Water Quality and Stream Invertebrate Assessment for the C.W. Young Channel, Englishman River, Nanaimo, BC

(Fall 2013)

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Report Submitted to:

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Executive Summary

The intent of this study is to provide an overview of the current water quality and freshwater invertebrate health of the C.W. Young Channel. The C.W. Young Channel is located within the Englishman River Regional Park and conservation area. The Englishman River and associated community watershed is located southwest of the city of Parksville, British Columbia, Canada.

This report was conducted and orchestrated by four students attending Vancouver Island University. Both field and lab work was executed on and off campus. Water quality analysis was conducted in the VIU laboratory, while another set of samples were shipped to the ALS facility in Vancouver. Four students enrolled in the Bachelor of Natural Resource Protection Program were assigned to the C.W. Young Channel during the fall semester of 2013. Water quality analysis, stream invertebrate sampling and the composition of this report were performed by: Gillian MacDonald, Elliot Molsberry, Alec Patterson, and Rebecca Segal.

There are five monitoring sites designated to the C.W. Young Channel, all have been previously monitored and analyzed by Vancouver Island University students from the years 2008-2012. The five sites were sampled on two separate occasions, October 30, 2013 and November 20, 2013. During the first sampling event, water quality, microbiology, field measurements, and water velocity were conducted at all five sites. Invertebrate sampling was conducted at sites 1, 3 and 4. ALS samples were taken at sites 1, 2 and 4. During the second sampling event, water quality, field measurements, and water velocity were taken at all five sites. ALS samples were collected from sites 1, 2 and 4 during the second sampling event; however, no microbiology or invertebrate sampling

were taken. Quality assurance and control measures were implemented throughout the entirety of this project as outlined in the freshwater and effluent sampling guidelines (RISC 1998).

Low concentrations of heavy metals, consistent pH, and minimal turbidity regulated by discharge, contribute to the acceptable water quality to sustain aquatic life. The hydrology of the C.W. Young Channel posed no risk to aquatic life and generally matched the results from previous years. Microbiology was congruent with previous sampling years except for 2012. The C.W. Young Channel has a remarkable ability to support a diversity of organisms based on the guidelines of aquatic life. The amount of large woody debris, various substrates, assorted fauna, and evidence of spawning salmon support this conclusion. Over the years, a number of individuals and organizations undertook the job of increasing substrate variance and fish habitat. Thanks to them, the C.W. Young Channel continues to thrive and flourish.

Acknowledgments

The authors of this report would like to thank Dr. Eric Demers for his continued support and encouragement throughout the entirety of this report. This study along with the final report would have never been completed without it. We would also like to acknowledge Dr. John Morgan for his guidance throughout this project. Sarah Greenway provided additional help for microbiology sampling, we are grateful for her patience through teaching us how to properly test for microbiology data. We would like to thank Vancouver Island University for providing all the sampling tools, field measurement tools and laboratory equipment for this study. Finally, this report would have never been possible without the help of Regional District of Nanaimo for allowing us access to the C.W. Young Channel.

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1. Introduction

The state of freshwater ecosystems throughout British Columbia has been in decline for over a century (MOE 2010). The importance to collect ambient water quality data and to assess the overall health of these freshwater ecosystems is vital in their protection and utilization of their associated resources (Decker et al. 2003). Four Bachelor of Natural Resource and Protection students enrolled in RMOT 306 Environmental Monitoring at Vancouver Island University (VIU) have conducted further environmental monitoring on one of Vancouver Island's most influential salmon spawning channels, the C.W. Young Channel. The continuation of environmental monitoring of the C.W. Young Channel will allow for the further monitoring of its overall health and the required conservation efforts for its protection.

The Englishman River and C.W. Young Channel is located southwest of the city of Parksville, British Columbia, Canada. The Englishman River is classified as a fourth-order stream, which extends 39 km northeasterly from the high elevation (1,800 m) of Mt. Arrowsmith down to the Georgia Straight, North of Craig Bay (MOE 2010). The Englishman River is located within the Nanaimo Lowland Eco-region (NAL) based off of the Ministry of Environment's (MOE) eco-region model (MOE 2010). The lower reaches of the Englishman River are located within the Coastal Douglas Fir (CDF) Biogeoclimatic zone and above that, lie within the Coastal Western Hemlock (CWH) Biogeoclimatic zone. The five proposed sample sites are located approximately 7 km upstream of the Englishman River Estuary, in the C.W. Young Spawning Channel (Figure 1). The C.W. Young Spawning Channel is located within the Englishman River Regional Park and conservation area (Figure 2). Four of the five samples sites were

chosen within the C.W. Young Spawning Channel to keep consistent with data collected from Vancouver Island University students since 2008. The fifth sample site is located at the C.W. Young Channel and the confluence of the main stem Englishman River. The Englishman River is one of the most valued and endangered rivers in BC. There are many federal, provincial and local organizations that take a special interest in the C.W. Young Channel, including DFO, MOE, Regional District of Nanaimo (RDN), First Nations, Pacific Estuary Conservation Program, Ducks Unlimited Canada, The Nature Trust of B.C., and VIU.

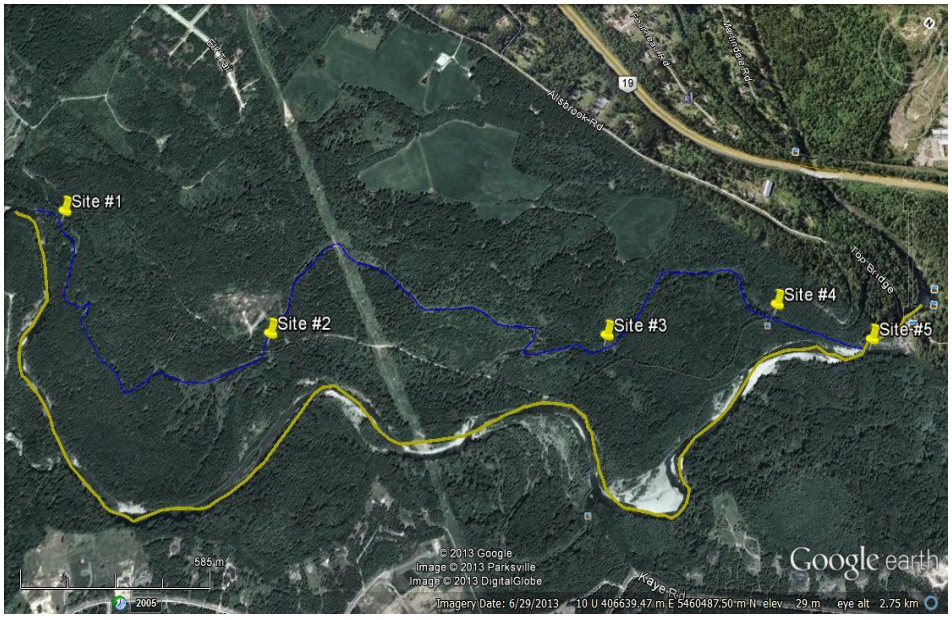

Figure 1: Map of site locations located in the C.W. Young Channel located in Nanaimo Regional District Park (Google Earth 2013).

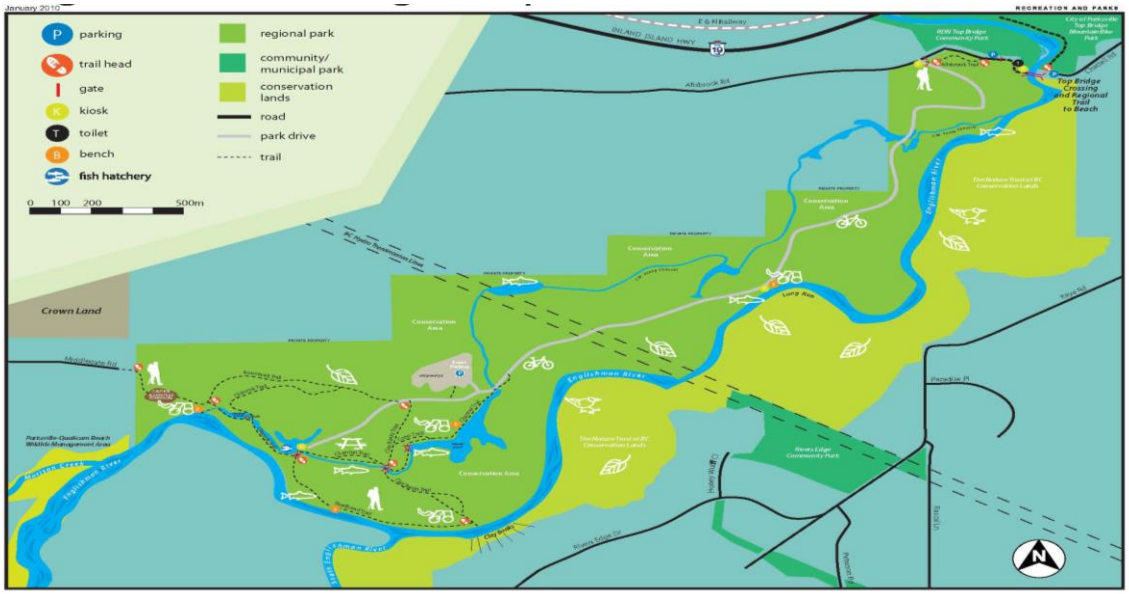

Figure 2: Regional District of Nanaimo map of C.W. Young Channel and Englishman River Regional Park (RDN 2013).

1.1. History of the Englishman River and the C.W. Young Channel

The Englishman River watershed consists of approximately 31,890 ha, most of which lies adjacent to privately owned land that is utilized for timber production. Ninety percent of the land adjacent to the Englishman River has been logged over the last fifty years, which has created an array of negative impacts to the watershed (MOE 2010). The loss of riparian cover, increased turbidity during high flows and the natural absence of large wood debris (LWD), has severely affected the habitat required for successful rearing of multiple salmonid species (Decker et al. 2003).

The Englishman River provides approximately 31 km of salmonid rearing habitat. The lower 8 km of the Englishman River provides the majority of salmonid spawning habitat, resulting from its lower gradient <2% (Decker et al. 2003). In 1992, DFO began the construction of two man-made spawning channels, Timber West and Weyerhaeuser (Decker et al. 2003). The Timber West and Weyerhaeuser spawning channels are located

off the main-stem of the Englishman River. In 2007, the Timber West channel was extended by 2.9 km, which increased the total available spawning and rearing habitat to 7.44 ha. The Timber West Channel was renamed the Clay Young Channel (C.W. Young Channel) after its extension (Taylor 2010).

The Englishman River is affected by a multitude of anthropogenic land uses including: recreation, agriculture, timber harvesting and industrial development. Partnerships formed between the Ministry of Environment and local stewardship groups, work together to help collect data, perform restoration efforts, and monitor the Englishman River for potential environmental impacts. The intent of this project is to highlight the current water quality and freshwater invertebrate health of the C.W. Young channel.

2. Methods

2.1. Site Locations and Characteristics

VIU students have sampled the five site locations annually since 2008. Sites 1 through 4 are located within the C.W. Young Side Channel and site 5 is located at the confluence of the C.W. Young Channel and the Englishman River main stem. Each of the sites contain similar vegetation characteristics, substrate composition and were chosen based on safety and ease of access (Table 1). Site photos can be observed in appendix B.

Table 1: Sample site characteristics of the C.W. Young Side Channel.

Site	Location	H. Type	Gradient	Substrate	Canopy Cover
Site 1	350 m upstream from Hatchery	Glide	2.5%	Cobble, Boulders	Alder and Big Leaf Maple
Site 2	1.25 km downstream from site 1	Glide	1.5%	Fines, Cobble, Boulders	Alder and Douglas Fir
Site 3	2.9 km downstream from site 1	Pool	<1%	Fines, Cobble, Gravel, Boulders	Minimal, mostly Alder
Site 4	3.9 km downstream	Pool, Riffle	10%	Gravel, Cobble, Boulders	Significant, Alder, Big Leaf Maple,
Site 5	4.1 km downstream of Site 1	Riffle	<1%	Gravel, Cobble and Boulders	Zero

2.1.1. Sample Frequency

Physical stream parameters from all five sites were collected on October 16, 2013 between 14:00hrs and 17:00hrs. The two sampling events took place on October 30th and November 20th, 2013. From the five sites, four samples were taken solely from the side channel itself, whereas the fifth sample was taken from the confluence of the two watercourses. Along with the five water samples, a triplicate sample was taken from site 3. ALS samples were taken from sites 1, 2, and 4 during both sampling events. Microbiological samples were taken on October 30th at all five sampling sites. Invertebrate samples were taken during the first sampling event on October 30th, 2013, at sites 1, 3 and 4.

2.2. Water Quality

2.2.1. Field Measurements

The water quality measurements that were conducted and obtained in the field included; dissolved oxygen, conductivity, and temperature. A pre calibrated electronic probe was used to assess these parameters. The probe was placed in similar water conditions at all five sampling sites. These areas were generally located in a faster

moving glide with variable substrate composition, straying away from areas that could potentially produce inaccurate data. Areas of inaccuracies that were avoided included; large riffles, areas with a muddy or fine sediment composition, back eddies or any other area which appeared to be an inaccurate representation of the entire site. Recording the data from the probe occurred once the calculations of each parameter had stabilized for approximately five seconds.

2.2.2. Water Sampling

Water collection and sampling was completed with five different containers for ALS and VIU water sample analyses. For the ALS analysis there were three bottles used, these included one 250 mL plastic bottle, one amber glass 250 mL jar, and one 1 L plastic bottle. Water samples for VIU analysis were collected with 500 mL plastic bottles, and microbiological water samples were taken with 100 mL whirlpacks. The amount of containers used to sample water varied upon each sample site.

All containers had been sterilized prior to carrying out water sampling. All bottles had been marked with sample dates, site number, and location. ALS and VIU water quality samples were collected facing upstream by plunging the bottle underwater until full. The reason for which the bottles were completely submerged was to accurately gather water quality results that yielded a better representation of the entire stream, rather than taking water samples from the surface water.

Water quality samples for the ALS laboratory analysis were taken slightly different than in comparison to the samples taken for VIU laboratory analysis. As previously stated, there were three groups of three bottles used at three separate sites. The first sample was taken in a 1 L plastic bottle for general water quality parameter analysis.

The second sample was taken in a glass amber bottle where sulphuric acid was added to adequately measure nutrient levels. The third sample was collected in a 250 mL plastic bottle where nitric acid was added to measure the amount of total metal concentrations. All ALS water samples were kept in a refrigerator at approximately 4°C, until sent to the ALS laboratory for analysis.

2.2.3. VIU Laboratory Analysis

The water samples that were collected for VIU Laboratory analyses for both sampling events were analyzed the same day of collection. The VIU laboratory analyses tested for turbidity (NTU), alkalinity (mg/L as $CaCO_3$), hardness (mg/L as $CaCO_{3)}$, total nitrates (mg/L NO_3^-), total phosphorus (mg/L PO_4^{3-}), and pH. All water samples collected from the five sites were tested using the same methodology. The turbidity was calculated by using a HACH 2100P Turbidimeter. Alkalinity was determined by adding one Bromcresol Green-Methyl Red and Phyenolphthalein Indicator Powder Pillow to the water sample, and then slowly adding sulfuric acid with a titration cartridge until the solution colour changed. Hardness was calculated by using a similar method of titration, however using an EDTA solution rather than the Pillow Bags; the solution was then observed changing from a redish-pink colour to a bluish-green colour. Nitrate was analyzed with HACH method no. 8192. Phosphate was analyzed with HACH method no. 8048. A HACH 2800 spectrophotometer was used for both nitrate and phosphate tests. pH was tested by submerging a handheld pH meter into a plastic beaker containing each individual sample. The pH levels were recorded once the values had stabilized for approximately ten seconds.

2.2.4. ALS Laboratory Analysis

Water samples were sent to the ALS laboratory to gather a more precise and accurate analysis of the samples collected. The water samples that were analyzed at the ALS laboratory were analyzed on November 9th, 2013 and December 4th, 2013. The analyzed parameters included conductivity, hardness, pH, anions, nutrients, and total metals (Table 2). The water quality samples collected for nutrients and metals were preserved with sulphuric acid and nitric acid; this ensured that no water samples lost specific characteristics or qualities that were to be analyzed.

2.2.5. Quality Assurance/ Quality Control

For the purposes of the water quality sampling there were both quality assurance and control standards set to reduce the amount of error, contamination and inaccuracies in the data. Techniques were used in a consistent manner both in the field and in the laboratory. The control methods for preserving the quality assurance and integrity of samples are as follows:

In the field, an electronic probe was placed in similar water conditions at all five sites avoiding areas which could produce inaccurate data. The containers/bottles were pre-labeled prior to entering the field; all containers that were used throughout the water sampling event were rinsed thoroughly three times. Fingers and other foreign objects were made sure to not touch or come into contact with the lid and or rim of container/ bottle. The water samples that were analyzed at the VIU laboratory were analyzed the same day as the sample event took place, while the water samples taken for ALS analysis were kept at a consistent temperature of 4°C until shipped to Vancouver.

The methodology for assuring quality control measures in the assessment of sample contamination throughout the water sample analysis were as follows: a replicate sample was taken at site 3 during each sampling event, and a trip blank was provided by Dr. Eric Demers. Duplicate samples were taken at a frequency of >10%; and a microbiological analysis obtained filtration blanks at the same frequency of >10%.

2.2.6. Microbiology

The microbiological analysis of the water samples were conducted during the first sampling event, and were monitored with the first set of water samples taken. The microbiological samples were taken much like the water samples; however, a whirlpack was used instead of using a plastic bottle. The whirlpack was plunged underwater until full, then excess water was squeeze out until there was approximately a 100 mL sample. All water quality samples were kept in a cooler at approximately 8°C.

The microbiological analysis had been completed with the use of a selective differential membrane filtration medium, m-ColiBlue 24 broth. Each water sample collected from each site was analyzed for fecal and non-fecal coliform growth; however, only 25 mL of the 100 mL water sample that was collected was used for this analysis. Each water sample was filtered through a membrane using a vacuum pump. The membrane was removed with sterilized forceps, and placed on an absorbent pad within a sterile petri dish. The samples were incubated at 37^{o} C for 20 hours before observations were documented. Coliform growth was counted by sectioning the membrane into quarters, counting one quarter, and then multiplying by four to represent an approximation of total coliform growth. That number was then multiplied by four again to assess the entire amount of coliform growth within the 100 mL water sample.

2.2.7. Basic Hydrology

Sampling hydrological aspects of the C.W. Young Channel was carried out at all five sites during both water quality sampling events. Velocity was calculated by measuring a five meter distance in the stream, dropping a ping pong ball in the channel while starting the stopwatch at that exact moment. Once the ping pong ball had travelled the distance of the five meters, the timer would be stopped. This was done three times, to give an average velocity. Velocity was calculated by dividing the distance of five meters by the time it took to travel five meters. (V (m/second) = D (distance / T (seconds)).

Discharge was another hydrological aspect of the channel that was completed during both sampling events. Discharge was calculated by measuring physical characteristics of the stream multiplying the number together, and multiplying by a constant. The physical characteristics used to calculate discharge were average wetted width, average depth, and the average velocity [(Avg. Wetted Width) x (Avg. Depths) x (Ave. Velocity)]. Once these physical characteristics were multiplied together, that figure was then multiplied by a constant [(0.8) ((Discharge) x (Constant (0.8)]. The constant was used to accurately assess the average discharge rate, due to the inconsistency of water velocity in each site. Water velocity changes throughout the water column; therefore by multiplying the discharge rate by a constant of (0.8) will increase the accuracy of the calculation.

2.2.8. Stream Invertebrates

A Hess sampler was used to collect invertebrates from sites 1, 3, and 4. The Hess sampler was placed over the flattest substrate surface facing upstream within each habitat unit. Once the sampler was set, the substrate within the sampler was disturbed for approximately 40 seconds releasing any attached invertebrates. Water from the stream was used to wash excess debris and invertebrates into the attached container. It was unscrewed and transferred into a labeled container. Large debris was removed from the samples to concentrate collected invertebrates. If needed, extra water from the channel was added to increase the lifespan of the captured invertebrates and prevent the sample from drying out.

Before each use of the Hess sampler, the container was rinsed out, and the net of the sampler was washed free of debris. Samples were placed into a cooler and taken to the VIU lab for analysis. Dissection microscopes were used for invertebrate identification. Samples collected from sites 1, 3, and 4 were analyzed separately and recorded accordingly during the identification process. Invertebrates were transferred into petri dishes using tweezers, where they were sorted and counted based on taxonomy. Collected invertebrates were recorded on the invertebrate survey interpretation sheets as per site and can be located in Appendix C.

3. Results and Discussion

3.1 Water Quality

3.1.1. Field Measurements and VIU Laboratory Analysis

Dissolved oxygen levels remained consistent throughout all five sites during both sampling events. An average dissolved oxygen content of 13 mg/L was observed between all 5 sites during both sampling events. The dissolved oxygen levels from both sampling events lie within the BC Water Quality Guidelines for aquatic life (RISC 1998).

Conductivity ranged from 63-68.2 µS/cm during the first sampling event and from 31.3-45.9 µS/cm during the second. We speculate the lower conductivity levels observed during the second sampling event resulted from ionic flushing caused by increased rainfall. Conductivity levels are congruent with data collected from years prior and pose no inherent risk to aquatic life based on the BC Water Quality Guidelines (RISC 1998).

Turbidity levels remained constant throughout sites 1-5 with an average of 1.09 NTU during the first sampling event. There was a slight decrease in turbidity levels during the second sampling event which can be attributed to increased precipitation leading up to the sampling event. Turbidity levels between all sites during both sampling events stayed within the BC Water Quality Guidelines and posed no significant threat to the aquatic ecological communities. We speculate the regulated water discharge and associated decreased velocity in the C.W. Young Channel allowed for increased sediment precipitation.

Alkalinity ranged from 31.2-35.2mg/L during the first sampling event and from 21.2-27.6 mg/L during the second. Site 3 contained the lowest measures of alkalinity

during both sampling events but did not differentiate substantially from the remaining sites. Alkalinity results from all five sites during both sampling events suggest low sensitivity with regards to potential acidic input.

Hardness calculated for sites 1-5 during the first sampling event ranged from 33-45 mg/L with the lowest reading taken from site 3 and the highest from site 1. Hardness decreased during the second sampling event and ranged from 20-28 mg/L with highest reading taken from site 5 and the lowest from site 3. Hardness levels for the C.W. Young Channel are consistent with the soft waters typically found in most BC lakes and streams.

The pH levels remained constant with an average of 6.6 between sites 1-5 during the first sampling event. The average pH levels remained constant between sites 1-5 during the second sampling event but rose to a pH of 7.7 in comparison with the first sampling event. The pH levels from both sampling events fall within the BC Water Quality Guidelines and are fairly consistent with pH levels from years prior.

The average concentration of phosphates between sites 1-5 remained fairly consistent between both sampling events. Site 4 yielded a phosphate level of 0.24 mg/L during the first sampling event which suggests possible analysis error when compared to phosphate levels in the four other sites. Similarly, we found a higher level of phosphate in site 5 during the second sampling event but are unable to deduce any environmental or anthropogenic contributions. The average concentrations of phosphate between all sampling sites and events are within the BC Water Quality Guidelines for aquatic life.

The average concentration of nitrates between sites 1-5 remained consistent between the two sampling events. Concentrations of nitrates found in all five sites

between both sampling events fell well within the BC Water Quality Guidelines and remained consistent with the averages discerned from the previous year.

The average water temperatures between sites 1-5 varied considerably between the two separate sampling events. The first sampling event yielded an average water temperature of 5.5^{o}C where as the second sampling yielded an average temperature of 3.2^{o}C. We speculate the decrease in average water temperatures is a direct result of decreasing ambient air temperatures between the two sampling events (RISC 1998).

Table 2: October 30, 2013 VIU laboratory results for C.W. Young Channel water quality parameters compared to BC Water Quality Guidelines for aquatic life.

Parameters	Units	Site#1	Site#2	Site#3	Site#4	Site#5	Site#3 Replicate	Guidelines
Dissolved O_2	**mg/L**	**13.4**	**12.7**	**13**	**12.9**	**13.3**	**13**	**>5.0**
Conductivity	**µS/cm**	**65.1**	**64.6**	**63**	**68.2**	**66.4**	**63**	**N/A**
Turbidity	**NTU**	**1.38**	**0.55**	**0.71**	**0.63**	**0.64**	**0.71**	**5**
Alkalinity ($CaCO_3$)	**mg/L**	**27.2**	**26**	**25.2**	**27.6**	**31.2**	**25.2**	**>20 low sensitivity**
Hardness ($CaCO_3$)	**mg/L**	**45**	**38**	**37**	**39**	**38**	**33**	**Soft**
pH	**N/A**	**6.66**	**6.57**	**6.55**	**6.53**	**6.56**	**6.58**	**6.5- 9.0**
Phosphate (PO_4^{3-})	**mg/L**	**0.04**	**0.05**	**0.04**	**0.24**	**0.06**	**0.04**	**N/A**
Nitrate (NO_3-)	**mg/L**	**0.08**	**0.04**	**0.06**	**0.10**	**0.05**	**0.04**	**<200**
Temperature	**°C**	**4.9**	**5.1**	**5.6**	**5.6**	**6.4**	**5.6**	**<15**

Table 3: November 20, 2013 VIU laboratory results for C.W. Young Side Channel water quality parameters compared to BC Water Quality Guidelines for aquatic life.

Parameters	Units	Site#1	Site#2	Site#3	Site#4	Site#5	Site#3 Replicate	Guidelines
Dissolved O_2	mg/L	14.6	12.9	13.1	13.0	14.1	13.1	>5.0
Conductivity	µS/cm	33.8	34.4	34.3	45.9	31.3	34.3	N/A
Turbidity	NTU	2.04	1.62	3.43	1.78	2.19	3.45	5
Alkalinity ($CaCO_3$)	mg/L	23.6	22.4	21.2	27.2	27.6	23.2	>20 low sensitivity
Hardness ($CaCO_3$)	mg/L	22	23	20	26	28	22	Soft
pH	N/A	7.86	7.76	7.69	7.65	7.58	7.70	6.5- 9.0
Phosphate (PO_4^{3-})	mg/L	0.05	0.06	0.04	0.05	0.22	0.06	0.005-0.015
Nitrate (NO_3-)	mg/L	0.03	0.06	0.1	0.04	0.06	0.03	<200
Temperature	°C	2.8	3.2	3.3	3.3	3.1	3.3	<15

3.1.2. ALS Laboratory Analysis

A comparative analysis was performed between the ALS results and VIU laboratory results to determine possible deviation and potential sources of error (Table 4). The increased duration of time between sample collection and ALS sample analyses may have caused potential sources of deviation when compared to the VIU analyses.

The water quality analysis performed by ALS shows deviation from the VIU laboratory analysis with regards to pH. Water quality analysis conducted by ALS determined nearly identical levels of pH between both sampling events. VIU analysis shows an average pH level of 6.6 during the first sampling event where as the ALS analysis shows an average pH of 7.8. The ALS averages of pH for the second sampling event are congruent with the averages obtained by the VIU analysis which further suggests the possibility of error in sample event 1 analyses.

Table 4: Comparative analysis between VIU and ALS analyses for both sampling events.

Parameters	Units	VIU #1	ALS #1	VIU#2	ALS#2
Conductivity	µS/cm	65.05	118	35.67	68.7
Hardness	mg/L as $CaCO_3$	38.33	38.9	23.5	25.9
pH	N/A	6.58	7.68	7.71	7.52

Conductivity levels differentiated between the two analyses for both sample events. A deviation of 50 µS/cm was observed between the two analyses for the first sample event while a deviation of 23 µS/cm was observed in the second sampling event. There are several factors which could explain these deviations but we speculate that the discrepancies of values resulted from the different locations of analysis. In the field, the electronic probe sat on the bottom of the stream, where as the analysis for ALS was collected from the higher velocity stream surface.

Hardness levels between both analyses were congruent and determined the water located in the C.W. Young Channel to be soft. Soft water indicates increased susceptibility of acidification, if metals were to be deposited into the watercourse. Tables 7 and 8 demonstrate the guidelines for interpreting water quality in BC. The tables represent the maximum allowable concentrations; however, not all parameters are included, due to the fact that the majority of metals and minerals fall below the minimal detection limit (RISC 1998). Nutrient and anion levels observed in the ALS results were congruent with the BC Water Quality Guidelines and did not suggest any adverse affects on the streams ability to harbor aquatic life.

3.1.2.1 Quality Assurance/ Quality Control

The ALS laboratory is a professionally run lab which is utilizes numerous advanced techniques and quality control measures. ALS offers ultra trace metals

analysis by high resolution inductively and Plasma Mass Spectrometry for environmental matrices including biota, water samples. ALS uses the most advanced technology available for analysis of trace metals. The ALS laboratory utilizes sample duplicates, control spikes, matrix spikes and maintains a sterile environment to ensure best management practices are adhered to (ALS 2013).

3.2. Microbiology

All samples from the C.W. Young Channel contained fecal coliforms (Table 5). Total coliform counts increased progressively from sites 1-4. Fecal coliform counts are lower by almost 50% in sites 1-5 compared to 2011 data. Coliform counts deviated in site 5 from previous years as a result of its sample locality. Samples from site 5 were taken from the Englishman River, where as in previous years they were conducted within the C.W. Young Side Channel. We speculate the deviation in location has contributed to the lower counts of coliforms resulting from its increased discharge and associated dilution.

Table 5: October 30, 2013 total coliform counts from C.W. Young Side Channel.

Sample Sites	Non-Fecal	Fecal	% Fecal
Site #1	**912**	**12**	**1.316**
Site #2	**1216**	**12**	**0.967**
Site #3	**1952**	**12**	**0.615**
Site #4	**1728**	**40**	**2.315**
Site #5	**736**	**12**	**1.630**
Site #3 REP.	**1264**	**4**	**0.316**

3.3. Basic Hydrology

Sampling hydrological aspects of the C.W. Young Channel was carried out during both water quality sampling events at all five sites on October 30th, 2013 and November 20th, 2013. Velocity was calculated by measuring a five meter distance in the stream,

dropping a ping pong ball in the channel while starting the stopwatch at the exact moment. Once the ping pong ball had travelled the distance of the five meters, the timer would be stopped. This was done three times, to give an average velocity. Velocity was calculated by dividing the distance of five meters by the time it took to travel five meters [V (m/second) = D (distance / T (seconds)].

Discharge was another hydrological aspect of the channel that was completed during both sampling events. Discharge was calculated by measuring physical characteristics of the stream multiplying the number together, and dividing by a constant. The physical characteristics used to calculate discharge are average wedded width, the average depth, and the average velocity [((Ave. Wedded Width) x (Ave. Depths) x (Ave. Velocity))]. Once these physical characteristics were multiplied together, that figure was then multiplied by a constant [(0.8) ((Discharge) x (Constant (0.8)]. The constant was used to accurately assess the average discharge rate, due to the inconsistency of water velocity in each site. Water velocity changes throughout the water column; therefore by multiplying the discharge rate by a constant the variation of water velocity could be accurately calculated.

3.4. Stream Invertebrates

The total area sampled at each site was 0.27 m^2. Overall, 789 invertebrates were collected among the nine samples. Mayfly nymphs were the most predominant species collected throughout all three sites, making up more than 80% (665) of the collection. Aquatic snowbugs, alderfly larvae, midge larvae, and amphipods were the least prominent species collected.

Site 1 contained the highest number of invertebrates collected totaling 350, with a density per area sampled of 1296.29 m2. Site 4 had the least number of invertebrates collected with an overall count of 92 and a density of 340.74 m2. Site 3 had a total of 347 invertebrates collected with a density per area sampled of 1285.18 m2 (Figure 9).

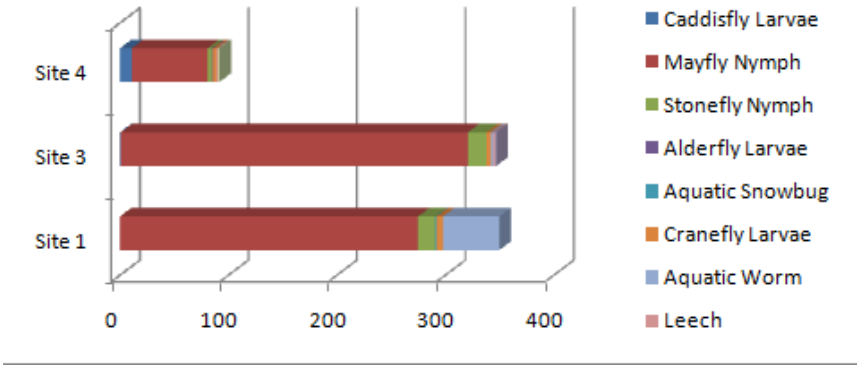

Figure 3: The total number of invertebrates collected from the C.W. Young Channel by species.

The constant gentle flow of glides caters to the biological needs of mayfly nymphs. Since collection of invertebrates took place in glides, the sampling methods may have contributed to the large number of mayfly nymphs collected. We speculate that the overall health of the C.W. Young Channel could have contributed to the increased density of this pollution intolerant species. In contrast, the number of stonefly nymphs collected in 2011 tripled the number collected in 2013 at Sites 3 and 4. Mayfly nymph densities have remained consistent with years prior. Based on the EPT index, the assessment rating of the C.W. Young Channel is between 2.5 and 3, which places it between marginal and acceptable. According to this assessment rating, the C.W. Young Channel supports an acceptable diversity and density of aquatic insects to sustain aquatic life.

Table 6: Population densities and diversity among invertebrates collected on October 30, 2013.

Pollution Tolerance	Invertebrate Taxa	Site 1	Site 3	Site 4
Category 1	Caddisfly Larvae (EPT)	0	1	11
	Mayfly Nymph (EPT)	275	320	70
	Stonefly Nymph (EPT)	16	17	4
Category 2	Alderfly Larvae			1
	Aquatic Sowbug	1		
	Cranefly Larvae	6	4	3
	Amphipod (Freshwater Shrimp		1	
Category 3	Aquatic Worm (oligochaete)	52	2	
	Leech		2	2
	Midge Larvae		2	1
Totals	Total Abundance	350	347	92
	Density	1296	1285	340
	Site Assessment Rating	2.5	3	3

4. Conclusion

The sampling events on October 30, and November 20, 2013, a variety of parameters were tested within the C.W. Young Channel. After analyzing water quality, basic hydrology, microbiology, and invertebrate communities, it can be concluded that the C.W. Young Channel supports an extremely diverse and productive ecosystem. The stream itself boasts extraordinary health, and every parameter was well within the acceptable BC Water Quality Guidelines for aquatic life.

Water quality analyses conducted at the five sites located throughout the C.W. Young Channel indicate exemplary conditions to support aquatic life. Low concentrations of heavy metals, consistent pH, and minimal turbidity regulated by discharge, contribute to the acceptable water quality to sustain aquatic life.

The hydrology of the C.W. Young Channel posed no risk to aquatic life and generally matched the results from previous years. The regulatory valve located at the beginning of the channel controlled discharge and water velocity within the stream.

Discharge rates in site 5 differed from sites 1, 2, 3, and 4 because it was taken in the Englishman River, and not in the channel itself. Discharge in the Englishman River is unregulated, deeper, and exhibits a higher velocity which explains the deviations found in our results.

Microbiology was congruent with previous sampling years except for 2012. In 2012, total coliforms ranged from 11-15 CFU/100mL. Our microbiology results were comparable to the years of 2010 and 2011, where total coliforms ranged from 176-2370 CFU/100mL. Site 5 contained less fecal coliform than sites 1, 2, 3, and 4. This can be surmised by the fact that the Englishman River's increased rate of discharge potentially diluted coliform levels.

During the single invertebrate sampling event in October, 2013, there was an abundance of mayfly nymphs collected throughout sampling sites 1, 3, and 4. Mayfly nymphs are a pollution intolerant species which rely on excellent stream health in order to not only survive, but thrive. All three sites had a lower density of aquatic worms, stipulating that the stream is healthy and not suffering from eutrophication. Site 4 had the lowest number of invertebrates collected due to the fast flowing riffle, but the number of mayfly nymphs far outweighed the other species collected. In comparing the results with previous years, the number of mayfly nymphs has increased, while the number of stonefly nymphs has decreased.

The C.W. Young Channel has a remarkable ability to support a diversity of organisms based on the guidelines of aquatic life. The amount of large woody debris, various substrates, assorted fauna, and evidence of spawning salmon supports this conclusion. Over the years, a number of individuals and organizations undertook the

job of increasing substrate variance and fish habitat. Thanks to them, the C.W. Young Channel continues to thrive and flourish.

5. Recommendations

We propose that annual sampling events take place between the spring and summer months in preparation for fall spawning. Annual sampling events will increase awareness to potential environmental concerns that may be present throughout the year. Another suggestion is increasing the number of sample sites to seven, instead of five. We believe that an added site before the intake valve will give us a better understanding of water quality flowing into the C.W. Young Channel. The other added site will be after site five heading into the headwaters of the Englishman River. This added site will also give us an accurate representation of all water coming from the C.W. Young Channel as well as the Englishman River. We also purpose that electro-fishing be conducted throughout the stream at the five sites in late summer, to gauge fish health before monitoring of the stream in the fall. Electro-fishing can determine important characteristics in conjunction to populations, age, species distribution and presence of invasive species. Finally, increased awareness to the area could be implemented through added signage. Placing signs in high pedestrian used trails throughout the C.W. Young Channel could provide public awareness with regards to salmonid activity and sensitive habitat protection, therefore keeping pollution and littering to a minimum and improving stream health.

6. Citations

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7. Appendices

Appendix A. ALS data results

Table A1: 2013 ALS results from sampling events occurring on October 30, and November 20, 2013 from sites 1, 3, 4 located in the C.W. Young Channel.

Sample Event:			**Sample Event # 1**				**Sample Event #2**	
Conductivity		118	116	119		64.1	64.6	77.4
Hardness (as CaCO3)		37.8	37.4	41.6		23.6	24.1	29.9
pH		7.69	7.64	7.70		7.55	7.48	7.54
Anions and Nutrients								
Ammonia, Total (as N)		<0.0050	0.0099	0.0084		<0.0050	0.0096	0.0294
Nitrate (as N)		0.0259	0.0202	0.0444		0.0538	0.0584	0.0921
Nitrite (as N)		<0.0010	<0.0010	0.0014		<0.0010	0.0014	0.0032
Total Nitrogen		0.064	0.069	0.103		0.157	0.167	0.227
Orthophosphate-Dissolved (as P)		<0.0010	<0.0010	0.0018		0.0018	0.0025	0.0076
Phosphorus (P)-Total		0.0027	0.0040	0.0060		0.0059	0.0091	0.0148
Total Metals								
Aluminum (Al)-Total		<0.20	<0.20	<0.20		<0.20	0.26	<0.20
Arsenic (As)-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
Calcium (Ca)-Total		12.9	12.7	13.1		7.84	7.92	8.97
Chromium (Cr)-Total		<0.010	<0.010	<0.010		<0.010	<0.010	<0.010
Copper (Cu)-Total		<0.010	<0.010	<0.010		<0.010	<0.010	<0.010
Iron (Fe)-Total		0.033	0.097	0.145		0.107	0.339	0.243
Lead (Pb)-Total		<0.050	<0.050	<0.050		<0.050	<0.050	<0.050
Lithium (Li)-Total		<0.010	<0.010	<0.010		<0.010	<0.010	<0.010
Magnesium (Mg)-Total		1.38	1.39	2.16		0.98	1.04	1.82
Manganese (Mn)-Total		<0.0050	0.0063	0.0065		<0.0050	0.0125	0.0086
Nickel (Ni)-Total		<0.050	<0.050	<0.050		<0.050	<0.050	<0.050
Phosphorus (P)-Total		<0.30	<0.30	<0.30		<0.30	<0.30	<0.30
Potassium (K)-Total		<2.0	<2.0	<2.0		<2.0	<2.0	<2.0
Selenium (Se)-Total		<0.20	<0.20	<0.20		<0.20	<0.20	<0.20
Silicon (Si)-Total		2.98	2.97	3.52		3.02	3.31	3.57
Silver (Ag)-Total		<0.010	<0.010	<0.010		<0.010	<0.010	<0.010
Sodium (Na)-Total		8.4	8.3	7.9		3.7	3.6	3.8
Strontium (Sr)-Total		0.0602	0.0587	0.0565		0.0341	0.0342	0.0355
Tin (Sn)-Total		<0.030	<0.030	<0.030		<0.030	<0.030	<0.030
Titanium (Ti)-Total		<0.010	<0.010	<0.010		<0.010	0.014	<0.010
Zinc (Zn)-Total		<0.0050	<0.0050	<0.0050		<0.0050	<0.0050	<0.0050

Table A2: ALS analysis of parameters which are above the minimum detection limit for sampling event on October 30, 2013

Parameters	Units	Site #1	Site #2	Site #4	Guideline
Ammonia (NH_3)	**mg/L**	**<0.0050**	**0.0099**	**0.0084**	**25.8**
Nitrite (NO_2-)	**mg/L**	**<0.0010**	**<0.0010**	**0.0014**	**0.06**
Nitrate (NO_3-)	**mg/L**	**0.0259**	**0.0202**	**0.04444**	**200**
Phosphorus (P)	**mg/L**	**0.0027**	**0.0040**	**0.0060**	**Oligotrophic**
Calcium (Ca)	**mg/L**	**12.9**	**12.7**	**13.1**	**>8 Low Acid Sensitivity**
Iron (Fe)	**mg/L**	**0.033**	**0.097**	**0.145**	**1.0**
Manganese (Mn)	**mg/L**	**<0.0050**	**0.0063**	**0.0065**	**1.26**

Table A3: ALS analysis of parameters which are above the minimum detection limit for sampling event on November 20, 2013

Parameters	Units	Site #1	Site #2	Site #4	Guideline
Ammonia (NH_3)	**mg/L**	**<0.0050**	**0.0096**	**0.0294**	**25.8**
Nitrite (NO_2-)	**mg/L**	**<0.0010**	**0.0014**	**0.0032**	**0.06**
Nitrate (NO_3-)	**mg/L**	**0.0538**	**0.0584**	**0.0921**	**200**
Phosphorus (P)	**mg/L**	**0.0059**	**0.0091**	**0.0148**	**Oligotrophic**
Calcium (Ca)	**mg/L**	**7.84**	**7.92**	**8.97**	**>8 Low Acid Sensitivity**
Iron (Fe)	**mg/L**	**0.107**	**0.339**	**0.243**	**1.0**
Manganese (Mn)	**mg/L**	**<0.0050**	**0.0125**	**0.0086**	**1.26**

Appendix B. Photos of the five sampling sites located in the C.W. Young Channel, taken on October 30, 2013 by authors

Figure B1: Downstream photo of site 1 located in the C.W. Young Channel.

Figure B2: Downstream photo of site 2 located in the C.W. Young Channel.

Figure B3: Upstream photo of site 3 located in the C.W. Channel.

Figure B4: Downstream photo of site 4 located in the C.W. Young Channel.

Figure B5: Downstream photo of site 5 located in the C.W. Young Channel.

Appendix C. Invertebrate field data sheets

Table C1: Site 1 invertebrate survey field data sheet, collected October 30, 2013.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	C.W Young Channel	Date:	30-Oct-13
Station Name:	Site 1	Flow status:	Normal
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates	
Hess Sampler	3	0.9 x 3 = 0.27	m^2

Column A	Column B	Column C	Column D
Pollution Tolerance	**Common Name**	**Number Counted**	**Number of Taxa**
Category 1	Caddisfly Larva (EPT)	EPT1 0	EPT4 0
	Mayfly Nymph (EPT)	EPT2 275	EPT5 2
	Stonefly Nymph (EPT)	EPT3 16	EPT6 1
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		C1 291	D1 3
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug	1	1
Somewhat Pollution Tolerant	Clam, Mussel		
	Cranefly Larva	6	1
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Amphipod (freshwater shrimp)		
	Watersnipe Larva		
Sub-Total		C2 7	D2 2
Category 3	Aquatic Worm (oligochaete)	52	3
	Blackfly Larva		
	Leech		
Pollution Tolerant	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		C3 52	D3 3
TOTAL		CT 350	DT 8

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: S1 = 350

DENSITY: Invertebrate density per total area sampled:

S1 350 ÷ 0.27 'm = S2 = 1296.29 / m^2

PREDOMINANT TAXON: S3 = Mayfly Larvae = 275

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

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 3 + 2 x 2 + 2 = S4 = 16

EPT INDEX: Total number of EPT taxa.

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

EPT4 + EPT5 + EPT6

0 + 2 + 1 = S5 = 3

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 + 275 + 16) / 350 = S6 = 0.83

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: S7 = 8

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

275 / 350 = S8 = 0.78

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 2
EPT Index	R2 2
EPT To Total Ratio	R3 4
Predominant Taxon Ratio	R4 2

Average Rating = Average of R4, R5, R6, R8 = 2.5

Table C2: Site 3 invertebrate survey field data sheet, collected October 30, 2013.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	C.W Young Channel	Date:	30-Oct-13
Station Name:	Site 3	Flow status:	Low

Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates
Hess Sampler	3	0.09 x 3 = 0.27 m^2

Column A	Column B	Column C	Column D
Pollution Tolerance	**Common Name**	**Number Counted**	**Number of Taxa**
Category 1	Caddisfly Larva (EPT)	EPT1 1	EPT4 1
	Mayfly Nymph (EPT)	EPT2 320	EPT5 3
	Stonefly Nymph (EPT)	EPT3 17	EPT6 2
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		C1 338	D1 6
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
Somewhat Pollution Tolerant	Clam, Mussel		
	Cranefly Larva	4	1
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Amphipod (freshwater shrimp)	1	1
	Watersnipe Larva		
Sub-Total		C2 5	D2 2
Category 3	Aquatic Worm (oligochaete)	2	1
	Blackfly Larva		
	Leech	2	1
Pollution Tolerant	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		C3 4	D3
TOTAL		CT 347	DT 10

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: S1 = 347

DENSITY: Invertebrate density per total area sampled:

S1 347 ÷ 0.27 m^2 = S2 = 1285.18 / m^2

PREDOMINANT TAXON: S3 = Mayfly Nymph = 320

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

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 2 + 2 = S4 = 24

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

(1 + 320 + 17) / 347 = S6 = 0.97

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: S7 = 10

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

320 / 347 = S8 = 0.92

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 3
EPT To Total Ratio	R3 4
Predominant Taxon Ratio	R4 1

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

Table C3: Site 4 invertebrate survey field data sheet, collected October 30, 2013.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	C.W Young Channel	Date:	30-Oct-13
Station Name:	Site 4	Flow status:	Low

Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates
Hess Sampler	3	0.09 x 3 = 0.27 m^2

Column A	Column B	Column C	Column D
Pollution Tolerance	**Common Name**	**Number Counted**	**Number of Taxa**
Category 1	Caddisfly Larva (EPT)	EPT1 11	EPT4 1
	Mayfly Nymph (EPT)	EPT2 70	EPT5 3
	Stonefly Nymph (EPT)	EPT3 4	EPT6 1
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		C1 85	D1 5
Category 2	Alderfly Larva	1	1
	Aquatic Beetle		
	Aquatic Sowbug		
Somewhat Pollution Tolerant	Clam, Mussel		
	Cranefly Larva	3	1
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Amphipod (freshwater shrimp)		
	Watersnipe Larva		
Sub-Total		C2 4	D2 2
Category 3	Aquatic Worm (oligochaete)		
	Blackfly Larva		
	Leech	2	1
Pollution Tolerant	Midge Larva (chironomid)	1	1
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		C3 3	D3 2
TOTAL		CT 92	DT 9

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: S1 = 92

DENSITY: Invertebrate density per total area sampled:

S1 92 ÷ 0.27 m^2 = S2 340.7 / m^2

PREDOMINANT TAXON: S3 = Mayfly Nymphs = 70

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

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 5 + 2 x 2 + 2 = S4 21

EPT INDEX: Total number of EPT taxa.

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

EPT4 + EPT5 + EPT6

1 + 3 + 1 = S5 5

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

(11 + 70 + 4) / 92 = S6 0.92

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: S7 = 9

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

70 / 92 = S8 0.76

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 3
EPT Index	R2 3
EPT To Total Ratio	R3 4
Predominant Taxon Ratio	R4 2

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