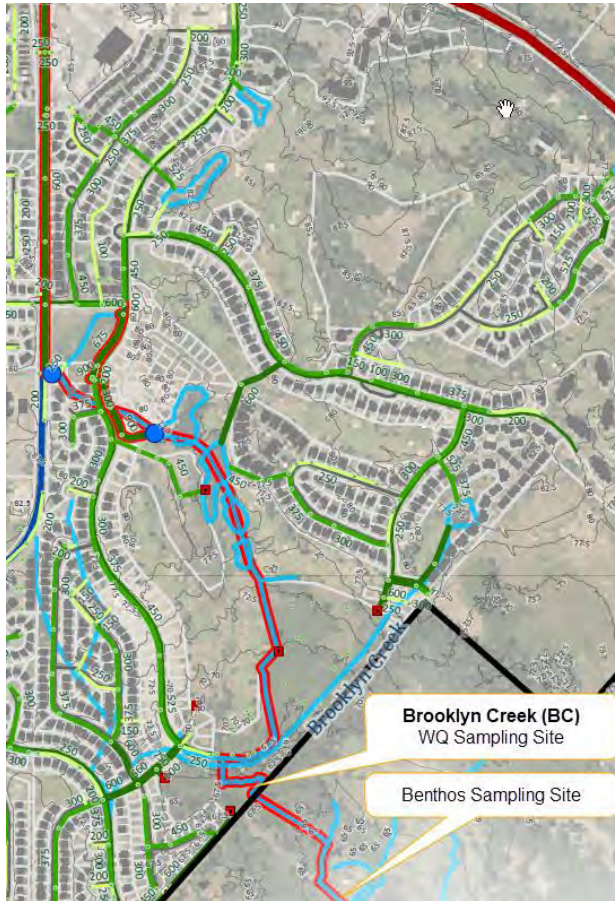


**Inset 5. City map of stormwater infrastructure (left) showing approximate upstream catchment area and photos of the Glen Urquhart Creek sample site southeast of Ryan Road looking downstream (below left) and upstream (below right) on Jan. 20, 2020.**



4.3.1.6 Brooklyn Creek (BC)

The Brooklyn Creek sample site is located at the southeast corner of Crowne Isle at the downstream discharge point of a series of storm detention ponds that captures runoff from the residential and golf course areas approximately located between Lerwick Road to the west, Ryan Road to the north, and Idiens Way to the south (Inset 6).



**Inset 6. City map of stormwater infrastructure (left) showing approximate upstream catchment area and photos of the Brooklyn Creek sample site east of Crowne Isle pond looking upstream (above right) on Jan. 10, 2020.**

### 4.3.2 Benthic Index of Biological Integrity (B-IBI)

The benthic index of biological integrity (B-IBI) combines the relative abundance and taxa richness of benthic invertebrates and is intended to be used as an indicator of stream condition (Page et al. 2008). The index has been determined to be correlated with stream level and watershed scale human disturbances, consistent rankings over time, resilience to variations in laboratory and field sampling practices, and statistically significant measures of minor changes to resource conditions (Page et al. 2008). The metric is organized into a scoring matrix that provides a description of stream health ranging from *Very Poor* to *Excellent* (Table 6).

**Table 6. 10 Metric B-IBI Score matrix is derived from individual contributing factors of important biological components that is used to rate a stream’s biological condition.**

10 Metric B-IBI Score	Stream Condition
46-50	Excellent
38-44	Good
28-36	Fair
18-26	Poor
10-16	Very Poor

**Table 7. 10 Metric B-IBI Score category results for 6 sample sites representing stream condition affected by stormwater in the major watershed catchments around the City of Courtenay.**

Abundance data in matrix format and BIBI calculations						
B-IBI Values	Sample Site (average of 3 sub-samples)					
	PC	CR	MC	PR	GU	BC
<b>Taxon Richness</b>	1	1	3	3	3	3
<b>E richness</b>	1	1	1	1	1	1
<b>P richness</b>	1	1	1	1	1	1
<b>T richness</b>	1	1	1	1	1	1
<b>Intolerant Richness</b>	1	1	1	1	1	1
<b>Clinger Richness</b>	1	1	1	1	1	1
<b>Long-Lived Richness</b>	1	1	3	3	3	1
<b>% Tolerant</b>	3	3	5	3	5	3
<b>% Predator</b>	1	1	1	1	1	1
<b>%Dominance (3)</b>	3	1	1	3	3	3
<b>B-IBI Site Score</b>	<b>14</b>	<b>12</b>	<b>18</b>	<b>18</b>	<b>20</b>	<b>16</b>
<b>B-IBI Site Category</b>	Very Poor	Very Poor	Poor	Poor	Poor	Very Poor

The 10 Metric B-IBI contains seven categories of taxa richness and three categories of % life history strategies (Dominance, Tolerant, Predator). The categories are scored with B-IBI values and the scores are summed for comparison against the matrix in Table 6. Based on the above criteria, all of the sample sites in this study received an I-BIB rating of *Poor* or *Very Poor* for benthic diversity as an indicator of ecosystem health (Table 7).

#### **4.4 WATER QUALITY**

Hand-meter data and laboratory analysis of water quality samples collected through summer (Sept. – Oct. 2019) and winter (Jan. – Feb. 2020) periods are intended to reflect chronic (30-day average) and acute (single event exceedance) conditions during low- and high-flow conditions affecting the urban watersheds in and around the City of Courtenay as presented in the following sub-sections.

##### **4.4.1 Hand-meter Raw Data**

Hand-meter raw data was collected in conjunction with water quality samples for lab analysis and benthic organism sampling during the period from Sept. 12- Oct. 16, 2019, and again alongside laboratory water quality sampling Jan. 10 – Feb. 6, 2020. Tables 8a and 9a represent raw hand-meter data where acute exceedances of water quality standards have occurred (highlighted in red text), while Tables 8b and 9b represent the 30-day mean with chronic exceedances using descriptive statistically values for each sampling location that include mean, max., min., and standard deviations for each hand-meter collected parameter. A discussion of these results is presented in Section 5.41.

**Table 8a/b. Summer (Sept. 12- Oct. 16, 2019) hand-meter water quality raw data (2a below left) and descriptive statistics (2b below right). Mean values in descriptive statistics represents chronic condition.**

Water Quality - Handmeter Raw Data					
DATE	pH	Cond (uS)	Temp	DO (mg/L)	Turb (NTU)
Piercy Creek (1PC)					
12-Sep-19	7.60	54	17.8	7.9	7.9
18-Sep-19	7.67	132	17.9	6.9	2.1
25-Sep-19	7.64	219	16.7	7.3	0.59
01-Oct-19	7.95	228	12.2	7.1	0.73
09-Oct-19	7.96	206	14.7	7.9	0.38
16-Oct-19	7.62	192	15.1	8.1	2.51
Courtenay River (1CR)					
12-Sep-19	7.60	48	17.9	8.2	5.8
18-Sep-19	7.67	242	17.6	7.5	1.21
25-Sep-19	7.85	195	16.7	7.3	0.39
01-Oct-19	7.74	485	18.3	7.9	7.28
09-Oct-19	7.78	291	13.7	8.4	0.56
16-Oct-19	7.60	84	12.4	8.7	24.3
Morrison Creek (1MC)					
12-Sep-19	6.97	50	17.3	8.3	16.4
18-Sep-19	7.36	247	17.7	8.0	200.0
25-Sep-19	7.56	247	17.5	7.9	20.5
01-Oct-19	7.77	201	16	8.4	2.26
09-Oct-19	7.72	285	13.2	8.6	1.9
16-Oct-19	7.42	278	14	8.4	6.04
Puntledge River (1PR)					
12-Sep-19	7.61	40	17.4	8.3	7.1
18-Sep-19	7.91	304	18.3	8.3	2.5
25-Sep-19	8.13	355	16.5	8.3	0.67
01-Oct-19	8.29	363	15.4	8.6	2.55
09-Oct-19	8.22	376	13.3	8.9	1.26
16-Oct-19	7.6	84	12.4	8.7	24.3
Glen Urquhart Creek (1GU)					
12-Sep-19	7.48	94	16.6	6.7	9.5
18-Sep-19	7.64	141	19.2	6.6	1.52
25-Sep-19	7.89	180	14.8	7.5	0.81
01-Oct-19	7.94	163	13.2	7.3	1.49
09-Oct-19	7.53	186	9.7	7.7	1.85
16-Oct-19	7.48	143	12	7.2	4.82
Brooklyn Creek (1BC)					
12-Sep-19	7.43	186	17.2	5.2	0.5
18-Sep-19	7.97	222	20.3	7.7	1.24
25-Sep-19	7.39	168	15.3	5.9	0.76
01-Oct-19	7.29	168	13.9	6.1	0.54
09-Oct-19	7.44	157	13.1	6.2	0.39
16-Oct-19	7.48	157	11.4	6.9	3.62

Water Quality - Handmeter Descriptive Statistics					
DATE	pH	Cond (uS)	Temp	DO (mg/L)	Turb (NTU)
Piercy Creek (1PC)					
n	6	6	6	6	6
Median	7.66	199	15.9	7.6	1.4
Mean	7.74	172	15.7	7.5	2.4
Min	7.60	54	12.2	6.9	0.4
Max	7.96	228	17.9	8.1	7.9
SD	0.15	61	2.0	0.5	2.6
Courtenay River (1CR)					
n	6	6	6	6	6
Median	7.71	219	17.2	8.1	3.5
Mean	7.71	224	16.1	8.0	6.6
Min	7.60	48	12.4	7.3	0.4
Max	7.85	485	18.3	8.7	24.3
SD	0.09	144	2.2	0.5	8.4
Morrison Creek (1MC)					
n	6	6	6	6	6
Median	7.49	247	16.7	8.4	11.2
Mean	7.47	218	16.0	8.3	41.2
Min	6.97	50	13.2	7.9	1.9
Max	7.77	285	17.7	8.6	200.0
SD	0.27	80	1.8	0.2	71.4
Puntledge River (1PR)					
n	6	6	6	6	6
Median	8.02	330	16.0	8.5	2.5
Mean	7.96	254	15.6	8.5	6.4
Min	7.60	40	12.4	8.3	0.7
Max	8.29	376	18.3	8.9	24.3
SD	0.28	138	2.1	0.2	8.3
Glen Urquhart Creek (1GU)					
n	6	6	6	6	6
Median	7.59	153	14.0	7.3	1.7
Mean	7.66	151	14.3	7.2	3.3
Min	7.48	94	9.7	6.6	0.8
Max	7.94	186	19.2	7.7	9.5
SD	0.19	31	3.1	0.4	3.0
Brooklyn Creek (1BC)					
n	6	6	6	6	6
Median	7.44	168	14.6	6.2	0.7
Mean	7.50	176	15.2	6.3	1.2
Min	7.29	157	11.4	5.2	0.4
Max	7.97	222	20.3	7.7	3.6
SD	0.22	23	2.9	0.8	1.1

Values marked in red are beyond the critical limit for adult and juvenile salmonid health.

Lowest turbidity measurement taken during season used to represent background (exceedances are 8 ntu over background)

**Table 9a/b. Winter (Jan. 10 – Feb. 6, 2020) hand-meter water quality raw data (3a below left) and descriptive statistics (3b below right). Mean values in descriptive statistics represents chronic condition.**

Water Quality - Handmeter Raw Data					
DATE	pH	Cond (uS)	Temp	DO (mg/L)	Turb (NTU)
Piercy Creek (1PC)					
10-Jan-20	7.94	73	5.3	10.4	21.70
20-Jan-20	7.31	133	6	9.7	4.27
24-Jan-20	7.00	83	6.2	9.6	12.70
28-Jan-20	7.00	154	6.9	9.5	3.03
06-Feb-20	7.10	258	6.8	9.3	7.45
Courtenay River (1CR)					
10-Jan-20	8.06	75	5.6	11.1	17.10
20-Jan-20	7.94	131	6.9	10.3	4.80
24-Jan-20	7.37	107	7.1	10.1	10.05
28-Jan-20	7.33	135	7.5	9.8	2.57
06-Feb-20	7.45	198	7.2	9.9	11.80
Morrison Creek (1MC)					
10-Jan-20	7.21	80	4.1	11.1	23.4
20-Jan-20	6.98	205	4.3	10.3	7.99
24-Jan-20	6.95	122	6.0	10.0	10.33
28-Jan-20	7.03	178	7.3	9.5	4.66
06-Feb-20	7.01	358	6.3	9.7	15.8
Puntledge River (1PR)					
10-Jan-20	7.49	110	6.0	10.9	18.50
20-Jan-20	7.35	164	6.0	10.4	12.70
24-Jan-20	7.40	146	6.7	10.3	18.50
28-Jan-20	7.46	195	7.4	10.1	8.83
06-Feb-20	7.99	158	9.2	10.2	11.40
Glen Urquhart Creek (1GU)					
10-Jan-20	7.65	147	5.3	10.1	11.30
20-Jan-20	7.59	158	6.8	9.7	5.98
24-Jan-20	7.12	121	7.2	9.0	6.40
28-Jan-20	7.20	160	7.2	9.4	2.80
06-Feb-20	7.38	170	6.7	10.0	8.95
Brooklyn Creek (1BC)					
10-Jan-20	7.54	119	5.1	9.3	15.20
20-Jan-20	7.04	133	6.8	9.5	6.89
24-Jan-20	7.11	99	7.9	9.1	7.51
28-Jan-20	7.00	90	7.4	9.9	4.45
06-Feb-20	7.43	120	6.3	10.7	3.05

Water Quality - Handmeter Descriptive Statistics					
DATE	pH	Cond (uS)	Temp	DO (mg/L)	Turb (NTU)
Piercy Creek (1PC)					
n	5	5	5	5	5
Median	7.10	133	6.2	9.6	7.5
Mean	7.27	140	6.2	9.7	9.8
Min	7.00	73	5.3	9.3	3.0
Max	7.94	258	6.9	10.4	21.7
SD	0.35	66	0.6	0.4	6.8
Courtenay River (1CR)					
n	5	5	5	5	5
Median	7.45	131	7.1	10.1	10.1
Mean	7.63	129	6.9	10.2	9.3
Min	7.33	75	5.6	9.8	2.6
Max	8.06	198	7.5	11.1	17.1
SD	0.31	40	0.7	0.5	5.2
Morrison Creek (1MC)					
n	5	5	5	5	5
Median	7.01	178	6.0	10.0	10.3
Mean	7.04	189	5.6	10.1	12.4
Min	6.95	80	4.1	9.5	4.7
Max	7.21	358	7.3	11.1	23.4
SD	0.09	95	1.2	0.6	6.6
Puntledge River (1PR)					
n	5	5	5	5	5
Median	7.46	158	6.7	10.3	12.7
Mean	7.54	155	7.1	10.4	14.0
Min	7.35	110	6.0	10.1	8.8
Max	7.99	195	9.2	10.9	18.5
SD	0.23	28	1.2	0.3	3.9
Glen Urquhart Creek (1GU)					
n	5	5	5	5	5
Median	7.38	158	6.8	9.7	6.4
Mean	7.39	151	6.6	9.6	7.1
Min	7.12	121	5.3	9.0	2.8
Max	7.65	170	7.2	10.1	11.3
SD	0.21	17	0.7	0.4	2.9
Brooklyn Creek (1BC)					
n	5	5	5	5	5
Median	7.11	119	6.8	9.5	6.9
Mean	7.22	112	6.7	9.7	7.4
Min	7.00	90	5.1	9.1	3.1
Max	7.54	133	7.9	10.7	15.2
SD	0.22	16	1.0	0.6	4.2

Values marked in red are beyond the critical limit for adult and juvenile salmonid health.

Lowest turbidity measurement taken during season used to represent background (exceedances are 8 ntu over background)

#### 4.4.2 Laboratory Analysis

Water quality sample collection for lab analysis included parameters for *E. coli*, total coliform, nitrate, and total metals. The potential contaminants of concern and rationales for their consideration are based in part on “Core Monitoring Program” parameters established by Metro Vancouver (2014) MAMF protocols<sup>28</sup>:

1. **Total Coliform:** A microbiological parameter used as an indicator of fecal contamination in water. Coliforms are used as a surrogate for pathogenic microorganisms with an inherent level of uncertainty of indicating pathogen presence -which limits their use as an indicator of fecal contamination.<sup>27</sup>
2. ***E. coli*:** A thermotolerant coliform, *Escherichia coli*, is understood to originate specifically from mammalian or avian fecal contamination (i.e. human, other mammal, bird). A common indicator of fecal contamination in water sources, it is limited by the inability to differentiate human from other mammalian wildlife sources. Source differentiation is possible in Microbial Source Tracking but was not undertaken as part of this study.
3. **Nitrate:** Higher levels of nitrate (NO<sub>3</sub>) can be an indicator of anthropogenic pollution as it correlates with effects of run-off from urbanization and agriculture.<sup>28</sup> Some atmospheric nitrate (as nitrogen) can enter surface water from the atmosphere that can transport nitrogen containing compounds derived from automobiles and other urban sources as well as effluent from municipal sanitary/storm cross-connections, leaky septic systems, poorly contained wastewater treatment plants, or agricultural runoff.
4. **Total Metals:** A wide range of metals can be transported from urban sources into surface waters that have known deleterious effects on aquatic life. Urban rainwater is often known to contain elevated levels of iron, copper, lead, zinc, and cadmium among other elements. Sources include vehicle exhaust, tires, and brake rotors; roofing materials; and gutters/downspouts.<sup>28</sup>

In general, the BCWQG for long-term (chronic) water quality conditions represented by 5 samples in 30 days were followed in both summer and winter sampling periods. An exception occurred for lab samples collected on Oct. 1, 2019 having an excessive hold time at the lab over the Thanksgiving long-weekend that resulted in an unviable condition. An additional sampling event was added on Oct. 16, 2019 to account for this issue.

Raw water quality data tables are provided in Appendix C for each watershed at sample stations shown in Figure 1; while summaries of these results have been interpreted against BC WQG for aquatic life on the following pages for both long-term (chronic) conditions observed during summer 2019 (Table 10) and winter 2020 (Table 11), and short-term (acute) conditions representing each sample event. Allowable concentration exceedances of provincial standards have been highlighted accordingly. Short-term (acute) “Core Monitoring Program” parameters established by Metro Vancouver (2014) MAMF protocols during summer (Sep-Oct) and winter (Jan-Feb) sampling periods are provided in Table 12.

<sup>27</sup> Ministry of Environment. (2011). Water Quality Assessment and Objectives for Comox Lake. Environmental Protection Division. Environmental Sustainability Division. Pp. 74.

<sup>28</sup> Metro Vancouver (2014). Monitoring and Adaptive Management Framework for Stormwater. Integrated Liquid Waste and Resource Management. Vancouver, BC. Pp. 112.

**Table 10. Long-term (chronic) water quality conditions averaging 5 samples over thirty days (Sept. – Oct. 2019) from 6 sample locations subject to urban rainwater inputs around the City of Courtenay. Exceedances of BC WQG highlighted in Red.**

Long Term Chronic Water Quality Conditions (30 day avg.)											
MAMF Core Metals											
Parameter	Low est Detection Limit	Units	1PC	1CR	1MC	1PR	1GU	1BC	BC 2019 Working WQG (mg/L)	Note	Exceedance
Cadmium (Cd)-Total	0.0000050	mg/L	0.0000253	0.0000139	0.0000159	0.0000121	0.0000123	0.0000083	0.00004	1	No
Copper (Cu)-Total	0.00050	mg/L	0.0059260	0.0046740	0.0053880	0.0041500	0.0036240	0.0013900	0.002	2	Yes
Iron (Fe)-Total	0.010	mg/L	0.8404000	5.5030000	0.9612000	0.5412000	0.3846000	0.1860000	1.0	3	Yes
Lead (Pb)-Total	0.000050	mg/L	0.0009256	0.0007877	0.0008713	0.0005123	0.0003467	0.0000640	0.001	8	No
Zinc (Zn)-Total	0.0030	mg/L	0.0797000	0.0104600	0.0155200	0.0176400	0.0081500	0.0036600	0.0075	4	Yes
Microbiological											
Parameter	Low est Detection Limit	Units	1PC	1CR	1MC	1PR	1GU	1BC	BC 2017 Recreational WQG (mg/L)		
E. coli	1	MPN/100mL	113	662	6357	803	159	41	200	7	Yes
Coliform Bacteria - Total	1	MPN/100mL	7934	246004	162825	131964	10541	16446	20	5	Yes
Nutrients											
Parameter	Low est Detection Limit	Units	1PC	1CR	1MC	1PR	1GU	1BC	BC 2017 Recreational WQG (mg/L)		
Nitrate (as N)	0.0050	mg/L	1.6	0.8	1.1	3.0	1.3	0.2	40	6	No
Notes:											
1. CCME Freshwater Long-term Average at CaCO3 >0 to <17 mg/L (most conservative)											
2. Hardness unknown CCME CWQG 2/ug/L											
3. or 0.35 dissolved											
4. at Hardness <90 mg/L; [Long-term CWQG = e(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625)]											
5. Recreation - primary contact.											
6. Long term chronic max is 40 mg/L, short-term max. is 200 mg/L											
7. Health Canada (2012) RWQG mean of 5 samples in 30 days											
8. Hardness unknown CCME CWQG 1 ug/L											

**Table 11. Long-term (chronic) water quality conditions averaging 5 samples over thirty days (Jan. – Feb. 2020) from 6 sample locations subject to urban rainwater inputs around the City of Courtenay. Exceedances of BC WQG highlighted in Red.**

Long Term Chronic Water Quality Conditions (30 day avg.)											
MAMF Core Metals											
Parameter	Low est Detection Limit	Units	2PC	2CR	2MC	2PR	2GU	2BC	BC 2019 (long-term) Working WQG (mg/L)	Note	Exceedance
Cadmium (Cd)-Total	0.0000050	mg/L	0.0000133	0.0000394	0.0000144	0.0000180	0.0000107	0.0000101	0.0001	1	No
Copper (Cu)-Total	0.00050	mg/L	0.0040600	0.0046320	0.0051420	0.0053260	0.0045800	0.0055000	0.0003 - 0.0008	2	Yes
Iron (Fe)-Total	0.010	mg/L	0.4654000	0.5216000	0.8564000	0.8724000	0.5132000	0.4562000	1.0	3	No
Lead (Pb)-Total	0.000050	mg/L	0.0003676	0.0014766	0.0004978	0.0011170	0.0004734	0.0001742	0.0041 - 0.0048	8	No
Zinc (Zn)-Total	0.0030	mg/L	0.0329600	0.0252400	0.0129800	0.0214400	0.0196800	0.0080400	0.0075	4	Yes
Microbiological											
Parameter	Low est Detection Limit	Units	2PC	2CR	2MC	2PR	2GU	2BC	BC 2019 (long-term) Working WQG (mg/L)	Note	Exceedance
E. coli	1	MPN/100mL	219	128	155	310	1672	26	200	7	Yes
Coliform Bacteria - Total	1	MPN/100mL	2647	1595	3739	3800	14000	366	20	5	Yes
Nutrients											
Parameter	Low est Detection Limit	Units	2PC	2CR	2MC	2PR	2GU	2BC	BC 2019 (long-term) Working WQG (mg/L)	Note	Exceedance
Nitrate (as N)	0.0050	mg/L	1.3	1.0	0.8	1.3	1.1	0.9		3 6	No
Notes:											
1. Dissolved cadmium at 36.46 mg/L hardness (average) for freshwater aquatic life.											
2. Range of standards dependent on site chemistry. If hardness unknown CCME CWQG standard is 2 ug/L (0.002 mg/L)											
3. or 0.35 mg/L dissolved											
4. at Hardness < 90 mg/L; [Long-term CWQG = e(0.947[ln(hardness mg·L <sup>-1</sup> )] - 0.815[pH] + 0.398[ln(DOC mg·L <sup>-1</sup> )] + 4.625)]											
5. Recreation - primary contact.											
6. Long term chronic max is 40 mg/L, short-term max. is 200 mg/L											
7. Health Canada (2012) RWQG mean of 5 samples in 30 days											
8. Hardness varies by site resulting in range of standards.											

**Table 12. Short-term (acute) “Core Monitoring Program” parameters established by Metro Vancouver (2014) MAMF protocols during summer (Sep-Oct) and winter (Jan-Feb) sampling periods. Exceedances of BC WQG highlighted in Red.**

Piercy Creek								
Date	MAMF Core Metals (mg/L)					Microbiological (MPN/100 mL)		Nutrients
	Cadmium (Cd)-Total	Copper (Cu)-Total	Iron (Fe)-Total	Lead (Pb)-Total	Zinc (Zn)-Total	E. coli	Ttl. Coliform	Nitrate (as N)^
12-Sep-19	0.0000682	0.01750	2.700	0.003220	0.1140	>2419.6	>2419.6	3.02
18-Sep-19	0.0000131	0.00544	0.158	0.000157	0.0814	199	11000	1.69
25-Sep-19	<0.0000050	0.00215	0.074	0.000143	0.0603	<1	46	1.23
01-Oct-19	0.0000103	0.00211	0.134	0.000116	0.0634	62	691	0.86
09-Oct-19	0.0000097	0.00462	0.375	0.000316	0.0794	79	20000	1.99
10-Jan-20	0.0000176	0.00610	1.060	0.000898	0.0336	461	3100	0.80
20-Jan-20	0.0000151	0.00370	0.245	0.000215	0.0352	387	>2420	1.51
24-Jan-20	0.0000112	0.00490	0.610	0.000367	0.0292	165	>200	1.25
28-Jan-20	0.0000085	0.00255	0.152	0.000087	0.0289	20	2420	1.52
6-Feb-20	0.0000143	0.00305	0.260	0.000271	0.0379	63	2420	1.27
Acute Standard*	0.00006-0.00071	0.002	0.350	0.0044-0.1000	0.033-0.056	400	10	33
Exceedance	No	Yes	Yes	No	Yes	Yes	Yes	No

Courtenay River								
Date	MAMF Core Metals (mg/L)					Microbiological (MPN/100 mL)		Nutrients
	Cadmium (Cd)-Total	Copper (Cu)-Total	Iron (Fe)-Total	Lead (Pb)-Total	Zinc (Zn)-Total	E. coli	Coliform Bacteria	Nitrate (as N)
12-Sep-19	0.0000223	0.00892	1.400	0.001420	0.0249	>2419.6	>2419.6	0.93
18-Sep-19	0.0000134	0.00448	0.133	0.000300	0.0085	248	3000	0.79
25-Sep-19	0.0000072	0.00284	0.090	0.000190	0.0069	<1	5	0.54
01-Oct-19	0.0000126	0.00319	1.210	0.000835	0.0077	9	1010	0.18
09-Oct-19	<0.0000050	0.00162	0.069	0.000083	0.0043	1730	980000	1.56
10-Jan-20	0.0000954	0.00717	1.140	0.002720	0.0446	248	>2420000	0.63
20-Jan-20	0.0000274	0.00347	0.294	0.001030	0.0203	58	1990	1.4
24-Jan-20	0.0000460	0.00533	0.540	0.002410	0.0254	>200	>200	1.08
28-Jan-20	0.0000120	0.00249	0.166	0.000602	0.0134	57	1200	1.17
6-Feb-20	0.0000162	0.00470	0.468	0.000621	0.0225	147	>2420	0.85
Acute Standard	0.00006-0.00071	0.002	0.350	0.0044-0.1000	0.033-0.056	400	10	33
Exceedance	No	Yes	Yes	No	Yes	Yes	Yes	No

Morrison Creek								
Date	MAMF Core Metals (mg/L)					Microbiological (MPN/100 mL)		Nutrients
	Cadmium (Cd)-Total	Copper (Cu)-Total	Iron (Fe)-Total	Lead (Pb)-Total	Zinc (Zn)-Total	E. coli	Coliform Bacteria	Nitrate (as N)
12-Sep-19	0.0000247	0.01820	4.420	0.002630	0.0354	>2419.6	>2419.6	0.93
18-Sep-19	0.0000132	0.00699	23.100	0.000673	0.0135	25000	68000	0.91
25-Sep-19	0.0000097	0.00487	1.790	0.000270	0.0145	33	1300	0.74
01-Oct-19	<0.0000050	0.00133	0.631	<0.000050	0.0064	272	3000	0.80
09-Oct-19	<0.0000050	0.00126	0.594	<0.000050	0.0078	122	579000	1.11
10-Jan-20	0.0000148	0.00653	1.290	0.000919	0.0183	158	5200	0.48
20-Jan-20	0.0000229	0.00494	0.752	0.000375	0.0109	276	>2420	1.07
24-Jan-20	0.0000100	0.00471	0.788	0.000386	0.0099	165	>200	0.88
28-Jan-20	0.0000081	0.00305	0.457	0.000117	0.0068	11	816	1.13
6-Feb-20	0.0000162	0.00648	0.995	0.000692	0.0190	166	5200	0.66
Acute Standard	0.00006-0.00071	0.002	0.350	0.0044-0.1000	0.033-0.056	400	10	33
Exceedance	No	Yes	Yes	No	Yes	Yes	Yes	No

Puntledge River								
Date	MAMF Core Metals (mg/L)					Microbiological (MPN/100 mL)		Nutrients
	Cadmium (Cd)-Total	Copper (Cu)-Total	Iron (Fe)-Total	Lead (Pb)-Total	Zinc (Zn)-Total	E. coli	Coliform Bacteria	Nitrate (as N)
12-Sep-19	0.0000262	0.00904	1.100	0.001730	0.0249	>2419.6	>2419.6	5.18
18-Sep-19	0.0000092	0.00356	0.181	0.000254	0.0215	96	39000	4.85
25-Sep-19	0.0000065	0.00202	0.052	0.000134	0.0161	3	166	2.55
01-Oct-19	0.0000065	0.00164	0.115	0.000467	0.0118	691	691	1.41
09-Oct-19	<0.0000050	0.00152	0.038	<0.000050	0.0139	2420	488000	4.25
10-Jan-20	0.0000189	0.00624	1.030	0.001230	0.0261	1120	5200	0.95
20-Jan-20	0.0000195	0.00457	0.726	0.000903	0.0223	345	>2420	1.53
24-Jan-20	0.0000195	0.00729	1.170	0.001180	0.0207	21	>200	1.33
28-Jan-20	0.0000117	0.00339	0.454	0.000612	0.0161	37	3100	1.59
6-Feb-20	0.0000205	0.00514	0.982	0.001660	0.0220	28	3100	1.19
Acute Standard	0.00006-0.00071	0.002	0.350	0.0044-0.1000	0.033-0.056	400	10	33
Exceedance	No	Yes	Yes	No	No	Yes	Yes	No

Glen Urquhart Creek								
Date	MAMF Core Metals (mg/L)					Microbiological (MPN/100 mL)		Nutrients
	Cadmium (Cd)-Total	Copper (Cu)-Total	Iron (Fe)-Total	Lead (Pb)-Total	Zinc (Zn)-Total	E. coli	Coliform Bacteria	Nitrate (as N)
12-Sep-19	0.0000125	0.00802	1.170	0.000600	0.0154	>2419.6	>2419.6	0.51
18-Sep-19	0.0000121	0.00460	0.373	0.000136	0.0074	345	9000	0.75
25-Sep-19	<0.0000050	0.00256	0.278	0.000061	<0.0030	1	165	0.52
01-Oct-19	<0.0000050	0.00314	0.379	0.000122	0.0058	79	7000	0.40
09-Oct-19	<0.0000050	0.00141	0.576	<0.000050	0.0040	210	26000	1.37
10-Jan-20	0.0000104	0.00381	0.556	0.000576	0.0240	2420	12200	0.74
20-Jan-20	0.0000122	0.00301	0.407	0.000243	0.0190	1550	>2420	1.50
24-Jan-20	0.0000077	0.00373	0.449	0.000694	0.0192	>200	>200	1.09
28-Jan-20	0.0000112	0.00327	0.566	0.000340	0.0161	727	10900	1.31
6-Feb-20	0.0000120	0.00908	0.588	0.000514	0.0201	1990	18900	0.90
Acute Standard	0.00006-0.00071	0.002	0.350	0.0044-0.1000	0.033-0.056	400	10	33
Exceedance	No	Yes	Yes	No	No	Yes	Yes	No

Brooklyn Creek								
Date	MAMF Core Metals (mg/L)					Microbiological (MPN/100 mL)		Nutrients
	Cadmium (Cd)-Total	Copper (Cu)-Total	Iron (Fe)-Total	Lead (Pb)-Total	Zinc (Zn)-Total	E. coli	Coliform Bacteria	
12-Sep-19	0.0000061	0.00139	0.186	0.000064	0.0037	>2419.6	>2419.6	0.01
18-Sep-19	0.0000099	0.00306	0.114	0.000065	0.0039	23	11000	0.15
25-Sep-19	<0.0000050	0.00188	0.138	<0.000050	0.0033	<1	13	0.09
01-Oct-19	0.0000089	0.00186	0.081	<0.000050	0.0030	<1	770	0.05
09-Oct-19	<0.0000050	0.00330	0.420	0.000375	0.0044	59	54000	0.57
10-Jan-20	0.0000088	0.00482	0.808	0.000189	0.0048	37	>2420000	1.21
20-Jan-20	0.0000105	0.00519	0.426	0.000206	0.0096	50	>2420	0.86
24-Jan-20	0.0000080	0.00615	0.366	0.000180	0.0093	21	200	0.91
28-Jan-20	0.0000102	0.00577	0.326	0.000144	0.0080	14	488	0.79
6-Feb-20	0.0000129	0.00557	0.355	0.000152	0.0085	7	411	0.74
Acute Standard	<b>0.00006-0.00071</b>	<b>0.002</b>	<b>0.350</b>	<b>0.0044-0.1000</b>	<b>0.033-0.056</b>	<b>400</b>	<b>10</b>	<b>33</b>
Exceedance	No	Yes	Yes	No	No	Yes	Yes	No

\* Where ranges (min. and max. by watershed) are provided for Acute standards they represent maximum allowable concentrations for freshwater aquatic life based on bioavailability affected by observed hardness for each sample.  
 - Acute standard for E. coli based on recreational limit. No standard exists for freshwater aquatic life.  
 - Acute standard for Total Coliform based on BC limit for drinking water. No standard exists for freshwater aquatic life.  
 - Final result exceeded test range  
 ^ Nitrate sample collection in fall 2019 did not occur alongside other parameters. Collection dates were Sept 18, 25 & Oct 1, 16, 24

## 5.0 DISCUSSION

The following table represents a summary of all study parameters categorized by watershed sampling location (Section 4.3.1) and overall existing biological conditions in the City of Courtenay. Each of the categories shown in Table 13 are described in detail under the succeeding sub-headings (Section 5.1 - 5.4). A discussion of priority watersheds and actions to be taken by the City to protect, enhance, and restore biological conditions is provided in Section 6.

**Table 13. Summary of all study parameters categorized by watershed sampling location and overall priority sites selected for City management.**

Summary of all study parameter results categorized by watershed sampling location and overall priority sites selected for City management.											
Watershed	Courtenay River	Glen Urquhart Creek	Little River	Millard/Piercy Creek	Morrison Creek	Portuguese Creek	Puntledge River	Brooklyn Creek	Tsolum River	City of Courtenay	
% Fish Bearing Stream Channels (w/n City limits)	100	56	83	91	87	12	100	0	68	74.6 (Average)	
% Watershed Covered in Impervious Surfaces and Predicted Stream Quality (Scheuler 1994)	Non-supporting	Non-supporting	Impacted	Sensitive	Non-supporting	Non-supporting	Non-supporting	Non-supporting	Impacted	Majority Non-supporting	
Benthic index of biological integrity (B-IBI) Stream Health Score (Page et al. 2008)	Very Poor	Poor	n/a	Very Poor	Poor	n/a	Poor	Very Poor	n/a	Very Poor/Poor	
Water Quality Handmeter Exceedance of BC Standards (Summer)	Acute	Temp./Turbidity	Temp./Turbidity	n/a	No	Temperature	n/a	Temp./Turbidity	Temperature	n/a	Temp./Turbidity
	Chronic	No	No	n/a	No	Turbidity	n/a	No	No	n/a	Turbidity
Water Quality Handmeter Exceedance of BC Standards (Winter)	Acute	Turbidity	No	n/a	Turbidity	Turbidity	n/a	No	Turbidity	n/a	Turbidity
	Chronic	No	No	n/a	No	No	n/a	No	No	n/a	No
Water Quality Laboratory Exceedance of BC Standards (Summer)	Acute	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, E. coli, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, Zinc, E. coli, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, E. coli, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform
	Chronic	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Zinc, Ttl. Coliform	n/a	Copper, Zinc, Ttl. Coliform	Copper, Zinc, E. coli, Ttl. Coliform	n/a	Copper, Zinc, E. coli, Ttl. Coliform	Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform
Water Quality Laboratory Exceedance of BC Standards (Winter)	Acute	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, E. coli, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform	Copper, Iron, Ttl. Coliform	n/a	Copper, Iron, Zinc, E. coli, Ttl. Coliform
	Chronic	Copper, Zinc, Ttl. Coliform	Copper, Zinc, E. coli, Ttl. Coliform	n/a	Copper, Zinc, E. coli, Ttl. Coliform	Copper, Zinc, Ttl. Coliform	n/a	Copper, Zinc, E. coli, Ttl. Coliform	Copper, Zinc, Ttl. Coliform	n/a	Copper, Zinc, E. coli, Ttl. Coliform
Management Priority	MODERATE	HIGH	MODERATE	HIGH	HIGH	LOW	MODERATE	LOW	LOW		

Sites labelled "n/a" were not assessed for handmeter or laboratory water quality parameters according to budget/scope of study.

## 5.1 RIPARIAN CORRIDOR

Select measures for riparian corridor health represented in this assessment include fish presence and percent impervious surfaces (Section 4.1). In natural stream systems fish passage is dictated by the presence of barriers such as falls or cascades. The urban environment poses a series of additional challenges that most commonly include perched culverts at road crossings and extended lengths of underground pipe. Identification of specific culvert barriers in the City of Courtenay was beyond the scope of this assessment<sup>29</sup>; however, existing information regarding barriers in the Millard/Piercy Creek watershed exists (Fleenor & Silvester 2018) that identifies a series of barriers to fish migration that are present within the City's jurisdiction. Once identified, the majority of barriers within an urban environment are repairable and can be replaced or upgraded to meet the Federal and Provincial design criteria for fish passage (Chilibeck 1992, MOTH 2000, Parker 2000).

Impervious surfaces within the context of watershed or riparian area levels provide needed context for identifying impacts from development and land-use types as they pertain to these sensitive ecosystems. For example, the Millard/Piercy system was the only watershed to receive a *Sensitive* rating according to the Scheuler (1994) stream quality index. This result is primarily a factor of the relatively large proportion of agricultural land compared to urban area, when compared to other catchment areas in the City. When the same Millard/Piercy system is considered for impervious area within the riparian zone (30 m from the stream boundary) it shows approx. 14 % cover: similar to the City average of 16%.

The objective of impervious surface coverage analysis is to identify those systems most at risk of impacts from urban rainwater, that will require intervention to retain their natural form and function (*Sensitive* and *Impacted* categories), and where impacts have occurred, to mitigate those impacts to the greatest extent possible using effective rainwater management techniques. Those systems that have suffered from a history of impacts and been identified as *non-supporting* will also require intensive restoration techniques that may include active removal of upstream pollutants and instream habitat enhancement. All of the assessed watersheds with the exception of Tsolum River, Little River, and Millard/Piercy (the latter for the reasons described above) fall into the *non-supporting* category and would benefit from intensive and extensive interventions.

## 5.2 TERRESTRIAL, AQUATIC, AND SPECIES AT RISK

In general, species presence is notable as a baseline condition; however, specific management objectives only relate to the presence of species-at-risk (SAR) and invasive species. SAR, as defined by provincial and federal lists, are indexed by watershed in Appendix A. Few SAR in the study area are governed by federal action plans for their recovery or protection. The notable exception is the Morrison Creek Lamprey with mandated measures to be undertaken by the federal Department of Fisheries and Oceans (DFO). The City's Environmental DPAs currently provide protection over the lamprey habitat via requirements for development to adhere to Provincial *Riparian Areas Protection Regulation* methodologies that prescribed setbacks on protected areas. In addition, the City Council unanimously approved a motion to establish a blanket 30 m protection zone on Morrison Creek which, if eventually enacted through City bylaw will meet or exceed the federal protection standard.

<sup>29</sup> An exception being the perched culvert identified in Glen Urquhart Creek identified as a barrier to fish migration presented as an example of a barrier in Photo 1 of Section 4.1.1.

Numerous other species at risk are present in the City of Courtenay (Appendix A) that warrant protection and enhancement of their habitats to support their life history requirements. Ongoing protection of riparian corridors including wetlands and stream are a first step in that direction; while additional protection of critical habitats such as mature forest stands, although recently receiving attention via the City's *Tree Protection and Management Bylaw* and the *Urban Forest Strategy*, could receive enhanced protections through the creation of additional development permit areas for species at risk and critical habitats.

### 5.3 BENTHIC SPECIES

Taxa richness represents the diversity of species found within major categories of benthic species and represents 7 of the 10-metrics that form the benthic index of biological integrity (B-IBI). Scores are provided for these major categories separately but can be summarized under the score for Total Taxa Richness. According to the MAMF (2008)<sup>14</sup>, total taxa richness is defined when "The biodiversity of a stream declines as flow regimes are altered, habitat is lost, chemicals are introduced, energy cycles are disrupted, and alien taxa become dominant. Total taxa richness includes all the different invertebrates collected from a stream site."

Based on analysis of benthic samples, Piercy Creek and Courtenay River received the lowest scores for Taxa Richness, while the remaining sites scored the same, slightly higher rating. The stream with the greatest richness was the Puntledge River a fact that may be attributed to the sample site being located adjacent to and receiving most of its flow from the mainstem Puntledge River, although downstream of the nearby stormwater outfall from which water quality has been collected, overall species diversity is most likely being derived from the mainstem.

Within the B-IBI, species are further divided into three categories (Dominance, Tolerant, Predator) that depending on their allotments are used to indicate stream health under 3 of the overall 10-metrics. Although the overall score is ultimately used to categorize stream health from *Excellent* to *Very Poor* (Table 6), the 10-metric sub-categories can be useful to ascertain the types of impacts affecting the final score.

Percent Dominance (3 taxa) contains the overriding factor observed in all sample sites: representing 67-85 % of sample contents. This metric represents low diversity in benthic richness as these species belong to the most abundant taxa and reflect opportunistic life strategies that replace other species that specialize in particular habitats and food types resulting in low species richness across all samples sites.

Percent Tolerant species presence ranges between 4-34% for all sites. As this metric increases it represents greater influence from upstream disturbances. The sites with the highest % tolerant species were the Courtenay River site (34 %) and Piercy Creek and Brooklyn Creek (both at 26 %) indicating the highest disturbances. The Courtenay River sampling site is near the stormwater outlet servicing a relatively large commercial area with a dense accumulation of paved parking areas and roads (Section 4.3.1.2). Morrison Creek and Glen Urquhart Creek had the lowest % Tolerant species indicating less disturbance.

Percent Predator is the least common factor within the percent sample breakdown and ranges from 1.5-10 %. Higher predator % indicates a dependable source of other prey invertebrates are present as well. A lack of predatory presence indicates low species abundance and low trophic complexity. Sites with less disturbance have a greater variety of

prey species present that indicates greater stream health. In general predator presence was low across all sites and they received the same B-IBI score of 1 for % Predator.

## 5.4 WATER QUALITY

Seasonal water quality trends can be interpreted from combined hand-meter and laboratory analyses. For example, trends in turbidity (hand-meter) and copper (laboratory metals) suggest that higher concentrations of pollutants may be released under “first flush” conditions where a prolonged period of dry weather allows pollutants to concentrate on impervious surfaces and within stormwater infrastructure later to be mobilized by the first significant rainfall of the season resulting in a “spike” of pollutants released into the environment (see Sept. 12, 2019 for metals in Table 6). Depending on the type of pollutant released, these high concentration pollutants can be lethal to fish and other aquatic life. In winter, higher volumes and more consistent precipitation events typically represent on-going flushing of road surfaces into storm system that do not allow pollutants to accumulate in the same manner seen during “first flush” conditions. Instead, other issues may be presented such as higher rates of erosion causing turbidity spikes or flushing of wetlands and detention ponds mobilizing pollutants that would otherwise be sequestered.

### 5.4.1 Hand-meter water quality

Results from hand-meter water quality collection indicate that chronically high turbidity conditions may exist at the stormwater outlet into Morrison Creek while acute (single event) elevated temperature and turbidity events were observed periodically at all sites; apart from Piercy Creek which remained within water quality guidelines for all parameters. The Morrison Creek storm outlet was observed to convey high turbidity waters into the stream channel at Puntledge Park during a number of sampling events in late summer 2019, including an event in excess of 20x the allowable limit on Sept. 18<sup>th</sup> exposing observed pink salmon and their recently laid eggs in the spawning gravels immediately downstream from the outlet with sediment laden water (Section 9).

Other acute exceedances of water quality parameters occurred in summer 2019 for temperatures exceeding the 18 °C threshold on Sept. 18<sup>th</sup> in Puntledge River, Glen Urquhart, and Brooklyn Creek sample sites, and Oct. 1 for Courtenay River. Winter exceedances were limited to high turbidity events in Piercy Creek, Courtenay River, Morrison Creek, and Brooklyn Creek.

### 5.4.2 Acute and chronic water quality (laboratory analysis)

Acute water quality is short-term, single event data that has separate BC Water Quality Guideline standards from long-term, chronic 30-day average results. In general, chronic conditions are preferred as representative of the system being sampled unless short-term acute standards have been exceeded which is a noteworthy event that likely indicates underlying issues requiring treatment.

#### Acute conditions

Acute water quality results for all sample sites in the study area included five samples collected in summer 2019 and five in winter 2020. Acute exceedances were observed for copper, iron, zinc, *E. coil*, and total coliform for all sites, except for no zinc exceedances in Puntledge River, Glen Urquhart, and Brooklyn Creeks. In general, these exceedances were not limited to a single event

where each watershed showed multiple exceedances of each of the parameters except for Brooklyn having only one exceedance of *E. coli* on Sept. 12, 2019.

The repetitive nature of these acute exceedances is borne out in the chronic results but are also notable here as acute standards are typically less sensitive and represent a higher allowable limit which indicates there may even be a long-term exceedance of acute standards.

### Chronic conditions

The results shown for MAMF Core Metals indicate that all measured water quality sites, apart from Brooklyn Creek, contained chronically high concentrations of copper and zinc through the summer sampling season, while all sites were in exceedance for copper and zinc during the winter season. The Courtenay River site measured from outfall flows at the eastern terminus of 19<sup>th</sup> St. also showed a chronic exceedance of iron.

Average *E. coli* counts in summer 2019 exceeded recreational limits for the Courtenay River, Puntledge River, and the highest observed levels at Morrison Creek which was nearly 32x the allowable chronic condition. In winter 2020, *E. coli* exceeded chronic standards in Piercy Creek, Puntledge River, and Glen Urquhart Creek.

Total coliform counts were chronically elevated throughout summer and winter seasons in exceedance of recreational limits for all six sites with Piercy Creek showing the lowest average at nearly 400x, and the Courtenay River the highest at over 8,000x the allowable during summer. In winter the average concentration dropped, possibly as a result of higher flows, but remained well over allowable limits.

None of the sampling sites showed either acute or chronic exceedances of nitrate (NO<sub>3</sub>) above recreational guidelines under acute or chronic standards.

In general, acute and chronic exceedances of metals and fecal indicators showed an ongoing and impermissible state of water being discharged from City infrastructure into the environment. These conditions likely relate to other *Poor* indicators of stream health including benthic metrics, and predictors from % impervious surfaces.

## **6.0 CONCLUSIONS/RECOMMENDATIONS**

Overall, the City of Courtenay is not an outlier in the health of its watersheds described in this study, nor the management challenges that exist in moving towards achieving balance between municipal works and the health of the City's natural environments. Many municipalities across Vancouver Island and beyond are endeavouring to comprehend and amend the impacts associated with their activities by undertaking similar studies and enacting measures to reduce their impacts.

Chronic water quality exceedances have been observed to some extent in all of the study watersheds including turbidity, metals, and bacteriological parameters. Elevated concentrations of copper, iron, and zinc may be associated with vehicle pollutants entering rainwater systems and suggests that a heightened responsibility may exist between the City and private landowners/developers to improve treatment facilities and best management practices to better remove/detain heavy metals from runoff before they are allowed to enter natural waters. Similar efforts would also benefit elevated turbidity levels, such as those entering Morrison Creek, at an outfall with effluent discharging onto a notable salmon spawning reach.

*E. coli* and fecal coliform concentrations are well in exceedance of acceptable limits and indicate a chronic, City wide matter compelling corrective action. Storm/sanitary cross-connections in older neighbourhoods can oftentimes be responsible for elevated bacteriological activity and is within the purview of the City to amend.

It is recommended that a long-term water quality monitoring program be implemented by the City to better locate point sources, and as a means of determining whether corrective measures have been effective over time and where shortfalls remain to assist the City in future planning decisions. Specifically, semi-annual (summer/winter) water quality collection of hand-meter and laboratory parameters currently observed in acute and chronic exceedance, as well as the addition of analysis of differentiated *E. coli* to expand bacteriological sample analysis to distinguish human from other mammalian sources is recommended as it will be valuable to determine whether City sanitary infrastructure may be implicated in these suspected releases into natural waters.

As a minimum, the six sites presented in this assessment should be maintained in future water quality assessments with modifications to their locations or additions of new ones as deemed necessary in consultation with City staff and professionals involved in data collection according to the locations and extents of stormwater upgrades, point source investigations, stream enhancement projects, etc.

Ongoing water quality assessments used as a measure for success of enhanced rainwater management should be followed up with benthic sampling on a recurring five-year timescale as changes in benthic abundance and diversity will occur over a longer period. Improvements in benthic ecology will, however, provide a high level of confidence that changes enacted by the City have achieved their goals.

Impervious surfaces in the City stand at approximately 30 % of the land area with the range per watershed having approximately 25-45 % impermeable coverage. The City's *Tree Protection and Management Bylaw*, and maintenance of parks, greenways and riparian corridors will assist in mitigating the effects of increased impermeable areas from development contributing to pollutant conveyance into natural freshwater systems. In the City's riparian corridors, impervious surfaces are fairly consistent across watersheds at 16 % City-wide, with most systems affected by 10-25 % coverage. Additional protections of riparian corridors can assist in reducing cumulative impacts from development whereby the City can enact enhanced provisions to riparian corridors (30 m from highwater) of select systems in currently undeveloped areas, and as part of development permit processes for new construction.

Overall, each of the study watersheds have demonstrated some limitations to ecological function. However, priority treatment watersheds can be identified by the maturity of their development status, as well as future opportunities for the avoidance or mitigation of impacts, and feasibility of habitat enhancement to already impacted systems. Recommendations for priority management of these watersheds is as follows:

Piercy Creek (high priority)

Limitations to the quality of Piercy Creek appear to be related most closely to urban water quality impacts (*Very Poor* benthic stream health and many BCWQG exceedances) associated with impervious surface runoff and sanitary issues. The Piercy Creek watershed is in a unique position within the City as it contains the lowest % impervious surface of any watershed (Section 4.1.2) while being subject to numerous development projects in recent years, especially within the Arden Road corridor. A high priority should be given to

maintain pre-development stream quality with strict adherence to zoning restrictions to site imperviousness, maintaining enhanced stream buffers (e.g. City's *Arden Corridor Local Area* plan), enhancing streams reaches already impacted by urbanization, and to develop industry leading stormwater management practices.

#### Morrison Creek (high priority)

Morrison Creek is widely regarded as one of the most critically important watersheds in the Comox Valley for the preservation of its ecological values. Land-uses surrounding reaches of the Creek within the City are characterized by older residential areas associated with inputs from road surface contaminants and sanitary issues. Urban pollutants must be removed wherever possible during City infrastructure maintenance and upgrade projects and with a program to identify and repair any potential sewer cross-connections. The City council has already approved a motion to protect the Morrison Creek watershed, and next steps should be taken to formalize a 30 m setback on the Creek as well as the application of a *Morrison Creek Corridor* plan similar in nature to the *Arden Corridor* plan that contains, amongst other measures, specific stormwater management requirements for future development.

#### Glen Urquhart (high priority)

The Glen Urquhart watershed is a mix of agricultural and residential settings, although some of the riparian management of the lower reaches remains the City's responsibility. Most of the watershed's channels have been modified by past and present land use regimes including 43 % coverage by impervious surfaces and 56 % fish bearing status. Glen Urquhart would benefit greatly from strict stormwater management practices, limits to impervious surface development, removal of barriers to fish migration, and a stream channel enhancement program. Most of the land-uses within the Glen Urquhart watershed are stable and additional large-scale development does not appear to be an imminent threat. Its status as a relatively static environment lends it to site specific identification of limiting factors to biological conditions and their repair. It is recommended that Glen Urquhart be the subject of an *Overview/Level 1 Fish Habitat Assessment and Level 2 Enhancement Recommendations* report<sup>30</sup>.

#### Puntledge River & Courtenay River (moderate priority)

The Puntledge and Courtenay River study sites are both located within nearly 100 % urbanized catchments characterized by roads, parking lots, and residential/commercial properties. The ability to detain and remove contaminants from water discharged from stormwater infrastructure in these areas may be limited to end of pipe solutions as very limited areas of natural stream channels remain that have not been piped. Strict adherence to environmental practices by residents and businesses within the watershed are required to avoid inputs of deleterious substances into stormwater infrastructure flowing into the natural environments of downstream receptors. Urban pollutants must be removed wherever possible by requiring new developments to install pollutant scrubbing technologies in their stormwater infrastructure and for the City to maintain and upgrade its infrastructure to the highest standard.

#### Little River (moderate priority)

The Little River watershed contains some of the largest future development potential within the City. Currently, development is increasing in parts of this watershed and its

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<sup>30</sup> Johnston, N.T., and P.A. Slaney. (1996). *Fish Habitat Assessment Procedures*. Province of British Columbia, Ministry of Environment, Lands and Parks, and Ministry of Forests. Watershed Restoration Technical Circular No. 8: 97 p.

current standing as an “impacted” watershed at 11 % impervious cover is very likely to increase in the future. The Little River watershed is in a position to benefit from strict stormwater management practices, limits to impervious surface development, and protection and enhancement of existing stream channels and setbacks.

Tsolum/Portuguese Creek (low priority)

The study parameters applicable to the Tsolum River watershed were limited to imperviousness and fish presence -both of which are of moderate concern. Although some residential/commercial development has occurred within this watershed it is largely characterized by agricultural properties. Typically, agricultural properties are somewhat more stable than commercial/residential lands and are subject to significantly less inputs from impervious surfaces. Other risks do exist from land clearing and nutrient inputs associated with agricultural; however, these risks are not within the purview of management strategies associated with this IRMP.

Brooklyn Creek (low priority)

Within City boundaries Brooklyn Creek has recently been nearly 100% developed, including a series of detention ponds and other stormwater infrastructure that will not need to be upgraded for decades. Brooklyn Creek may, however, benefit from riparian enhancement around the ponds and channels on Crowne Isle that do not have canopy cover, and by removing the ~ 315 m of piped channel acting as an obstruction to fish passage immediately east of the City boundary (outside City jurisdiction).

A comprehensive, multi-disciplinary approach will be necessary to move the City of Courtenay into compliance with water quality guidelines, and best management practices for natural systems in urban environments. Many achievable opportunities exist to improve the City’s interface with its natural systems and establish the City of Courtenay as a leader in progressive urban environmental stewardship.

CURRENT ENVIRONMENTAL LTD.

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## 7.0 DISCLAIMER

This report was prepared exclusively for Urban Systems and the City of Courtenay by Current Environmental Ltd. The quality of information, conclusions and estimates contained herein is consistent with the level of effort expended and is based on: i) information available at the time of preparation; ii) data collected by the author, technical personnel and/or supplied by outside sources; and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by Urban Systems and the City of Courtenay only, subject to the terms and conditions of its contract or understanding with Current Environmental Ltd. Use or reliance on this report by any third party is at that party's sole risk.

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## 9.0 PHOTOS

The following photos were collected during summer water quality collection effort on Sept. 9, 2019 and winter Jan. 10, 2020 from all six City of Courtenay rainwater effluent sampling stations to illustrate seasonal difference in environmental and site conditions at the time of assessment.



Piercy Creek (1PC-01) Summer



Piercy Creek (2PC-01) Winter



Courtenay River (1CR-05) Summer



Courtenay River (2CR-01) Winter



Morrison Creek (1MC-01) Summer (note sediment plume from SW discharge and spawning salmon in Creek below)



Morrison Creek (2MC-01) Winter



Puntledge River (tributary) (1PR-03) Summer



Puntledge River (tributary) (2PR-02) Winter



Glen Urquhart Creek (1GU-01) Summer



Glen Urquhart Creek (2GU-01) Winter



Brooklyn Creek (stormwater pond) (1BC-01) Summer



Brooklyn Creek (stormwater pond) (2BC-01) Winter

## APPENDIX A

### SPECIES PRESENCE BY WATERSHED IN THE CITY OF COURTENAY ACCORDING TO TERRESTRIAL AND AQUATIC HABITATS AND SPECIES AT RISK

#### Puntledge River

Existing Conditions: Aquatic and Terrestrial Species and Habitat					
Puntledge River					
Freshwater Aquatic Species Inventory- Fish					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC list	
Chum salmon	<i>Oncorhynchus keta</i>	Not Listed	Not Listed	Yellow	FIDQ
Coho Salmon	<i>Oncorhynchus kisutch</i>	Not Listed	Not Listed	Yellow	FIDQ
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	E/T/SC (2018)	Endangered	Yellow	FIDQ
Sockeye Salmon	<i>Oncorhynchus nerka</i>	Not Listed	Not Listed	No Status	FIDQ
Pink Salmon	<i>Oncorhynchus gorbuscha</i>	Not Listed	Not Listed	No Status	FIDQ
Coastal Cutthroat Trout	<i>Oncorhynchus clarkii clarkii</i>	Not listed	Not Listed	Blue	FIDQ
Cutthroat trout	<i>Oncorhynchus clarkii</i>	Not Listed	Not Listed	No Status	FIDQ
Kokanee Trout	<i>Oncorhynchus nerka</i>	Not Listed	Not Listed	No Status	FIDQ
Rainbow Trout	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Dolly Varden Trout	<i>Salvelinus malma</i>	Not Listed	Not Listed	Yellow	FIDQ
Steelhead	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Prickly Sculpin	<i>Cottus asper</i>	Not Listed	Not Listed	Yellow	FIDQ
Coast range sculpin	<i>Cottus spp.</i>	Not Listed	Not Listed	Yellow	FIDQ
Pacific Lamprey	<i>Entosphenus tridentatus</i>	Not Listed	Not Listed	Yellow	FIDQ
Threespine Stickleback	<i>Gasterosteus aculeatus</i>	Not Listed	Not Listed	Yellow	FIDQ
Starry Flounder	<i>Platichthys stellatus</i>	Not Listed	Not Listed	No Status	FIDQ

#### Morrison Creek

Existing Conditions: Aquatic and Terrestrial Species and Habitat					
Morrison Creek					
Freshwater Aquatic Species Inventory- Fish					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
Chum salmon	<i>Oncorhynchus keta</i>	Not Listed	Not Listed	Yellow	FIDQ
Coho Salmon	<i>Oncorhynchus kisutch</i>	Not Listed	Not Listed	Yellow	FIDQ
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	E/T/SC (2018)	Endangered	Yellow	FIDQ
Pink Salmon	<i>Oncorhynchus gorbuscha</i>	Not Listed	Not Listed	No Status	FIDQ
Coastal Cutthroat Trout	<i>Oncorhynchus clarkii clarkii</i>	Not Listed	Not Listed	Blue	FIDQ
Rainbow Trout	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Steelhead	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Morrison Creek Lamprey	<i>Lampetra richardsoni var. marj</i>	Endangered	Endangered	Red	FIDQ
Cutthroat Trout	<i>Oncorhynchus clarkii</i>	Not Listed	Not Listed	Yellow	FIDQ

### Millard-Piercy Creek

Existing Conditions: Aquatic and Terrestrial Species and Habitat					
Millard-Piercy Creek					
Freshwater Aquatic Species Inventory- Fish					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
Chum salmon	<i>Oncorhynchus keta</i>	Not Listed	Not Listed	Yellow	FIDQ
Coho Salmon	<i>Oncorhynchus kisutch</i>	Not Listed	Not Listed	Yellow	FIDQ
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	Endangered	Endangered	Yellow	FIDQ
Pink Salmon	<i>Oncorhynchus gorbuscha</i>	Not Listed	Not Listed	No Status	FIDQ
Coastal Cutthroat Trout	<i>Oncorhynchus clarkii clarkii</i>	Not Listed	Not Listed	Blue	FIDQ
Cutthroat trout	<i>Oncorhynchus clarkii</i>	Not Listed	Not Listed	Yellow	FIDQ
Steelhead	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Pacific Lamprey	<i>Entosphenus tridentatus</i>	Not Listed	Not Listed	Yellow	FIDQ

### Tsolum River

Existing Conditions: Aquatic and Terrestrial Species and Habitat					
Tsolum River					
Freshwater Aquatic Species Inventory- Fish					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
Chum salmon	<i>Oncorhynchus keta</i>	Not Listed	Not Listed	Yellow	FIDQ
Coho Salmon	<i>Oncorhynchus kisutch</i>	Not Listed	Not Listed	Yellow	FIDQ
Sockeye Salmon	<i>Oncorhynchus nerka</i>	Not Listed	Not Listed	No Status	FIDQ
Pink Salmon	<i>Oncorhynchus gorbuscha</i>	Not Listed	Not Listed	No Status	FIDQ
Coastal Cutthroat Trout	<i>Oncorhynchus clarkii clarkii</i>	Not Listed	Not Listed	Blue	FIDQ
Kokanee Trout	<i>Oncorhynchus nerka</i>	Not Listed	Not Listed	No Status	FIDQ
Rainbow Trout	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Dolly Varden Trout	<i>Salvelinus malma</i>	Not Listed	Not Listed	Yellow	FIDQ
Steelhead	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Pacific Lamprey	<i>Entosphenus tridentatus</i>	Not Listed	Not Listed	Yellow	FIDQ
Threespine Stickleback	<i>Gasterosteus aculeatus</i>	Not Listed	Not Listed	Yellow	FIDQ

### Portuguese Creek

Existing Conditions: Aquatic and Terrestrial Species and Habitat					
Portuguese Creek					
Freshwater Aquatic Species Inventory- Fish					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
	<i>Oncorhynchus keta</i>	Not Listed	Not Listed	Yellow	FIDQ
Coho Salmon	<i>Oncorhynchus kisutch</i>	Not Listed	Not Listed	Yellow	FIDQ
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	E/T/SC (2018)	Not Listed	Yellow	FIDQ
Coastal Cutthroat Trout	<i>Oncorhynchus clarkii clarkii</i>	Not Listed	Not Listed	Blue	FIDQ
Cutthroat Trout	<i>Oncorhynchus clarkii</i>	Not Listed	Not Listed	Yellow	FIDQ
Steelhead	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Threespine Stickleback	<i>Gasterosteus aculeatus</i>	Not Listed	Not Listed	Yellow	FIDQ

## Glen Urquhart

Existing Conditions: Aquatic and Terrestrial Species and Habitat					
Glen Urquhart Creek					
Freshwater Aquatic Species Inventory- Fish					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
Chum salmon	<i>Oncorhynchus keta</i>	Not Listed	Not Listed	Yellow	FIDQ
Coho Salmon	<i>Oncorhynchus kisutch</i>	Not Listed	Not Listed	Yellow	FIDQ
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	E/T/SC (2018)	Not Listed	Yellow	FIDQ
Sockeye Salmon	<i>Oncorhynchus nerka</i>	Not Listed	Not Listed	No Status	FIDQ
Pink Salmon	<i>Oncorhynchus gorbuscha</i>	Not Listed	Not Listed	No Status	FIDQ
Coastal Cutthroat Trout	<i>Oncorhynchus clarkii clarkii</i>	Not Listed	Not Listed	Blue	FIDQ
Cutthroat Trout	<i>Oncorhynchus clarkii</i>	Not Listed	Not Listed	Yellow	FIDQ
Rainbow Trout	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Steelhead	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Coast range sculpin	<i>Cottus spp.</i>	Not Listed	Not Listed	Yellow	FIDQ
Burbot	<i>Lota lota</i>	Not Listed	Not Listed	Yellow	FIDQ
Threespine Stickleback	<i>Gasterosteus aculeatus</i>	Not Listed	Not Listed	Yellow	FIDQ
Starry Flounder	<i>Platichthys stellatus</i>	Not Listed	Not Listed	No Status	FIDQ

## Courtenay River and Estuary

Existing Conditions: Aquatic Species and Habitat					
Courtenay River and Estuary					
Freshwater Aquatic Species Inventory- Fish					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
Chum salmon	<i>Oncorhynchus keta</i>	Not Listed	Not Listed	Yellow	FIDQ
Coho Salmon	<i>Oncorhynchus kisutch</i>	Not Listed	Not Listed	Yellow	FIDQ
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	E/T/SC (2018)	Endangered	Yellow	FIDQ
Sockeye Salmon	<i>Oncorhynchus nerka</i>	Not Listed	Not Listed	No Status	FIDQ
Pink Salmon	<i>Oncorhynchus gorbuscha</i>	Not Listed	Not Listed	No Status	FIDQ
Coastal Cutthroat Trout	<i>Oncorhynchus clarkii clarkii</i>	Not listed	Not Listed	Blue	FIDQ
Cutthroat trout	<i>Oncorhynchus clarkii</i>	Not Listed	Not Listed	No Status	FIDQ
Kokanee Trout	<i>Oncorhynchus nerka</i>	Not Listed	Not Listed	No Status	FIDQ
Rainbow Trout	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Dolly Varden Trout	<i>Salvelinus malma</i>	Not Listed	Not Listed	Yellow	FIDQ
Steelhead	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Prickly Sculpin	<i>Cottus asper</i>	Not Listed	Not Listed	Yellow	FIDQ
Coast range sculpin	<i>Cottus spp.</i>	Not Listed	Not Listed	Yellow	FIDQ
Pacific Lamprey	<i>Entosphenus tridentatus</i>	Not Listed	Not Listed	Yellow	FIDQ
Threespine Stickleback	<i>Gasterosteus aculeatus</i>	Not Listed	Not Listed	Yellow	FIDQ
Starry Flounder	<i>Platichthys stellatus</i>	Not Listed	Not Listed	No Status	FIDQ
Brook Stickleback	<i>Culaea inconstans</i>	Not Listed	Not Listed	Yellow	DFO

**Comox Harbour**

Existing Conditions: Aquatic Species and Habitat					
Comox Harbour					
Marine/ Estuarine+ Aquatic Species Inventory- Fish					
Species Common Name	Species Scientific Name	STATUS			NOTES (source)
		Cosewic	SARA	BC Status	
Chum salmon	<i>Oncorhynchus keta</i>	Not Listed	Not Listed	Yellow	FIDQ
Coho Salmon	<i>Oncorhynchus kisutch</i>	Not Listed	Not Listed	Yellow	FIDQ
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	E/T/SC (2018)	Endangered	Yellow	FIDQ,
Sockeye Salmon	<i>Oncorhynchus nerka</i>	Not Listed	Not Listed	No Status	FIDQ
Pink Salmon	<i>Oncorhynchus gorbuscha</i>	Not Listed	Not Listed	No Status	FIDQ
Coastal Cutthroat Trout	<i>Oncorhynchus clarkii clarkii</i>	Not listed	Not Listed	Blue	FIDQ
Steelhead	<i>Oncorhynchus mykiss</i>	Not Listed	Not Listed	Yellow	FIDQ
Pacific Lamprey	<i>Entosphenus tridentatus</i>	Not Listed	Not Listed	Yellow	FIDQ
Dolly Varden Trout	<i>Salvelinus malma</i>	Not Listed	Not Listed	Yellow	FIDQ
Threespine Stickleback	<i>Gasterosteus aculeatus</i>	Not Listed	Not Listed	Yellow	FIDQ
Starry Flounder	<i>Platichthys stellatus</i>	Not Listed	Not Listed	No Status	FIDQ
Pacific Herring	<i>Clupea harengus pallasi</i>	Not Listed	Not Listed	No Status	DFO
Sturgeon poacher	<i>Podothecus accipenserinus</i>	Not Listed	Not Listed	No Status	DFO
Sablefish	<i>Anoplopoma fimbria</i>	Not Listed	Not Listed	No Status	DFO
Brown Cat Shark	<i>Apristurus brunneus</i>	Data Defficient	Not Listed	No Status	DFO
Bigfin Eelpout	<i>Lycodes cortezianus</i>	Not Listed	Not Listed	No Status	DFO
Bigeye Poacher	<i>Bathyagonus pentacanthus</i>	Not Listed	Not Listed	No Status	DFO
Arrowtooth	<i>Atheresthes stomias</i>	Not Listed	Not Listed	No Status	DFO
Speckled Sanddab	<i>Citharichthys stigmaeus</i>	Not Listed	Not Listed	No Status	DFO
Shiner Perch	<i>Cymatogaster aggregata</i>	Not Listed	Not Listed	No Status	DFO
Spinyhead Sculpin	<i>Dasycottus setiger</i>	Not Listed	Not Listed	No Status	DFO
Pacific Cod	<i>Gadus macrocephalus</i>	Not Listed	Not Listed	No Status	DFO
Rex Sole	<i>Glyptocephalus zachirus</i>	Not Listed	Not Listed	No Status	DFO
Flathead Sole	<i>Hippoglossoides elassodon</i>	Not Listed	Not Listed	No Status	DFO
Pacific Halibut	<i>Hippoglossus stnolepis</i>	Not Listed	Not Listed	No Status	DFO
Ratfish	<i>Hydrolagus collei</i>	Not Listed	Not Listed	No Status	DFO
Spotfin Sculpin	<i>Icelinus tenuis</i>	Not Listed	Not Listed	No Status	DFO
Butter Sole	<i>Isopsetta isolepis</i>	Not Listed	Not Listed	No Status	DFO
Pacific Lamprey	<i>Lampetra tridentatus</i>	Not Listed	Not Listed	No Status	DFO
Rock Sole	<i>Lepidopsetta bilineata</i>	Not Listed	Not Listed	No Status	DFO
Pacific staghorn sculpin	<i>Leptocottus armatus</i>	Not Listed	Not Listed	No Status	DFO
Pacific snake prickleback	<i>Lumpenus sagitta</i>	Not Listed	Not Listed	No Status	DFO
Blackbelly Eelpout	<i>Lycodopsis pacifica</i>	Not Listed	Not Listed	No Status	DFO
Slender Sole	<i>Lyopsetta exilus</i>	Not Listed	Not Listed	No Status	DFO
Blackfin Sculpin	<i>Malacottus kincaidi</i>	Not Listed	Not Listed	No Status	DFO
Pacific hake	<i>Merluccius productus</i>	Not Listed	Not Listed	No Status	DFO
Pacific Tomcod	<i>Microgadus proximus</i>	Not Listed	Not Listed	No Status	DFO
Dover sole	<i>Microstomau pacificus</i>	Not Listed	Not Listed	No Status	DFO
Lingcod	<i>Ophiodon elongatus</i>	Not Listed	Not Listed	No Status	DFO
English sole	<i>Parophrys vetulus</i>	Not Listed	Not Listed	No Status	DFO
Plainfin Midshipman	<i>Porichthys notatus</i>	Not Listed	Not Listed	No Status	DFO
Sand sole	<i>Psettichthys melanostictus</i>	Not Listed	Not Listed	No Status	DFO
Sandpaper Skate	<i>Bathyraja interrupta</i>	Not Listed	Not Listed	No Status	DFO
Longnose skate	<i>Raja rhina</i>	Not Listed	Not Listed	No Status	DFO
Pile perch	<i>Rhacochilus vacca</i>	Not Listed	Not Listed	No Status	DFO

Marine/ Estuarine Aquatic Species Inventory- Abundant MacroInvertebrates					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
Dungeness Crab	<i>Cancer magister</i>	Not Listed	Not Listed	No Status	DFO
Northern Kelp Crab	<i>Pugettia producta</i>	Not Listed	Not Listed	No Status	DFO
Red Rock Crab	<i>Cancer producta</i>	Not Listed	Not Listed	No Status	DFO
Giant Pink Star	<i>Pisaster brevispinus</i>	Not Listed	Not Listed	No Status	DFO
Ocre Star	<i>Pisaster ocraceus</i>	Not Listed	Not Listed	No Status	DFO
California Sea Cucumber	<i>Apostichopus californicus</i>	Not Listed	Not Listed	No Status	DFO
Barnacles	<i>Balanus spp.</i>	Not Listed	Not Listed	No Status	DFO
Clonal plumose anemone	<i>Metridium senile</i>	Not Listed	Not Listed	No Status	DFO
RedDorid	<i>Rostangia pulchra</i>	Not Listed	Not Listed	No Status	DFO
Blue Mussel	<i>Mytilus edulis</i>	Not Listed	Not Listed	No Status	DFO
Sea plume	<i>Obelia longissima</i>	Not Listed	Not Listed	No Status	DFO
Blood Star	<i>Henricia sanguinolenta</i>	Not Listed	Not Listed	No Status	DFO
Sunflower Star	<i>Pyncopodia helianthoides</i>	Not Listed	Not Listed	No Status	DFO
Lined Chiton	<i>Tonicella lineata</i>	Not Listed	Not Listed	No Status	DFO
Mossy Chiton	<i>Mopalia muscosa</i>	Not Listed	Not Listed	No Status	DFO
San Diego Dorid	<i>Dialula sandiegensis</i>	Not Listed	Not Listed	No Status	DFO
Conical Limpet	<i>Notoacmea persona</i>	Not Listed	Not Listed	No Status	DFO
Marine/ Estuarine Species Inventory- Mammals					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
Harbour seal	<i>Phoca vitulina</i>	Not At Risk	Not listed	Yellow	CDC Imap
Stellers Sea Lion	<i>Eumetopias jubatus</i>	Special Concern	S-1, Special Concern	Blue	CDC Imap
Killer Whale (NE Pacific Southe	<i>Orcinus orca</i>	Endangered	Endangered	Red	Morris et al 1979
Killer Whale(NE Pacific Transie	<i>Orcinus orca</i>	Threatened	Threatened	Red	Morris et al 1979
Harbour Porpoise	<i>Phocoena phocoena</i>	Special Concern	Special Concern	Blue	Morris et al 1979
Dalls Porpoise	<i>Phocoenoides dalli</i>	Not Listed	Not at Risk	Yellow	Morris et al 1979
Pacific White-Sided Dolphin	<i>Lagenorhynchus obliquidens</i>	Not Listed	Not at Risk	Yellow	Morris et al 1979
Grey Whale	<i>Eschrichtius robustus</i>	Special Concern	Special Concern	Blue	Morris et al 1979
Humpback Whale	<i>Megaptera novaeangliae</i>	Special Concern	Special Concern	Blue	Morris et al 1979

## Amphibian and Mammal Species in City of Courtenay

Existing Conditions: Amphibians and Mammals of the Puntledge River, Tsolum River, Morrison Creek, Millard/PiercyCreek, Portuguese Creek, Glen Urquhart Creek, Courtenay River Estuary, and Comox Harbour					
All Systems					
Amphibians					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
Northern Red-legged frog	<i>Rana aurora</i>	Special Concern	Special Concern	Blue Listed	CDC imap
Western Toad	<i>Anaxyrus boreas</i>	Not Listed	Not Listed	Yellow	Efauna
American Bullfrog	<i>Lithobates catesbeianus</i>	Not Listed	Not Listed	No Status	Efauna
Pacific Chorus Frog	<i>Pseudacris regilla</i>	Not Listed	Not Listed	Yellow	Efauna
Northwestern Salamander	<i>Ambystoma gracile</i>	Not At Risk	Not Listed	Yellow	Efauna
Longtoed Salamander	<i>Ambystoma macrodactylum</i>	Not Listed	Not Listed	Yellow	Efauna
Wandering Salamander	<i>Aneides vagrans</i>	Special Concern	Special Concern	Blue	Efauna
Western Redbacked Salamander	<i>Plethodon vehiculum</i>	Not at Risk	Not Listed	Yellow	Efauna
Rough Skinned Newt	<i>Taricha granulosa</i>	Not Listed	Not Listed	Yellow	Efauna
Terrestrial Mammals					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
Dusky Shrew	<i>Sorex monticolus</i>	Not Listed	Not Listed	No Status	DFO
Western Water Shrew	<i>Sorex palustris brooksi</i>	Not Listed	Not Listed	Red	DFO
Vagrant Shrew	<i>Sorex vagran</i>	Not Listed	Not Listed	No Status	DFO
Big Brown Bat	<i>Eptesicus fuscus</i>	Not Listed	Not Listed	Yellow	DFO
Silver Haired Bat	<i>Lasionycteris noctivagans</i>	Not Listed	Not Listed	Yellow	DFO
California myotis	<i>Myotis californicus</i>	Not Listed	Not Listed	Yellow	DFO
Little Brown Myotis	<i>Myotis lucifugus</i>	Not Listed	Not Listed	Yellow	DFO
Yuma Myotis	<i>Myotis yumanensis</i>	Not Listed	Not Listed	Yellow	DFO
Long-legged Myotis	<i>Myotis volans</i>	Not Listed	Not Listed	Yellow	DFO
Keens Myotis	<i>Myotis keeni</i>	Data Deficient	Special Concern	Red	DFO
Townsend's Big-Eared Bat	<i>Plecotus townsendii</i>	Not listed	Not listed	Blue	DFO
Western Long Eared Myotis	<i>Myotis evotis</i>	Not listed	Not listed	Yellow	DFO
Townsend's Vole	<i>Microtus townsendii</i>	Not listed	Not listed	Yellow	DFO
Vancouver Island Wolverine	<i>Gulo gulo vancouverensis</i>	Special Concern	Special Concern	Red	DFO
Deer Mouse	<i>Peromyscus maniculatus</i>	Not Listed	Not Listed	Yellow	DFO
House Mouse	<i>Mus musculus</i>	Not Listed	Not Listed	Yellow	DFO
Norway Rat	<i>Rattus norvegicus</i>	Not Listed	Not Listed	Yellow	DFO
Townsend's Chipmunk	<i>Tamias townsendii</i>	Not Listed	Not Listed	Yellow	DFO
Red Squirrel	<i>Tamiasciurus hudsonicus</i>	Not Listed	Not Listed	Yellow	DFO
Gray Wolf	<i>Canis lupus crassodon</i>	Not Listed	Not Listed	Yellow	DFO
Cougar	<i>Felis concolor vancouverensis</i>	Not Listed	Not Listed	Yellow	DFO
River Otter	<i>Lontra canadensis</i>	Not Listed	Not Listed	Yellow	DFO
Marten	<i>Martes americana</i>	Not Listed	Not Listed	Yellow	DFO
Mink	<i>Mustella vison evagor</i>	Not Listed	Not Listed	Yellow	DFO
Vancouver Island Ermine	<i>M. erminea anguinae</i>	Not Listed	Not Listed	Blue	DFO
Raccoon	<i>Procyon lotor</i>	Not Listed	Not Listed	Yellow	DFO
Vancouver Island Black Bear	<i>Ursus americanus vancouveri</i>	Not At Risk	Not Listed	Yellow	DFO
Roosevelt Elk	<i>Cervus elaphus roosevelti</i>	Not Listed	Not Listed	Blue	DFO
Mule Deer, Columbianus subspecies	<i>Odocoileus hemionus columbianus</i>	Not Listed	Not Listed	Yellow	DFO

## Dominant Vascular Plants in City of Courtenay

Existing Conditions: Dominant Vascular Plants of the Puntledge River, Tsolum River, Morrison Creek, Millard/PiercyCreek, Portuguese Creek, Glen Urquhart Creek, Courtenay River Estuary, and Comox Harbour, Based on the CWHxm1 BEC Zone					
All Systems					
Terrestrial					
Species Common Name	Species Scientific Name	STATUS			NOTES
		Cosewic	SARA	BC Status	
Douglas Fir	<i>Pseudotsuga menziesi</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Western Red Cedar	<i>Thuja plicata</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Western Hemlock	<i>Tsuga heterophylla</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Salal	<i>Gaultheria shallon</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Dull Oregon Grape	<i>Mahonia nervosa</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Trailing Blackberry	<i>Vaccinium parvifolium</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Red Huckleberry	<i>Rubus ursinus</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Baldhip Rose	<i>Rosa gymnocarpa</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Oceanspray	<i>Holodiscus discolor</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Princes Pine	<i>Chimaphila umbellata</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Twinflower	<i>Linnaea borealis</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Sword Fern	<i>Polystichum munitum</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Bracken Fern	<i>Pteridium aquilinum</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide
Vanilla Leaf	<i>Achlys triphylla</i>	Not Listed	Not Listed	Yellow	* B.C. Field guide

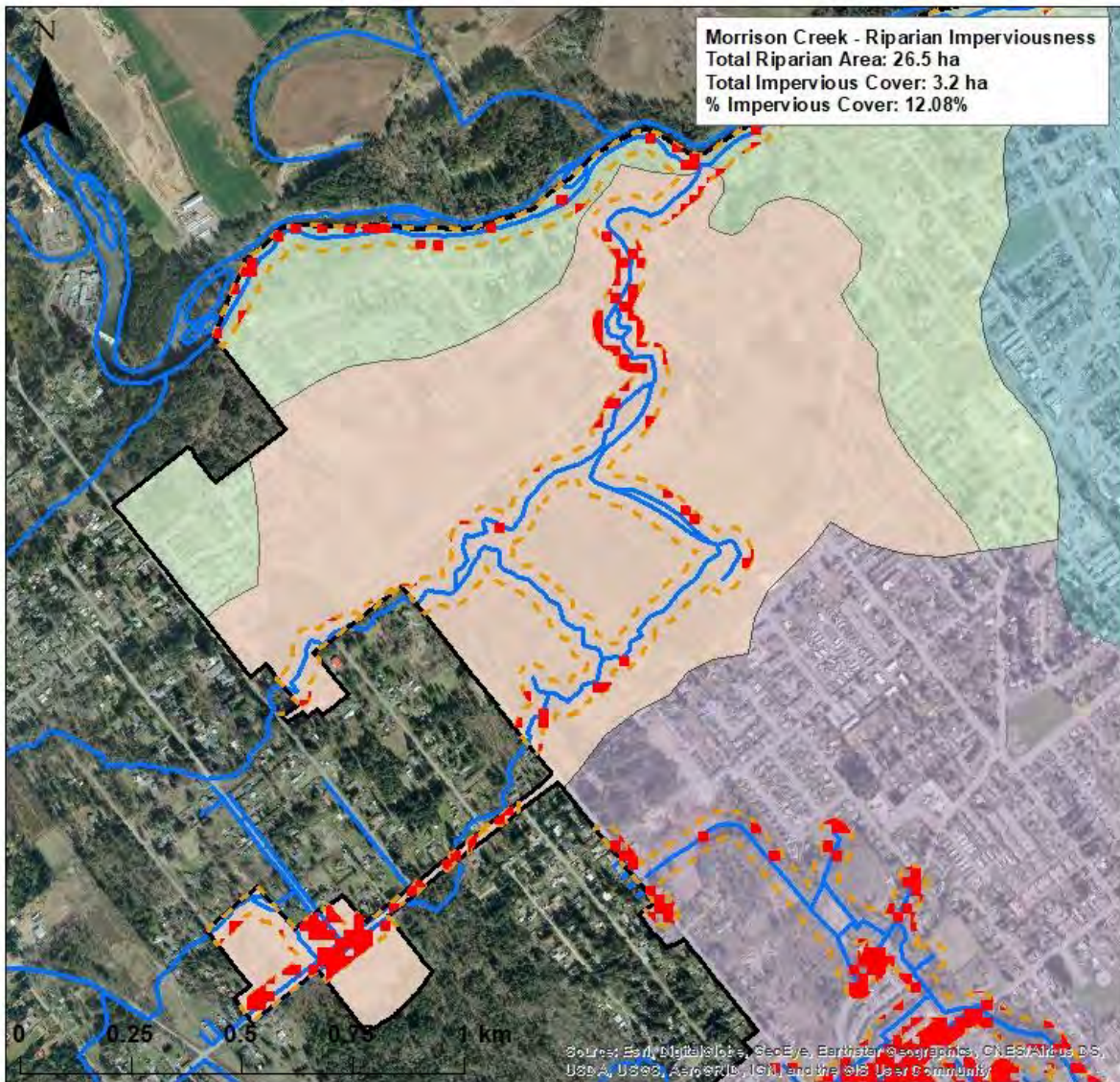
\* B.C. Field guide for site interpretation and identification, 1994

## Species at Risk

Species at Risk Inventory: All streams and environments within integrated rainwater management area						
Species Common Name	Species Scientific Name	STATUS			Specific water body	Source
		Cosewic	SARA	BC list		
<b>Fish</b>						
Coastal Cutthroat Trout	<i>Oncorynchus clarkii clarkii</i>	Not Listed	Not Listed	Blue	All Streams	FIDQ
Chinook Salmon (East Vancouver Island Spring Population)	<i>Oncorynchus tshawytscha</i>	Endangered	Endangered	Yellow	All Streams	FIDQ
<b>Amphibians</b>						
Northern Red-legged frog	<i>Rana aurora</i>	Special Concern	Special Concern	Blue	Puntledge, Tsolum	CDC Imap
Wandering Salamander	<i>Aneides vagrans</i>	Special Concern	Special Concern	Blue	All Streams	Efauna
<b>Avians</b>						
<b>Terrestrial</b>						
Evening Grosbeak	<i>Coccothraustes vespertinus</i>	Special Concern	Special Concern (1)	Yellow	Tsolum	Efauna
Northern Goshawk, laingi subspecies	<i>Accipiter gentilis laingi</i>	Threatened	Threatened (1)	Red	Puntledge	CDC Imap
Western Screech Owl, kennicottii subspecies	<i>Megascops kennicottii kennicottii</i>	Threatened	Threatened (1)	Blue	Puntledge, Tsolum, Morrison	CDC Imap, Efauna
Western Screech Owl	<i>Megascops kennicottii</i>	Threatened	Threatened (1)	No Status	Puntledge, Courtenay, Tsolum	Efauna, CDC Imap
Green Heron	<i>Butorides virescens</i>	Not Listed	Not Listed	Blue	Puntledge	CDC Imap
Great Blue Heron (faninii subspecies)	<i>Ardea herodias faninii</i>	Special Concern	Special Concern (1)	Blue	Puntledge	CDC Imap
<b>Marine</b>						
Western Grebe	<i>Aechmorus occidentalis</i>			Red	Courtenay River Estuary, Comox Harbour	DFO
Swainson's Hawk	<i>Buteo swainsoni</i>			Red	Courtenay River Estuary, Comox Harbour	DFO
Common Murre	<i>Uria aalge</i>			Red	Courtenay River Estuary, Comox Harbour	DFO
Marbled Murrelet	<i>Brachyramphus marmoratus</i>			Red	Courtenay River Estuary, Comox Harbour	DFO
Double Crested Cormorant	<i>Phalacrocorax auritus</i>			Blue	Courtenay River Estuary, Comox Harbour	DFO
Trumpeter Swan	<i>Cygnus buccinator</i>			Blue	Courtenay River Estuary, Comox Harbour	DFO
Long Tailed Duck	<i>Clangula hyemalis</i>			Blue	Courtenay River Estuary, Comox Harbour	DFO
Surf Scoter	<i>Melanitta perspicillata</i>			Blue	Courtenay River Estuary, Comox Harbour	DFO
Sandhill Crane	<i>Grus canadensis</i>			Blue	Courtenay River Estuary, Comox Harbour	DFO
Short Billed Dowitcher	<i>Limnodromus griseus</i>			Blue	Courtenay River Estuary, Comox Harbour	DFO
California Gull	<i>Larus californicus</i>			Blue	Courtenay River Estuary, Comox Harbour	DFO
Brant Goose	<i>Branta bernicla</i>	Not Listed	Not Listed	Blue	Comox Harbour, CDC IMAP	
<b>Invertebrates</b>						
<b>Terrestrial</b>						
Dun Skipper					Puntledge	Efauna
Yellow Sand Verbena moth	<i>Copablepharon fuscum</i>	Endangered	Endangered	Red	Comox Harbour	
<b>Mammals</b>						
<b>Terrestrial</b>						
Vancouver Island Wolverine	<i>Gulo gulo vancouverensis</i>	Special Concern	Special Concern	Red	All Streams(CWF dry maritime subzone)	DFO
Keens Myotis	<i>Myotis keeni</i>	Data Deficient	Special Concern	Red	All Streams(CWF dry maritime subzone)	DFO
Vancouver Island Ermine	<i>M. erminea anguinae</i>	Not Listed	Not Listed	Blue	All Streams(CWF dry maritime subzone)	DFO
Townsend's Big-Eared Bat	<i>Plecotus townsendii</i>	Not Listed	Not Listed	Blue	All Streams(CWF dry maritime subzone)	
<b>Aquatic</b>						
Vancouver Island Water Shrew	<i>Sorex palustris brooksi</i>	Not Listed	Not Listed	Red	All Streams(CWF dry maritime subzone)	CDC Imap, DFO
<b>Marine</b>						
Stellers Sea Lion	<i>Eumetopias jubatus</i>	Special Concern	S-1, Special Concern	Blue	Comox Harbour, Courtenay River Estuary	CDC Imap
Killer Whale (NE Pacific Southern Resident Population)	<i>Orcinus orca</i>	Endangered	Endangered	Red	Comox Harbour	Morris et al. 1979
Killer Whale(NE Pacific Transient Population)	<i>Orcinus orca</i>	Threatened	Threatened	Red	Comox Harbour	Morris et al 1979
Harbour Porpoise	<i>Phocoena phocaena</i>	Special Concern	Special Concern	Blue	Comox Harbour	Morris et al 1979
Grey Whale	<i>Eschrichtius robustus</i>	Special Concern	Special Concern	Blue	Comox Harbour	Morris et al 1979
Humpback Whale	<i>Megaptera novaeangliae</i>	Special Concern	Special Concern	Blue	Comox Harbour	Morris et al 1979
<b>Plants</b>						
V1 beggarticks	<i>Bidens amplissima</i>	Special Concern	Special Concern	Blue	Puntledge,Tsolum, Courtenay,Glenn Urquhart, Comox Harbour	CDC IMAP
Hendersons Checkermallow	<i>Sidalcea hendersonii</i>	Not Listed	Not Listed	Blue	Comox Harbour	CDC IMAP
Yellow Sand Verbena	<i>Abronia latifolia</i>	Not Listed	Not Listed	Blue	Comox Harbour	CDC IMAP

## APPENDIX B

### IMPERVIOUS SURFACE MAPS FOR EACH WATERSHED IN THE CITY OF COURTENAY



### City of Courtenay Riparian Corridor Imperviousness Morrison Creek

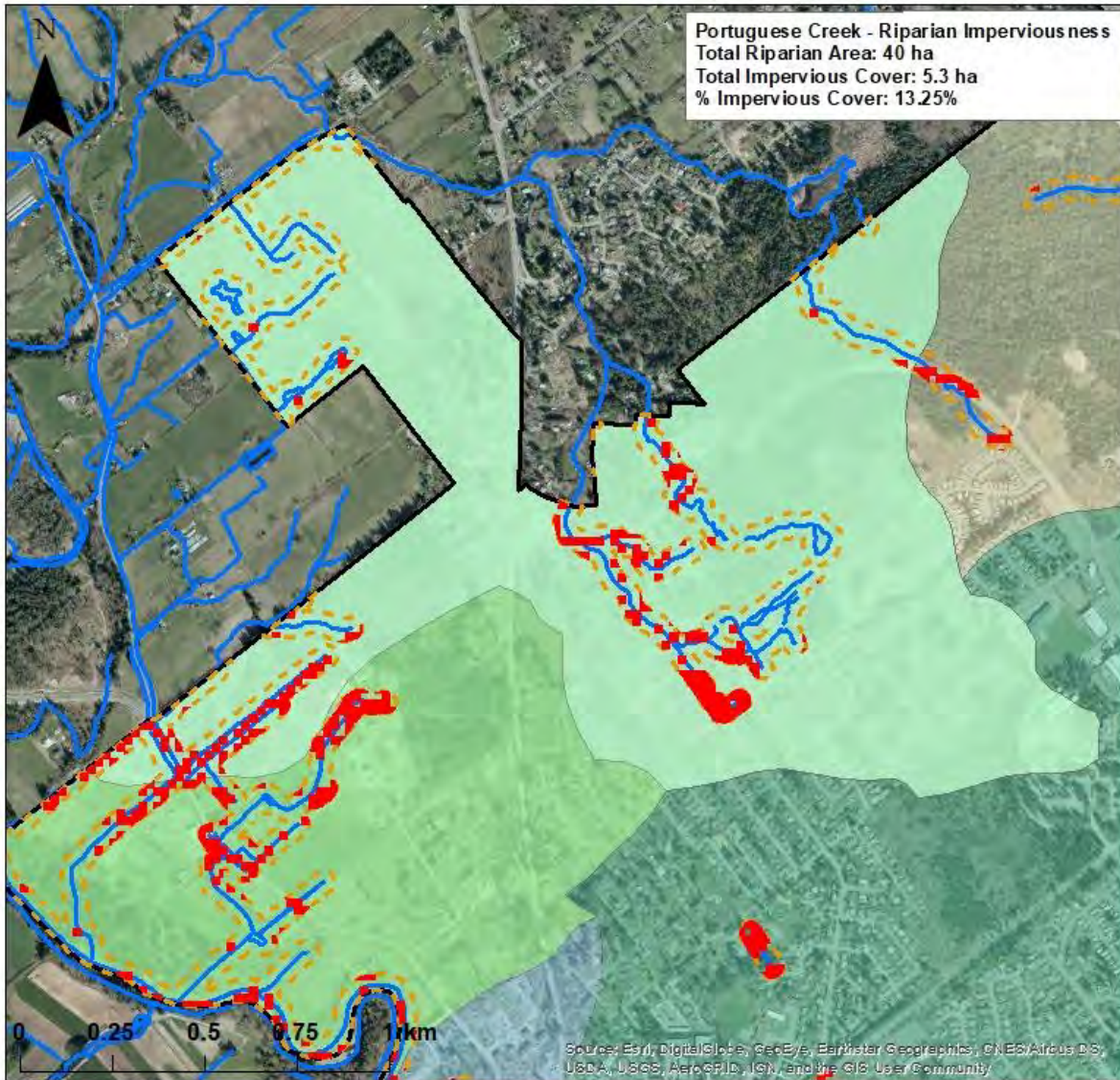
Date: 12/06/2019  
Projection: UTM 10  
Datum: NAD 1983  
Author: CPalmer  
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#### Legend

- Impervious Surface
- 30 m Riparian Buffer
- City of Courtenay Boundary
- Watercourses
- Morrison Creek Watershed
- Puntledge River Watershed
- Courtenay River Watershed
- Millard Piercy Creek Watershed

Figure 3. Morrison Creek riparian corridor imperviousness.



### City of Courtenay Riparian Corridor Imperviousness Portuguese Creek Watershed

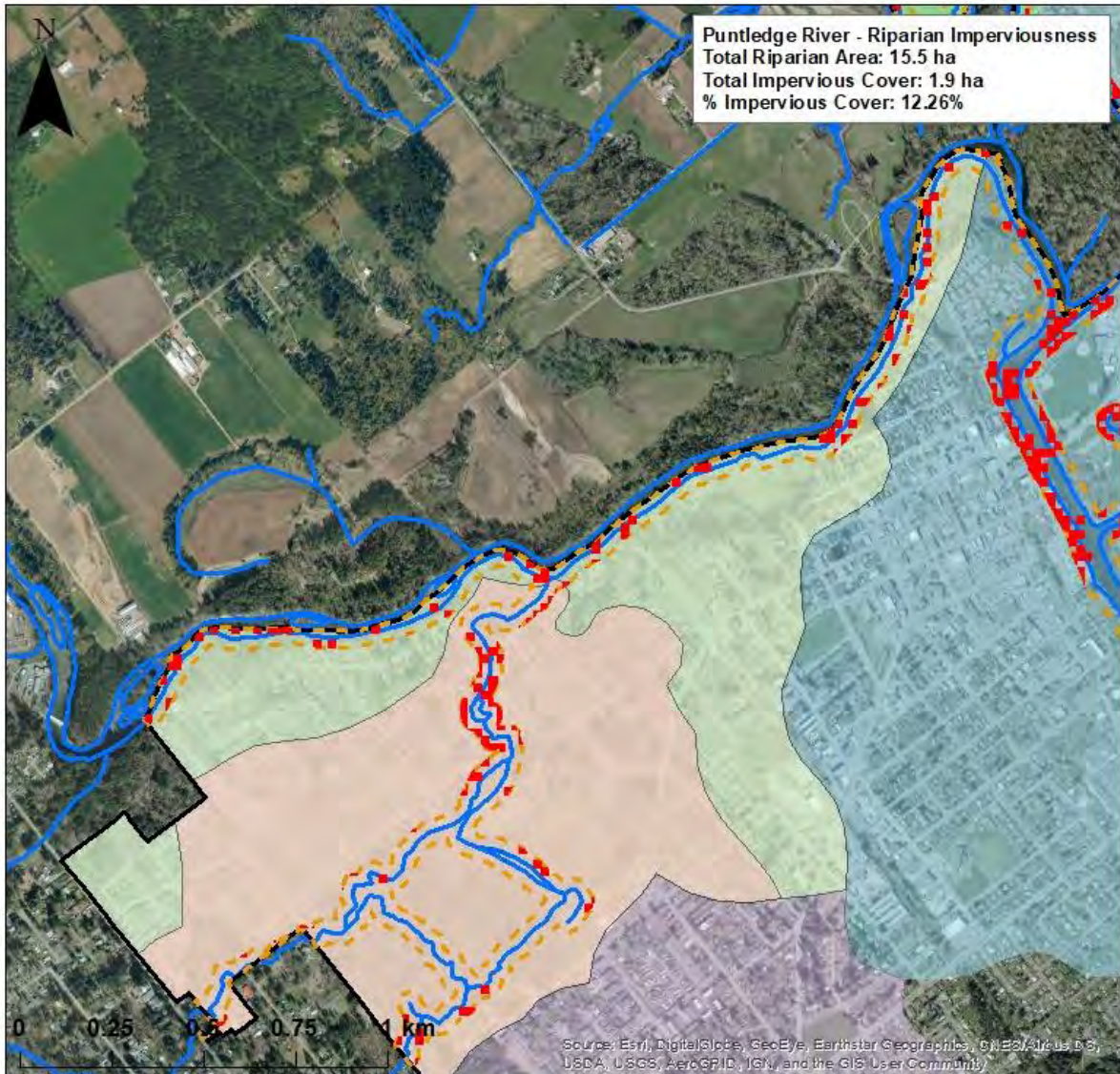
Date: 12/06/2019  
Projection: UTM 10  
Datum: NAD 1983  
Author: CPalmer  
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#### Legend

- Impervious Surface
- Tsolum River Watershed
- 30 m Riparian Buffer
- Little River Watershed
- City of Courtenay Boundary
- Courtenay River Watershed
- Watercourses
- Glenn Urquhart Creek Watershed
- Portuguese Creek Watershed

**Figure 4. Portuguese Creek riparian corridor imperviousness.**



**City of Courtenay Riparian Corridor Imperviousness  
Puntledge River**

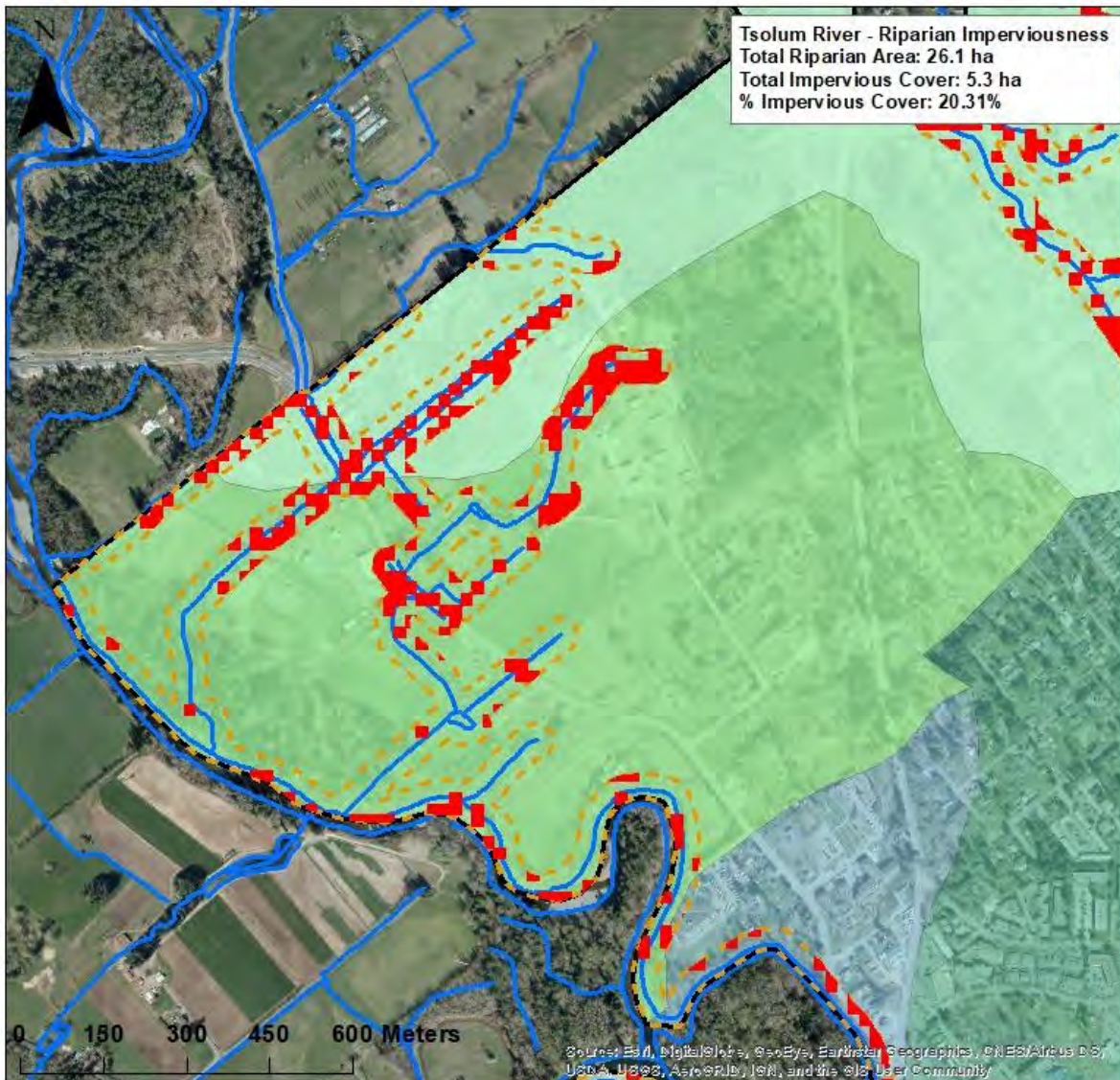
Date: 12/06/2019  
Projection: UTM 10  
Datum: NAD 1983  
Author: CPalmer  
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**Legend**

- Impervious Surface
- 30 m Riparian Buffer
- City of Courtenay Boundary
- Watercourses
- Puntledge River Watershed
- Morrison Creek Watershed
- Courtenay River Watershed
- Millard Piercy Creek Watershed

**Figure 5. Puntledge River riparian corridor imperviousness.**



**City of Courtenay Riparian Corridor Imperviousness  
Tsolum River**

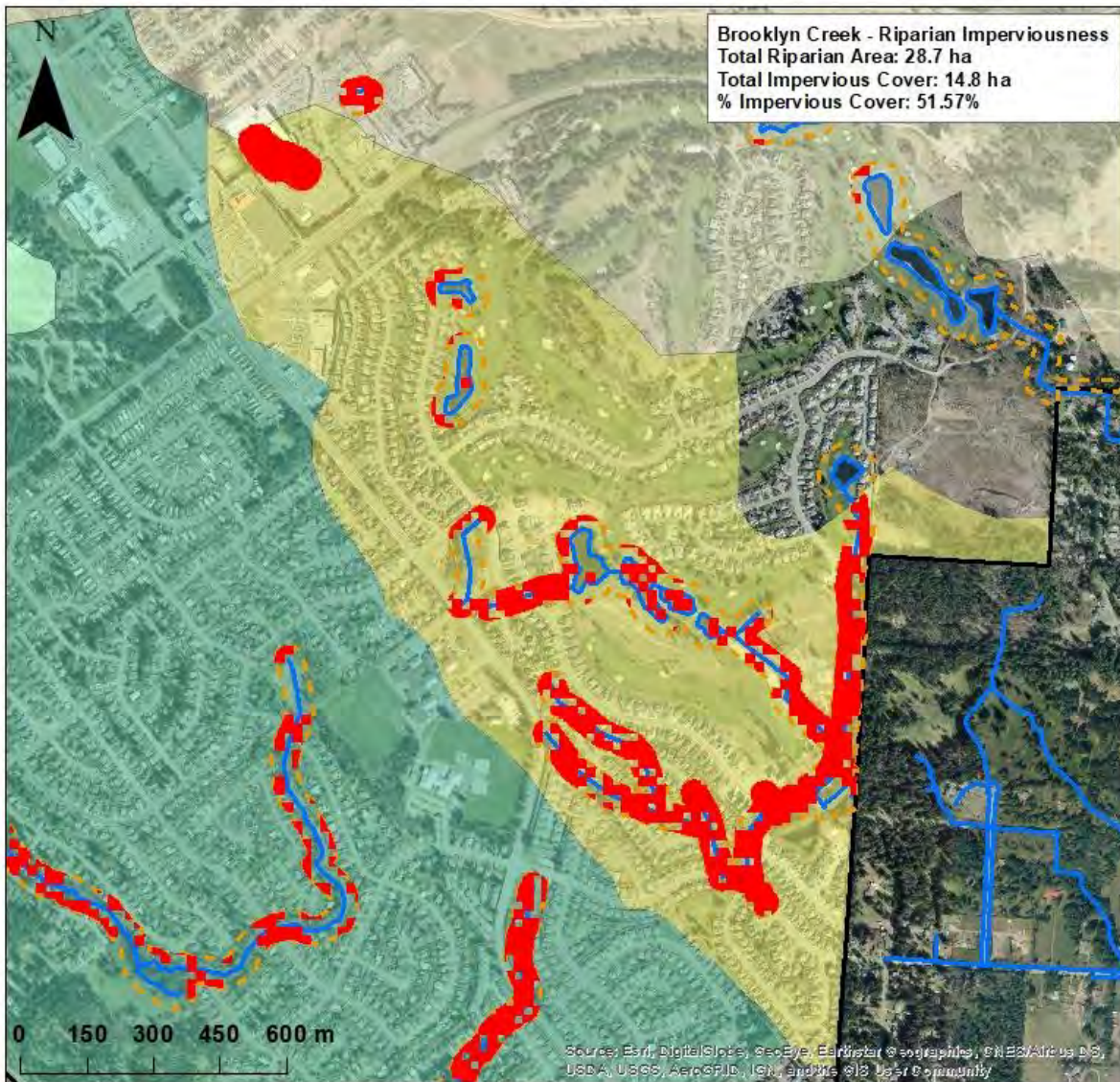
Date: 12/06/2019  
Projection: UTM 10  
Datum: NAD 1983  
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**Legend**

- Impervious Surface
- 30 m Riparian Buffer
- City of Courtenay Boundary
- Watercourses
- Tsolum River Watershed
- Portuguese Creek Watershed
- Courtenay River Watershed
- Glenn Urquhart Creek Watershed

**Figure 6. Tsolum River riparian corridor imperviousness.**



### City of Courtenay Riparian Corridor Imperviousness Brooklyn Creek

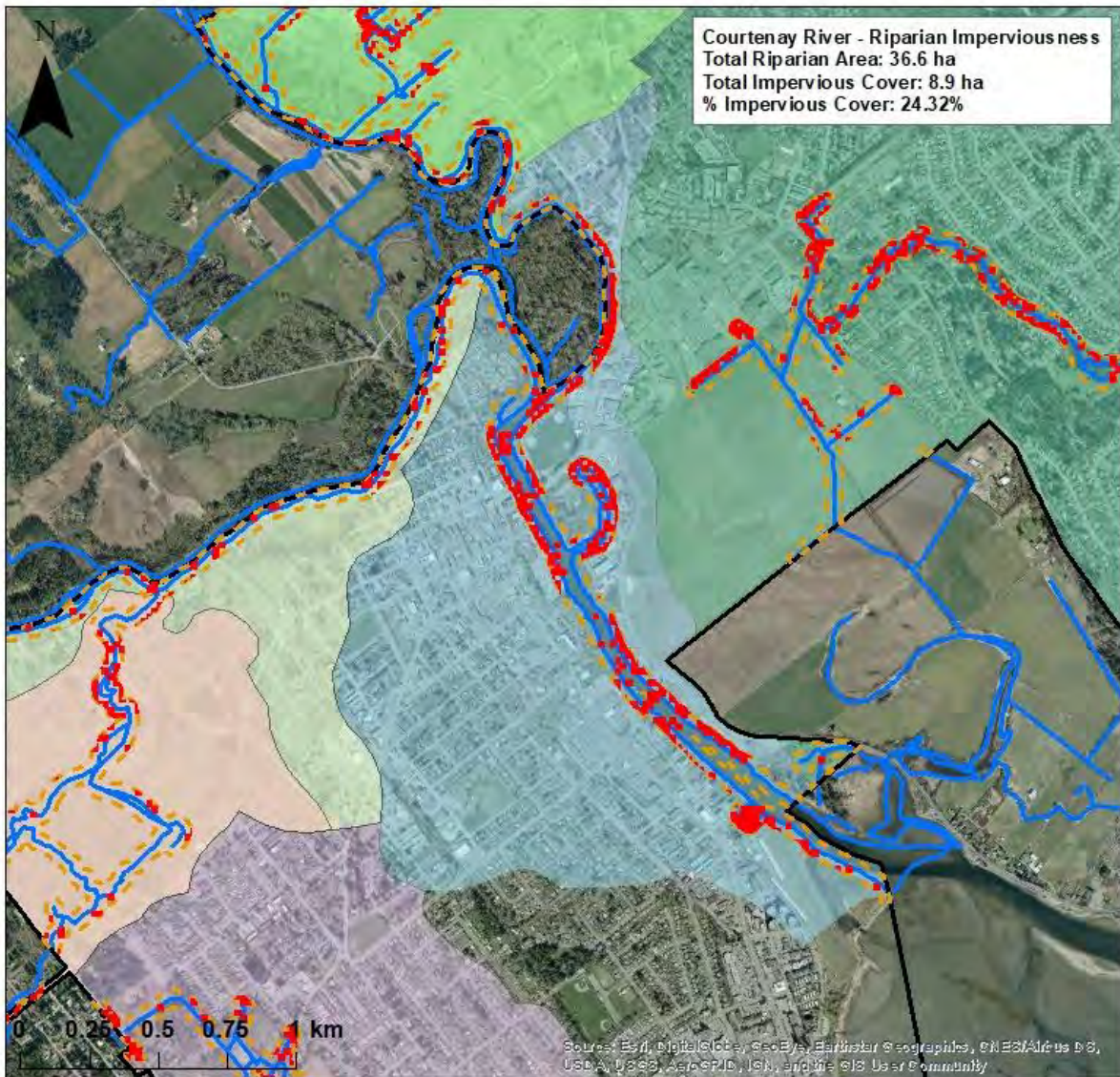
Date: 12/06/2019  
Projection: UTM 10  
Datum: NAD 1983  
Author: CPalmer  
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#### Legend

- Impervious Surface
- 30 m Riparian Buffer
- City of Courtenay Boundary
- Watercourses
- Brooklyn Creek Watershed
- Little River Watershed
- Glenn Urquhart Creek Watershed
- Portuguese Creek Watershed

Figure 7. Brooklyn Creek riparian corridor imperviousness.



**City of Courtenay Riparian Corridor Imperviousness  
Courtenay River**

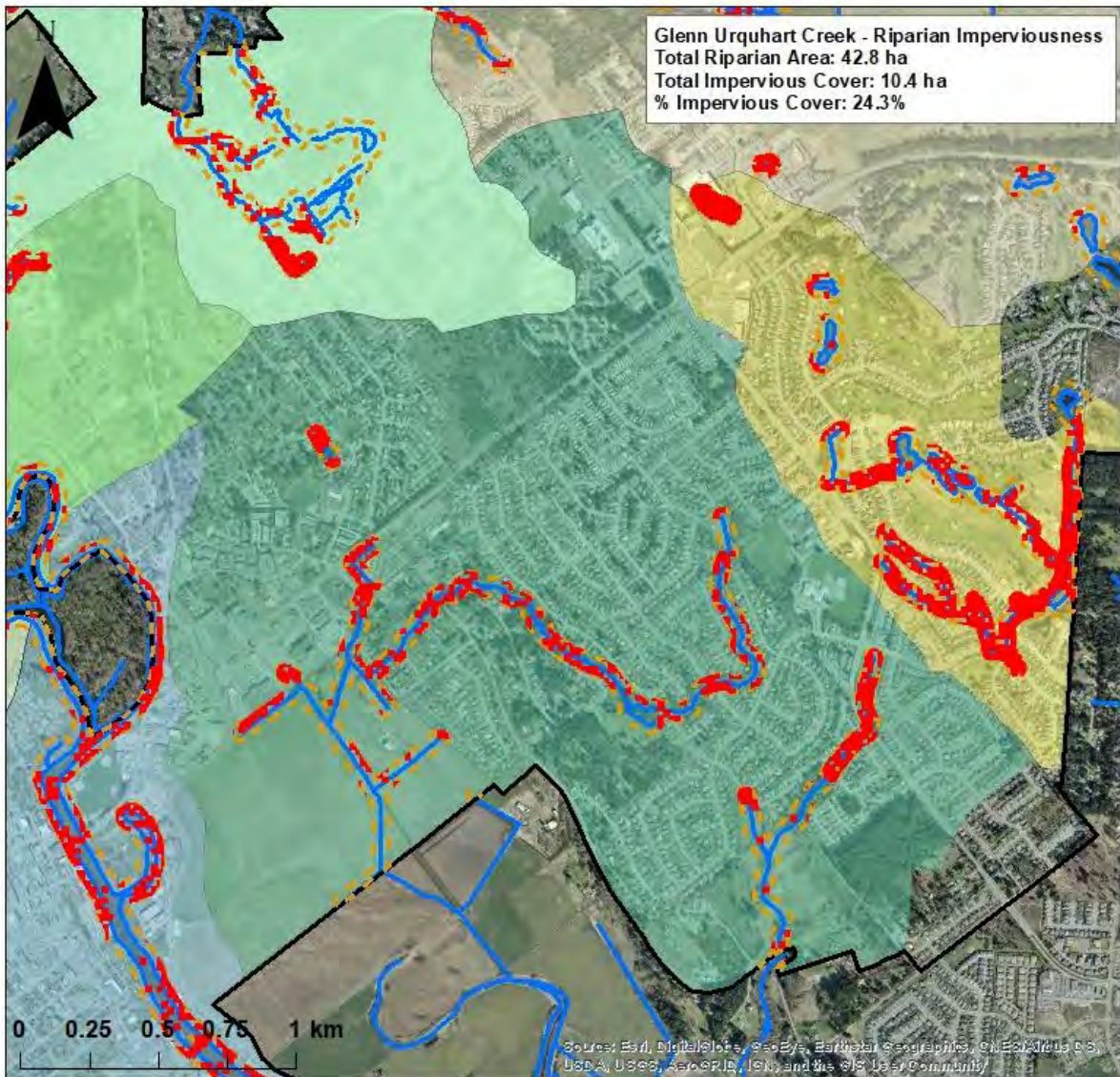
Date: 12/06/2019  
Projection: UTM 10  
Datum: NAD 1983  
Author: CPalmer  
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**Legend**

- |                            |                                |
|----------------------------|--------------------------------|
| Impervious Surface         | Glenn Urquhart Creek Watershed |
| 30 m Riparian Buffer       | Tsolum River Watershed         |
| City of Courtenay Boundary | Millard Piercy Creek Watershed |
| Watercourses               | Morrison Creek Watershed       |
| Courtenay River Watershed  | Puntledge River Watershed      |

**Figure 8. Courtenay River riparian corridor imperviousness.**



**City of Courtenay Riparian Corridor Imperviousness  
Glenn Urquhart Creek**

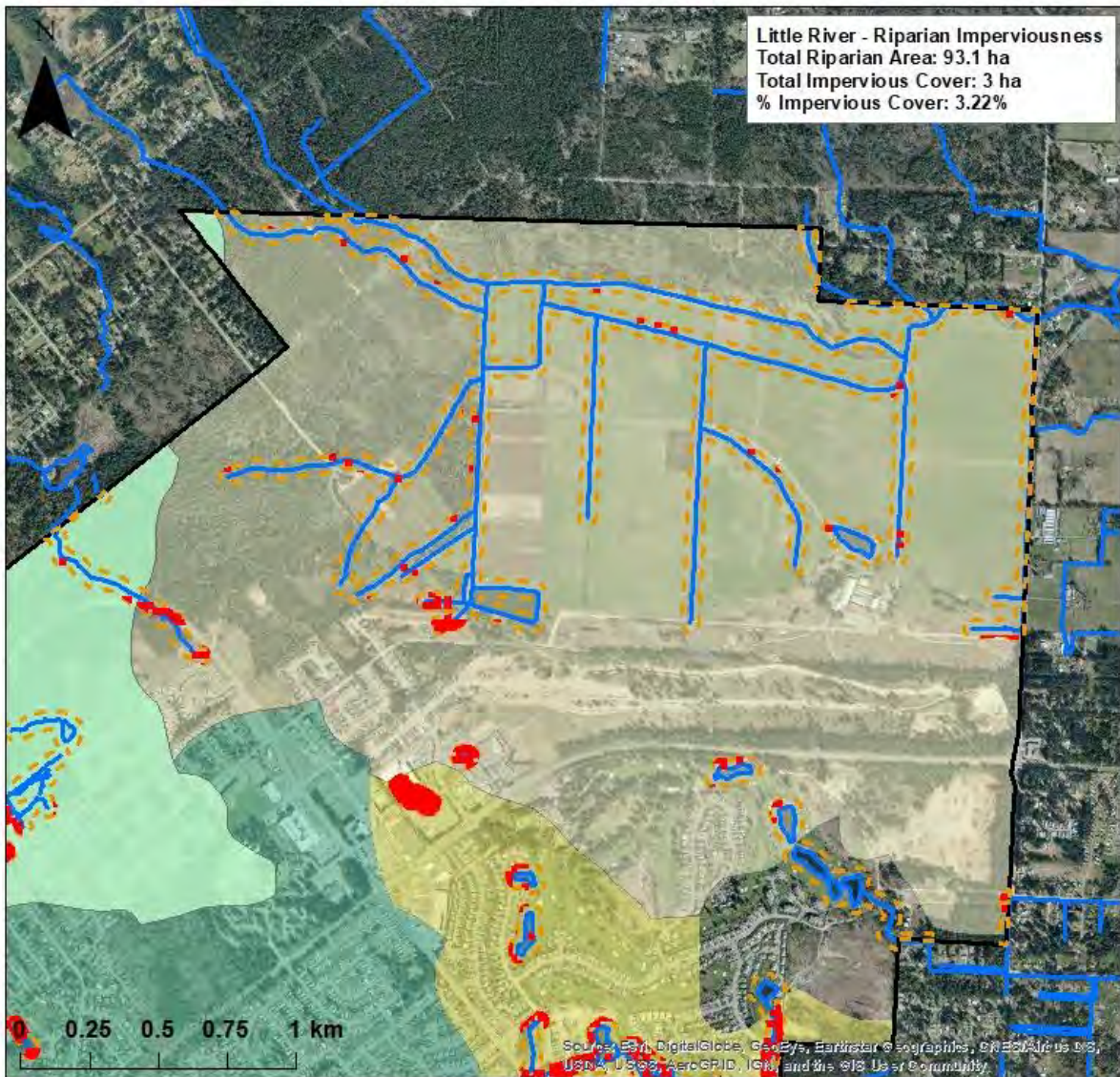
Date: 12/06/2019  
Projection: UTM 10  
Datum: NAD 1983  
Author: CPalmer  
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**Legend**

- Impervious Surface
- 30 m Riparian Buffer
- City of Courtenay Boundary
- Watercourses
- Glenn Urquhart Creek Watershed
- Brooklyn Creek Watershed
- Little River Watershed
- Portuguese Creek Watershed
- Tsolum River Watershed

**Figure 9. Portuguese Creek riparian corridor imperviousness.**



City of Courtenay Riparian Corridor Imperviousness  
Little River

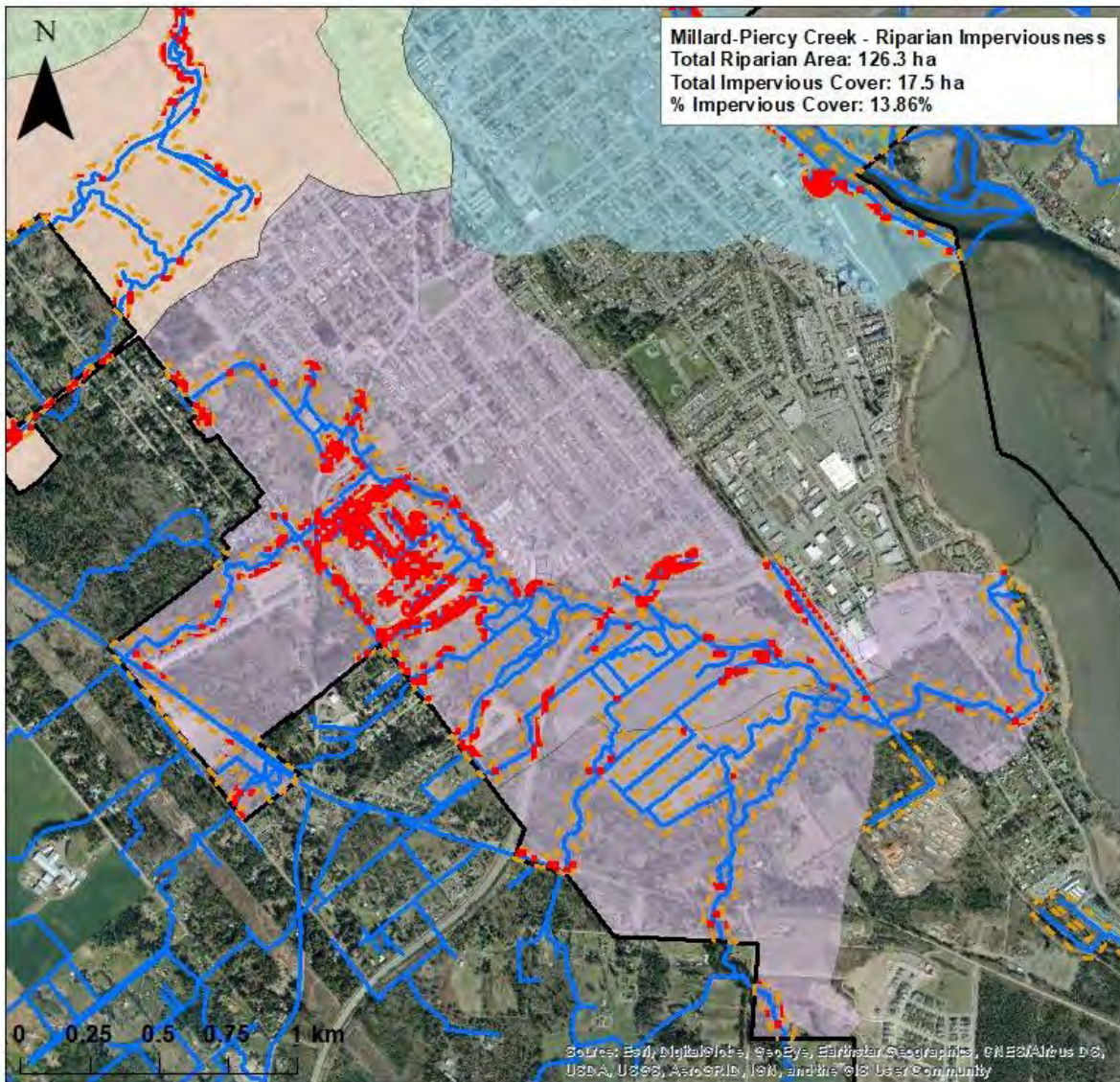
Date: 12/06/2019  
Projection: UTM 10  
Datum: NAD 1983  
Author: CPalmer  
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**Legend**

- Impervious Surface
- 30 m Riparian Buffer
- City of Courtenay Boundary
- Watercourses
- Little River Watershed
- Portuguese Creek Watershed
- Glenn Urquhart Creek Watershed
- Brooklyn Creek Watershed

Figure 10. Little River riparian corridor imperviousness.



**City of Courtenay Riparian Corridor Imperviousness  
Millard-Piercy Creek**

Date: 12/06/2019  
Projection: UTM 10  
Datum: NAD 1983  
Author: CPalmer  
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**Legend**

- Impervious Surface
- 30 m Riparian Buffer
- City of Courtenay Boundary
- Watercourses
- Millard Piercy Creek Watershed
- Morrison Creek Watershed
- Puntledge River Watershed
- Courtenay River Watershed

**Figure 11. Millard-Piercy Creek riparian corridor imperviousness.**

## APPENDIX C

### RAW DATA OF LABORATORY ANALYSIS FROM SELECT WATER QUALITY PARAMETERS IN CITY OF COURTENAY URBAN RAINWATER SYSTEMS, SEPT. - OCT., 2019



CURRENT ENVIRONMENTAL LTD.  
ATTN: Dusty Silvester  
558 England Ave  
Courtenay BC V9N 2N3

Date Received: 13-SEP-19  
Report Date: 19-SEP-19 17:40 (MT)  
Version: FINAL

Client Phone: 250-871-1944

## Certificate of Analysis

**Lab Work Order #:** L2346896  
Project P.O. #: NOT SUBMITTED  
Job Reference:  
C of C Numbers: 17-760043  
Legal Site Desc:

Edward Ngai  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

## ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L2346896-1 Water 12-SEP-19 12:18 IPC-01	L2346896-2 Water 12-SEP-19 12:43 ICR-01	L2346896-3 Water 12-SEP-19 13:08 IMC-01	L2346896-4 Water 12-SEP-19 13:26 IPR-01	L2346896-5 Water 12-SEP-19 14:08 IGU-01
Grouping	Analyte					
<b>WATER</b>						
<b>Bacteriological Tests</b>	E. coli (MPN/100mL)	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6
	Coliform Bacteria - Total (MPN/100mL)	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)	1.89	0.921	3.12	0.763	0.602
	Antimony (Sb)-Total (mg/L)	0.00073	0.00055	0.00054	0.00035	0.00028
	Arsenic (As)-Total (mg/L)	0.00079	0.00066	0.00139	0.00047	0.00111
	Barium (Ba)-Total (mg/L)	0.0121	0.00673	0.0115	0.00956	0.00404
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Total (mg/L)	0.000121	<0.000050	0.000078	0.000263	<0.000050
	Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	0.013	0.013
	Cadmium (Cd)-Total (mg/L)	0.0000682	0.0000223	0.0000247	0.0000262	0.0000125
	Calcium (Ca)-Total (mg/L)	5.62	2.91	6.50	3.77	7.63
	Cesium (Cs)-Total (mg/L)	0.000061	0.000024	0.000091	0.000032	0.000021
	Chromium (Cr)-Total (mg/L)	0.00480	0.00285	0.00708	0.00289	0.00269
	Cobalt (Co)-Total (mg/L)	0.00140	0.00067	0.00208	0.00060	0.00045
	Copper (Cu)-Total (mg/L)	0.0175	0.00892	0.0182	0.00904	0.00802
	Iron (Fe)-Total (mg/L)	2.70	1.40	4.42	1.10	1.17
	Lead (Pb)-Total (mg/L)	0.00322	0.00142	0.00263	0.00173	0.000600
	Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	0.0015	<0.0010	<0.0010
	Magnesium (Mg)-Total (mg/L)	1.90	0.906	1.76	0.948	2.18
	Manganese (Mn)-Total (mg/L)	0.0658	0.0489	0.0899	0.0482	0.100
	Molybdenum (Mo)-Total (mg/L)	0.000743	0.000409	0.000343	0.000243	0.000236
	Nickel (Ni)-Total (mg/L)	0.00322	0.00148	0.00415	0.00125	0.00083
	Phosphorus (P)-Total (mg/L)	0.157	0.066	0.122	0.112	0.092
	Potassium (K)-Total (mg/L)	0.552	0.478	0.662	0.773	0.805
	Rubidium (Rb)-Total (mg/L)	0.00067	0.00046	0.00109	0.00064	0.00068
	Selenium (Se)-Total (mg/L)	0.000110	0.000069	0.000082	<0.000050	0.000072
	Silicon (Si)-Total (mg/L)	4.02	2.01	4.93	1.78	3.36
	Silver (Ag)-Total (mg/L)	0.000024	0.000016	0.000023	0.000011	<0.000010
	Sodium (Na)-Total (mg/L)	6.99	3.81	4.31	3.07	4.84
	Strontium (Sr)-Total (mg/L)	0.0201	0.0122	0.0211	0.0161	0.0230
	Sulfur (S)-Total (mg/L)	0.91	<0.50	0.55	<0.50	0.71
	Tellurium (Te)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Thorium (Th)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Tin (Sn)-Total (mg/L)	0.00069	0.00036	0.00036	0.00022	0.00016
	Titanium (Ti)-Total (mg/L)	0.174	0.0820	0.298	0.0629	0.0462
	Tungsten (W)-Total (mg/L)	0.00043	<0.00010	<0.00010	<0.00010	<0.00010

## ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID	Description	Sampled Date	Sampled Time	Client ID
		L2346896-6	Water	12-SEP-19	15:58	IBC-01
<b>WATER</b>						
<b>Bacteriological Tests</b>	E. coli (MPN/100mL)					>2419.6
	Coliform Bacteria - Total (MPN/100mL)					>2419.6
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)					0.0161
	Antimony (Sb)-Total (mg/L)					<0.00010
	Arsenic (As)-Total (mg/L)					0.00207
	Barium (Ba)-Total (mg/L)					0.00300
	Beryllium (Be)-Total (mg/L)					<0.00010
	Bismuth (Bi)-Total (mg/L)					<0.000050
	Boron (B)-Total (mg/L)					0.017
	Cadmium (Cd)-Total (mg/L)					0.0000061
	Calcium (Ca)-Total (mg/L)					16.7
	Cesium (Cs)-Total (mg/L)					0.000016
	Chromium (Cr)-Total (mg/L)					0.00088
	Cobalt (Co)-Total (mg/L)					<0.00010
	Copper (Cu)-Total (mg/L)					0.00139
	Iron (Fe)-Total (mg/L)					0.186
	Lead (Pb)-Total (mg/L)					0.000064
	Lithium (Li)-Total (mg/L)					<0.0010
	Magnesium (Mg)-Total (mg/L)					5.12
	Manganese (Mn)-Total (mg/L)					0.0465
	Molybdenum (Mo)-Total (mg/L)					0.000105
	Nickel (Ni)-Total (mg/L)					<0.00050
	Phosphorus (P)-Total (mg/L)					<0.050
	Potassium (K)-Total (mg/L)					0.756
	Rubidium (Rb)-Total (mg/L)					0.00077
	Selenium (Se)-Total (mg/L)					<0.000050
	Silicon (Si)-Total (mg/L)					1.27
	Silver (Ag)-Total (mg/L)					<0.000010
	Sodium (Na)-Total (mg/L)					9.52
	Strontium (Sr)-Total (mg/L)					0.0537
	Sulfur (S)-Total (mg/L)					1.49
	Tellurium (Te)-Total (mg/L)					<0.00020
	Thallium (Tl)-Total (mg/L)					<0.000010
	Thorium (Th)-Total (mg/L)					<0.00010
	Tin (Sn)-Total (mg/L)					<0.00010
	Titanium (Ti)-Total (mg/L)					0.00084
	Tungsten (W)-Total (mg/L)					<0.00010

## ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2346896-1	L2346896-2	L2346896-3	L2346896-4	L2346896-5
		Description	Water	Water	Water	Water	Water
		Sampled Date	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19
		Sampled Time	12:18	12:43	13:08	13:26	14:08
		Client ID	IPC-01	ICR-01	IMC-01	IPR-01	IGU-01
Grouping	Analyte						
<b>WATER</b>							
<b>Total Metals</b>	Uranium (U)-Total (mg/L)		0.000040	0.000025	0.000035	0.000014	0.000017
	Vanadium (V)-Total (mg/L)		0.00832	0.00475	0.0139	0.00423	0.00369
	Zinc (Zn)-Total (mg/L)		0.114	0.0249	0.0354	0.0249	0.0154
	Zirconium (Zr)-Total (mg/L)		0.00065	0.00039	0.00055	0.00032	0.00021
<b>Total Metals (Undigested)</b>	Turbidity Screen (Metals Sample) (NTU)		7.9	5.8	16.4	7.1	9.5

# ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L2346896-6 Water 12-SEP-19 15:58 IBC-01				
Grouping	Analyte					
<b>WATER</b>						
<b>Total Metals</b>	Uranium (U)-Total (mg/L)	<0.000010				
	Vanadium (V)-Total (mg/L)	<0.00050				
	Zinc (Zn)-Total (mg/L)	0.0037				
	Zirconium (Zr)-Total (mg/L)	<0.00020				
<b>Total Metals (Undigested)</b>	Turbidity Screen (Metals Sample) (NTU)	<1.0				

## Reference Information

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
<b>ECOLI-COLI-ENV-VA</b>	Water	E.coli by Colilert	APHA METHOD 9223
<p>This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.</p>			
<b>MET-T-CCMS-VA</b>	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)
<p>Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.</p> <p>Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.</p>			
<b>TCOLI-COLI-ENV-VA</b>	Water	Total coliform by Colilert	APHA METHOD 9223
<p>This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is quantified by a statistical estimation of bacteria density (most probable number).</p>			
<b>TURB-MET-VA</b>	Water	Turbidity on Preserved Metals Sample	APHA 2130 Turbidity
<p>This analysis is not true turbidity - it is a screen conducted using an acidified sub-sample. It is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.</p>			

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

### Chain of Custody Numbers:

17-760043

### GLOSSARY OF REPORT TERMS

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



CURRENT ENVIRONMENTAL LTD.  
ATTN: Dusty Silvester  
558 England Ave  
Courtenay BC V9N 2N3

Date Received: 19-SEP-19  
Report Date: 27-SEP-19 17:46 (MT)  
Version: FINAL

Client Phone: 250-871-1944

## Certificate of Analysis

Lab Work Order #: L2350748  
Project P.O. #: NOT SUBMITTED  
Job Reference:  
C of C Numbers: 17-763476  
Legal Site Desc:

Edward Ngai  
Account Manager

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## ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2350748-1 Water 18-SEP-19 14:15 1PC-02	L2350748-2 Water 18-SEP-19 14:30 1CR-02	L2350748-3 Water 18-SEP-19 15:00 1MC-02	L2350748-4 Water 18-SEP-19 15:20 1PR-02	L2350748-5 Water 18-SEP-19 16:00 1GU-02
Grouping	Analyte					
<b>WATER</b>						
Physical Tests	Turbidity (NTU)	2.10	1.21	200	2.50	1.52
Anions and Nutrients	Nitrate (as N) (mg/L)	3.02	0.925	0.925	5.18	0.505
	Total Kjeldahl Nitrogen (mg/L)	0.492	0.261	0.317	0.407 <sup>TKNI</sup>	0.562
Bacteriological Tests	E. coli (MPN/100mL)	199	248	25000	96	345
	Coliform Bacteria - Total (MPN/100mL)	11000	3000	68000	39000	9000
Total Metals	Aluminum (Al)-Total (mg/L)	0.146	0.0823	0.292	0.166	0.102
	Antimony (Sb)-Total (mg/L)	0.00014	0.00017	0.00026	0.00015	0.00011
	Arsenic (As)-Total (mg/L)	0.00030	0.00022	0.00757	0.00037	0.00033
	Barium (Ba)-Total (mg/L)	0.00757	0.0133	0.0101	0.0429	0.00264
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.017	0.034	0.023	0.037	0.018
	Cadmium (Cd)-Total (mg/L)	0.0000131	0.0000134	0.0000132	0.0000092	0.0000121
	Calcium (Ca)-Total (mg/L)	20.8	16.2	22.9	25.8	14.2
	Cesium (Cs)-Total (mg/L)	<0.000010	<0.000010	0.000020	0.000014	<0.000010
	Chromium (Cr)-Total (mg/L)	0.00053	0.00045	0.00121	0.00069	0.00042
	Cobalt (Co)-Total (mg/L)	0.00011	<0.00010	0.00054	0.00012	0.00015
	Copper (Cu)-Total (mg/L)	0.00544	0.00448	0.00699	0.00356	0.00460
	Iron (Fe)-Total (mg/L)	0.158	0.133	23.1	0.181	0.373
	Lead (Pb)-Total (mg/L)	0.000157	0.000300	0.000673	0.000254	0.000136
	Lithium (Li)-Total (mg/L)	<0.0010	0.0011	<0.0010	0.0016	<0.0010
	Magnesium (Mg)-Total (mg/L)	6.87	4.92	9.10	9.74	4.03
	Manganese (Mn)-Total (mg/L)	0.0169	0.0111	0.217	0.0140	0.0616
	Molybdenum (Mo)-Total (mg/L)	<0.00025 <sup>DLB</sup>	<0.00020 <sup>DLB</sup>	<0.00025 <sup>DLB</sup>	<0.00025 <sup>DLB</sup>	<0.00020 <sup>DLB</sup>
	Nickel (Ni)-Total (mg/L)	0.00056	<0.00050	0.00097	0.00056	<0.00050
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.179	0.056	<0.050
	Potassium (K)-Total (mg/L)	1.50	0.911	0.564	0.781	0.944
	Rubidium (Rb)-Total (mg/L)	0.00050	0.00053	0.00042	0.00067	0.00066
	Selenium (Se)-Total (mg/L)	<0.000050	<0.000050	0.000114	0.000092	<0.000050
	Silicon (Si)-Total (mg/L)	8.56	6.93	12.8	9.37	5.52
	Silver (Ag)-Total (mg/L)	<0.000010	0.000031	0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	8.75	22.1	14.3	20.9	8.06
Strontium (Sr)-Total (mg/L)	0.0797	0.0823	0.0707	0.144	0.0425	
Sulfur (S)-Total (mg/L)	1.00	2.26	1.51	2.16	0.95	
Tellurium (Te)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>	L2350748-6 Water 18-SEP-19 16:30 1BC-02			
Grouping	Analyte				
<b>WATER</b>					
<b>Physical Tests</b>	Turbidity (NTU)	1.24			
<b>Anions and Nutrients</b>	Nitrate (as N) (mg/L)	0.0133			
	Total Kjeldahl Nitrogen (mg/L)	0.425			
<b>Bacteriological Tests</b>	E. coli (MPN/100mL)	23			
	Coliform Bacteria - Total (MPN/100mL)	11000			
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)	0.0620			
	Antimony (Sb)-Total (mg/L)	0.00011			
	Arsenic (As)-Total (mg/L)	0.00581			
	Barium (Ba)-Total (mg/L)	0.00244			
	Beryllium (Be)-Total (mg/L)	<0.00010			
	Bismuth (Bi)-Total (mg/L)	<0.000050			
	Boron (B)-Total (mg/L)	0.015			
	Cadmium (Cd)-Total (mg/L)	0.0000099			
	Calcium (Ca)-Total (mg/L)	16.5			
	Cesium (Cs)-Total (mg/L)	0.000013			
	Chromium (Cr)-Total (mg/L)	0.00133			
	Cobalt (Co)-Total (mg/L)	<0.00010			
	Copper (Cu)-Total (mg/L)	0.00306			
	Iron (Fe)-Total (mg/L)	0.114			
	Lead (Pb)-Total (mg/L)	0.000065			
	Lithium (Li)-Total (mg/L)	<0.0010			
	Magnesium (Mg)-Total (mg/L)	5.91			
	Manganese (Mn)-Total (mg/L)	0.0108			
	Molybdenum (Mo)-Total (mg/L)	0.000326			
	Nickel (Ni)-Total (mg/L)	<0.00050			
	Phosphorus (P)-Total (mg/L)	<0.050			
	Potassium (K)-Total (mg/L)	0.866			
	Rubidium (Rb)-Total (mg/L)	0.00071			
	Selenium (Se)-Total (mg/L)	<0.000050			
	Silicon (Si)-Total (mg/L)	1.03			
	Silver (Ag)-Total (mg/L)	<0.000010			
	Sodium (Na)-Total (mg/L)	20.5			
	Strontium (Sr)-Total (mg/L)	0.0544			
	Sulfur (S)-Total (mg/L)	0.91			
	Tellurium (Te)-Total (mg/L)	<0.00020			
	Thallium (Tl)-Total (mg/L)	<0.000010			

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2350748-1	L2350748-2	L2350748-3	L2350748-4	L2350748-5
		Description	Water	Water	Water	Water	Water
		Sampled Date	18-SEP-19	18-SEP-19	18-SEP-19	18-SEP-19	18-SEP-19
		Sampled Time	14:15	14:30	15:00	15:20	16:00
		Client ID	1PC-02	1CR-02	1MC-02	1PR-02	1GU-02
Grouping	Analyte						
<b>WATER</b>							
<b>Total Metals</b>	Thorium (Th)-Total (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Tin (Sn)-Total (mg/L)		<0.00010	<0.00010	0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)		0.00977	0.00525	0.0223	0.0133	0.00698
	Tungsten (W)-Total (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Uranium (U)-Total (mg/L)		0.000019	0.000014	0.000022	<0.000010	<0.000010
	Vanadium (V)-Total (mg/L)		0.00239	0.00109	0.00466	0.00278	0.00126
	Zinc (Zn)-Total (mg/L)		0.0814	0.0085	0.0135	0.0215	0.0074
	Zirconium (Zr)-Total (mg/L)		<0.00020	<0.00020	0.00030	<0.00020	<0.00020

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>	L2350748-6 Water 18-SEP-19 16:30 1BC-02			
Grouping	Analyte				
<b>WATER</b>					
<b>Total Metals</b>	Thorium (Th)-Total (mg/L)	<0.00010			
	Tin (Sn)-Total (mg/L)	<0.00010			
	Titanium (Ti)-Total (mg/L)	0.00278			
	Tungsten (W)-Total (mg/L)	<0.00010			
	Uranium (U)-Total (mg/L)	<0.000010			
	Vanadium (V)-Total (mg/L)	0.00066			
	Zinc (Zn)-Total (mg/L)	0.0039			
	Zirconium (Zr)-Total (mg/L)	<0.00020			

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## Reference Information

### QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Molybdenum (Mo)-Total	MB-LOR	L2350748-1, -2, -3, -4, -5, -6
Matrix Spike	Aluminum (Al)-Total	MS-B	L2350748-1, -2, -3, -4, -5, -6
Matrix Spike	Barium (Ba)-Total	MS-B	L2350748-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Total	MS-B	L2350748-1, -2, -3, -4, -5, -6
Matrix Spike	Iron (Fe)-Total	MS-B	L2350748-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2350748-1, -2, -3, -4, -5, -6
Matrix Spike	Manganese (Mn)-Total	MS-B	L2350748-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L2350748-1, -2, -3, -4, -5, -6
Matrix Spike	Zinc (Zn)-Total	MS-B	L2350748-1, -2, -3, -4, -5, -6

### Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
TKNI	TKN result may be biased low due to Nitrate interference. Nitrate-N is > 10x TKN.

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
<b>EC-SCREEN-VA</b>	Water	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
<b>ECOLI-COLI-ENV-VA</b>	Water	E.coli by Colilert	APHA METHOD 9223
This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.			
<b>MET-T-CCMS-VA</b>	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)
Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
<b>NO3-L-IC-N-VA</b>	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
<b>TCOLI-COLI-ENV-VA</b>	Water	Total coliform by Colilert	APHA METHOD 9223
This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is quantified by a statistical estimation of bacteria density (most probable number).			
<b>TKN-F-VA</b>	Water	TKN in Water by Fluorescence	APHA 4500-NORG D.
This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.			
<b>TURBIDITY-VA</b>	Water	Turbidity by Meter	APHA 2130 Turbidity
This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.			

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

### Chain of Custody Numbers:

17-763476

## Reference Information

### GLOSSARY OF REPORT TERMS

*Surrogate* - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

*mg/kg* - milligrams per kilogram based on dry weight of sample.

*mg/kg wwt* - milligrams per kilogram based on wet weight of sample.

*mg/kg lwt* - milligrams per kilogram based on lipid-adjusted weight of sample.

*mg/L* - milligrams per litre.

*<* - Less than.

*D.L.* - The reported Detection Limit, also known as the Limit of Reporting (LOR).

*N/A* - Result not available. Refer to qualifier code and definition for explanation.

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



CURRENT ENVIRONMENTAL LTD.  
ATTN: Dusty Silvester  
558 England Ave  
Courtenay BC V9N 2N3

Date Received: 27-SEP-19  
Report Date: 04-OCT-19 13:06 (MT)  
Version: FINAL

Client Phone: 250-871-1944

## Certificate of Analysis

Lab Work Order #: L2356020  
Project P.O. #: NOT SUBMITTED  
Job Reference:  
C of C Numbers: 17-763477  
Legal Site Desc:

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Account Manager

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## ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID	L2356020-1 Water 25-SEP-19 14:15 IPC-03	L2356020-2 Water 25-SEP-19 14:30 ICR-03	L2356020-3 Water 25-SEP-19 11:25 IMC-03	L2356020-4 Water 25-SEP-19 14:00 IPR-03	L2356020-5 Water 25-SEP-19 14:50 IGU-03
<b>Grouping</b>	<b>Analyte</b>				
<b>WATER</b>					
<b>Physical Tests</b>	Turbidity (NTU)				
	0.59	0.39	20.5	0.67	0.81
<b>Anions and Nutrients</b>	Nitrate (as N) (mg/L)				
	1.69	0.793	0.911	4.85	0.751
<b>Bacteriological Tests</b>	E. coli (MPN/100mL)				
	<1 <sup>PEHR</sup>	<1 <sup>PEHR</sup>	33 <sup>PEHR</sup>	3 <sup>PEHR</sup>	1 <sup>PEHR</sup>
	Coliform Bacteria - Total (MPN/100mL)				
	46 <sup>PEHR</sup>	5 <sup>PEHR</sup>	1300 <sup>PEHR</sup>	166 <sup>PEHR</sup>	165 <sup>PEHR</sup>
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)				
	0.0396	0.0279	1.15	0.0350	0.0348
	Antimony (Sb)-Total (mg/L)				
	<0.00010	<0.00010	0.00013	0.00011	<0.00010
	Arsenic (As)-Total (mg/L)				
	0.00030	0.00023	0.00086	0.00037	0.00035
	Barium (Ba)-Total (mg/L)				
	0.00759	0.0200	0.0106	0.0435	0.00241
	Beryllium (Be)-Total (mg/L)				
	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Total (mg/L)				
	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)				
	0.019	0.027	0.025	0.046	0.021
	Cadmium (Cd)-Total (mg/L)				
	<0.0000050	0.0000072	0.0000097	0.0000065	<0.0000050
	Calcium (Ca)-Total (mg/L)				
	21.3	18.4	21.8	29.2	18.1
	Cesium (Cs)-Total (mg/L)				
	<0.000010	<0.000010	0.000036	<0.000010	<0.000010
	Chromium (Cr)-Total (mg/L)				
	0.00038	0.00028	0.00219	0.00036	0.00026
	Cobalt (Co)-Total (mg/L)				
	<0.00010	<0.00010	0.00051	<0.00010	0.00011
	Copper (Cu)-Total (mg/L)				
	0.00215	0.00284	0.00487	0.00202	0.00256
	Iron (Fe)-Total (mg/L)				
	0.074	0.090	1.79	0.052	0.278
	Lead (Pb)-Total (mg/L)				
	0.000143	0.000190	0.000270	0.000134	0.000061
	Lithium (Li)-Total (mg/L)				
	<0.0010	<0.0010	0.0014	0.0018	0.0015
	Magnesium (Mg)-Total (mg/L)				
	8.08	5.25	8.60	10.2	5.87
	Manganese (Mn)-Total (mg/L)				
	0.0190	0.0176	0.0659	0.00683	0.0719
	Molybdenum (Mo)-Total (mg/L)				
	0.000152	0.000082	0.000163	0.000165	0.000139
	Nickel (Ni)-Total (mg/L)				
	<0.00050	<0.00050	0.00137	<0.00050	<0.00050
	Phosphorus (P)-Total (mg/L)				
	0.056	<0.050	0.052	0.052	<0.050
	Potassium (K)-Total (mg/L)				
	0.690	0.431	0.691	0.765	0.744
	Rubidium (Rb)-Total (mg/L)				
	0.00031	0.00038	0.00076	0.00066	0.00053
	Selenium (Se)-Total (mg/L)				
	0.000061	<0.000050	0.000125	0.000115	0.000061
	Silicon (Si)-Total (mg/L)				
	11.5	8.16	13.0	10.9	8.32
	Silver (Ag)-Total (mg/L)				
	<0.000010	0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)				
	10.0	13.2	14.2	21.7	9.32
	Strontium (Sr)-Total (mg/L)				
	0.0769	0.0871	0.0676	0.149	0.0553
	Sulfur (S)-Total (mg/L)				
	1.05	1.43	1.15	2.25	1.11
	Tellurium (Te)-Total (mg/L)				
	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Thallium (Tl)-Total (mg/L)				
	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Thorium (Th)-Total (mg/L)				
	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>	L2356020-6 Water 25-SEP-19 15:30 IBC-03			
Grouping	Analyte				
<b>WATER</b>					
<b>Physical Tests</b>	Turbidity (NTU)	0.76			
<b>Anions and Nutrients</b>	Nitrate (as N) (mg/L)	0.147			
<b>Bacteriological Tests</b>	E. coli (MPN/100mL)	<1 <sup>PEHR</sup>			
	Coliform Bacteria - Total (MPN/100mL)	13 <sup>PEHR</sup>			
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)	0.0220			
	Antimony (Sb)-Total (mg/L)	0.00010			
	Arsenic (As)-Total (mg/L)	0.00255			
	Barium (Ba)-Total (mg/L)	0.00241			
	Beryllium (Be)-Total (mg/L)	<0.00010			
	Bismuth (Bi)-Total (mg/L)	<0.000050			
	Boron (B)-Total (mg/L)	0.013			
	Cadmium (Cd)-Total (mg/L)	<0.0000050			
	Calcium (Ca)-Total (mg/L)	12.9			
	Cesium (Cs)-Total (mg/L)	<0.000010			
	Chromium (Cr)-Total (mg/L)	0.00094			
	Cobalt (Co)-Total (mg/L)	<0.00010			
	Copper (Cu)-Total (mg/L)	0.00188			
	Iron (Fe)-Total (mg/L)	0.138			
	Lead (Pb)-Total (mg/L)	<0.000050			
	Lithium (Li)-Total (mg/L)	<0.0010			
	Magnesium (Mg)-Total (mg/L)	3.96			
	Manganese (Mn)-Total (mg/L)	0.0275			
	Molybdenum (Mo)-Total (mg/L)	0.000114			
	Nickel (Ni)-Total (mg/L)	<0.00050			
	Phosphorus (P)-Total (mg/L)	<0.050			
	Potassium (K)-Total (mg/L)	0.757			
	Rubidium (Rb)-Total (mg/L)	0.00070			
	Selenium (Se)-Total (mg/L)	0.000066			
	Silicon (Si)-Total (mg/L)	1.54			
	Silver (Ag)-Total (mg/L)	<0.000010			
	Sodium (Na)-Total (mg/L)	11.3			
	Strontium (Sr)-Total (mg/L)	0.0417			
	Sulfur (S)-Total (mg/L)	1.06			
	Tellurium (Te)-Total (mg/L)	<0.00020			
	Thallium (Tl)-Total (mg/L)	<0.000010			
	Thorium (Th)-Total (mg/L)	<0.00010			

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2356020-1	L2356020-2	L2356020-3	L2356020-4	L2356020-5
		Description	Water	Water	Water	Water	Water
		Sampled Date	25-SEP-19	25-SEP-19	25-SEP-19	25-SEP-19	25-SEP-19
		Sampled Time	14:15	14:30	11:25	14:00	14:50
		Client ID	IPC-03	ICR-03	IMC-03	IPR-03	IGU-03
Grouping	Analyte						
<b>WATER</b>							
<b>Total Metals</b>	Tin (Sn)-Total (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)		0.00238	0.00162	0.0736	0.00205	0.00231
	Tungsten (W)-Total (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Uranium (U)-Total (mg/L)		0.000016	<0.000010	0.000041	0.000014	0.000014
	Vanadium (V)-Total (mg/L)		0.00271	0.00111	0.00689	0.00270	0.00131
	Zinc (Zn)-Total (mg/L)		0.0603	0.0069	0.0145	0.0161	<0.0030
	Zirconium (Zr)-Total (mg/L)		<0.00020	<0.00020	0.00048	<0.00020	<0.00020

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID		L2356020-6				
Description		Water				
Sampled Date		25-SEP-19				
Sampled Time		15:30				
Client ID		IBC-03				
Grouping	Analyte					
<b>WATER</b>						
<b>Total Metals</b>	Tin (Sn)-Total (mg/L)	<0.00010				
	Titanium (Ti)-Total (mg/L)	0.00103				
	Tungsten (W)-Total (mg/L)	<0.00010				
	Uranium (U)-Total (mg/L)	<0.000010				
	Vanadium (V)-Total (mg/L)	<0.00050				
	Zinc (Zn)-Total (mg/L)	0.0033				
	Zirconium (Zr)-Total (mg/L)	<0.00020				

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## Reference Information

**QC Samples with Qualifiers & Comments:**

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Silicon (Si)-Total	B	L2356020-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L2356020-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Total	MS-B	L2356020-6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2356020-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2356020-6
Matrix Spike	Sodium (Na)-Total	MS-B	L2356020-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Total	MS-B	L2356020-6
Matrix Spike	Strontium (Sr)-Total	MS-B	L2356020-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L2356020-6
Matrix Spike	Uranium (U)-Total	MS-B	L2356020-6

**Qualifiers for Individual Parameters Listed:**

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
PEHR	Parameter Exceeded Recommended Holding Time On Receipt: Proceed With Analysis As Requested.

**Test Method References:**

ALS Test Code	Matrix	Test Description	Method Reference**
<b>EC-SCREEN-VA</b>	Water	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
<b>ECOLI-COLI-ENV-VA</b>	Water	E.coli by Colilert	APHA METHOD 9223
This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.			
<b>MET-T-CCMS-VA</b>	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)
Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
<b>NO3-L-IC-N-VA</b>	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
<b>TCOLI-COLI-ENV-VA</b>	Water	Total coliform by Colilert	APHA METHOD 9223
This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is quantified by a statistical estimation of bacteria density (most probable number).			
<b>TURBIDITY-VA</b>	Water	Turbidity by Meter	APHA 2130 Turbidity
This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.			

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

**Chain of Custody Numbers:**

17-763477

## Reference Information

### GLOSSARY OF REPORT TERMS

*Surrogate* - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

*mg/kg* - milligrams per kilogram based on dry weight of sample.

*mg/kg wwt* - milligrams per kilogram based on wet weight of sample.

*mg/kg lwt* - milligrams per kilogram based on lipid-adjusted weight of sample.

*mg/L* - milligrams per litre.

*<* - Less than.

*D.L.* - The reported Detection Limit, also known as the Limit of Reporting (LOR).

*N/A* - Result not available. Refer to qualifier code and definition for explanation.

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



CURRENT ENVIRONMENTAL LTD.  
ATTN: Dusty Silvester  
558 England Ave  
Courtenay BC V9N 2N3

Date Received: 02-OCT-19  
Report Date: 09-OCT-19 17:48 (MT)  
Version: FINAL

Client Phone: 250-871-1944

## Certificate of Analysis

Lab Work Order #: L2358577  
Project P.O. #: NOT SUBMITTED  
Job Reference: 1306  
C of C Numbers: 17-764456  
Legal Site Desc:

Edward Ngai  
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
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## ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID	L2358577-1 WATER 01-OCT-19 10:05 IPC-04	L2358577-2 WATER 01-OCT-19 14:30 ICR-04	L2358577-3 WATER 01-OCT-19 12:00 IMC-04	L2358577-4 WATER 01-OCT-19 12:10 IPR-04	L2358577-5 WATER 01-OCT-19 16:25 IGU-04
Grouping	Analyte				
<b>WATER</b>					
<b>Physical Tests</b>	Turbidity (NTU)				
	0.73	7.28	2.26	1.40	1.49
<b>Anions and Nutrients</b>	Nitrate (as N) (mg/L)				
	1.23	0.541	0.737	2.55	0.520
<b>Bacteriological Tests</b>	E. coli (MPN/100mL)				
	62	9	272	691	79
	Coliform Bacteria - Total (MPN/100mL)				
	691	1010	3000	691	7000
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)				
	0.0616	0.161	0.0359	0.0811	0.0271
	Antimony (Sb)-Total (mg/L)				
	<0.00010	<0.00010	<0.00010	0.00010	<0.00010
	Arsenic (As)-Total (mg/L)				
	0.00032	0.00050	0.00041	0.00043	0.00034
	Barium (Ba)-Total (mg/L)				
	0.00694	0.0112	0.00440	0.0402	0.00229
	Beryllium (Be)-Total (mg/L)				
	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Total (mg/L)				
	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)				
	0.018	0.037	0.020	0.045	0.020
	Cadmium (Cd)-Total (mg/L)				
	0.0000103	0.0000126	<0.0000050	0.0000065	<0.0000050
	Calcium (Ca)-Total (mg/L)				
	18.0	14.0	17.6	28.4	16.9
	Cesium (Cs)-Total (mg/L)				
	<0.000010	<0.000010	<0.000010	0.000011	<0.000010
	Chromium (Cr)-Total (mg/L)				
	0.00048	0.00048	0.00030	0.00042	0.00025
	Cobalt (Co)-Total (mg/L)				
	<0.00010	0.00024	<0.00010	<0.00010	0.00014
	Copper (Cu)-Total (mg/L)				
	0.00211	0.00319	0.00133	0.00164	0.00314
	Iron (Fe)-Total (mg/L)				
	0.134	1.21	0.631	0.115	0.379
	Lead (Pb)-Total (mg/L)				
	0.000116	0.000835	<0.000050	0.000467	0.000122
	Lithium (Li)-Total (mg/L)				
	<0.0010	0.0014	<0.0010	0.0017	<0.0010
	Magnesium (Mg)-Total (mg/L)				
	8.62	7.15	8.02	12.0	6.15
	Manganese (Mn)-Total (mg/L)				
	0.0165	0.111	0.0503	0.00704	0.102
	Molybdenum (Mo)-Total (mg/L)				
	0.000151	0.000157	0.000111	0.000221	0.000149
	Nickel (Ni)-Total (mg/L)				
	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Phosphorus (P)-Total (mg/L)				
	0.056	0.051	<0.050	0.073	<0.050
	Potassium (K)-Total (mg/L)				
	0.394	1.58	0.396	0.720	0.603
	Rubidium (Rb)-Total (mg/L)				
	0.00029	0.00064	0.00028	0.00074	0.00043
	Selenium (Se)-Total (mg/L)				
	<0.000050	<0.000050	0.000064	0.000128	<0.000050
	Silicon (Si)-Total (mg/L)				
	10.9	6.99	9.87	11.6	8.06
	Silver (Ag)-Total (mg/L)				
	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)				
	10.5	34.2	10.8	24.5	8.70
	Strontium (Sr)-Total (mg/L)				
	0.0721	0.0772	0.0590	0.167	0.0551
	Sulfur (S)-Total (mg/L)				
	1.30	3.35	1.12	2.41	1.14
	Tellurium (Te)-Total (mg/L)				
	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Thallium (Tl)-Total (mg/L)				
	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Thorium (Th)-Total (mg/L)				
	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>	L2358577-6	WATER	01-OCT-19	17:25	IBC-04
Grouping	Analyte					
<b>WATER</b>						
<b>Physical Tests</b>	Turbidity (NTU)	0.54				
<b>Anions and Nutrients</b>	Nitrate (as N) (mg/L)	0.0943				
<b>Bacteriological Tests</b>	E. coli (MPN/100mL)	<1				
	Coliform Bacteria - Total (MPN/100mL)	770				
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)	0.0187				
	Antimony (Sb)-Total (mg/L)	0.00011				
	Arsenic (As)-Total (mg/L)	0.00182				
	Barium (Ba)-Total (mg/L)	0.00220				
	Beryllium (Be)-Total (mg/L)	<0.00010				
	Bismuth (Bi)-Total (mg/L)	<0.000050				
	Boron (B)-Total (mg/L)	0.013				
	Cadmium (Cd)-Total (mg/L)	0.0000089				
	Calcium (Ca)-Total (mg/L)	14.3				
	Cesium (Cs)-Total (mg/L)	<0.000010				
	Chromium (Cr)-Total (mg/L)	0.00103				
	Cobalt (Co)-Total (mg/L)	<0.00010				
	Copper (Cu)-Total (mg/L)	0.00186				
	Iron (Fe)-Total (mg/L)	0.081				
	Lead (Pb)-Total (mg/L)	<0.000050				
	Lithium (Li)-Total (mg/L)	<0.0010				
	Magnesium (Mg)-Total (mg/L)	4.91				
	Manganese (Mn)-Total (mg/L)	0.0151				
	Molybdenum (Mo)-Total (mg/L)	0.000142				
	Nickel (Ni)-Total (mg/L)	<0.00050				
	Phosphorus (P)-Total (mg/L)	<0.050				
	Potassium (K)-Total (mg/L)	0.979				
	Rubidium (Rb)-Total (mg/L)	0.00069				
	Selenium (Se)-Total (mg/L)	<0.000050				
	Silicon (Si)-Total (mg/L)	1.31				
	Silver (Ag)-Total (mg/L)	<0.000010				
	Sodium (Na)-Total (mg/L)	13.4				
	Strontium (Sr)-Total (mg/L)	0.0470				
	Sulfur (S)-Total (mg/L)	1.30				
	Tellurium (Te)-Total (mg/L)	<0.00020				
	Thallium (Tl)-Total (mg/L)	<0.000010				
	Thorium (Th)-Total (mg/L)	<0.00010				

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2358577-1	L2358577-2	L2358577-3	L2358577-4	L2358577-5
		Description	WATER	WATER	WATER	WATER	WATER
		Sampled Date	01-OCT-19	01-OCT-19	01-OCT-19	01-OCT-19	01-OCT-19
		Sampled Time	10:05	14:30	12:00	12:10	16:25
		Client ID	IPC-04	ICR-04	IMC-04	IPR-04	IGU-04
Grouping	Analyte						
<b>WATER</b>							
<b>Total Metals</b>	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00493	0.00934	0.00274	0.00612	0.00612	<0.0021 <sup>DLM</sup>
	Tungsten (W)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Uranium (U)-Total (mg/L)	0.000014	0.000020	0.000010	0.000023	0.000023	0.000011
	Vanadium (V)-Total (mg/L)	0.00302	0.00253	0.00163	0.00344	0.00344	0.00133
	Zinc (Zn)-Total (mg/L)	0.0634	0.0077	0.0064	0.0118	0.0118	0.0058
	Zirconium (Zr)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

		<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>	L2358577-6 WATER 01-OCT-19 17:25 IBC-04				
Grouping	Analyte						
<b>WATER</b>							
<b>Total Metals</b>	Tin (Sn)-Total (mg/L)	<0.00010					
	Titanium (Ti)-Total (mg/L)	0.00121					
	Tungsten (W)-Total (mg/L)	<0.00010					
	Uranium (U)-Total (mg/L)	<0.000010					
	Vanadium (V)-Total (mg/L)	0.00055					
	Zinc (Zn)-Total (mg/L)	0.0030					
	Zirconium (Zr)-Total (mg/L)	<0.00020					

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## Reference Information

### QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Total	MS-B	L2358577-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Total	MS-B	L2358577-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2358577-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L2358577-1, -2, -3, -4, -5, -6

### Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
<b>EC-SCREEN-VA</b>	Water	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
<b>ECOLI-COLI-ENV-VA</b>	Water	E.coli by Colilert	APHA METHOD 9223
This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.			
<b>MET-T-CCMS-VA</b>	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)
Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
<b>NO3-L-IC-N-VA</b>	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
<b>TCOLI-COLI-ENV-VA</b>	Water	Total coliform by Colilert	APHA METHOD 9223
This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is quantified by a statistical estimation of bacteria density (most probable number).			
<b>TURBIDITY-VA</b>	Water	Turbidity by Meter	APHA 2130 Turbidity
This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.			

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

### Chain of Custody Numbers:

17-764456

## Reference Information

### GLOSSARY OF REPORT TERMS

*Surrogate* - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

*mg/kg* - milligrams per kilogram based on dry weight of sample.

*mg/kg wwt* - milligrams per kilogram based on wet weight of sample.

*mg/kg lwt* - milligrams per kilogram based on lipid-adjusted weight of sample.

*mg/L* - milligrams per litre.

*<* - Less than.

*D.L.* - The reported Detection Limit, also known as the Limit of Reporting (LOR).

*N/A* - Result not available. Refer to qualifier code and definition for explanation.

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



CURRENT ENVIRONMENTAL LTD.  
ATTN: Dusty Silvester  
558 England Ave  
Courtenay BC V9N 2N3

Date Received: 15-OCT-19  
Report Date: 22-OCT-19 15:34 (MT)  
Version: FINAL

Client Phone: 250-871-1944

## Certificate of Analysis

Lab Work Order #: L2365310  
Project P.O. #: NOT SUBMITTED  
Job Reference: 1306 - #5  
C of C Numbers: 17-764454  
Legal Site Desc:

Comments: Analyses for E.coli, total coliform, NO<sub>3</sub>, and turbidity were not done due to samples received past holdtimes. Client will resample and submit.

Edward Ngai  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
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## ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2365310-1	L2365310-2	L2365310-3	L2365310-4	L2365310-5
		Description	Water	Water	Water	Water	Water
		Sampled Date	09-OCT-19	09-OCT-19	09-OCT-19	09-OCT-19	09-OCT-19
		Sampled Time	09:30	10:00	10:20	10:30	10:50
		Client ID	IPC-05	ICR-05	IMC-05	IPR-05	IGU-05
Grouping	Analyte						
<b>WATER</b>							
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)		0.141	0.0178	0.0244	0.0285	0.100
	Antimony (Sb)-Total (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)		0.00042	0.00023	0.00054	0.00039	0.00044
	Barium (Ba)-Total (mg/L)		0.00759	0.0128	0.00537	0.0427	0.00290
	Beryllium (Be)-Total (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Total (mg/L)		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)		0.016	0.022	0.021	0.042	0.020
	Cadmium (Cd)-Total (mg/L)		0.0000097	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Total (mg/L)		19.6	18.4	24.8	30.2	19.5
	Cesium (Cs)-Total (mg/L)		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Chromium (Cr)-Total (mg/L)		0.00074	0.00021	0.00028	0.00032	0.00034
	Cobalt (Co)-Total (mg/L)		0.00013	<0.00010	<0.00010	<0.00010	0.00018
	Copper (Cu)-Total (mg/L)		0.00462	0.00162	0.00126	0.00152	0.00141
	Iron (Fe)-Total (mg/L)		0.375	0.069	0.594	0.038	0.576
	Lead (Pb)-Total (mg/L)		0.000316	0.000083	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)		<0.0010	<0.0010	<0.0010	0.0017	<0.0010
	Magnesium (Mg)-Total (mg/L)		8.31	5.65	10.7	12.1	6.83
	Manganese (Mn)-Total (mg/L)		0.0216	0.0106	0.0584	0.00516	0.112
	Molybdenum (Mo)-Total (mg/L)		0.000094	0.000086	0.000117	0.000179	0.000139
	Nickel (Ni)-Total (mg/L)		0.00056	<0.00050	<0.00050	<0.00050	<0.00050
	Phosphorus (P)-Total (mg/L)		<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)		0.405	0.414	0.506	0.739	0.796
	Rubidium (Rb)-Total (mg/L)		0.00034	0.00033	0.00038	0.00062	0.00055
	Selenium (Se)-Total (mg/L)		0.000054	0.000059	0.000072	0.000078	<0.000050
	Silicon (Si)-Total (mg/L)		9.98	7.16	11.5	10.3	7.76
	Silver (Ag)-Total (mg/L)		0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)		11.4	12.6	15.3	24.9	10.7
	Strontium (Sr)-Total (mg/L)		0.0717	0.0856	0.0822	0.165	0.0619
	Sulfur (S)-Total (mg/L)		2.07	1.27	1.51	2.59	1.26
	Tellurium (Te)-Total (mg/L)		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Thallium (Tl)-Total (mg/L)		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Thorium (Th)-Total (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Tin (Sn)-Total (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)		0.0100	0.00076	0.00150	0.00189	0.00718
	Tungsten (W)-Total (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Uranium (U)-Total (mg/L)		0.000013	0.000012	0.000014	0.000017	0.000040
	Vanadium (V)-Total (mg/L)		0.00379	0.00089	0.00147	0.00277	0.00139

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>	L2365310-6 Water 09-OCT-19 13:00 IBC-05			
Grouping	Analyte				
<b>WATER</b>					
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)	0.134			
	Antimony (Sb)-Total (mg/L)	0.00011			
	Arsenic (As)-Total (mg/L)	0.00295			
	Barium (Ba)-Total (mg/L)	0.00369			
	Beryllium (Be)-Total (mg/L)	<0.00010			
	Bismuth (Bi)-Total (mg/L)	<0.000050			
	Boron (B)-Total (mg/L)	0.013			
	Cadmium (Cd)-Total (mg/L)	<0.0000050			
	Calcium (Ca)-Total (mg/L)	15.0			
	Cesium (Cs)-Total (mg/L)	0.000010			
	Chromium (Cr)-Total (mg/L)	0.00148			
	Cobalt (Co)-Total (mg/L)	0.00016			
	Copper (Cu)-Total (mg/L)	0.00330			
	Iron (Fe)-Total (mg/L)	0.420			
	Lead (Pb)-Total (mg/L)	0.000375			
	Lithium (Li)-Total (mg/L)	<0.0010			
	Magnesium (Mg)-Total (mg/L)	4.80			
	Manganese (Mn)-Total (mg/L)	0.179			
	Molybdenum (Mo)-Total (mg/L)	0.000086			
	Nickel (Ni)-Total (mg/L)	<0.00050			
	Phosphorus (P)-Total (mg/L)	0.050			
	Potassium (K)-Total (mg/L)	0.831			
	Rubidium (Rb)-Total (mg/L)	0.00073			
	Selenium (Se)-Total (mg/L)	0.000051			
	Silicon (Si)-Total (mg/L)	1.62			
	Silver (Ag)-Total (mg/L)	<0.000010			
	Sodium (Na)-Total (mg/L)	12.9			
	Strontium (Sr)-Total (mg/L)	0.0489			
	Sulfur (S)-Total (mg/L)	2.43			
	Tellurium (Te)-Total (mg/L)	<0.00020			
	Thallium (Tl)-Total (mg/L)	<0.000010			
	Thorium (Th)-Total (mg/L)	<0.00010			
	Tin (Sn)-Total (mg/L)	<0.00010			
	Titanium (Ti)-Total (mg/L)	0.00884			
	Tungsten (W)-Total (mg/L)	<0.00010			
	Uranium (U)-Total (mg/L)	<0.000010			
	Vanadium (V)-Total (mg/L)	0.00121			

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2365310-1	L2365310-2	L2365310-3	L2365310-4	L2365310-5
		Description	Water	Water	Water	Water	Water
		Sampled Date	09-OCT-19	09-OCT-19	09-OCT-19	09-OCT-19	09-OCT-19
		Sampled Time	09:30	10:00	10:20	10:30	10:50
		Client ID	IPC-05	ICR-05	IMC-05	IPR-05	IGU-05
Grouping	Analyte						
<b>WATER</b>							
<b>Total Metals</b>	Zinc (Zn)-Total (mg/L)	0.0794	0.0043	0.0078	0.0139	0.0040	
	Zirconium (Zr)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

		<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>	L2365310-6 Water 09-OCT-19 13:00 IBC-05				
Grouping	Analyte						
<b>WATER</b>							
<b>Total Metals</b>	Zinc (Zn)-Total (mg/L)	0.0044					
	Zirconium (Zr)-Total (mg/L)	<0.00020					

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## Reference Information

### QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Total	MS-B	L2365310-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Total	MS-B	L2365310-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2365310-1, -2, -3, -4, -5, -6
Matrix Spike	Selenium (Se)-Total	MS-B	L2365310-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Total	MS-B	L2365310-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L2365310-1, -2, -3, -4, -5, -6
Matrix Spike	Sulfur (S)-Total	MS-B	L2365310-1, -2, -3, -4, -5, -6

### Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
<b>MET-T-CCMS-VA</b>	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)
Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

### Chain of Custody Numbers:

17-764454

### GLOSSARY OF REPORT TERMS

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



CURRENT ENVIRONMENTAL LTD.  
ATTN: Dusty Silvester  
558 England Ave  
Courtenay BC V9N 2N3

Date Received: 17-OCT-19  
Report Date: 24-OCT-19 17:59 (MT)  
Version: FINAL

Client Phone: 250-871-1944

## Certificate of Analysis

Lab Work Order #: L2366721  
Project P.O. #: NOT SUBMITTED  
Job Reference: 1306 #5B  
C of C Numbers: 17-764453  
Legal Site Desc:

Edward Ngai  
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
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## ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2366721-1	L2366721-2	L2366721-3	L2366721-4	L2366721-5
		Description	Water	Water	Water	Water	Water
		Sampled Date	16-OCT-19	16-OCT-19	16-OCT-19	16-OCT-19	16-OCT-19
		Sampled Time	11:00	11:30	11:20	11:40	12:20
		Client ID	1PC -05B	1CR -05B	1MC -05B	1PR -05B	1GU -05B
Grouping	Analyte						
<b>WATER</b>							
<b>Anions and Nutrients</b>	Nitrate (as N) (mg/L)		0.859	0.180	0.797	1.41	0.404
<b>Bacteriological Tests</b>	E. coli (MPN/100mL)		79	1730	122	2420	210
	Coliform Bacteria - Total (MPN/100mL)		20000	980000	579000	488000	26000

# ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L2366721-6 Water 16-OCT-19 12:55 1BC -05B				
Grouping	Analyte					
<b>WATER</b>						
<b>Anions and Nutrients</b>	Nitrate (as N) (mg/L)	0.0533				
<b>Bacteriological Tests</b>	E. coli (MPN/100mL)	59				
	Coliform Bacteria - Total (MPN/100mL)	54000				

## Reference Information

**QC Samples with Qualifiers & Comments:**

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
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**Test Method References:**

ALS Test Code	Matrix	Test Description	Method Reference**
<b>EC-SCREEN-VA</b>	Water	Conductivity Screen (Internal Use Only)	APHA 2510 Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.
<b>ECOLI-COLI-ENV-VA</b>	Water	E.coli by Colilert	APHA METHOD 9223 This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.
<b>NO3-L-IC-N-VA</b>	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod) Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
<b>TCOLI-COLI-ENV-VA</b>	Water	Total coliform by Colilert	APHA METHOD 9223 This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is quantified by a statistical estimation of bacteria density (most probable number).

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

**Chain of Custody Numbers:**

17-764453

**GLOSSARY OF REPORT TERMS**

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



CURRENT ENVIRONMENTAL LTD.  
ATTN: Dusty Silvester  
558 England Ave  
Courtenay BC V9N 2N3

Date Received: 25-OCT-19  
Report Date: 01-NOV-19 14:33 (MT)  
Version: FINAL

Client Phone: 250-871-1944

## Certificate of Analysis

Lab Work Order #: L2371951  
Project P.O. #: NOT SUBMITTED  
Job Reference: 1306-#6  
C of C Numbers: 17-763480  
Legal Site Desc:

Edward Ngai  
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

# ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2371951-1	L2371951-2	L2371951-3	L2371951-4	L2371951-5
		Description	Water	Water	Water	Water	Water
		Sampled Date	24-OCT-19	24-OCT-19	24-OCT-19	24-OCT-19	24-OCT-19
		Sampled Time	09:30	10:00	10:15	10:25	10:30
		Client ID	1-GU-06	1-CR-06	1-PC-06	1-MC-06	1-PR-06
Grouping	Analyte						
<b>WATER</b>							
Anions and Nutrients	Nitrate (as N) (mg/L)	1.37	1.56	1.99	1.11	4.25	

# ALS ENVIRONMENTAL ANALYTICAL REPORT

<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>	L2371951-6 Water 24-OCT-19 10:45 1-BC-06				
<b>Grouping</b>	<b>Analyte</b>				
<b>WATER</b>					
<b>Anions and Nutrients</b>	Nitrate (as N) (mg/L)	0.571			

## Reference Information

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
<b>EC-SCREEN-VA</b>	Water	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
<b>NO3-L-IC-N-VA</b>	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

### Chain of Custody Numbers:

17-763480

### GLOSSARY OF REPORT TERMS

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



## CERTIFICATE OF ANALYSIS

**Work Order** : **VA20A0290**  
**Client** : **Current Environmental Ltd.**  
**Contact** : Dusty Silvester  
**Address** : 558 England Avenue  
Courtenay BC Canada V9N 2N3  
**Telephone** : ----  
**Project** : 1306-7  
**PO** : ----  
**C-O-C number** : 17-786093  
**Sampler** : ----  
**Site** : ----  
**Quote number** : Q68045  
**No. of samples received** : 6  
**No. of samples analysed** : 6

**Page** : 1 of 6  
**Laboratory** : Vancouver - Environmental  
**Account Manager** : Edward Ngai  
**Address** : 8081 Lougheed Highway  
Burnaby BC Canada V5A 1W9  
**Telephone** : +1 604 253 4188  
**Date Samples Received** : 11-Jan-2020 10:55  
**Date Analysis Commenced** : 11-Jan-2020  
**Issue Date** : 20-Jan-2020 11:02

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

### Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Laboratory Department</i>
Angela Ren	Team Leader - Metals	Metals, Burnaby, British Columbia
Caitlin Macey	Team Leader - Inorganics	Microbiology, Burnaby, British Columbia
Cristina Alexandre	Supervisor - Metals ICP Instrumentation	Metals, Burnaby, British Columbia
Tracy Harley	Supervisor - Water Quality Instrumentation	Inorganics - Water Quality, Burnaby, British Columbia



## General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances  
LOR: Limit of Reporting (detection limit).

<i>Unit</i>	<i>Description</i>
mg/L	milligrams per litre
MPN/100mL	most probable number per 100 mL

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in reports identified as "Preliminary Report" are considered authorized for use.

## Qualifiers

<i>Qualifier</i>	<i>Description</i>
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.



## Analytical Results

Sub-Matrix: Water					Client sample ID				
(Matrix: Water)					2PC-01	2CR-01	2MC-01	2PR-01	2GU-01
Client sampling date / time					10-Jan-2020 10:20	10-Jan-2020 09:50	10-Jan-2020 10:40	10-Jan-2020 10:55	10-Jan-2020 11:30
Analyte	CAS Number	Method	LOR	Unit	VA20A0290-001	VA20A0290-002	VA20A0290-003	VA20A0290-004	VA20A0290-005
					Result	Result	Result	Result	Result
<b>Physical Tests</b>									
alkalinity, total (as CaCO3)	----	E290-L	1.0	mg/L	21.1	18.4	22.5	27.4	22.0
hardness (as CaCO3), from total Ca/Mg	----	EC100A	0.60	mg/L	26.7	23.0	27.9	36.7	29.6
<b>Anions and Nutrients</b>									
nitrate (as N)	14797-55-8	E235.NO3-L	0.0050	mg/L	0.799	0.632	0.478	0.952	0.735
<b>Organic / Inorganic Carbon</b>									
carbon, dissolved organic [DOC]	----	E358-L	0.50	mg/L	2.16	1.73	2.44	2.46	2.06 <sup>HTD</sup>
<b>Bacteriological Tests</b>									
coliforms, total	----	E010	1	MPN/100mL	3100	>2420000	5200	5200	12200
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	461	248	158	1120	2420
<b>Total Metals</b>									
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.824	0.739	0.926	0.853	0.359
antimony, total	7440-36-0	E420	0.00010	mg/L	0.00022	0.00022	0.00020	0.00017	0.00018
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00046	0.00058	0.00044	0.00042	0.00024
barium, total	7440-39-3	E420	0.00010	mg/L	0.00592	0.0145	0.00592	0.0143	0.00756
beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
bismuth, total	7440-69-9	E420	0.000050	mg/L	0.000060	<0.000050	0.000149	0.000068	<0.000050
boron, total	7440-42-8	E420	0.010	mg/L	<0.010	<0.010	<0.010	0.012	<0.010
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000176	0.0000954	0.0000148	0.0000189	0.0000104
calcium, total	7440-70-2	E420	0.050	mg/L	7.00	6.58	6.96	9.88	7.92
cesium, total	7440-46-2	E420	0.000010	mg/L	0.000022	0.000018	0.000020	0.000019	0.000011
chromium, total	7440-47-3	E420	0.00050	mg/L	0.00214	0.00144	0.00268	0.00202	0.00144
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00061	0.00072	0.00070	0.00050	0.00028
copper, total	7440-50-8	E420	0.00050	mg/L	0.00610	0.00717	0.00653	0.00624	0.00381
iron, total	7439-89-6	E420	0.010	mg/L	1.06	1.14	1.29	1.03	0.556
lead, total	7439-92-1	E420	0.000050	mg/L	0.000898	0.00272	0.000919	0.00123	0.000576
lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
magnesium, total	7439-95-4	E420	0.0050	mg/L	2.25	1.59	2.55	2.91	2.39
manganese, total	7439-96-5	E420	0.00010	mg/L	0.0308	0.0944	0.0428	0.0402	0.0432
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000138	0.000120	0.000111	0.000149	0.000114
nickel, total	7440-02-0	E420	0.00050	mg/L	0.00124	0.00120	0.00139	0.00123	0.00062



## Analytical Results

Sub-Matrix: Water					Client sample ID				
(Matrix: Water)					2PC-01	2CR-01	2MC-01	2PR-01	2GU-01
Client sampling date / time					10-Jan-2020 10:20	10-Jan-2020 09:50	10-Jan-2020 10:40	10-Jan-2020 10:55	10-Jan-2020 11:30
Analyte	CAS Number	Method	LOR	Unit	VA20A0290-001	VA20A0290-002	VA20A0290-003	VA20A0290-004	VA20A0290-005
					Result	Result	Result	Result	Result
<b>Total Metals</b>									
phosphorus, total	7723-14-0	E420	0.050	mg/L	0.060	0.056	0.068	0.068	0.051
potassium, total	7440-09-7	E420	0.050	mg/L	0.455	0.414	0.416	0.711	0.602
rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00039	0.00040	0.00032	0.00044	0.00036
selenium, total	7782-49-2	E420	0.000050	mg/L	0.000051	<0.000050	0.000068	0.000066	<0.000050
silicon, total	7440-21-3	E420	0.10	mg/L	3.87	3.06	4.47	4.83	3.03
silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	0.000020	<0.000010	0.000010	<0.000010
sodium, total	7440-23-5	E420	0.050	mg/L	4.27	7.98	7.80	7.82	17.6
strontium, total	7440-24-6	E420	0.00020	mg/L	0.0221	0.0299	0.0196	0.0484	0.0318
sulfur, total	7704-34-9	E420	0.50	mg/L	0.84	1.05	0.68	1.18	1.12
tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
tin, total	7440-31-5	E420	0.00010	mg/L	0.00015	0.00012	0.00012	<0.00010	0.00013
titanium, total	7440-32-6	E420	0.00030	mg/L	0.0754	0.0605	0.0853	0.0697	0.0266
tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
uranium, total	7440-61-1	E420	0.000010	mg/L	0.000014	0.000012	0.000011	0.000016	<0.000010
vanadium, total	7440-62-2	E420	0.00050	mg/L	0.00383	0.00319	0.00522	0.00413	0.00170
zinc, total	7440-66-6	E420	0.0030	mg/L	0.0336	0.0446	0.0183	0.0261	0.0240
zirconium, total	7440-67-7	E420	0.00020	mg/L	0.00038	0.00036	0.00034	0.00029	0.00021

Please refer to the General Comments section for an explanation of any qualifiers detected.



## Analytical Results

Sub-Matrix: Water					Client sample ID	2BC-01	----	----	----	----
(Matrix: Water)					Client sampling date / time	10-Jan-2020 12:00	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit	VA20A0290-006	-----	-----	-----	-----	
					Result	---	---	---	---	
<b>Physical Tests</b>										
alkalinity, total (as CaCO3)	----	E290-L	1.0	mg/L	31.2	----	----	----	----	
hardness (as CaCO3), from total Ca/Mg	----	EC100A	0.60	mg/L	35.3	----	----	----	----	
<b>Anions and Nutrients</b>										
nitrate (as N)	14797-55-8	E235.NO3-L	0.0050	mg/L	1.21	---	---	---	---	
<b>Organic / Inorganic Carbon</b>										
carbon, dissolved organic [DOC]	----	E358-L	0.50	mg/L	2.59	----	----	----	----	
<b>Bacteriological Tests</b>										
coliforms, total	----	E010	1	MPN/100mL	>2420000	----	----	----	----	
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	37	----	----	----	----	
<b>Total Metals</b>										
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.820	----	----	----	----	
antimony, total	7440-36-0	E420	0.00010	mg/L	<0.00010	----	----	----	----	
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00169	----	----	----	----	
barium, total	7440-39-3	E420	0.00010	mg/L	0.00601	----	----	----	----	
beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	----	----	----	----	
bismuth, total	7440-69-9	E420	0.000050	mg/L	<0.000050	----	----	----	----	
boron, total	7440-42-8	E420	0.010	mg/L	<0.010	----	----	----	----	
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000088	----	----	----	----	
calcium, total	7440-70-2	E420	0.050	mg/L	9.52	----	----	----	----	
cesium, total	7440-46-2	E420	0.000010	mg/L	0.000020	----	----	----	----	
chromium, total	7440-47-3	E420	0.00050	mg/L	0.00145	----	----	----	----	
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00035	----	----	----	----	
copper, total	7440-50-8	E420	0.00050	mg/L	0.00482	----	----	----	----	
iron, total	7439-89-6	E420	0.010	mg/L	0.808	----	----	----	----	
lead, total	7439-92-1	E420	0.000050	mg/L	0.000189	----	----	----	----	
lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	----	----	----	----	
magnesium, total	7439-95-4	E420	0.0050	mg/L	2.81	----	----	----	----	
manganese, total	7439-96-5	E420	0.00010	mg/L	0.0303	----	----	----	----	
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000071	----	----	----	----	
nickel, total	7440-02-0	E420	0.00050	mg/L	0.00078	----	----	----	----	
phosphorus, total	7723-14-0	E420	0.050	mg/L	<0.050	----	----	----	----	



## Analytical Results

Sub-Matrix: Water					Client sample ID	2BC-01	----	----	----	----
(Matrix: Water)					Client sampling date / time	10-Jan-2020 12:00	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit	VA20A0290-006	-----	-----	-----	-----	
					Result	---	---	---	---	
<b>Total Metals</b>										
potassium, total	7440-09-7	E420	0.050	mg/L	1.18	----	----	----	----	
rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00077	----	----	----	----	
selenium, total	7782-49-2	E420	0.000050	mg/L	<0.000050	----	----	----	----	
silicon, total	7440-21-3	E420	0.10	mg/L	4.16	----	----	----	----	
silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	----	----	----	----	
sodium, total	7440-23-5	E420	0.050	mg/L	8.20	----	----	----	----	
strontium, total	7440-24-6	E420	0.00020	mg/L	0.0418	----	----	----	----	
sulfur, total	7704-34-9	E420	0.50	mg/L	1.72	----	----	----	----	
tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	----	----	----	----	
thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	----	----	----	----	
thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	----	----	----	----	
tin, total	7440-31-5	E420	0.00010	mg/L	<0.00010	----	----	----	----	
titanium, total	7440-32-6	E420	0.00030	mg/L	0.0542	----	----	----	----	
tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	----	----	----	----	
uranium, total	7440-61-1	E420	0.000010	mg/L	0.000014	----	----	----	----	
vanadium, total	7440-62-2	E420	0.00050	mg/L	0.00303	----	----	----	----	
zinc, total	7440-66-6	E420	0.0030	mg/L	0.0048	----	----	----	----	
zirconium, total	7440-67-7	E420	0.00020	mg/L	0.00043	----	----	----	----	

Please refer to the General Comments section for an explanation of any qualifiers detected.



**CERTIFICATE OF ANALYSIS**

**Work Order** : **VA20A0534**  
**Client** : **Current Environmental Ltd.**  
**Contact** : Dusty Silvester  
**Address** : 558 England Avenue  
 Courtenay BC Canada V9N 2N3  
**Telephone** : ----  
**Project** : 1306-8  
**PO** : ----  
**C-O-C number** : 17-836127  
**Sampler** : ----  
**Site** : ----  
**Quote number** : Q68045  
**No. of samples received** : 6  
**No. of samples analysed** : 6

**Page** : 1 of 6  
**Laboratory** : Vancouver - Environmental  
**Account Manager** : Edward Ngai  
**Address** : 8081 Lougheed Highway  
 Burnaby BC Canada V5A 1W9  
**Telephone** : +1 604 253 4188  
**Date Samples Received** : 21-Jan-2020 09:30  
**Date Analysis Commenced** : 21-Jan-2020  
**Issue Date** : 28-Jan-2020 18:41

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

**Signatories**

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Laboratory Department</i>
Angela Ren	Team Leader - Metals	Metals, Burnaby, British Columbia
Cristina Alexandre	Supervisor - Metals ICP Instrumentation	Metals, Burnaby, British Columbia
Kim Jensen	Department Manager - Metals	Metals, Burnaby, British Columbia
Lindsay Gung	Supervisor - Water Chemistry	Microbiology, Burnaby, British Columbia
Tracy Harley	Supervisor - Water Quality Instrumentation	Inorganics - Water Quality, Burnaby, British Columbia



## General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances  
LOR: Limit of Reporting (detection limit).

<i>Unit</i>	<i>Description</i>
mg/L	milligrams per litre
MPN/100mL	most probable number per 100 mL

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in reports identified as "Preliminary Report" are considered authorized for use.



## Analytical Results

Sub-Matrix: Water					Client sample ID				
(Matrix: Water)					2PC-02	2CR-02	2MC-02	2PR-02	2GU-02
Client sampling date / time					20-Jan-2020 10:20	20-Jan-2020 10:00	20-Jan-2020 10:40	20-Jan-2020 11:00	20-Jan-2020 12:00
Analyte	CAS Number	Method	LOR	Unit	VA20A0534-001	VA20A0534-002	VA20A0534-003	VA20A0534-004	VA20A0534-005
					Result	Result	Result	Result	Result
<b>Physical Tests</b>									
alkalinity, total (as CaCO3)	----	E290-L	1.0	mg/L	35.2	33.1	34.7	36.5	35.3
hardness (as CaCO3), from total Ca/Mg	----	EC100A	0.60	mg/L	49.3	45.0	47.9	57.9	49.8
<b>Anions and Nutrients</b>									
nitrate (as N)	14797-55-8	E235.NO3-L	0.0050	mg/L	1.51	1.40	1.07	1.53	1.50
<b>Organic / Inorganic Carbon</b>									
carbon, dissolved organic [DOC]	----	E358-L	0.50	mg/L	2.98	2.65	3.39	2.39	3.06
<b>Bacteriological Tests</b>									
coliforms, total	----	E010	1	MPN/100mL	>2420	1990	>2420	>2420	>2420
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	387	58	276	345	1550
<b>Total Metals</b>									
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.246	0.249	0.588	0.601	0.311
antimony, total	7440-36-0	E420	0.00010	mg/L	0.00013	0.00012	0.00014	0.00017	0.00011
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00024	0.00027	0.00038	0.00027	0.00030
barium, total	7440-39-3	E420	0.00010	mg/L	0.00423	0.0100	0.00627	0.0158	0.00412
beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
bismuth, total	7440-69-9	E420	0.000050	mg/L	<0.000050	<0.000050	<0.000050	0.000062	<0.000050
boron, total	7440-42-8	E420	0.010	mg/L	<0.010	0.012	0.011	0.016	0.012
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000151	0.0000274	0.0000229	0.0000195	0.0000122
calcium, total	7440-70-2	E420	0.050	mg/L	12.3	12.8	12.1	15.3	13.3
cesium, total	7440-46-2	E420	0.000010	mg/L	<0.000010	<0.000010	0.000017	0.000018	0.000010
chromium, total	7440-47-3	E420	0.00050	mg/L	0.00071	0.00057	0.00139	0.00133	0.00067
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00018	0.00020	0.00045	0.00040	0.00023
copper, total	7440-50-8	E420	0.00050	mg/L	0.00370	0.00347	0.00494	0.00457	0.00301
iron, total	7439-89-6	E420	0.010	mg/L	0.245	0.294	0.752	0.726	0.407
lead, total	7439-92-1	E420	0.000050	mg/L	0.000215	0.00103	0.000375	0.000903	0.000243
lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
magnesium, total	7439-95-4	E420	0.0050	mg/L	4.50	3.15	4.29	4.76	4.04
manganese, total	7439-96-5	E420	0.00010	mg/L	0.0162	0.0378	0.0430	0.0404	0.0412
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000086	0.000075	0.000102	0.000112	0.000091
nickel, total	7440-02-0	E420	0.00050	mg/L	0.00055	0.00054	0.00099	0.00098	0.00054



## Analytical Results

Sub-Matrix: Water					Client sample ID				
(Matrix: Water)					2PC-02	2CR-02	2MC-02	2PR-02	2GU-02
Client sampling date / time					20-Jan-2020 10:20	20-Jan-2020 10:00	20-Jan-2020 10:40	20-Jan-2020 11:00	20-Jan-2020 12:00
Analyte	CAS Number	Method	LOR	Unit	VA20A0534-001	VA20A0534-002	VA20A0534-003	VA20A0534-004	VA20A0534-005
					Result	Result	Result	Result	Result
<b>Total Metals</b>									
phosphorus, total	7723-14-0	E420	0.050	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
potassium, total	7440-09-7	E420	0.050	mg/L	0.803	0.626	0.717	0.707	0.720
rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00043	0.00042	0.00047	0.00041	0.00048
selenium, total	7782-49-2	E420	0.000050	mg/L	<0.000050	0.000094	0.000086	0.000071	0.000066
silicon, total	7440-21-3	E420	0.10	mg/L	5.49	4.86	6.45	6.43	5.25
silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	<0.000010	<0.000010	0.000012	<0.000010
sodium, total	7440-23-5	E420	0.050	mg/L	9.67	10.1	25.0	12.4	11.8
strontium, total	7440-24-6	E420	0.00020	mg/L	0.0396	0.0522	0.0374	0.0604	0.0438
sulfur, total	7704-34-9	E420	0.50	mg/L	0.90	1.38	1.08	1.32	1.27
tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
tin, total	7440-31-5	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
titanium, total	7440-32-6	E420	0.00030	mg/L	0.0211	0.0181	0.0525	0.0498	0.0238
tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
uranium, total	7440-61-1	E420	0.000010	mg/L	0.000011	<0.000010	0.000010	0.000015	0.000024
vanadium, total	7440-62-2	E420	0.00050	mg/L	0.00177	0.00131	0.00375	0.00334	0.00168
zinc, total	7440-66-6	E420	0.0030	mg/L	0.0352	0.0203	0.0109	0.0223	0.0190
zirconium, total	7440-67-7	E420	0.00020	mg/L	0.00025	0.00022	0.00046	0.00036	0.00022

Please refer to the General Comments section for an explanation of any qualifiers detected.



## Analytical Results

Sub-Matrix: Water					Client sample ID	2BC-02	----	----	----	----
(Matrix: Water)					Client sampling date / time	20-Jan-2020 12:30	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit	VA20A0534-006	-----	-----	-----	-----	
					Result	---	---	---	---	
<b>Physical Tests</b>										
alkalinity, total (as CaCO3)	----	E290-L	1.0	mg/L	24.4	----	----	----	----	
hardness (as CaCO3), from total Ca/Mg	----	EC100A	0.60	mg/L	32.1	----	----	----	----	
<b>Anions and Nutrients</b>										
nitrate (as N)	14797-55-8	E235.NO3-L	0.0050	mg/L	0.857	---	---	---	---	
<b>Organic / Inorganic Carbon</b>										
carbon, dissolved organic [DOC]	----	E358-L	0.50	mg/L	2.26	----	----	----	----	
<b>Bacteriological Tests</b>										
coliforms, total	----	E010	1	MPN/100mL	>2420	----	----	----	----	
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	50	----	----	----	----	
<b>Total Metals</b>										
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.319	----	----	----	----	
antimony, total	7440-36-0	E420	0.00010	mg/L	0.00015	----	----	----	----	
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00336	----	----	----	----	
barium, total	7440-39-3	E420	0.00010	mg/L	0.00422	----	----	----	----	
beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	----	----	----	----	
bismuth, total	7440-69-9	E420	0.000050	mg/L	<0.000050	----	----	----	----	
boron, total	7440-42-8	E420	0.010	mg/L	<0.010	----	----	----	----	
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000105	----	----	----	----	
calcium, total	7440-70-2	E420	0.050	mg/L	8.43	----	----	----	----	
cesium, total	7440-46-2	E420	0.000010	mg/L	<0.000010	----	----	----	----	
chromium, total	7440-47-3	E420	0.00050	mg/L	0.00163	----	----	----	----	
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00023	----	----	----	----	
copper, total	7440-50-8	E420	0.00050	mg/L	0.00519	----	----	----	----	
iron, total	7439-89-6	E420	0.010	mg/L	0.426	----	----	----	----	
lead, total	7439-92-1	E420	0.000050	mg/L	0.000206	----	----	----	----	
lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	----	----	----	----	
magnesium, total	7439-95-4	E420	0.0050	mg/L	2.68	----	----	----	----	
manganese, total	7439-96-5	E420	0.00010	mg/L	0.0420	----	----	----	----	
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000088	----	----	----	----	
nickel, total	7440-02-0	E420	0.00050	mg/L	0.00054	----	----	----	----	
phosphorus, total	7723-14-0	E420	0.050	mg/L	<0.050	----	----	----	----	



## Analytical Results

Sub-Matrix: Water					Client sample ID	2BC-02	---	---	---	---
(Matrix: Water)					Client sampling date / time	20-Jan-2020 12:30	---	---	---	---
Analyte	CAS Number	Method	LOR	Unit	VA20A0534-006	-----	-----	-----	-----	
					Result	---	---	---	---	
<b>Total Metals</b>										
potassium, total	7440-09-7	E420	0.050	mg/L	0.920	---	---	---	---	
rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00054	---	---	---	---	
selenium, total	7782-49-2	E420	0.000050	mg/L	0.000064	---	---	---	---	
silicon, total	7440-21-3	E420	0.10	mg/L	3.26	---	---	---	---	
silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	---	---	---	---	
sodium, total	7440-23-5	E420	0.050	mg/L	14.2	---	---	---	---	
strontium, total	7440-24-6	E420	0.00020	mg/L	0.0291	---	---	---	---	
sulfur, total	7704-34-9	E420	0.50	mg/L	1.39	---	---	---	---	
tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	---	---	---	---	
thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	---	---	---	---	
thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	---	---	---	---	
tin, total	7440-31-5	E420	0.00010	mg/L	0.00014	---	---	---	---	
titanium, total	7440-32-6	E420	0.00030	mg/L	0.0211	---	---	---	---	
tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	---	---	---	---	
uranium, total	7440-61-1	E420	0.000010	mg/L	0.000010	---	---	---	---	
vanadium, total	7440-62-2	E420	0.00050	mg/L	0.00155	---	---	---	---	
zinc, total	7440-66-6	E420	0.0030	mg/L	0.0096	---	---	---	---	
zirconium, total	7440-67-7	E420	0.00020	mg/L	0.00027	---	---	---	---	

Please refer to the General Comments section for an explanation of any qualifiers detected.



**CERTIFICATE OF ANALYSIS**

**Work Order** : **VA20A0815**  
**Client** : **Current Environmental Ltd.**  
**Contact** : Dusty Silvester  
**Address** : 558 England Avenue  
Courtenay BC Canada V9N 2N3  
**Telephone** : ----  
**Project** : 1306-9  
**PO** : ----  
**C-O-C number** : 17-786088  
**Sampler** : ----  
**Site** : ----  
**Quote number** : Q68045  
**No. of samples received** : 6  
**No. of samples analysed** : 6

**Page** : 1 of 6  
**Laboratory** : Vancouver - Environmental  
**Account Manager** : Edward Ngai  
**Address** : 8081 Lougheed Highway  
Burnaby BC Canada V5A 1W9  
**Telephone** : +1 604 253 4188  
**Date Samples Received** : 25-Jan-2020 11:41  
**Date Analysis Commenced** : 26-Jan-2020  
**Issue Date** : 31-Jan-2020 15:32

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

**Signatories**

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Laboratory Department</i>
Cindy Tang	Team Leader - Inorganics	Inorganics - Water Quality, Burnaby, British Columbia
Kim Jensen	Department Manager - Metals	Metals, Burnaby, British Columbia
Lindsay Gung	Supervisor - Water Chemistry	Microbiology, Burnaby, British Columbia



## General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances  
LOR: Limit of Reporting (detection limit).

<i>Unit</i>	<i>Description</i>
mg/L	milligrams per litre
MPN/100mL	most probable number per 100 mL

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in reports identified as "Preliminary Report" are considered authorized for use.



## Analytical Results

Sub-Matrix: Water					Client sample ID				
(Matrix: Water)					2CR-03	2PC-03	2MC-03	2PR-03	2GU-03
Client sampling date / time					24-Jan-2020 13:00	24-Jan-2020 13:20	24-Jan-2020 13:45	24-Jan-2020 14:00	24-Jan-2020 14:30
Analyte	CAS Number	Method	LOR	Unit	VA20A0815-001	VA20A0815-002	VA20A0815-003	VA20A0815-004	VA20A0815-005
					Result	Result	Result	Result	Result
<b>Physical Tests</b>									
alkalinity, total (as CaCO3)	----	E290-L	1.0	mg/L	32.7	36.3	36.1	39.8	33.1
hardness (as CaCO3), from total Ca/Mg	----	EC100A	0.60	mg/L	40.8	45.0	44.9	51.9	41.2
<b>Anions and Nutrients</b>									
nitrate (as N)	14797-55-8	E235.NO3-L	0.0050	mg/L	1.08	1.25	0.884	1.33	1.09
<b>Organic / Inorganic Carbon</b>									
carbon, dissolved organic [DOC]	----	E358-L	0.50	mg/L	2.49	2.79	3.63	2.76	2.98
<b>Bacteriological Tests</b>									
coliforms, total	----	E010	1	MPN/100mL	>200	>200	>200	>200	>200
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	>200	165	165	21	>200
<b>Total Metals</b>									
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.422	0.542	0.616	0.856	0.252
antimony, total	7440-36-0	E420	0.00010	mg/L	0.00016	0.00013	0.00011	0.00015	0.00012
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00032	0.00040	0.00035	0.00048	0.00026
barium, total	7440-39-3	E420	0.00010	mg/L	0.00951	0.00504	0.00555	0.0169	0.00391
beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
bismuth, total	7440-69-9	E420	0.000050	mg/L	0.000083	<0.000050	<0.000050	<0.000050	<0.000050
boron, total	7440-42-8	E420	0.010	mg/L	0.013	0.011	0.011	0.017	0.011
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000460	0.0000112	0.0000100	0.0000195	0.0000077
calcium, total	7440-70-2	E420	0.050	mg/L	11.6	11.8	11.6	14.4	11.1
cesium, total	7440-46-2	E420	0.000010	mg/L	0.000010	0.000016	0.000017	0.000023	<0.000010
chromium, total	7440-47-3	E420	0.00050	mg/L	0.00087	0.00141	0.00182	0.00218	0.00087
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00032	0.00040	0.00045	0.00057	0.00026
copper, total	7440-50-8	E420	0.00050	mg/L	0.00533	0.00490	0.00471	0.00729	0.00373
iron, total	7439-89-6	E420	0.010	mg/L	0.540	0.610	0.788	1.17	0.449
lead, total	7439-92-1	E420	0.000050	mg/L	0.00241	0.000367	0.000386	0.00118	0.000694
lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
magnesium, total	7439-95-4	E420	0.0050	mg/L	2.87	3.78	3.85	3.88	3.25
manganese, total	7439-96-5	E420	0.00010	mg/L	0.0363	0.0269	0.0359	0.0404	0.0410
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000094	0.000100	0.000113	0.000120	0.000088
nickel, total	7440-02-0	E420	0.00050	mg/L	0.00084	0.00094	0.00110	0.00140	0.00059



## Analytical Results

Sub-Matrix: Water					Client sample ID				
(Matrix: Water)					2CR-03	2PC-03	2MC-03	2PR-03	2GU-03
Client sampling date / time					24-Jan-2020 13:00	24-Jan-2020 13:20	24-Jan-2020 13:45	24-Jan-2020 14:00	24-Jan-2020 14:30
Analyte	CAS Number	Method	LOR	Unit	VA20A0815-001	VA20A0815-002	VA20A0815-003	VA20A0815-004	VA20A0815-005
					Result	Result	Result	Result	Result
<b>Total Metals</b>									
phosphorus, total	7723-14-0	E420	0.050	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
potassium, total	7440-09-7	E420	0.050	mg/L	0.529	0.631	0.539	0.607	0.563
rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00039	0.00046	0.00038	0.00054	0.00044
selenium, total	7782-49-2	E420	0.000050	mg/L	0.000052	0.000064	0.000076	0.000063	<0.000050
silicon, total	7440-21-3	E420	0.10	mg/L	5.05	5.82	6.73	6.95	4.88
silver, total	7440-22-4	E420	0.000010	mg/L	0.000015	<0.000010	<0.000010	0.000013	<0.000010
sodium, total	7440-23-5	E420	0.050	mg/L	7.64	6.48	9.67	8.92	8.56
strontium, total	7440-24-6	E420	0.00020	mg/L	0.0476	0.0370	0.0359	0.0611	0.0392
sulfur, total	7704-34-9	E420	0.50	mg/L	1.17	0.91	1.07	1.64	1.18
tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
tin, total	7440-31-5	E420	0.00010	mg/L	<0.00010	<0.00010	0.00027	<0.00010	0.00013
titanium, total	7440-32-6	E420	0.00030	mg/L	0.0320	0.0482	0.0546	0.0786	0.0224
tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
uranium, total	7440-61-1	E420	0.000010	mg/L	<0.000010	0.000015	0.000010	0.000022	0.000012
vanadium, total	7440-62-2	E420	0.00050	mg/L	0.00205	0.00309	0.00463	0.00498	0.00176
zinc, total	7440-66-6	E420	0.0030	mg/L	0.0254	0.0292	0.0099	0.0207	0.0192
zirconium, total	7440-67-7	E420	0.00020	mg/L	0.00036	0.00040	0.00039	0.00053	0.00025

Please refer to the General Comments section for an explanation of any qualifiers detected.



## Analytical Results

Sub-Matrix: Water					Client sample ID	2BC-03	----	----	----	----
(Matrix: Water)					Client sampling date / time	24-Jan-2020 15:00	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit	VA20A0815-006	-----	-----	-----	-----	
					Result	---	---	---	---	
<b>Physical Tests</b>										
alkalinity, total (as CaCO3)	----	E290-L	1.0	mg/L	26.8	----	----	----	----	
hardness (as CaCO3), from total Ca/Mg	----	EC100A	0.60	mg/L	32.2	----	----	----	----	
<b>Anions and Nutrients</b>										
nitrate (as N)	14797-55-8	E235.NO3-L	0.0050	mg/L	0.913	---	---	---	---	
<b>Organic / Inorganic Carbon</b>										
carbon, dissolved organic [DOC]	----	E358-L	0.50	mg/L	2.53	----	----	----	----	
<b>Bacteriological Tests</b>										
coliforms, total	----	E010	1	MPN/100mL	200	----	----	----	----	
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	21	----	----	----	----	
<b>Total Metals</b>										
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.251	----	----	----	----	
antimony, total	7440-36-0	E420	0.00010	mg/L	<0.00010	----	----	----	----	
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00315	----	----	----	----	
barium, total	7440-39-3	E420	0.00010	mg/L	0.00402	----	----	----	----	
beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	----	----	----	----	
bismuth, total	7440-69-9	E420	0.000050	mg/L	<0.000050	----	----	----	----	
boron, total	7440-42-8	E420	0.010	mg/L	<0.010	----	----	----	----	
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000080	----	----	----	----	
calcium, total	7440-70-2	E420	0.050	mg/L	8.73	----	----	----	----	
cesium, total	7440-46-2	E420	0.000010	mg/L	<0.000010	----	----	----	----	
chromium, total	7440-47-3	E420	0.00050	mg/L	0.00125	----	----	----	----	
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00020	----	----	----	----	
copper, total	7440-50-8	E420	0.00050	mg/L	0.00615	----	----	----	----	
iron, total	7439-89-6	E420	0.010	mg/L	0.366	----	----	----	----	
lead, total	7439-92-1	E420	0.000050	mg/L	0.000180	----	----	----	----	
lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	----	----	----	----	
magnesium, total	7439-95-4	E420	0.0050	mg/L	2.52	----	----	----	----	
manganese, total	7439-96-5	E420	0.00010	mg/L	0.0325	----	----	----	----	
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000056	----	----	----	----	
nickel, total	7440-02-0	E420	0.00050	mg/L	<0.00050	----	----	----	----	
phosphorus, total	7723-14-0	E420	0.050	mg/L	<0.050	----	----	----	----	



## Analytical Results

Sub-Matrix: Water					Client sample ID	2BC-03	----	----	----	----
(Matrix: Water)					Client sampling date / time	24-Jan-2020 15:00	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit	VA20A0815-006	-----	-----	-----	-----	
					Result	---	---	---	---	
<b>Total Metals</b>										
potassium, total	7440-09-7	E420	0.050	mg/L	0.791	----	----	----	----	
rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00055	----	----	----	----	
selenium, total	7782-49-2	E420	0.000050	mg/L	<0.000050	----	----	----	----	
silicon, total	7440-21-3	E420	0.10	mg/L	3.38	----	----	----	----	
silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	----	----	----	----	
sodium, total	7440-23-5	E420	0.050	mg/L	7.75	----	----	----	----	
strontium, total	7440-24-6	E420	0.00020	mg/L	0.0311	----	----	----	----	
sulfur, total	7704-34-9	E420	0.50	mg/L	1.29	----	----	----	----	
tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	----	----	----	----	
thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	----	----	----	----	
thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	----	----	----	----	
tin, total	7440-31-5	E420	0.00010	mg/L	<0.00010	----	----	----	----	
titanium, total	7440-32-6	E420	0.00030	mg/L	0.0166	----	----	----	----	
tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	----	----	----	----	
uranium, total	7440-61-1	E420	0.000010	mg/L	0.000010	----	----	----	----	
vanadium, total	7440-62-2	E420	0.00050	mg/L	0.00146	----	----	----	----	
zinc, total	7440-66-6	E420	0.0030	mg/L	0.0093	----	----	----	----	
zirconium, total	7440-67-7	E420	0.00020	mg/L	0.00023	----	----	----	----	

Please refer to the General Comments section for an explanation of any qualifiers detected.



**CERTIFICATE OF ANALYSIS**

**Work Order** : **VA20A0979**  
**Client** : **Current Environmental Ltd.**  
**Contact** : Dusty Silvester  
**Address** : 558 England Avenue  
 Courtenay BC Canada V9N 2N3  
**Telephone** : ----  
**Project** : 1306-10  
**PO** : ----  
**C-O-C number** : 17-836126  
**Sampler** : ----  
**Site** : ----  
**Quote number** : Q68045  
**No. of samples received** : 6  
**No. of samples analysed** : 6

**Page** : 1 of 6  
**Laboratory** : Vancouver - Environmental  
**Account Manager** : Edward Ngai  
**Address** : 8081 Lougheed Highway  
 Burnaby BC Canada V5A 1W9  
**Telephone** : +1 604 253 4188  
**Date Samples Received** : 29-Jan-2020 13:10  
**Date Analysis Commenced** : 29-Jan-2020  
**Issue Date** : 05-Feb-2020 16:23

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

**Signatories**

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Laboratory Department</i>
Angela Ren	Team Leader - Metals	Metals, Burnaby, British Columbia
Caitlin Macey	Team Leader - Inorganics	Microbiology, Burnaby, British Columbia
Cristina Alexandre	Supervisor - Metals ICP Instrumentation	Metals, Burnaby, British Columbia
Lindsay Gung	Supervisor - Water Chemistry	Inorganics - Water Quality, Burnaby, British Columbia



## General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

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Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances  
LOR: Limit of Reporting (detection limit).

<i>Unit</i>	<i>Description</i>
mg/L	milligrams per litre
MPN/100mL	most probable number per 100 mL

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in reports identified as "Preliminary Report" are considered authorized for use.



## Analytical Results

Sub-Matrix: Water					Client sample ID				
(Matrix: Water)					2CR-04	2PC-04	2MC-04	2PR-04	2GU-04
Client sampling date / time					28-Jan-2020 13:30	28-Jan-2020 13:45	28-Jan-2020 14:00	28-Jan-2020 14:20	28-Jan-2020 14:50
Analyte	CAS Number	Method	LOR	Unit	VA20A0979-001	VA20A0979-002	VA20A0979-003	VA20A0979-004	VA20A0979-005
					Result	Result	Result	Result	Result
<b>Physical Tests</b>									
alkalinity, total (as CaCO3)	----	E290-L	1.0	mg/L	41.0	48.5	50.0	47.1	43.8
hardness (as CaCO3), from total Ca/Mg	----	EC100A	0.60	mg/L	47.5	60.6	64.6	65.7	55.9
<b>Anions and Nutrients</b>									
nitrate (as N)	14797-55-8	E235.NO3-L	0.0050	mg/L	1.17	1.52	1.13	1.59	1.31
<b>Organic / Inorganic Carbon</b>									
carbon, dissolved organic [DOC]	----	E358-L	0.50	mg/L	2.10	2.56	3.61	2.69	3.36
<b>Bacteriological Tests</b>									
coliforms, Escherichia coli [E. coli]	----	E010.EC	1	MPN/100mL	57	20	11	37	727
coliforms, total	----	E010.TC	1	MPN/100mL	1200	2420	816	3100	10900
<b>Total Metals</b>									
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.143	0.158	0.261	0.428	0.325
antimony, total	7440-36-0	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	0.00011	<0.00010
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00017	0.00020	0.00028	0.00026	0.00026
barium, total	7440-39-3	E420	0.00010	mg/L	0.0107	0.00427	0.00495	0.0178	0.00414
beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
bismuth, total	7440-69-9	E420	0.000050	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
boron, total	7440-42-8	E420	0.010	mg/L	0.014	0.012	0.012	0.019	0.013
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000120	0.0000085	0.0000081	0.0000117	0.0000112
calcium, total	7440-70-2	E420	0.050	mg/L	12.9	15.1	16.2	16.9	14.7
cesium, total	7440-46-2	E420	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
chromium, total	7440-47-3	E420	0.00050	mg/L	<0.00050	0.00060	0.00102	0.00113	0.00077
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00011	0.00012	0.00025	0.00027	0.00031
copper, total	7440-50-8	E420	0.00050	mg/L	0.00249	0.00255	0.00305	0.00339	0.00327
iron, total	7439-89-6	E420	0.010	mg/L	0.166	0.152	0.457	0.454	0.566
lead, total	7439-92-1	E420	0.000050	mg/L	0.000602	0.000087	0.000117	0.000612	0.000340
lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
magnesium, total	7439-95-4	E420	0.0050	mg/L	3.71	5.57	5.88	5.69	4.67
manganese, total	7439-96-5	E420	0.00010	mg/L	0.0334	0.0166	0.0398	0.0393	0.0661
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000058	0.000070	0.000069	0.000077	0.000094
nickel, total	7440-02-0	E420	0.00050	mg/L	<0.00050	<0.00050	0.00068	0.00074	0.00060



## Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	2CR-04	2PC-04	2MC-04	2PR-04	2GU-04
Client sampling date / time					28-Jan-2020 13:30	28-Jan-2020 13:45	28-Jan-2020 14:00	28-Jan-2020 14:20	28-Jan-2020 14:50	
Analyte	CAS Number	Method	LOR	Unit	VA20A0979-001	VA20A0979-002	VA20A0979-003	VA20A0979-004	VA20A0979-005	
					Result	Result	Result	Result	Result	
<b>Total Metals</b>										
phosphorus, total	7723-14-0	E420	0.050	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	
potassium, total	7440-09-7	E420	0.050	mg/L	0.505	0.504	0.479	0.562	0.601	
rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00042	0.00030	0.00029	0.00038	0.00043	
selenium, total	7782-49-2	E420	0.000050	mg/L	<0.000050	0.000061	0.000080	0.000074	<0.000050	
silicon, total	7440-21-3	E420	0.10	mg/L	5.90	7.79	8.44	7.44	6.03	
silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
sodium, total	7440-23-5	E420	0.050	mg/L	9.37	8.54	10.8	13.7	11.2	
strontium, total	7440-24-6	E420	0.00020	mg/L	0.0547	0.0447	0.0429	0.0719	0.0454	
sulfur, total	7704-34-9	E420	0.50	mg/L	1.44	1.09	1.37	1.34	1.59	
tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
tin, total	7440-31-5	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
titanium, total	7440-32-6	E420	0.00030	mg/L	0.00836	0.0139	0.0233	0.0344	0.0252	
tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
uranium, total	7440-61-1	E420	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	0.000013	
vanadium, total	7440-62-2	E420	0.00050	mg/L	0.00102	0.00179	0.00332	0.00301	0.00191	
zinc, total	7440-66-6	E420	0.0030	mg/L	0.0134	0.0289	0.0068	0.0161	0.0161	
zirconium, total	7440-67-7	E420	0.00020	mg/L	<0.00020	<0.00020	0.00026	0.00026	0.00021	

Please refer to the General Comments section for an explanation of any qualifiers detected.



## Analytical Results

Sub-Matrix: Water					Client sample ID	2BC-04	----	----	----	----
(Matrix: Water)					Client sampling date / time	28-Jan-2020 15:30	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit	VA20A0979-006	-----	-----	-----	-----	
					Result	---	---	---	---	
<b>Physical Tests</b>										
alkalinity, total (as CaCO3)	----	E290-L	1.0	mg/L	28.9	----	----	----	----	
hardness (as CaCO3), from total Ca/Mg	----	EC100A	0.60	mg/L	33.0	----	----	----	----	
<b>Anions and Nutrients</b>										
nitrate (as N)	14797-55-8	E235.NO3-L	0.0050	mg/L	0.788	---	---	---	---	
<b>Organic / Inorganic Carbon</b>										
carbon, dissolved organic [DOC]	----	E358-L	0.50	mg/L	3.24	----	----	----	----	
<b>Bacteriological Tests</b>										
coliforms, Escherichia coli [E. coli]	----	E010.EC	1	MPN/100mL	14	----	----	----	----	
coliforms, total	----	E010.TC	1	MPN/100mL	488	----	----	----	----	
<b>Total Metals</b>										
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.196	----	----	----	----	
antimony, total	7440-36-0	E420	0.00010	mg/L	<0.00010	----	----	----	----	
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00500	----	----	----	----	
barium, total	7440-39-3	E420	0.00010	mg/L	0.00323	----	----	----	----	
beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	----	----	----	----	
bismuth, total	7440-69-9	E420	0.000050	mg/L	<0.000050	----	----	----	----	
boron, total	7440-42-8	E420	0.010	mg/L	<0.010	----	----	----	----	
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000102	----	----	----	----	
calcium, total	7440-70-2	E420	0.050	mg/L	8.46	----	----	----	----	
cesium, total	7440-46-2	E420	0.000010	mg/L	<0.000010	----	----	----	----	
chromium, total	7440-47-3	E420	0.00050	mg/L	0.00163	----	----	----	----	
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00014	----	----	----	----	
copper, total	7440-50-8	E420	0.00050	mg/L	0.00577	----	----	----	----	
iron, total	7439-89-6	E420	0.010	mg/L	0.326	----	----	----	----	
lead, total	7439-92-1	E420	0.000050	mg/L	0.000144	----	----	----	----	
lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	----	----	----	----	
magnesium, total	7439-95-4	E420	0.0050	mg/L	2.88	----	----	----	----	
manganese, total	7439-96-5	E420	0.00010	mg/L	0.0448	----	----	----	----	
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000057	----	----	----	----	
nickel, total	7440-02-0	E420	0.00050	mg/L	<0.00050	----	----	----	----	
phosphorus, total	7723-14-0	E420	0.050	mg/L	<0.050	----	----	----	----	



## Analytical Results

Sub-Matrix: Water					Client sample ID	2BC-04	---	---	---	---
(Matrix: Water)					Client sampling date / time	28-Jan-2020 15:30	---	---	---	---
Analyte	CAS Number	Method	LOR	Unit	VA20A0979-006	-----	-----	-----	-----	
					Result	---	---	---	---	
<b>Total Metals</b>										
potassium, total	7440-09-7	E420	0.050	mg/L	0.849	---	---	---	---	
rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00052	---	---	---	---	
selenium, total	7782-49-2	E420	0.000050	mg/L	<0.000050	---	---	---	---	
silicon, total	7440-21-3	E420	0.10	mg/L	3.19	---	---	---	---	
silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	---	---	---	---	
sodium, total	7440-23-5	E420	0.050	mg/L	8.17	---	---	---	---	
strontium, total	7440-24-6	E420	0.00020	mg/L	0.0294	---	---	---	---	
sulfur, total	7704-34-9	E420	0.50	mg/L	1.27	---	---	---	---	
tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	---	---	---	---	
thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	---	---	---	---	
thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	---	---	---	---	
tin, total	7440-31-5	E420	0.00010	mg/L	<0.00010	---	---	---	---	
titanium, total	7440-32-6	E420	0.00030	mg/L	0.0114	---	---	---	---	
tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	---	---	---	---	
uranium, total	7440-61-1	E420	0.000010	mg/L	<0.000010	---	---	---	---	
vanadium, total	7440-62-2	E420	0.00050	mg/L	0.00110	---	---	---	---	
zinc, total	7440-66-6	E420	0.0030	mg/L	0.0080	---	---	---	---	
zirconium, total	7440-67-7	E420	0.00020	mg/L	<0.00020	---	---	---	---	

Please refer to the General Comments section for an explanation of any qualifiers detected.



## CERTIFICATE OF ANALYSIS

**Work Order** : **VA20A1453**  
**Client** : **Current Environmental Ltd.**  
**Contact** : Dusty Silvester  
**Address** : 558 England Avenue  
Courtenay BC Canada V9N 2N3  
**Telephone** : ----  
**Project** : 1306-11  
**PO** : ----  
**C-O-C number** : 17-836125  
**Sampler** : ----  
**Site** : ----  
**Quote number** : Q68045  
**No. of samples received** : 6  
**No. of samples analysed** : 6

**Page** : 1 of 6  
**Laboratory** : Vancouver - Environmental  
**Account Manager** : Edward Ngai  
**Address** : 8081 Lougheed Highway  
Burnaby BC Canada V5A 1W9  
**Telephone** : +1 604 253 4188  
**Date Samples Received** : 07-Feb-2020 08:35  
**Date Analysis Commenced** : 07-Feb-2020  
**Issue Date** : 13-Feb-2020 13:37

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

### Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Laboratory Department</i>
Caitlin Macey	Team Leader - Inorganics	Microbiology, Burnaby, British Columbia
Kim Jensen	Department Manager - Metals	Metals, Burnaby, British Columbia
Lindsay Gung	Supervisor - Water Chemistry	Inorganics - Water Quality, Burnaby, British Columbia
Tracy Harley	Supervisor - Water Quality Instrumentation	Inorganics - Water Quality, Burnaby, British Columbia



## General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances  
LOR: Limit of Reporting (detection limit).

<i>Unit</i>	<i>Description</i>
mg/L	milligrams per litre
MPN/100mL	most probable number per 100 mL

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in reports identified as "Preliminary Report" are considered authorized for use.



## Analytical Results

Sub-Matrix: Water					Client sample ID				
(Matrix: Water)					2CR-05	2PC-05	2MC-05	2PR-05	2GU-05
Client sampling date / time					06-Feb-2020 11:40	06-Feb-2020 12:00	06-Feb-2020 12:20	06-Feb-2020 11:15	06-Feb-2020 12:50
Analyte	CAS Number	Method	LOR	Unit	VA20A1453-001	VA20A1453-002	VA20A1453-003	VA20A1453-004	VA20A1453-005
					Result	Result	Result	Result	Result
<b>Physical Tests</b>									
alkalinity, total (as CaCO3)	----	E290-L	1.0	mg/L	39.8	47.7	40.0	42.0	38.3
hardness (as CaCO3), from total Ca/Mg	----	EC100A	0.60	mg/L	46.4	60.7	54.1	59.8	48.9
<b>Anions and Nutrients</b>									
nitrate (as N)	14797-55-8	E235.NO3-L	0.0050	mg/L	0.853	1.27	0.656	1.19	0.901
<b>Organic / Inorganic Carbon</b>									
carbon, dissolved organic [DOC]	----	E358-L	0.50	mg/L	1.98	1.79	2.09	1.54	2.04
<b>Bacteriological Tests</b>									
coliforms, Escherichia coli [E. coli]	----	E010.EC	1	MPN/100mL	147	63	166	28	1990
coliforms, total	----	E010.TC	1	MPN/100mL	>2420	2420	5200	3100	18900
<b>Total Metals</b>									
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.334	0.210	0.612	0.819	0.363
antimony, total	7440-36-0	E420	0.00010	mg/L	0.00022	0.00013	0.00023	0.00015	0.00021
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00022	0.00022	0.00038	0.00040	0.00026
barium, total	7440-39-3	E420	0.00010	mg/L	0.0116	0.00504	0.00622	0.0257	0.00405
beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
bismuth, total	7440-69-9	E420	0.000050	mg/L	0.000092	<0.000050	0.000142	0.000157	0.000104
boron, total	7440-42-8	E420	0.010	mg/L	0.011	0.011	<0.010	0.016	0.011
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000162	0.0000143	0.0000162	0.0000205	0.0000120
calcium, total	7440-70-2	E420	0.050	mg/L	12.9	15.1	13.4	15.2	12.9
cesium, total	7440-46-2	E420	0.000010	mg/L	<0.000010	<0.000010	0.000015	0.000054	0.000011
chromium, total	7440-47-3	E420	0.00050	mg/L	0.00082	0.00069	0.00152	0.00163	0.00089
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00031	0.00020	0.00060	0.00094	0.00034
copper, total	7440-50-8	E420	0.00050	mg/L	0.00470	0.00305	0.00648	0.00514	0.00908
iron, total	7439-89-6	E420	0.010	mg/L	0.468	0.260	0.995	0.982	0.588
lead, total	7439-92-1	E420	0.000050	mg/L	0.000621	0.000271	0.000692	0.00166	0.000514
lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
magnesium, total	7439-95-4	E420	0.0050	mg/L	3.45	5.59	5.00	5.26	4.04
manganese, total	7439-96-5	E420	0.00010	mg/L	0.0431	0.0210	0.0637	0.0750	0.0578
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000102	0.000095	0.000156	0.000099	0.000119
nickel, total	7440-02-0	E420	0.00050	mg/L	0.00083	0.00060	0.00118	0.00141	0.00073



## Analytical Results

Sub-Matrix: Water  
 (Matrix: Water)

					Client sample ID				
					2CR-05	2PC-05	2MC-05	2PR-05	2GU-05
					Client sampling date / time				
					06-Feb-2020 11:40	06-Feb-2020 12:00	06-Feb-2020 12:20	06-Feb-2020 11:15	06-Feb-2020 12:50
Analyte	CAS Number	Method	LOR	Unit	VA20A1453-001	VA20A1453-002	VA20A1453-003	VA20A1453-004	VA20A1453-005
					Result	Result	Result	Result	Result
<b>Total Metals</b>									
phosphorus, total	7723-14-0	E420	0.050	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
potassium, total	7440-09-7	E420	0.050	mg/L	0.411	0.391	0.405	0.498	0.494
rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00034	0.00030	0.00029	0.00054	0.00034
selenium, total	7782-49-2	E420	0.000050	mg/L	0.000065	0.000082	0.000087	0.000091	0.000082
silicon, total	7440-21-3	E420	0.10	mg/L	5.59	7.34	6.35	6.84	5.35
silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	<0.000010	0.000011	0.000011	<0.000010
sodium, total	7440-23-5	E420	0.050	mg/L	19.9	27.2	52.5	14.4	16.7
strontium, total	7440-24-6	E420	0.00020	mg/L	0.0539	0.0449	0.0417	0.0706	0.0414
sulfur, total	7704-34-9	E420	0.50	mg/L	1.30	1.13	1.05	1.34	1.22
tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
tin, total	7440-31-5	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
titanium, total	7440-32-6	E420	0.00030	mg/L	0.0246	0.0158	0.0532	0.0531	0.0276
tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
uranium, total	7440-61-1	E420	0.000010	mg/L	0.000010	<0.000010	0.000010	0.000018	0.000012
vanadium, total	7440-62-2	E420	0.00050	mg/L	0.00168	0.00195	0.00394	0.00407	0.00191
zinc, total	7440-66-6	E420	0.0030	mg/L	0.0225	0.0379	0.0190	0.0220	0.0201
zirconium, total	7440-67-7	E420	0.00020	mg/L	0.00033	<0.00020	0.00038	0.00026	0.00022

Please refer to the General Comments section for an explanation of any qualifiers detected.



## Analytical Results

Sub-Matrix: Water					Client sample ID	2BC-05	----	----	----	----
(Matrix: Water)					Client sampling date / time	06-Feb-2020 13:30	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit	VA20A1453-006	-----	-----	-----	-----	
					Result	---	---	---	---	
<b>Physical Tests</b>										
alkalinity, total (as CaCO3)	----	E290-L	1.0	mg/L	32.8	----	----	----	----	
hardness (as CaCO3), from total Ca/Mg	----	EC100A	0.60	mg/L	39.0	----	----	----	----	
<b>Anions and Nutrients</b>										
nitrate (as N)	14797-55-8	E235.NO3-L	0.0050	mg/L	0.740	---	---	---	---	
<b>Organic / Inorganic Carbon</b>										
carbon, dissolved organic [DOC]	----	E358-L	0.50	mg/L	2.32	----	----	----	----	
<b>Bacteriological Tests</b>										
coliforms, Escherichia coli [E. coli]	----	E010.EC	1	MPN/100mL	7	----	----	----	----	
coliforms, total	----	E010.TC	1	MPN/100mL	411	----	----	----	----	
<b>Total Metals</b>										
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.190	----	----	----	----	
antimony, total	7440-36-0	E420	0.00010	mg/L	0.00010	----	----	----	----	
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00594	----	----	----	----	
barium, total	7440-39-3	E420	0.00010	mg/L	0.00338	----	----	----	----	
beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	----	----	----	----	
bismuth, total	7440-69-9	E420	0.000050	mg/L	<0.000050	----	----	----	----	
boron, total	7440-42-8	E420	0.010	mg/L	<0.010	----	----	----	----	
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000129	----	----	----	----	
calcium, total	7440-70-2	E420	0.050	mg/L	9.91	----	----	----	----	
cesium, total	7440-46-2	E420	0.000010	mg/L	<0.000010	----	----	----	----	
chromium, total	7440-47-3	E420	0.00050	mg/L	0.00191	----	----	----	----	
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00017	----	----	----	----	
copper, total	7440-50-8	E420	0.00050	mg/L	0.00557	----	----	----	----	
iron, total	7439-89-6	E420	0.010	mg/L	0.355	----	----	----	----	
lead, total	7439-92-1	E420	0.000050	mg/L	0.000152	----	----	----	----	
lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	----	----	----	----	
magnesium, total	7439-95-4	E420	0.0050	mg/L	3.45	----	----	----	----	
manganese, total	7439-96-5	E420	0.00010	mg/L	0.0576	----	----	----	----	
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000059	----	----	----	----	
nickel, total	7440-02-0	E420	0.00050	mg/L	<0.00050	----	----	----	----	
phosphorus, total	7723-14-0	E420	0.050	mg/L	<0.050	----	----	----	----	



## Analytical Results

Sub-Matrix: Water					Client sample ID	2BC-05	----	----	----	----
(Matrix: Water)					Client sampling date / time	06-Feb-2020 13:30	----	---	---	----
Analyte	CAS Number	Method	LOR	Unit	VA20A1453-006	-----	-----	-----	-----	
					Result	---	---	---	---	
<b>Total Metals</b>										
potassium, total	7440-09-7	E420	0.050	mg/L	0.904	----	----	----	----	
rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00054	----	----	----	----	
selenium, total	7782-49-2	E420	0.000050	mg/L	0.000076	----	----	----	----	
silicon, total	7440-21-3	E420	0.10	mg/L	3.77	----	----	----	----	
silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	----	----	----	----	
sodium, total	7440-23-5	E420	0.050	mg/L	10.4	----	----	----	----	
strontium, total	7440-24-6	E420	0.00020	mg/L	0.0335	----	----	----	----	
sulfur, total	7704-34-9	E420	0.50	mg/L	1.43	----	----	----	----	
tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	----	----	----	----	
thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	----	----	----	----	
thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	----	----	----	----	
tin, total	7440-31-5	E420	0.00010	mg/L	<0.00010	----	----	----	----	
titanium, total	7440-32-6	E420	0.00030	mg/L	0.0114	----	----	----	----	
tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	----	----	----	----	
uranium, total	7440-61-1	E420	0.000010	mg/L	<0.000010	----	----	----	----	
vanadium, total	7440-62-2	E420	0.00050	mg/L	0.00116	----	----	----	----	
zinc, total	7440-66-6	E420	0.0030	mg/L	0.0085	----	----	----	----	
zirconium, total	7440-67-7	E420	0.00020	mg/L	<0.00020	----	----	----	----	

Please refer to the General Comments section for an explanation of any qualifiers detected.

## APPENDIX D

### BENTHIC LAB RESULTS FROM BIOLOGICA ENVIRONMENTAL SERVICES LTD.



**Freshwater Benthic Enumeration and Identification Methods**  
**Client: Current Environmental**  
**Project: Metro Vancouver AMF Streams**  
**Protocol: B-IBI (Metro Vancouver Adaptive Management Framework)**

**Sample Inventory**

Sample arrival: 11-Oct-19  
 Number of samples: 18  
 Number of jars: 18  
 Collection screen size: 500 µm  
 Field screen size: 335 µm  
 Lab Screen size: 250 µm  
 Biologica project number: 19-041

The chain of custody documents were checked and approved with the client. Samples were screened and transferred from formalin into 70% ethanol, and stained with Rose Bengal to aid in sorting. Each sample was provided a unique identification number and placed in the queue for analysis.

**Table 1.** Summary of benthic samples processed for Current Environmental Metro Vancouver AMF Streams, 2019.

Client Sample ID	Replicate	Date Sampled	Biologica Sample ID	Field Screen	Lab Screen	Sub-sample	Organisms Counted
1-BC	1	9-Oct-19	19-041-001	500 µm	250 µm	1/12	480
1-BC	2	9-Oct-19	19-041-002	500 µm	250 µm	1/12	578
1-BC	3	9-Oct-19	19-041-003	500 µm	250 µm	5/24	490
1-CR	1	1-Oct-19	19-041-004	500 µm	250 µm	15/24	419
1-CR	2	1-Oct-19	19-041-005	500 µm	250 µm	Whole	83
1-CR	3	1-Oct-19	19-041-006	500 µm	250 µm	Whole	627
1-GU	1	9-Oct-19	19-041-007	500 µm	250 µm	5/24	440
1-GU	2	9-Oct-19	19-041-008	500 µm	250 µm	5/12	490
1-GU	3	9-Oct-19	19-041-009	500 µm	250 µm	9/24	451
1-MC	1	25-Sep-19	19-041-010	500 µm	250 µm	7/48	410
1-MC	2	25-Sep-19	19-041-011	500 µm	250 µm	Whole	259
1-MC	3	25-Sep-19	19-041-012	500 µm	250 µm	13/24	440
1-PC	1	1-Oct-19	19-041-013	500 µm	250 µm	7/48	401
1-PC	2	1-Oct-19	19-041-014	500 µm	250 µm	5/12	492
1-PC	3	1-Oct-19	19-041-015	500 µm	250 µm	7/48	457
1-PR	1	1-Oct-19	19-041-016	500 µm	250 µm	5/48	413
1-PR	2	1-Oct-19	19-041-017	500 µm	250 µm	2/3	425
1-PR	3	1-Oct-19	19-041-018	500 µm	250 µm	7/24	411

## Sample Processing

### Sorting:

Samples were sorted using dissecting microscopes at 10–40x magnification by trained personnel. All debris in each sample was checked microscopically, including leaves, twigs, moss, elutriated gravel, and other large debris, to ensure “clinger taxa” were recovered consistently from the samples. If present, any large organisms (>1.5 cm) were removed from the unsorted portion of the sample and identified to ensure all rare taxa were captured in the data. To minimize potential sorter bias, samples were distributed among technicians such that no one person sorted all the replicates of a given sample or station.

### Sorting QA/QC:

To ensure sorting efficiency was >95%, whole and/or partial sub-samples were re-sorted. Sorting efficiency was calculated using the following equation (where total count = final total number of organisms in sample):

Sorting efficiency =  $[1 - (\# \text{ of organisms in spotcheck or resort} / \text{total organisms})] \times 100$

\*Total organisms includes the original count and the number found from the resort

Sorting efficiency QA/QC was performed on 16% of samples. 25% of the debris was re-sorted for the selected samples. All samples checked must meet or exceed 95% sorting efficiency. Any samples falling below 95% sorting efficiency were re-sorted in their entirety, and additional checks were undertaken as necessary. Refer to Table 2 for sorting efficiency results.

For quality assurance, QA resorts were performed on 10% of samples. 2 samples were randomly selected and resorted in its entirety.

**Table 2.** Summary of sorting QA/QC results for Current Environmental Metro Vancouver AMF Streams, 2019.

Client Sample ID	Biologica Sample ID	Sorting Efficiency QC: Spotchecks	Sorting Efficiency QA: Whole Resort
1-BC-Rep1	19-041-001		97.70%
1-BC-Rep2	19-041-002		
1-BC-Rep3	19-041-003		
1-CR-Rep1	19-041-004	98.10%	
1-CR-Rep2	19-041-005		
1-CR-Rep3	19-041-006		
1-GU-Rep1	19-041-007		96.95%
1-GU-Rep2	19-041-008		
1-GU-Rep3	19-041-009		
1-MC-Rep1	19-041-010		
1-MC-Rep2	19-041-011	97.00%	
1-MC-Rep3	19-041-012		
1-PC-Rep1	19-041-013		
1-PC-Rep2	19-041-014		
1-PC-Rep3	19-041-015	96.00%	
1-PR-Rep1	19-041-016		

Client Sample ID	Biologica Sample ID	Sorting Efficiency QC: Spotchecks	Sorting Efficiency QA: Whole Resort
1-PR-Rep2	19-041-017		
1-PR-Rep3	19-041-018		
<b>Average:</b>		<b>97.03%</b>	<b>97.33%</b>

**Identification:**

All organisms were identified using a combination of dissecting (10–40x) and compound (100–1000x) microscopes and standard taxonomic keys (see methodological and taxonomic references) to the lowest practicable level as specified by Plotnikoff and White (1996). All specimens were archived in air-tight glass vials with glycerin and 70% ethanol for long-term storage. Taxonomic data were recorded in Biologica’s custom database.

Data were compiled in an excel spreadsheet. Incidental organisms (e.g., pupae, Collembola, terrestrial insects) were reported separately. These data were entered into Biologica’s database and completely double-checked for entry errors.

The multi-metric benthic index of biological integrity (B-IBI) was calculated based on the following metrics after Karr and Chu (1999), Morely (2002) and Page et al. (2008):

- Total number of unique taxa
- Total number of unique mayfly (Ephemeroptera) taxa
- Total number of unique stonefly (Plecoptera) taxa
- Total number of unique caddisfly (Trichoptera) taxa
- Number of long lived taxa (organisms living a minimum of 2-3 years in the immature state)
- Number of intolerant taxa
- Percent of predatory individuals
- Number of clinger taxa
- Percent dominance: the percent of individuals in the three most dominant taxa.

Long-lived, predatory, clinger, and tolerant/intolerant taxa were defined consistently with available species list attributes at pugetsoundstreambenthos.org (files constructed by R.W. Wisseman and L. Fore).

Each metric in each sample was assigned a value (1, 3 or 5) according to the thresholds reported at pugetsoundstreambenthos.org and Page et al. (2008). The sum of these values gave the sample B-IBI.

No species were found that were new to Biologica’s verified reference collections.

**Identification QA/QC:**

For quality assurance of identification, 5% of samples were randomly selected and re-identified by a second trained taxonomist. Refer to Table 3 for QA results. Standard taxonomic effort and a list of Biologica’s taxonomists certified by the Society of Freshwater Science (SFS) are presented in Tables 4 and 5, respectively.

**Table 3.** Summary of taxonomic QA/QC results for Current Environmental Metro Vancouver AMF Streams, 2019.

Client Sample ID	Biologica Sample ID	Bray-Curtis Similarity	% Taxonomic Agreement	% Similarity in Enumeration
1-BC-Rep2	19-041-002	99.91%	100.00%	99.83%

**% Identification Agreement:**

$100 - [(\# \text{ of disagreements} / \text{ total } \# \text{ of taxa identified}) \times 100]$

*\*differences in resolution are not considered disagreements*

**% Enumeration Agreement:**

$\{100 - [(difference \text{ in abundance between samples} / \text{ total abundance of original sample}) \times 100]\}\%$

**Table 4.** Taxonomists certified by the Society of Freshwater Science (SFS).

Taxonomist	Certification	Date of Certification
Robynn Holma	North American Chironomidae	2017
	Western Arthropods	2017
	Western EPT	2019
	Western Chironomidae	2014
	Eastern EPT	2017
Karen Hoban	Eastern Arthropods	2019
	Western EPT	2017
	Western Arthropods	2017
	Eastern EPT	2019
Breanna Bomback	Eastern Arthropods	2019
	North American Chironomidae	2019
Hiroki Tomoe	North American Oligochaeta	2015
Natalia Filip	North American Chironomidae	2016

**Data**

All data were recorded in Biologica’s custom database. Results were provided to the Current Environmental project manager in Excel spreadsheets via email.

## Methodological and Taxonomic References

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Benthic report of quality control, quality assurance for subsampling and taxonomy for Current Environmental Metro Vancouver AMF Streams, 2019.

Biologica Sample ID	Client Sample ID	Sorting Efficiency QC: Spotcheck	Sorting Efficiency QA: Random whole resorts	Bray-Curtis similarity for taxonomy & enumeration	Percent taxonomic Agreement (PTA)	Percent similarity in Enumeration (PSE)
19-041-001	1-BC-Rep1		97.70%			
19-041-002	1-BC-Rep2			99.91%	100.00%	99.83%
19-041-003	1-BC-Rep3					
19-041-004	1-CR-Rep1	98.10%				
19-041-005	1-CR-Rep2					
19-041-006	1-CR-Rep3					
19-041-007	1-GU-Rep1		96.95%			
19-041-008	1-GU-Rep2					
19-041-009	1-GU-Rep3					
19-041-010	1-MC-Rep1					
19-041-011	1-MC-Rep2	97.00%				
19-041-012	1-MC-Rep3					
19-041-013	1-PC-Rep1					
19-041-014	1-PC-Rep2					
19-041-015	1-PC-Rep3	96.00%				
19-041-016	1-PR-Rep1					
19-041-017	1-PR-Rep2					
19-041-018	1-PR-Rep3					
<b>Average:</b>		<b>97.03%</b>	<b>97.33%</b>	<b>99.91%</b>	<b>100.00%</b>	<b>99.83%</b>

**Quality Control**

Sorting efficiency: [(total count – organisms recovered in spot check and/or re-sort) / total count] x 100%

Spot Check: 25% of sample debris resorted for 17% of samples

**Table 2. QA Identification for Current Environmental Metro Vancouver AMF Streams, 2019.**

Biologica Sample #	Client Sample #	Agreements	Disagreements/ Misidentification	Difference in Resolution	Difference in Enumeration	Total Organisms Found in Original Sample	Total Organisms Found in QA	Percent Taxonomic Agreement (PTA)	Percent Agreement in Enumeration
19-041-002	1-BC-Rep2	19	0	1	1	578	579	100.00	99.83

**Quality Assurance (QA) Identification Agreement Rate**

Identification Agreement Rate: [(# incorrect identifications/total organisms found in audit) x100%]-100

Enumeration, questionable taxonomic resolution and insufficient taxonomic resolution are not included in the % Agreement Rate



## Abbreviations & Definitions

### **Worksheets:**

- |                                |  |
|--------------------------------|--|
| 1. Abbreviations & Definitions | Glossary of terms and outline of report.                                     |
| 2. Data-Matrix                 | Abundance data in matrix format, including total taxa and BIBI calculations. |
| 3. Data-Long                   | Abundance data in long format.   |
| 4. QC-QA Report                | Results of sorting efficiency.   |
| 5. MEMO-Incidentals            | Taxa not included in BIBI calculations.                                      |

### **Life/Size Stages:**

- |                           |   |
|---------------------------|---|
| A                         | Adult   |
| Int                       | Intermediate - has adult features but not of typical reproductive size  |
| J                         | Juvenile  |
| L                         | Larvae  |
| N                         | Nymph   |
| P                         | Pupa  |
| Col                       | Colony  |
| Deut                      | Deutonymph  |
| Total Number of Taxa      | Number of unique taxa (= species richness), not including higher-order taxa for which there exists a lower-order id |
| Total Number of Organisms | Total Abundance, not including incidental taxa  |

### **B-IBI codes:**

- |                   |  |
|-------------------|--|
| Voltinism         | Refers to the length of a life cycle of an organism.                                 |
| Univoltine (Uv)   | One generation/year  |
| Semivoltine (Ll)  | Organism takes more than one year to complete its life cycle (considered Long-lived) |
| Multivoltine (Mv) | Numerous generations/year  |

Clingers: Organisms that cling to substrates, yes/no

Tol/Intol: Tolerance of organisms to organic pollution (Tolerance/Intolerance)

I : Intolerant  
T: Tolerant  
0: No information

Feeding:

SC: Scrapers  
SH: Shredders  
PR: Predators  
CG: Collector-Gatherer  
PA: Parasites  
CF: Collector-Filterer

**Major Taxonomic Groups:**

EPT Ephemeroptera, Plecoptera, Trichoptera

**Miscellaneous**

AMPH Amphibia  
BRYO Bryozoa  
CNHY Cnidaria Hydrozoa  
CNXX Cnidaria  
NTEA Nemertea  
PISC Pisces  
PLTY Platyhelminthes  
PORI Porifera  
ROTI Rotifera  
TARD Tardigrada  
EGGS Invertebrate eggs

**Annelida**

ANHI Annelida Hirudinea  
ANOL Annelida Oligochaeta  
ANXX Annelida

**Arthropoda**

CHAR Chelicerata Arachnida  
CHXX Chelicerata  
CRAM Crustacea Amphipoda  
CRCL Crustacea Cladocera

CRCO  
CRCU  
CRIS  
CRMY  
CROS  
CRXX

**Insecta**

INCM  
INCO  
INDI  
INEP  
INHM  
INHY  
INLE  
INMG  
INOD  
INPL  
INTR  
INXX

**Mollusca**

MOBI  
MOGA  
MOXX

Crustacea Copepoda  
Crustacea Cumacea  
Crustacea Isopoda  
Crustacea Mysidacea  
Crustacea Ostracoda  
Crustacea

Insecta Collembola  
Insecta Coleoptera  
Insecta Diptera  
Insecta Ephemeroptera  
Insecta Hemiptera  
Insecta Hymenoptera  
Insecta Lepidoptera  
Insecta Megaloptera  
Insecta Odonata  
Insecta Plecoptera  
Insecta Tricoptera  
Insecta

Mollusca Bivalvia  
Mollusca Gastropoda  
Mollusca







Abundance data in long format including unique taxa codes (species richness) for Current Environmental Metro Vancouver AMF Streams, 2019.

Table with columns: Client, Project, Year, Split, Collection Screen (µm), Field Screen (µm), Lab Screen (µm), Biologica Sample ID, Client Sample ID, Replicate, Sample Date, grpcode, Phylum, Class, Order, Family, Subfamily, Tribe, Taxon, A, J, L, N, P, Deut, Raw Total, Split Multiplier, Total Abundance, Unique Taxa Count, Comments, Voltinism, Tol/Intol, Clinger, Feeding. The table contains 1000 rows of detailed abundance data for various species across different stream samples.

Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-007	1-GU	1	9-Oct-19	MOBI	Mollusca	Bivalvia	Veneroida	Pisidiidae		Pisidiidae indet.	1	5		6	4.8	29	1	LL	0	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-007	1-GU	1	9-Oct-19	MOGA	Mollusca	Gastropoda	Basommatophora	Lymnaeidae		Stagnicola sp.	1			1	4.8	5	1	Uv	T	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-007	1-GU	1	9-Oct-19	NTEA	Nemertea	Enopla	Hoploneurata	Tetrastemmatidae		Prostoma sp.	2			2	4.8	10	1	Uv	T	no	PR	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	ANOL	Annelida	Citellata				Oligochaeta indet.	186			186	2.4	446	1	Uv-Sv	0	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	CHAR	Arthropoda	Arachnida				Acari indet.	12			12	2.4	29	1	Mv	0	no	PR	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	CRAM	Arthropoda	Malacostraca	Amphipoda	Crangonyctidae		Crangonyx sp.	26			26	2.4	62	1	Uv	T	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	CRAM	Arthropoda	Malacostraca	Amphipoda			Amphipoda indet.	4			4	2.4	10		Uv	T	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	CRIS	Arthropoda	Isopoda		Asellidae		Caecidotea sp.	17			17	2.4	41	1	Uv	T	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	CRIS	Arthropoda	Malacostraca	Isopoda			Isopoda indet.	1			1	2.4	2		Uv	0	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	INDI	Arthropoda	Insecta	Diptera	Chironomidae		Chironomidae indet.		18			18	2.4	43	1	Uv-Mv	0	no	CG
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	INDI	Arthropoda	Insecta	Diptera	Simuliidae	Simuliinae	Simulium	Simulium sp.	5			5	2.4	12	1	Uv	0	yes	CF
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	INDI	Arthropoda	Insecta	Diptera	Simuliidae		Simulium indet.	7			7	2.4	17		Uv	0	yes	CF	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	INEP	Arthropoda	Insecta	Ephemeroptera	Baetidae		Baetis sp.		80			80	2.4	192	1	Uv-Mv	0	yes	CG
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	INPL	Arthropoda	Insecta	Plecoptera	Nemouridae	Nemourinae	Zapada cinctipes		13			13	2.4	31	1	LL	0	no	SH
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera	Glossosomatinae	Glossosomatinae	Glossosoma sp.	90			90	2.4	216	1	Uv	0	yes	SC	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	Cheumatopsyche sp.	2			2	2.4	5	1	Uv-Mv	T	yes	CF	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	Hydropsyche sp.	15			15	2.4	36	1	Uv-Mv	0	yes	CF	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostomatinae	Lepidostoma sp.	5			5	2.4	12	1	Uv	0	no	SH	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera			Trichoptera indet.	6			6	2.4	14		Uv	0	no	UN	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	NTEA	Nemertea	Enopla	Hoploneurata	Tetrastemmatidae		Prostoma sp.	1			1	2.4	2	1	Uv	T	no	PR	
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	PLTY	Platyhelminthes					Platyhelminthes indet.	1	1		2	2.4	5		Mv	0	no	PR	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	ANOL	Annelida	Citellata				Oligochaeta indet.	186			186	2.7	496	1	Uv-Sv	0	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	CHAR	Arthropoda	Arachnida				Acari indet.	4			4	2.7	11	1	Mv	0	no	PR	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	CRAM	Arthropoda	Malacostraca	Amphipoda	Crangonyctidae		Crangonyx sp.	36			36	2.7	96	1	Uv	T	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	CRAM	Arthropoda	Malacostraca	Amphipoda			Amphipoda indet.	11	4		15	2.7	40	1	Uv	T	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	CRIS	Arthropoda	Malacostraca	Isopoda	Asellidae		Caecidotea sp.	7			7	2.7	19	1	Uv	T	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	CRIS	Arthropoda	Malacostraca	Isopoda			Isopoda indet.	4			4	2.7	11		Uv	0	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INDI	Arthropoda	Insecta	Diptera	Chironomidae		Chironomidae indet.		14			14	2.7	37	1	Uv-Mv	0	no	CG
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INDI	Arthropoda	Insecta	Diptera	Psychodidae	Psychodinae	Simulium sp.	33	1		1	2.7	1	1	Uv	0	yes	CF	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INDI	Arthropoda	Insecta	Diptera	Simuliidae	Simuliinae	Simulium sp.	10			10	2.7	27	1	Uv	0	yes	CF	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INDI	Arthropoda	Insecta	Diptera	Simuliidae		Simulium indet.	5			5	2.7	13		Uv	0	yes	CF	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INDI	Arthropoda	Insecta	Diptera	Tipulidae	Tipulinae	Tipula sp.	1			1	2.7	3	1	LL	0	no	OM	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INEP	Arthropoda	Insecta	Ephemeroptera	Baetidae		Baetidae indet.		27			27	2.7	72		Uv-Mv	0	yes	CG
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INEP	Arthropoda	Insecta	Ephemeroptera	Baetidae		Baetis sp.		58			58	2.7	155	1	Uv-Mv	0	yes	CG
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INPL	Arthropoda	Insecta	Plecoptera	Nemouridae	Nemourinae	Zapada cinctipes		6			6	2.7	16	1	LL	0	no	SH
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera	Glossosomatidae	Glossosomatinae	Glossosoma sp.	46			46	2.7	123	1	Uv	0	yes	SC	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	Hydropsyche sp.	3			3	2.7	8	1	Uv-Mv	0	yes	CF	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostomatinae	Lepidostoma sp.	2			2	2.7	5	1	Uv	0	no	SH	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera			Ecclosomyia sp.	1			1	2.7	3	1	Uv	I	yes	OM	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila sp.	1			1	2.7	3	1	LL	I	yes	PR	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	INTR	Arthropoda	Insecta	Trichoptera			Trichoptera indet.	9	9		9	2.7	24		Uv	0	no	UN	
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	MOGA	Mollusca	Bivalvia	Veneroida	Pisidiidae		Pisidiidae indet.	9	5		14	2.7	37	1	Uv	0	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-009	1-GU	3	9-Oct-19	MOGA	Mollusca	Gastropoda	Basommatophora	Lymnaeidae		Lymnaea indet.	1			1	2.7	3	1	Uv	T	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	ANOL	Annelida	Citellata				Oligochaeta indet.	297			297	6.9	2,037	1	Uv-Sv	0	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	CHAR	Arthropoda	Arachnida				Acari indet.	3		1	4	6.9	27	1	Mv	0	no	PR	
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	CRAM	Arthropoda	Malacostraca	Amphipoda	Crangonyctidae		Crangonyx sp.	2			2	6.9	14	1	Uv	T	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	CRAM	Arthropoda	Malacostraca	Amphipoda			Amphipoda indet.	1			1	6.9	7		Uv	T	no	CG	
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	INCO	Arthropoda	Insecta	Coleoptera	Elmidae	Elminae	Heterimnius sp.		20			20	6.9	137	1	LL	0	yes	CG
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	INCO	Arthropoda	Insecta	Coleoptera	Elmidae		Elmidae indet.	1	7			8	6.9	55		LL	0	yes	CG
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	INDI	Arthropoda	Insecta	Diptera	Chironomidae		Chironomidae indet.		8			8	6.9	55	1	Uv-Mv	0	no	CG
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	INEP	Arthropoda	Insecta	Ephemeroptera			Ephemeroptera indet.		2			2	6.9	14	1	UN	0	no	UN
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	INPL	Arthropoda	Insecta	Plecoptera	Chloroperlidae	Chloroperlinae	Swetla sp.		2			2	6.9	14	1	LL	0	no	PR
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	INPL	Arthropoda	Insecta	Plecoptera	Nemouridae	Nemourinae	Zapada cinctipes		2			2	6.9	14	1	LL	0	no	SH
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	INTR	Arthropoda	Insecta	Trichoptera	Glossosomatidae	Glossosomatinae	Glossosoma sp.	26			26	6.9	178	1	Uv	0	yes	SC	
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	INTR	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	Hydropsyche sp.	6			6	6.9	41	1	Uv-Mv	0	yes	CF	
Current Environmental	Metro Vancouver AMF Streams</																												





Incidental (memo) taxa not included in BIBI calculations for Current Environmental Metro Vancouver AMF Streams, 2019.

Client	Project	Year	Split	Collection Screen (µm)	Field Screen (µm)	Lab Screen (µm)	Biologica Sample ID	Client Sample ID	Replicate	Sample Date	grpcode	Taxon	A	J	L	N	P	Deut	Raw Total	Split Multiplier	Total Abundance	Comment
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-001	1-BC	1	9-Oct-19	MEMO	Acari indet.	15						15	12.00	180	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-001	1-BC	1	9-Oct-19	MEMO	Chironomidae indet.					2		2	12.00	24	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-001	1-BC	1	9-Oct-19	MEMO	Nematoda indet.	2						2	12.00	24	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-002	1-BC	2	9-Oct-19	MEMO	Chironomidae indet.					4		4	12.00	48	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-002	1-BC	2	9-Oct-19	MEMO	Copepoda indet.	1						1	12.00	12	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-002	1-BC	2	9-Oct-19	MEMO	Egg/egg mass	37						37	12.00	444	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-002	1-BC	2	9-Oct-19	MEMO	Hypogastruridae indet.	1						1	12.00	12	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-002	1-BC	2	9-Oct-19	MEMO	Insecta indet.	1						1	12.00	12	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-002	1-BC	2	9-Oct-19	MEMO	Nematoda indet.	6						6	12.00	72	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-002	1-BC	2	9-Oct-19	MEMO	Ostracoda indet.	1						1	12.00	12	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	1/12	500	335	250	19-041-002	1-BC	2	9-Oct-19	MEMO	Philopotamidae indet.					1		1	12.00	12	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-003	1-BC	3	9-Oct-19	MEMO	Copepoda indet.	1						1	4.80	5	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-003	1-BC	3	9-Oct-19	MEMO	Curculionidae indet.	1						1	4.80	5	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-003	1-BC	3	9-Oct-19	MEMO	Egg/egg mass	17						17	4.80	82	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-003	1-BC	3	9-Oct-19	MEMO	Insecta indet.					1		1	4.80	5	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-003	1-BC	3	9-Oct-19	MEMO	Insecta indet.	3						3	4.80	14	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-003	1-BC	3	9-Oct-19	MEMO	Staphylinidae indet.	1						1	4.80	5	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	15/24	500	335	250	19-041-004	1-CR	1	1-Oct-19	MEMO	Acari indet.	3						3	1.60	5	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	15/24	500	335	250	19-041-004	1-CR	1	1-Oct-19	MEMO	Egg/egg mass	7						7	1.60	11	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	15/24	500	335	250	19-041-004	1-CR	1	1-Oct-19	MEMO	Insecta indet.					1		1	1.60	2	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	15/24	500	335	250	19-041-004	1-CR	1	1-Oct-19	MEMO	Nematoda indet.	86						86	1.60	138	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-005	1-CR	2	1-Oct-19	MEMO	Acari indet.	2						2	1.00	2	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-005	1-CR	2	1-Oct-19	MEMO	Acari indet.	3						3	1.00	3	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-005	1-CR	2	1-Oct-19	MEMO	Insecta indet.	1						1	1.00	1	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-005	1-CR	2	1-Oct-19	MEMO	Insecta indet.	2						2	1.00	2	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-005	1-CR	2	1-Oct-19	MEMO	Nematoda indet.	2						2	1.00	2	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-005	1-CR	2	1-Oct-19	INLE	Noctuidae indet.			1				1	1.00	1	Not included in BIBI, damaged
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-006	1-CR	3	1-Oct-19	MEMO	Curculionidae indet.	1						1	1.00	1	Not included in BIBI, damaged
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-006	1-CR	3	1-Oct-19	MEMO	Egg/egg mass	30						30	1.00	30	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-006	1-CR	3	1-Oct-19	MEMO	Insecta indet.	1						1	1.00	1	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-006	1-CR	3	1-Oct-19	MEMO	Ostracoda indet.	2						2	1.00	2	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-007	1-GU	1	9-Oct-19	MEMO	Chironomidae indet.					6		6	4.80	29	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-007	1-GU	1	9-Oct-19	MEMO	Egg/egg mass	12						12	4.80	58	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-007	1-GU	1	9-Oct-19	MEMO	Insecta indet.	1						1	4.80	5	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-007	1-GU	1	9-Oct-19	MEMO	Nematoda indet.	5						5	4.80	24	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/24	500	335	250	19-041-007	1-GU	1	9-Oct-19	MEMO	Simulium sp.					4		4	4.80	19	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	MEMO	Chironomidae indet.					2		2	2.40	5	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	MEMO	Glossosoma sp.					2		2	2.40	5	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	MEMO	Insecta indet.			1				1	2.40	2	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	MEMO	Insecta indet.	1						1	2.40	2	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	MEMO	Insecta indet.	5						5	2.40	12	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	MEMO	Nematoda indet.	1						1	2.40	2	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	MEMO	Simulium sp.					2		2	2.40	5	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-008	1-GU	2	9-Oct-19	MEMO	Trichoptera indet.					4		4	2.40	10	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	MEMO	Chironomidae indet.					2		2	2.67	5	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	MEMO	Egg/egg mass	2						2	2.67	5	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	MEMO	Insecta indet.	1						1	2.67	3	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	MEMO	Insecta indet.	1						1	2.67	3	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	MEMO	Simulium sp.					2		2	2.67	5	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	9/24	500	335	250	19-041-009	1-GU	3	9-Oct-19	MEMO	Trichoptera indet.					2		2	2.67	5	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	MEMO	Egg/egg mass	2						2	6.86	14	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	MEMO	Insecta indet.					1		1	6.86	7	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	MEMO	Nematoda indet.	2						2	6.86	14	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-010	1-MC	1	25-Sep-19	MEMO	Trichoptera indet.					1		1	6.86	7	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-011	1-MC	2	25-Sep-19	MEMO	Acari indet.	1						1	1.00	1	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-011	1-MC	2	25-Sep-19	MEMO	Chironomidae indet.					1		1	1.00	1	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-011	1-MC	2	25-Sep-19	MEMO	Insecta indet.	4						4	1.00	4	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-011	1-MC	2	25-Sep-19	MEMO	Isotomidae indet.	2						2	1.00	2	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	Whole	500	335	250	19-041-011	1-MC	2	25-Sep-19	MEMO	Nematoda indet.	1						1	1.00	1	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	13/24	500	335	250	19-041-012	1-MC	3	25-Sep-19	MEMO	Chironomidae indet.					1		1	1.85	2	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	13/24	500	335	250	19-041-012	1-MC	3	25-Sep-19	MEMO	Trichoptera indet.					1		1	1.85	2	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-013	1-PC	1	1-Oct-19	MEMO	Chironomidae indet.					1		1	6.86	7	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-013	1-PC	1	1-Oct-19	MEMO	Copepoda indet.	13						13	6.86	89	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-013	1-PC	1	1-Oct-19	MEMO	Egg/egg mass	8						8	6.86	55	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-013	1-PC	1	1-Oct-19	MEMO	Isotomidae indet.	1						1	6.86	7	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-013	1-PC	1	1-Oct-19	MEMO	Nematoda indet.	32						32	6.86	219	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/12	500	335	250	19-041-014	1-PC	2	1-Oct-19	MEMO	Nematoda indet.	2						2	2.40	5	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/48	500	335	250	19-041-015	1-PC	3													

Current Environmental	Metro Vancouver AMF Streams	2019	5/48	500	335	250	19-041-016	1-PR	1	1-Oct-19	MEMO	Insecta indet.	1		1	9.60	10	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	5/48	500	335	250	19-041-016	1-PR	1	1-Oct-19	MEMO	Ostracoda indet.	5		5	9.60	48	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	2/3	500	335	250	19-041-017	1-PR	2	1-Oct-19	MEMO	Chironomidae indet.		1	1	1.50	2	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	2/3	500	335	250	19-041-017	1-PR	2	1-Oct-19	MEMO	Collembola indet.	1		1	1.50	2	Not included in BIBI, damaged
Current Environmental	Metro Vancouver AMF Streams	2019	2/3	500	335	250	19-041-017	1-PR	2	1-Oct-19	MEMO	Diptera indet.		1	1	1.50	2	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	2/3	500	335	250	19-041-017	1-PR	2	1-Oct-19	MEMO	Gastropoda indet.	1	1	1	1.50	2	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	2/3	500	335	250	19-041-017	1-PR	2	1-Oct-19	MEMO	Ostracoda indet.	1		1	1.50	2	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	2/3	500	335	250	19-041-017	1-PR	2	1-Oct-19	MEMO	Trichoptera indet.		1	1	1.50	2	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/24	500	335	250	19-041-018	1-PR	3	1-Oct-19	MEMO	Chironomidae indet.		9	9	3.43	31	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/24	500	335	250	19-041-018	1-PR	3	1-Oct-19	MEMO	Egg/egg mass	1		1	3.43	3	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/24	500	335	250	19-041-018	1-PR	3	1-Oct-19	MEMO	Glossosomatidae indet.		1	1	3.43	3	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/24	500	335	250	19-041-018	1-PR	3	1-Oct-19	MEMO	Hydroptilidae indet.		1	1	3.43	3	Pupae not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/24	500	335	250	19-041-018	1-PR	3	1-Oct-19	MEMO	Insecta indet.	2		2	3.43	7	Terrestrial - not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/24	500	335	250	19-041-018	1-PR	3	1-Oct-19	MEMO	Nematoda indet.	2		2	3.43	7	Not included in BIBI
Current Environmental	Metro Vancouver AMF Streams	2019	7/24	500	335	250	19-041-018	1-PR	3	1-Oct-19	MEMO	Ostracoda indet.	11		11	3.43	38	Not included in BIBI