DATA REPORT

Water Quality and Stream Invertebrate Assessment

for the C.W. Young Channel, Englishman River, BC

(Fall 2014)

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RMOT 306 (Environmental Monitoring)

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Executive Summary

This report examines the current status of water quality and invertebrate ecosystem health of the C.W. Young Channel located within the Englishman River Regional Park, BC. Although just over four kilometers in length, this small, but vital salmonid rearing habitat is credited with 42% of coho salmon smolt production in the Englishman River watershed, and thus contributes significantly to an important fishery. The channel also feeds into the drinking water source of over 30 thousand residents of the neighbouring town of Parksville, BC. It is therefore vitally important to maintain a rigorous assessment regime that is able to reflect long term trends in water quality and ecosystem health, as well as highlight the possibility of transient pollution events that may have occurred since the last report. Four Vancouver Island University students enrolled in the Bachelor of Natural Resource Protection program conducted the fieldwork, analysis and report compilation, under the supervision of Dr. Eric Demers in pursuit of this endeavour. Results from this most recent survey show that the C.W Young channel continues to flourish. The most obvious indicator is the presence of spawning salmon, but more rigorous analysis reveals strong invertebrate ecosystem health and good overall water quality. In almost all parameters, the channel meets strict provincial guidelines, but where certain parameters have not been met, such as aluminum levels, these have been documented by Ministry of Environment staff in other technical reports and attributed to normal background levels consistent with the geology in the area.

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1. Introduction

1.1 Project Overview

Continuing a series of annual water quality and invertebrate ecosystem assessments carried out on the Englishman River (predominantly the C.W. Young Channel), this report highlights the current status of this important salmonid rearing habitat. Under the supervision of Dr. Eric Demers, four Vancouver Island University (VIU) students conducted the field sampling during two events on October 27 and November 17, 2014. These dates were chosen in an effort to collect samples during both a low-flow (normally late October) and a high-flow (normally mid-November) period. Unusually, the water flows recorded for the two events were in opposition to the levels expected. This anomaly was a result of high rainfall just prior to the initial sampling event, coupled with zero rainfall in the days preceding the second sampling event. Despite this anomaly, the two flow levels met the sampling requirements adequately. Water quality testing and stream invertebrate sampling has occurred on the C.W. Young Channel since 2008, and as such, data collected from this year's work provides continuity and the opportunity for trend analysis. As well as providing an overview of water quality and freshwater invertebrate health, the information collected from this project provides a short and long term assessment of actual and potential environmental impacts, potentially associated with agriculture, development and land use in the surrounding watershed.

1.2 Historical Review

The Englishman River and C.W. Young Channel are located on the Eastern side of Vancouver Island, southwest of Parksville, BC. From headwaters in the alpine lakes of Mount Arrowsmith (1,819 m), the Englishman River flows in a northeasterly direction before discharging into the Strait of Georgia just north of Craig Bay. With a total length of nearly 40 km, the Englishman River drains a watershed area of about 324 km^2 (Decker et al. 2003). There are four main tributaries contributing to the total flow of the Englishman River: the South Englishman River, Morison Creek, Shelley Creek and Centre Creek. The Englishman River Falls, located 16 km upstream from the mouth, creates a barrier for all fish. The lower 10 km of the Englishman River is represented by low stream gradient (<2%). The importance of side-channel habitats in providing refuge from adverse conditions in mainstream habitats during winter has been widely accepted (Cunjak 1996). Beginning in the early 1980's, Hurst (1988) suggests that concerns for the declining return of coho salmon (*Oncorhynchus kisutch*) to the Englishman River started garnering more attention. Under the direction of the Department of Fisheries and Oceans (DFO), construction of the C.W. Young Channel (previously referred to as the TimberWest channel) began in 1992 (with a 2.9km extension added in 2007) to provide spawning, rearing and overwintering habitat primarily for coho salmon (Decker et al. 2003). This side channel, located 7 km upstream from the estuary on the north bank and running approximately 5.2 km long, was created to mimic a low gradient (0.5%) stream. Today, the C.W. Young Channel is incredibly productive, responsible for 42% of the Englishman River coho smolt population (PFLA 2014).

1.3 Potential Environmental Concerns

Agriculture, forestry and domestic septic installations are potential sources of pollution in the Englishman River watershed. Reduced forest cover and extensive road building from rapid commercial, residential and industrial (logging) growth in the Englishman River watershed have all led to slope instability (Decker et al. 2003). Barlak et al (2010) also catalogue a variety of other concerns, which include high sediment loading from peat bog tilling, nutrients from lawn fertilizers and the urbanization trend in the lower reaches of the river. These activities, as well as natural erosion and the presence of wildlife could all potentially affect water quality in the Englishman River.

2. Project Objectives

The primary project objective was to document current environmental conditions and the overall health of the Englishman River (primarily the C.W. Young Channel). A secondary, but nonetheless vital component was to compare these results with previous years data (2008-2013) and continue to add value to the long-term study of the river and channel.

3. Methods

3.1 Sampling Locations and Habitat Characteristics

Site one is located at the outflow pipe at the headwaters of the channel (UTM 10 U 0405267 m E, 5459846 m N) (Figure 1). Sampling took place 1 metre downstream of the steel pipe. This reach has a shallow gradient of <1°. The substrate at this location consists of predominantly coarse gravel (90%) with fines and silt (10%). The sparse (<10%) canopy is comprised of alder (*Alnus rubra*) and big leaf maple (*Acer macrophyllum*). Riparian vegetation consists of various grasses and alder on the east bank and maple on the west bank.

Site two is found 1.25km downstream where the access road crosses the channel (UTM 10 U 0406143 m E, 5459962 m N). The sample site is 3m downstream of the culvert pipe. This reach has a similar gradient to site one, but has a more pronounced riffle. The substrate is comprised of coarse gravel (40%), cobble (20%), boulders (20%), and large woody debris (10%), with the remainder consisting of sand and silt (10%). The canopy is thicker (~35%) than site one and features Douglas fir (*Pseudotsuga menziesii*) and western red cedar (*Thuja plicata*). The riparian understory vegetation is mostly salal (*Gaultheria shallon*).

Site three is located 2.9km downstream from Site one and can be found 50m west of the access road at (UTM 10U 0407089 m E, 5460663 m N). The sample location is mid channel, 4m downstream of the bend in the watercourse. This reach is characterized by very low gradient and consequent slow flow, adjacent wetland / meadow area and sparse canopy (<5%) comprised of maple and cedar. The substrate consists of coarse gravel (30%) large woody debris (20%), small woody debris (10%), Cobble (20%) and fines / silt (20%).

Site four is located 3.8km downstream from Site one (UTM 10U 0407495 m E, 5461056 m N). The sampling point is 3m upstream of the steel footbridge. Just below the sampling point the gradient is higher than all the other sites (~4°) and forms a cascade. The canopy cover is moderate (~30%) and consists of maple and Douglas fir. The substrate is composed of large cobble (50%), boulders (15%), coarse gravel (20%) and fines / silt (15%). There is minimal erosion on the banks due to large boulder placements. The riparian understory consists of salmonberry (*Rubus spectabilis*) and sword fern (*Polystichum munitum*).

Site five is located on the Englishman River main stem, just downstream of the C.W Young outflow (UTM 10U 0407805 m E, 5461177 m N). There is no canopy coverage in the centre of the channel, although there are mature maples on the east bank and a mix of willow (*Salix spp.*) and alder on the west bank. The substrate consists of Boulder (5%), Cobble (75%) sand (5%) and fines / coarse gravel (15%).

Figure 1. Assessment site locations along the C.W. Young channel (Google Earth, 2014)

3.2 Sampling Frequency

Two sets of field samples were collected over the timespan of the project. Set sample dates had been coordinated with fellow classmates, along with the availability of equipment. Predetermined sampling activities took place over each of the two sample events (Table 1). October 27 and November 17 were chosen as the sampling dates. For each of the five site stations, water and microbiology samples were taken. Stream invertebrate samples were taken from three sites. For safety reasons, due to historical weather patterns, which could potentially cause high flow, microbiology and invertebrate samples were only taken during the first sample. At each site, photographs were taken to document the associated environmental conditions and water levels at each site.

Table 1. Water quality and stream invertebrate sampling taken during October (A) and November (B) sampling events.

Water Quality Schedule					
Station	Field measurements	VIU Analyses	ALS Lab Analyses (X3)	Microbiology	Stream Invertebrates
1	A, B	A, B	A, B	A	A
2	A, B	A, B	A, B	A	---
3	A, B	A, B	---	A	A
4	A, B	A, B	A, B	A	A
5	A, B	A, B	---	A	---

3.3 Basic Hydrology and Environment

At each of the five sampling sites the following data was gathered: bankfull width, wetted width, velocity, and water depth. From these data a calculation of discharge was performed. To supplement hydrology parameters, crown canopy, percent cover, dominant cover, substrate proportion percentages were taken and documented along with disturbance indicators to assess the overall health of the habitat within each site.

3.4 Water Quality

3.4.1 Field Measurements

Water quality parameters were measured using a YSI 556 MPS electronic probe. At each site water temperature (+/- 0.01 °C) and dissolved oxygen (+/- 0.01 mg/L) data were gathered. In order to obtain an accurate reading, the YSI probe was immersed in a representative, medium flow area at each of the five sites. To ensure further accuracy, the probe was allowed to acclimatize underwater until readings were stable before any parameters were recorded.

3.4.2 Water Sample Collection

The two sampling events were scheduled using historic rainfall data in an attempt to represent low flow (late October), and high flow (mid November) conditions in the Englishman River side channel. Interestingly, the first sampling event captured high flow, while the second sampling event captured lower flow conditions. Despite this reversal in schedule, the overall aim of monitoring water quality during different flow conditions was nonetheless achieved. Each water-sampling event consisted of taking two sets of samples at each station. One set for VIU lab analysis, and another set for ALS[1] analysis.

Sampling methods included taking water samples from a downstream point within each site and subsequent samples from successive upstream positions to minimize contamination between samples. Within each site, water samples were taken mid-stream within laminar flow to ensure no surface water contamination. The sampler wore nitrile gloves, and rinsed sample bottles three times to prevent any contamination. The water samples were collected in sterilized sample bottles (Table 2).

[1] Australian Laboratory Services, located in Burnaby, BC

During transportation from the field to the lab, samples were held in a cooler containing icepacks for preservation. Samples were then placed in a refrigerator until tested in the VIU lab. ALS samples were handled in the same manner.

Table 2. Sampling containers and preservatives used for water quality samples on October 27 and November 17, 2014.

Analytical Parameters	Container	Preservative	Analysis
Total hardness, alkalinity, total suspended solids, reactive phosphorus, nitrate	500 mL plastic	N/A	VIU
Conductivity, pH, total hardness, total suspended solids	1 L plastic	N/A	ALS
Nutrients	250 mL amber glass	Sulphuric acid	ALS
Total metals	250 mL plastic	Nitric acid	ALS

3.4.3 VIU Laboratory Analyses

The VIU (Nanaimo campus) laboratory was used to conduct water quality and invertebrate analyses. The samples taken from all five sites were transported to VIU and analyzed two days after sampling events. Water quality was tested for total hardness (mg/L as $CACO_3$) using a HACH HA-71A test kit. Total Alkalinity was tested (mg/L as $CACO_3$) using a HACK AL-DT titration method. Turbidity was tested (NTUs), reactive phosphorus (mg/L PO_4^{3-}) and nitrate (mg/L NO_3^-) was tested using a HACH DR2800 spectrophotometer. Conductivity (µS/cm) and pH (pH unit) results were obtained by using a designated electronic meter.

3.4.4 ALS Laboratory Analyses

Water samples from sites one, two and four were shipped to ALS Laboratories. Samples were shipped two days after sample events in a cooler containing icepacks for preservation. ALS Laboratories received the samples within three days of the initial sample time. The analyzed parameters included conductivity, hardness, pH, six anions, nutrients, and total metals (31 metals). Sulphuric acid was added to the anion and nutrient samples. Nitric acid was added to the total metal sample. The additives were used to preserve samples during transportation. These samples were collected in a 250 mL glass amber bottle and a 250 mL plastic bottle. The samples were inverted five times to ensure proper mixture of the additives.

3.4.5 Quality Assurance / Quality Control

To ensure accurate results, samples were taken in the same location within each site for each sample event. For consistency, the sample sites remained the same as those sites that were sampled during previous study years (2008-2013).

For each sampling event, a minimum of one trip blank and one field replicate was taken to ensure quality control. The trip blank was first prepared at the VIU lab, and contained distilled water. The field replicate was taken at Site four. The trip and field replicates were analyzed at VIU to ensure no contamination of the samples had occurred, in order to reproduce results.

3.4.6 Data Analyses, Comparison to Guidelines

The data analyzed from VIU and ALS Laboratories was compiled and referenced to the Provincial water quality guidelines requirements for freshwater aquatic organisms (RISC 1998). Results showed whether the water guidelines were being met or were outside prescribed parameters to support aquatic life.

3.5 Stream Invertebrates

3.5.1 Invertebrate Sample Collection

Sites one, three and four were sampled for stream invertebrates and care taken to ensure that different habitat types were taken into account. A Hess Sampler was used to collect the invertebrate samples. For each sample, the substrate within the Hess Sampler was disturbed for one minute to ensure all invertebrates were captured at the cod end. For quality control and assurance, four replicate samples were taken at each site. This ensured an accurate and representative sample per site. Habitat specific (adequate velocity and substrate) sample sites were chosen moving from downstream to upstream, to ensure sites weren't disturbed prior to sampling. The samples were transported in a sterile pre-labeled plastic container, with water to keep samples alive for lab analysis purposes.

3.5.2 Data Analyses

The invertebrates were identified and categorized to taxonomic order and pollution tolerance competence. This was achieved by pouring the samples into a shallow tray, separating individuals using obvious distinguishing characteristics, then counting numbers of like individuals within each taxon using a dissecting microscope. All the data for each site was recorded onto individual invertebrate survey field data sheets to determine the predominant taxon, overall abundance and density, water quality assessment, diversity assessment and the overall site assessment rating. The 'Shannon-Weiner Index' was used to calculate overall diversity of the stream for each site. These processes followed the 'Pacific Stream Keepers' procedures to facilitate quality assurance.

4. Results and Discussion

4.1 General Field Conditions

Our first sampling event occurred on October 27, 2014. Although water flow in the C.W. Young Channel is regulated, flow in the main channel of the Englishman River on this day was high. This can be attributed to heavy rainfall in the days leading up to this sampling event. We suspect that this increased rainfall, which caused an increased in water velocity, had an impact on several on our test results (conductivity, dissolved oxygen, turbidity). During our second sampling session, on November 17, 2014, water discharge in the river was significantly lower (than the first session). This was a result of minimal rainfall in the days leading up to this session. Therefore, theoretically our high-flow sampling event was in October, while the low-flow event proceeded in November.

4.2 Water Quality

4.2.1 Field Measurements

Parameters measured in the field included water temperature (^{o}C) and dissolved oxygen (DO) (mg/L). These measurements were taken at every site during both sampling events (Figure 1).

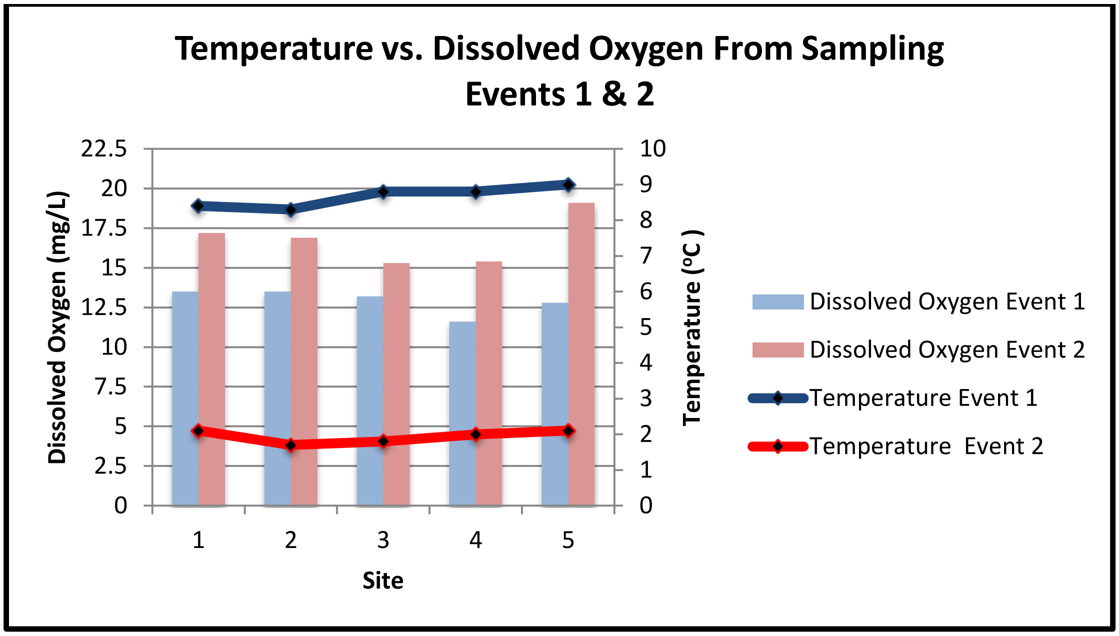

Figure 2. Temperature (°C) and dissolved oxygen (mg/L) results, obtained from sampling events one & two (October 27 and November 17, 2014, respectively) on the C.W. Young Channel and Englishman River.

Although cold water can hold more oxygen than warm water, our DO results from our second sampling event were much higher than anticipated. Suspecting that there may have been a calibration issue with our probe, we returned the next day with a different probe to retake these measurements; however, results remained the same. We suspect these high DO readings may be a result of less respiration required by organisms used for decomposition. According to the BC Water Quality Guidelines, all DO measurements from both events fall above the minimum limit, of 9.0 mg/L, to support aquatic life (RISC 1998).

Temperature dropped between sampling events one and two by an average of 6.64 °C. This drop in water temperature was a direct result of decreasing ambient air temperatures and solar radiation from reduced daylight hours (RISC 1998).

Flow discharge was calculated from hydrology measurements taken in the field at sites one and three during both sampling events. These measurements provided an accurate representation of the cross-sectional area of the channel at each location which, when multiplied by the average velocity in that reach, produced an indication of discharge (m^3 /s). Interestingly, the flow levels of the Englishman River main stem, when compared with the C.W. Young Channel, appeared to reflect no correlation. This observation is attributed to the sluice valve control and engineering of the intake pipe which draws water into the channel. It is worth noting however, that the huge differences in flow levels experienced in the main stem of the Englishman River (2-400 m^3 / s) still affect other water quality parameters in the channel, and it is prudent therefore, to consider the main river flow when qualifying results.

4.2.2 VIU Laboratory Analyses

Parameters measured in the VIU lab included conductivity, hardness (as $CaCO_3$), pH, turbidity, alkalinity (as $CaCO_3$), phosphate (PO_4^{3-}) and nitrate levels (Table 3). All VIU lab measurements were taken within 48 hours of gathering water samples from the field.

Table 3. All parameters measured in the VIU lab on October 29 and November 19, 2014.

Site	Conductivity (µS/cm)	Hardness ($CaCO_3$) (mg/L)	pH	Turbidity (NTU)	Alkalinity ($CaCO_3$) (mg/L)	Phosphate (PO_4^{3-}) (mg/L)	Nitrate (NO_{3-}) (mg/L)
			Sampling Event 1 (October 27, 2014)				
1	33	20	7.53	4.4	14.9	0.05	0.04
2	35	20	7.43	3.56	15.1	0.08	0.04
3	35	21	7.36	4.99	15.2	0.06	0.05
4	48	25	7.3	6.32	19.7	0.09	0.01
5	49	27	7.3	3.58	19.8	0.07	0.05
Replicate	48	25	7.25	4.13	20.0	0.07	0.04
			Sampling Event 2 (November 17, 2014)				
1	59	41	7.61	1.24	18.3	0.12	0.06
2	56	33	7.57	.8	19.6	0.04	0.04
3	55	32	7.61	.71	18.4	0.05	0.07
4	63	31	7.5	.98	27.7	0.12	0.07
5	63	29	7.49	1.86	23.6	0.1	0.04
Replicate	63	31	7.55	1.19	22.3	0.11	0.08

Mean pH levels remained very similar between sampling events one and two (7.38 and 7.56, respectively). These levels fall within the 6.5-9 pH parameters required to support aquatic life.

Conductivity levels increased from a mean of 40 to 59.2 µSiemens/cm, between the first and second sampling events. This was a result of increased flow/higher water levels during the first event. This decrease in water turbulence (during the second sampling event) resulted in a more concentrated water flow (increasing the amount of available ions) resulting in higher conductivity levels. With increased conductivity levels between the two sampling events, we anticipated to see an increase in hardness and alkalinity. Hardness (as $CaCO_3$) increased by an average of 10.6 mg/L between sampling events one and two. However, results from both sampling events fell within the RISC (1998) guidelines for softwater (0-60 mg/L). Based on these results, the metallic concentrations of the C.W. Young Channel should be closely monitored, as metal bioavailability, and thus toxicity, are higher in softwater conditions. Similar to conductivity and hardness results, alkalinity (as $CaCO_3$) increased between sampling events one and two by an average of 4.58 mg/L. Total alkalinity for the first sampling event averaged 16.94 mg/L resulting in a classification of moderate acid sensitivity, while the second event yielded an average of 21.52 mg/L, resulting in a classification of low acid sensitivity (RISC 1998). During both sampling events, alkalinity levels in the C.W Young Channel (sites one to four) were generally lower than levels in the main channel of the Englishman River (site five). This can be attributed to higher Calcium and magnesium levels in the main channel, from increased mineral weathering upstream.

In conjunction with the higher water levels, turbidity levels were higher during the first sampling events by an average of 3.2 NTU. The increased discharge observed at the first sampling event was responsible for increased turbidity results by disrupting sedimentation in the river. Turbidity levels were still well within the BC Water Quality Guidelines, and posed no threat to aquatic life.

Phosphate (PO_4^{3-}) and nitrate (NO_3^-) nutrient levels remained similar to those results from years past. Both phosphate and nitrate levels fell within the BC Water Quality Guidelines (RISC 1998). During both sampling events, site four had the highest phosphate levels. This increase in nutrient enrichment was reflected in our invertebrate sampling, where site four had the highest diversity of invertebrates.

All sites in the C.W. Young Channel and Englishman River were tested for the presence of coliform bacteria (Table 4). All sites contained some fecal bacteria, with the highest level observed at site two. We suspect site two had the highest fecal coliform count based on its location; located directly down stream from an open wetland, which is potentially frequented by wildlife. The increase of wildlife in the area would result in increased fecal matter deposited in the channel.

Table 4. Total coliform and fecal coliform counts from water samples taken in the C.W. Young Channel and Englishman River on October 27, 2014. All numbers are expressed as number of bacterial Colony Forming Units per 100 mL.

Site	Total Coliform	Fecal Coliform	% Fecal Coliform
1	432	12	2.78%
2	688	64	9.3%
3	3216	60	1.87%
4	2240	56	2.5%
5	3216	76	2.36%
Replicate	2120	44	2.08%

4.2.3 ALS Laboratory Analyses

Water samples from sites one, two and four were shipped to ALS Laboratories in Burnaby, British Columbia after each sampling event for physical tests (conductivity, hardness and pH), anions/nutrient tests, as well as total metallic presence (Appendix 2). With the exception of conductivity and dissolved orthophosphate (as P), results from the physical and nutrient tests conducted by ALS were consistent with the results obtained from the same tests conducted at VIU (Table 5). Although the relative differences in levels of phosphate measured are very large (VIU results are 25-35 times higher than ALS); the very low absolute levels involved (<0.12 mg/L) appear to be below the accurate range of the *Hach* testing kit at VIU. Indeed, the distilled water in the trip blanks indicated similar levels of PO_4^{3-} when measured with this kit. As a result of this lack of confidence in the Hach kit (examination of previous report data corroborates the idea that this is a systematic error), it is suggested that the ALS results alone be considered when determining phosphate levels in this channel. In considering the impact of this discrepancy, it is worth noting that total phosphate (as P) is very low. With the exception of site four (November sampling event, 0.219 mg/L), The ALS results are significantly under the RISC (1998) oligotrophic threshold (<0.010 mg/L).

Table 5. ALS and VIU physical test results from both sampling events.

Site	Conductivity (µS/cm)	Hardness ($CaCO_3$) (mg/L)	pH	Nitrate (NO_{3-}) (mg/L)	Orthophosphate-Dissolved (as P) (PO_4^{3-}) (mg/L)
Sampling Event 1 (October 27, 2014)					
Site 1:					
ALS Results:	44.4	17.8	7.41	0.0711	0.0014
VIU Results:	33.0	20.0	7.53	0.04	0.05
Difference:	11.4	2.2	0.12	0.031	0.0486
Site 2:					
ALS Results:	44.4	18.0	7.35	0.0720	0.0026
VIU Results:	35.0	20.0	7.43	0.04	0.08
Difference:	9.4	2.0	0.08	0.032	0.0774
Site 4:					
ALS Results:	60.3	24.2	7.44	0.139	0.0036
VIU Results:	48.0	25.0	7.3	0.01	0.09
Difference:	12.3	0.8	0.14	0.129	0.0864
Sampling Event 2 (November 17, 2014)					
Site 1:					
ALS Results:	71.5	26.2	7.59	0.0528	<0.001
VIU Results:	59.0	41.0	7.61	0.06	0.12
Difference:	12.5	14.8	0.02	0.0072	0.119
Site 2:					
ALS Results:	67.9	25.9	7.12	0.0508	0.0024
VIU Results:	56.0	33.0	7.57	0.04	0.04
Difference:	11.9	7.1	0.45	0.0108	0.0376
Site 4:					
ALS Results:	79.1	30.4	7.5	0.0813	0.005
VIU Results:	63.0	31.0	7.5	0.07	0.12
Difference:	16.1	0.6	0	0.0113	0.115

With the exception of aluminum (AL), all total metal concentrations were below the applicable water quality guidelines during the first sampling event (Appendix 2). When measuring total metal concentration, ALS measures the combined amount of metals dissolved in water, plus the amount bound to particles. It is unclear whether the high aluminum readings during sampling event one represent dissolved metals or those metals bound to particles. We suspect that the high readings are a reflection of the rich geologic composition of the Englishman River watershed.

4.2.4 Quality Assurance / Quality Control

To facilitate quality assurance, a trip blank filled with distilled water was carried with all collected samples from the field to the laboratory during both sampling events. Each trip blank was tested for phosphate and nitrate (Table 6). These results were very similar to the phosphate and nitrate results obtained in the VIU lab for site one through five, suggesting that the nutrient (phosphate and nitrate) quality of water from sites one through five was near that of distilled water. To ensure quality control, a replicate sample was taken from the channel during each sampling event.

Table 6. Trip blank, nitrate and phosphate results from both sampling events.

Trip Blank	Nitrate (mg/L)	Orthophosphate- Dissolved (as P) (mg/L)
October 27, 2014	0.07	0.09
November 17, 2014	0.06	0.09

4.3 Stream Invertebrate Communities

A total of 228 stream invertebrates representing ten broad taxonomic groups were counted at three stations on the C.W. Young Channel on October 27, 2014 (Table 7). The samples were taken during the high flow session, cognisant in hindsight that this could be a variable that affected the number of invertebrates counted.

Table 7. Abundance and density of stream invertebrates obtained from quadruple samples taken on October 27, 2014 at three stations on the C.W. Young Channel. Overall site assessment ratings are also provided for each station (out of a maximum rating of 4.00). Invertebrate Survey Field Data Sheets are included in Appendix 3.

Pollution Tolerance	Invertebrate Taxa	Site 1	Site 3	Site 4
Category 1 Pollution Intolerant	Caddisfly	6	0	0
	Mayfly Nymph	33	63	8
	Stonefly Nymph	9	15	1
Category 2 Somewhat Pollution Tolerant	Aquatic Sowbug	0	0	3
	Cranefly Larva	12	10	0
	Dragonfly Larva	0	1	0
	Amphipod	0	7	3
Category 3 Pollution Tolerant	Aquatic Worm	32	1	2
	Leech	0	2	0
	Midge Larva	5	1	4
	Planarian	0	0	1
	Pond Snails	0	0	3
	Water Mite	6	0	0
	Total Abundance	103	100	25
	Density (#/m2) Site	286.11	277.77	69.44
	Assesment Rating	3.25	3	2.5

4.3.1 Taxon Richness and Diversity

Site assessment ratings ranged from 2.5 - 3.5 indicating "acceptable" to "good" invertebrate community abundance and diversity (RISC 1998). Pollution intolerant mayfly nymphs were the predominant taxon in all the sites sampled. Of note, mayfly nymph densities are consistent with previous years' results, which have remained largely constant since surveying began in 2008. This is an encouraging observation and indicates that pollution levels in the channel have remained low (pollution intolerant species such as mayflies exhibit low or zero population counts if even temporary spikes in pollution have occurred). After calculating each site's Shannon-Weiner Diversity Index, it was concluded that site four had the highest diversity. This was an interesting result, because site four had the lowest density of species (Figure 2). We suspect this is a result of organic rich stream substrate at site four.

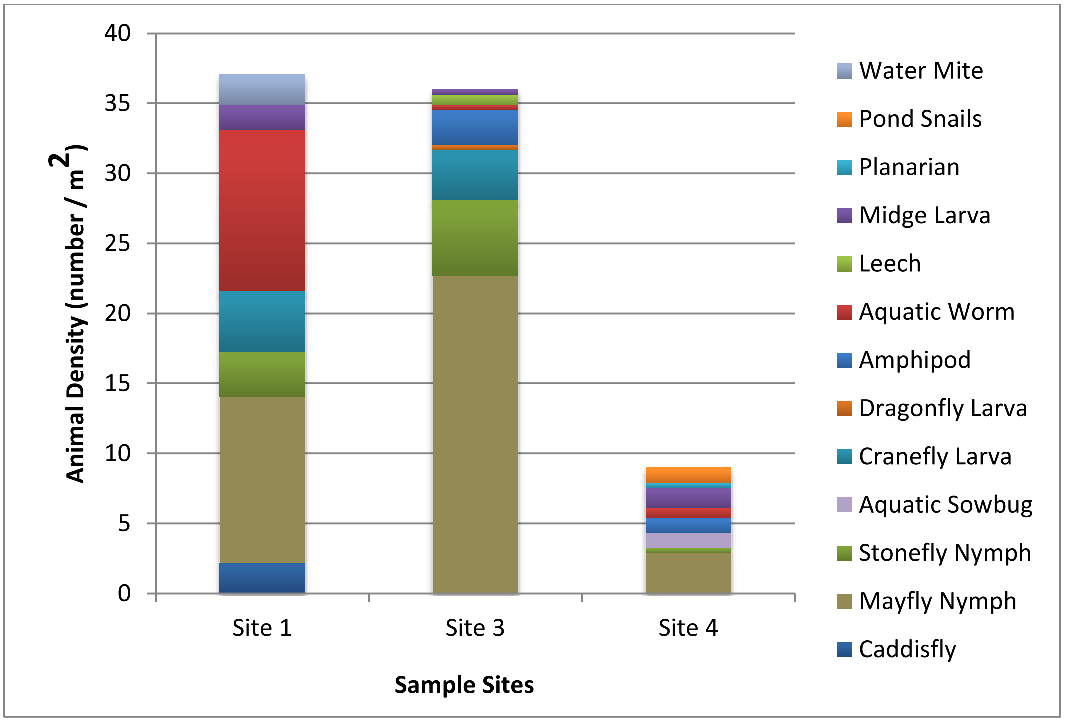

Figure 3. Density of invertebrates obtained from triplicate samples taken on November 27, 2014 at three stations on the C.W. Young Channel.

The C. W. Young Channel has been modified for fish habitat and accessibility. The addition of substrate (gravel) and large woody debris (LWD) caters to the biological needs of mayfly nymphs. Since the collection of invertebrates took place in these areas, the sampling methods may have contributed to the large number of mayfly nymphs collected. It is speculated that the addition of this gravel and LWD to the C.W. Young Channel is the main contributing factor in the predominance of this pollution intolerant species.

5. Conclusions and Recommendations

After rigorous testing of water quality, microbiology, hydrology and stream invertebrate density/abundance, it is apparent that the C.W. Young Channel continues to produce a healthy and productive ecosystem.

All water quality parameters tested fell within the provincial parameters for aquatic life. With the exception of dissolved oxygen and aluminum, all test results met or exceeded expectations. We suspect the higher than normal readings of dissolved oxygen were due to calibration issues. The level of aluminum, consistent with previous years, is associated with local geology (Barlak et al, 2010).

During the first sampling event, coliform counts were high in all sites. However, with the exception of site two, fecal coliform numbers were low, indeed much lower than the watershed specific guidelines proposed by Barlak et al (2010). We can attribute the higher number of fecal coliforms in site two to its geographical position within the channel, as the site is located directly downstream of a wetland area, and is frequented by wildlife. The increased presence of wildlife near site two is therefore attributed to increased fecal deposition within that portion of the channel.

Stream invertebrate analysis revealed an abundance of pollution intolerant species at each of the three sites tested, suggesting good overall health within the stream. According to the Shannon-Weiner Diversity Index, all sites maintained good or acceptable invertebrate diversity.

Although the current status of the channel is healthy, we recommend continued annual monitoring. Rural development upstream of the channel poses an increased risk of cultural eutrophication and the possibility of massive increases in sediment loading. Domestic animals, fertilized lawns and septic fields all have the potential to pollute this river. As even a small pollution event can damage a sensitive ecosystem, it is imperative that the community as a whole recognizes the importance of protecting this vital watershed.

6. References

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7. Appendices

Appendix 1: Photos taken of the five sites on the C.W. Young Channel and Englishman River.

Photo 1: Site one on the C.W. Young Channel, looking downstream. Photo taken on November 17, 2014

Photo 2: Site 2 on the C.W. Young Channel, looking upstream. Photo taken on November 17, 2014

Photo 3: Site 3 on the C.W. Young Channel, looking downstream. Photo taken on November 17, 2014

Photo 4: Site 4 on the C.W. Young Channel, looking downstream. Photo taken on November 17, 2014

Photo 5: Site 5 on the main channel of the Englishman River, looking downstream. Photo taken on November 17, 2014

Appendix 2: Laboratory results (ALS Laboratory) for total metals from water samples taken from sites one, two and four on the C.W. Young Channel, during both sampling events.

	October 27, 2014			November 17, 2014			BC Water Quality Guidelines	
Total Metals	**Site 1**	**Site 2**	**Site 4**	**Site 1**	**Site 2**	**Site 4**	**BC Max (mg/L)**	**BC 30-day mean (mg/L)**
Aluminum (Al)-Total	0.29	0.29	0.49	<.20	<.20	<.20	0.10	0.05
Antimony (Sb)-Total	<0.20	<0.20	<0.20	<.20	<.20	<.20	0.02	
Arsenic (As)-Total	<0.20	<0.20	<0.20	<.20	<.20	<.20	0.005	
Barium (Ba)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	5	1
Beryllium (Be)- Total	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0053	
Bismuth (Bi)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20		
Boron (B)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1.2	
Cadmium (Cd)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Variable	
Calcium (Ca)-Total	5.72	5.80	7.01	8.73	8.66	9.34	Variable	
Chromium (Cr)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.001	
Cobalt (Co)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.11	0.004
Copper (Cu)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Variable	0.002
Iron (Fe)-Total	0.354	0.391	0.708	0.164	0.135	0.147	1.000	
Lead (Pb)-Total	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	Variable	0.004
Lithium (Li)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	O.87	0.096
Magnesium (Mg)-Total	0.86	0.86	1.63	1.06	1.05	1.71	Variable	
Manganese (Mn)-Total	0.0078	0.0140	0.0175	<0.0050	0.0061	0.0061	Variable	0.70
Molybdenum (Mo)-Total	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	2	1
Nickel (Ni)-Total	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.025	
Phosphorus (P)-Total	<0.30	<0.30	<0.30	<.30	<.30	<.30		
Potassium (K)-Total	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0		
Silicon (Si)-Total	3.24	3.24	3.81	3.20	3.17	3.52		
Silver (Ag)-Total	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	0.0001	0.00005
Sodium (Na)-Total	2.2	2.2	2.6	4.2	4.1	4.1		
Strontium (Sr)-Total	0.0201	0.0205	0.0236	0.0367	0.0356	0.0358	0.0020	
Thallium (Tl)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20		
Tin (Sn)-Total	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030		
Titanium (Ti)-Total	0.017	0.013	0.024	<0.010	<0.010	<0.010		
Vanadium (V)-Total	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030		
Zinc (Zn)-Total	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.033	0.0075

Appendix 3: Invertebrate Survey Field Data Sheet completed for triplicate stream Invertebrate samples collected at Stations 1, 3 and 4 on the C.W. Young Channel during October 27, 2014.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: C.W. Young Channel		Date: October 27, 2014
Station Name: Site 1		Flow status: High
Sampler Used:	Number of replicates 4	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.36 m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	EPT1 6	EPT4 1
	Mayfly Nymph (EPT)	EPT 2 33	EPT5 3
	Stonefly Nymph (EPT)	EPT 3 9	EPT6 2
	Dobsonfly (hellgrammite)		
Pollution Intolerant	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		48	6
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva	12	3
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Amphipod (freshwater shrimp)		
	Watersnipe Larva		
Sub-Total		C2 12	D2 3
Category 3	Aquatic Worm (oligochaete)	32	3
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)	5	2
	Planarian (flatworm)		
Pollution Tolerant	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite	6	3
Sub-Total		43	D3 8
TOTAL		CT 103	DT 17

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**:

S1 103

DENSITY: Invertebrate density per total area sampled:

103 ! 0.36 'm² = S2 286.11 / m²

PREDOMINANT TAXON:
Invertebrate group with the highest number counted (Col. C)

S3 Mayfly Nymph

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Acceptable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x __6___ + 2 x ___3__ + ___8__ =

S4 32

EPT INDEX: Total number of EPT taxa.

Good	Acceptable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

__1__ + __3___ + _2____ =

S5 6

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Acceptable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(___6__ + ___33__ + __9___) / __103___=

S6 0.466

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**:

S7 17

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Acceptable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

___32_ / __103___ =

S8 0.311

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Acceptable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	R1 4
EPT Index	R2 2
EPT To Total Ratio	R3 4
Predominant Taxon Ratio	R4 2

Average Rating
Average of R4, R5, R6, R8

3.25

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: C.W. Young Channel		Date: October 27, 2014	
Station Name: Site 3		Flow status: High	
Sampler Used:	Number of replicates 4	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.36 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	EPT1	EPT4
	Mayfly Nymph (EPT)	EPT 2 63	EPT5 2
	Stonefly Nymph (EPT)	EPT 3 15	EPT6 2
	Dobsonfly (hellgrammite)		
Pollution Intolerant	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		78	4
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva	10	2
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva	1	
	Fishfly Larva		
	Amphipod (freshwater shrimp)	7	
	Watersnipe Larva		
Sub-Total		C2 18	D2 2
Category 3	Aquatic Worm (oligochaete)	1	1
	Blackfly Larva		
	Leech	2	2
	Midge Larva (chironomid)	1	1
Pollution Tolerant	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		4	D3 4
TOTAL		CT 100	DT 10

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**:

S1: 100

DENSITY: Invertebrate density per total area sampled:

100 ! 0.36 'm² = S2: 277.77 / m²

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C)

S3: Mayfly Nymph

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Acceptable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x __4___ + 2 x ___4__ + ___4__ =

S4: 24

EPT INDEX: Total number of EPT taxa.

Good	Acceptable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

__0___ + __2___ + _2____ =

S5: 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Acceptable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

___0__ + ___63__ + __15___) / __100___=

S6: 0.78

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**:

S7: 12

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Acceptable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

___63__ / __100___ =

S8: 0.63

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Acceptable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	R1 4
EPT Index	R2 2
EPT To Total Ratio	R3 4
Predominant Taxon Ratio	R4 2

Average Rating
Average of R4, R5, R6, R8
3

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: C.W. Young Channel		Date: October 27, 2014	
Station Name: Site 4		Flow status: High	
Sampler Used:	Number of replicates 4	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.36 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	EPT1 1	EPT4 1
	Mayfly Nymph (EPT)	EPT 2 8	EPT5 2
	Stonefly Nymph (EPT)	EPT 3	EPT6 1
	Dobsonfly (hellgrammite)		
Pollution Intolerant	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		C1 9	D1 3
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug	3	1
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Amphipod (freshwater shrimp)	3	1
	Watersnipe Larva		
Sub-Total		6	D2 2
Category 3	Aquatic Worm (oligochaete)	2	2
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)	4	2
	Planarian (flatworm)	1	1
Pollution Tolerant	Pouch and Pond Snails	3	1
	True Bug Adult		
	Water Mite		
Sub-Total		10	6
TOTAL		CT 25	DT 11

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**:

S1: 103

DENSITY: Invertebrate density per total area sampled:

103 ! 0.36 'm² = S2: 286.11 / m²

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C)

S3: Mayfly Nymph

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Acceptable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x __6___ + 2 x ___3__ + ___8__ =

S4: 32

EPT INDEX: Total number of EPT taxa.

Good	Acceptable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

__1__ + __3___ + _2____ =

S5: 6

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Acceptable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(___6__ + ___33__ + __9___) / __103___=

S6: 0.466

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**:

S7: 17

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Acceptable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

___32_ / __103___ =

S8: 0.311

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Acceptable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	R1 4
EPT Index	R2 2
EPT To Total Ratio	R3 4
Predominant Taxon Ratio	R4 2

Average Rating

Average of R4, R5, R6, R8

3.25