Englishman River Estuary West Side Water Sampling Study - 2019

Prepared for
Nature Trust of BC
Nanaimo, BC

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ABSTRACT

In 2017, the Nature Trust of BC (Nature Trust) initiated a five-year restoration project in the Englishman River Estuary's west side (West Side). The Mid Vancouver Island Habitat Enhancement Society (MVIHES) conducted a water sampling program on behalf of the Nature Trust to determine if water quality in the West Side was suitable for the restoration of an estuarine environment.

The focus of the sampling program were two City of Parksville stormwater outfalls that contributed the majority of freshwater into the West Side at the time of the study. Between May and November of 2019, MVIHES volunteers collected samples for analysis of dissolved metals, hydrocarbons, nutrients, and fecal bacteria (E. coli, Enterococcus). Samples were sent to ALS Environmental in Burnaby, BC for analysis.

Results of the analysis indicate that dissolved copper and zinc concentrations exceeded government water quality guidelines for the protection of aquatic life and may have caused negative effects to aquatic life in the West Side. The source of both metals was the stormwater outfalls.

E. coli and Enterococcus concentrations exceeded Health Canada water quality guidelines for recreational use of water, in some cases, by orders of magnitude. The source of the high concentrations were the stormwater outfalls, however, wildlife and waterfowl contributed some of the bacteria in the West Side. Human sewage was determined to be the source for some of the bacteria from the stormwater outfalls. Although these bacteria are not harmful to aquatic life, the presence of human sewage can be an indicator that pollutants such as detergents, cleaning products, and pharmaceuticals could be present and may have caused negative effects on the aquatic life.

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1.0 INTRODUCTION

In 2017, the Nature Trust of BC began a five-year restoration project to re-establish natural estuarine habitat and processes in the Englishman River Estuary. This involves removing an old abandoned dyke on the Englishman River Estuary's west side (West Side); enhancing tidal channels; increasing habitat complexity for fish and wildlife; and removing invasive plants. The project is funded by the Habitat Conservation Trust Fund. A link to the project description is below.
https://hctf.ca/restoration-work-begins-on-the-englishman-river-estuary/?gclid=EAIaIQobChMI2YvcpeDo6gIVTD6tBh3InwYVEAAYASAAEgJe1PD_BwE

Restoration of the Englishman River Estuary will aid in the recovery of salmon populations in the Englishman River system. Salmon smolts migrating out of the river in the spring require time in the estuary to develop a physiology adapted for a marine environment before entering the Salish Sea. Salmon spawners require time in the estuary in the fall to develop a physiology adapted for a freshwater environment before they migrate up the river to spawn. Fish species that provide food for adult salmon in the ocean use the estuary as a nursery area.

In mid 2018, the Mid Vancouver Island Habitat Enhancement Society (MVIHES) was approached by Nature Trust of BC to develop and conduct a water quality sampling program in the West Side. Since the West Side is currently the focus of restoration activity, the Nature Trust was interested in learning if water in this section contained contaminants that could impede restoration of the estuarine environment.

In 2019, MVIHES received a grant from the Pacific Salmon Foundation in partnership with the Nature Trust, the City of Parksville, and the Regional District of Nanaimo, that funded the costs for the transportation and laboratory analysis of water samples.

The focus of the sampling program were two City of Parksville stormwater outfalls that contributed the majority of freshwater into the West Side at the time of the study.

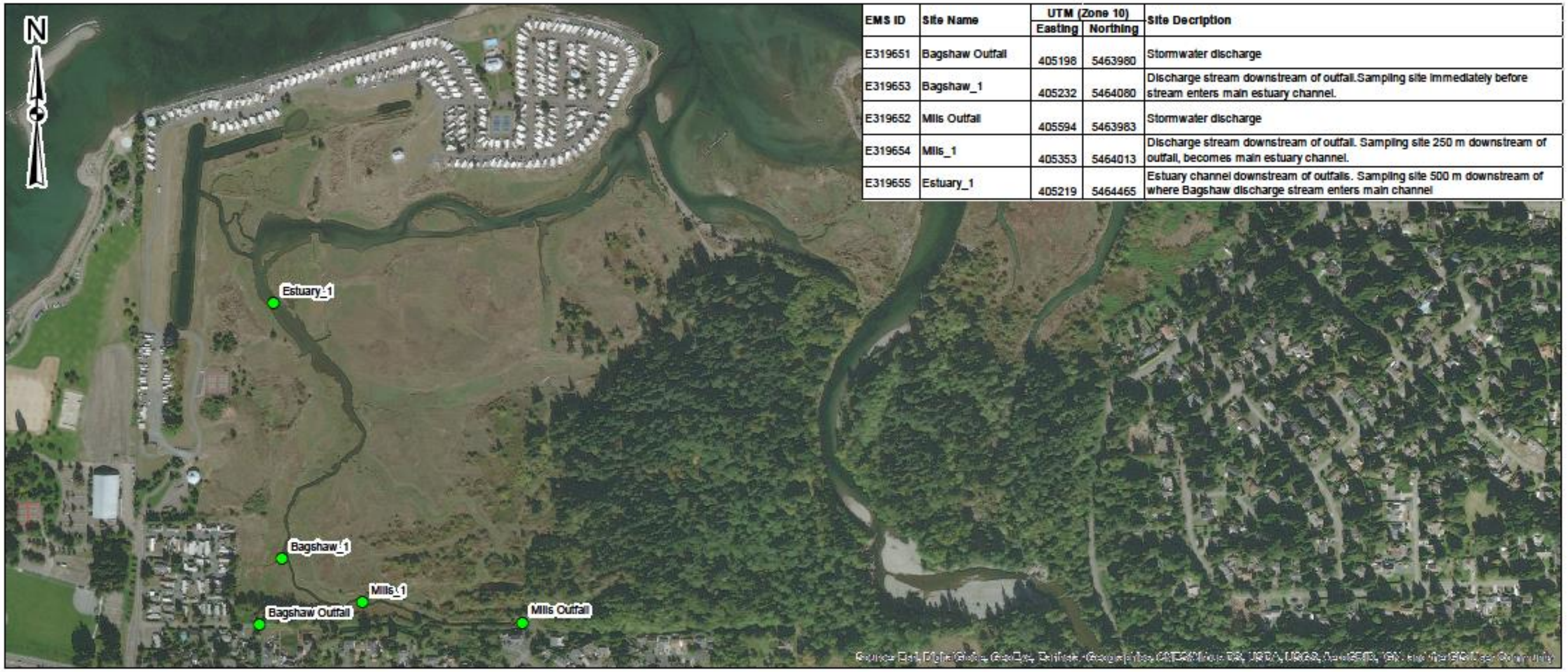
The objectives of the study were to:

- Determine the suitability of water quality in the West Side for the restoration of an estuarine environment.
- Train volunteers in water quality sampling techniques.
- Encourage partnerships among municipal and regional governments, land-owners, and volunteers in the stewardship of the Englishman River Estuary

2.0 METHODS

Five sample sites were selected and are shown in Figure 1. UTM coordinates and MOE's Environmental Management System (EMS) identifier code for each site are included in the figure. The sites are as follows:

- Mills Outfall, located at the end of Mills Street in Parksville.
- Mills_1, located in the flow channel 250 m downstream of the Outfall in the West Side.
- Bagshaw Outfall, located at the end of Bagshaw Street in Parksville.
- Bagshaw_1, located immediately before the Bagshaw Outfall flow channel joins the Mills Outfall flow channel in the West Side.
- Estuary_1, located 500 m downstream of where the Outfall flow channels merge.



EMS ID	Site Name	UTM (Zone 10)		Site Decription
		Easting	Northing	
E319651	Bagshaw Outfall	405198	5463980	Stormwater discharge
E319653	Bagshaw_1	405232	5464080	Discharge stream downstream of outfall.Sampling site immediately before stream enters main estuary channel.
E319652	Mills Outfall	405594	5463983	Stormwater discharge
E319654	Mills_1	405353	5464013	Discharge stream downstream of outfall. Sampling site 250 m downstream of outfall, becomes main estuary channel.
E319655	Estuary_1	405219	5464465	Estuary channel downstream of outfalls. Sampling site 500 m downstream of where Bagshaw discharge stream enters main channel

LEGEND

● WATER QUALITY SAMPLING LOCATION

190 95 0 190
Meters

PROJECT
HCTF: RESTORING THE ENGLISHMAN RIVER ESTUARY: IMPROVING HABITAT FOR FISH AND WILDLIFE

SITE
ENGLISHMAN RIVER ESTUARY

TITLE
WESTERN ESTUARY WATER QUALITY SAMPLING LOCATIONS

DESIGN	BR	21 APR. 2020
GIS	SWH	21 APR. 2020
CHECK	BR	21 APR. 2020
REVIEW	TR	24 APR. 2020
REV. 0	SCALE AS SHOWN	

FIGURE 1

MVIHES

REFERENCE

Projection: CSRS UTM Zone 10 Datum: NAD 83

The parameters selected for analysis were:

1. Dissolved Metals; can be toxic to aquatic life; sources include automotive emissions, tire and brake wear, oil and grease, corrosion, break down of road surfaces, pigments in paint and stain on building exteriors, and road salt. Fertilizers also contain some metals as nutrients.
2. Nutrients (Ammonia, Nitrate, Nitrite, Nitrogen); causes eutrophication leading to low oxygen levels and phytotoxins than can harm aquatic life; sources include lawn fertilizers and decaying vegetation and animal waste.
3. Polycyclic Aromatic Hydrocarbons (PAH's); can be toxic to aquatic life; sources include automotive emissions, tire wear, fuel, oil and grease spills, break down of road surfaces, heating systems.
4. Fecal Bacteria (E. coli and Enterococcus); human pathogens that can affect recreational use of water and contaminate shellfish, making them unfit for human consumption; sources include leaking septic systems, fecal material from pets and wildlife in runoff from residential areas and green spaces.

To determine if the City of Parksville Stormwater Outfalls are the only source of contaminants and assess the impact of tidal changes on water quality in the West Side, sampling was conducted during different tide stages (e.g. high, low, mid-ebb, mid-flood). For example, at high tide most of the water in the West Side is from the ocean. If contaminants are present at Estuary_1 that are not present in the Outfalls, or concentrations of contaminants at Estuary_1 are higher than those present in the Outfalls, the source of contaminants is the ocean water. At low tide there is little ocean water at Estuary_1 so contaminants at Estuary_1 would be from the Outfalls.

Water sampling supplies were received from ALS Environmental in Burnaby, BC, and included labeled sample bottles, reagents for stabilizing samples, syringes and filter discs for filtering dissolved metals samples, Chain of Custody forms, and coolers and cold packs for shipping samples to ALS Environmental for analysis.

Water sampling was conducted by MVIHES volunteers using methodology in the British Columbia Field Sampling Manual (Ministry of Environment, 2013). The water sampling program was organized and supervised by the author, who is a MVIHES volunteer and has extensive experience in water sampling procedures according to regulations under MOE and Environment Canada and Climate Change.

Physical conditions were also measured at each site. Water temperature, dissolved oxygen and specific conductivity were taken using a YSI meter, and turbidity was taken using a LaMotte meter. The YSI and LaMotte meters were calibrated the morning of each sampling day using the recommended calibration solutions. Care was taken to ensure expired solutions were not used.

The date and time of sampling at each site were written on the sample bottles and in a field notebook. Readings from the meters were also written in the notebook, along with comments regarding weather, and any wildlife activity or signs that may have affected sample results (such as waterfowl swimming or deer walking through the sample site prior to sampling).

Water sampling of the five sites took between two and three hours to complete. Sample bottles were placed in a cooler in an upright position with cold packs to maintain the samples at 4 deg C during transportation to the lab. A Chain of Custody form was completed along with a separate form for E. coli analysis and placed inside the cooler. The cooler was shipped to ALS Environmental via Purolator. Since bacterial samples must arrive at the lab within 24 hours of sample collection, overnight delivery service was selected on the Purolator Bill of Lading.

Results of water quality analysis from ALS Environmental that were below detection limits were divided by two to produce usable data. For example, <0.0050 mg/L became 0.0025 mg/L. This is a practice accepted by regulators when reporting water chemistry for discharges.

Water quality results for metals, hydrocarbons and nutrients were compared with Provincial and Federal water quality guidelines (WQG's) developed for the protection of aquatic life (Ministry of Environment & Climate Change Strategy, 2019) (Canadian Council of Ministers for the Environment). Some parameters have WQG's for both freshwater and marine/estuarine environments, in which case, both were applied. In the case where a parameter had both Ministry of the Environment (MOE) and Canadian Council of Ministers for the Environment (CCME) guidelines, the one for MOE was applied.

Both Short Term and Long Term WQGs were included. A Short Term WQG is a level that should never be exceeded in order to meet the intended protection of the most sensitive species and life stage against severe effects over a defined short term exposure period (e.g. 96 hrs). Long Term WQGs are intended to protect the most sensitive species and life stage against sub-lethal and lethal effects for indefinite exposures. When sampling results indicate that a Long Term WQG is exceeded, an averaging period approach (e.g. 5 samples in 30 days) is often used to determine if the exceedance is indeed long term, or short in duration and therefore not a concern (Ministry of Environment and Climate Change Strategy, 2019).

Water quality results for E. coli and Enterococcus were compared with Health Canada (2012) guidelines for recreational use of water. Although these pathogens do not directly impact aquatic life, they can be an indicator that pollutants are present that negatively affect aquatic life, especially if the source is human sewage.

Results of the field measurements for physical conditions were compared with thresholds and lethal limits for salmonids.

3.0 RESULTS AND DISCUSSION

Water sampling data, including WQG's, can be viewed at the link below.

https://docs.google.com/spreadsheets/d/1dH_NCOQQH52-RvKOVIXkDxHhq27y8x7w/edit#gid=273500793

Water sampling was conducted on the dates and tide stages listed in Table 3-1, resulting in a total of twenty- three samples for each parameter. Samples collected for metal analysis on September 4 could not be filtered to produce dissolved metal samples because syringes and filters were not included in the shipment of sampling supplies from ALS Environmental for that sampling period. Analysis for total metals was conducted instead.

Table 3-1. Sampling Dates and Tide Stages

Date	Tide Stage
May 2, 2019	Mid-ebb (ocean water flowing out of estuary)
May 28, 2019	Mid-flood (ocean water flowing into estuary)
September 4, 2019	Low High (ocean water partially filled estuary channel)
October 24, 2019	Low (minimal ocean water in estuary channel)
November 19, 2019	High High (ocean water flooded estuary channel)

3.1 Nutrients

No exceedances of Long Term or Short Term WQG's occurred for ammonia, nitrate, nitrite or nitrogen concentrations.

3.2 Polycyclic Aromatic Hydrocarbons

PAH's were detected in one of the twenty-three samples but did not exceed WQG's. Results for Bagshaw_1 on September 4^{th} contained 0.0051 ug/L of benzopyrene and 0.0076 ug/L of dibenza(a,h)anthracene. The Long Term and Short Term WQG's are the same for each compound: 0.01 ug/L for benzopyrene and 0.10 ug/L for dibenza(a,h)anthracene.

3.3 Dissolved Metals

Dissolved copper and zinc exceeded WQG's so are parameters of concern discussed in the sections below.

3.3.1 Dissolved Copper

Results of copper analysis indicate there were many exceedances of WQG's (Figure 3-3-1.) Table 3-3-1 displays the number of samples out of the total samples collected at each site that exceeded WQG's for dissolved copper. According to Table 3-3-1, all the samples from both Outfalls and all but one sample from their downstream sites exceeded the Long Term WQG. Results for Estuary_1 exceeded the WQG in four of five samples. Although an averaging period approach (5 samples in 30 days) was not used to determine if the exceedances were indeed Long Term, the fact that twenty-one of twenty-three samples exceeded the Long Term WQG between May and November, and several exceedances of the Short Term WQG's also occurred, strongly suggests the exceedances are Long Term.

Figure 3-3-1. Dissolved Copper Concentrations and Water Quality Guidelines (WQG)

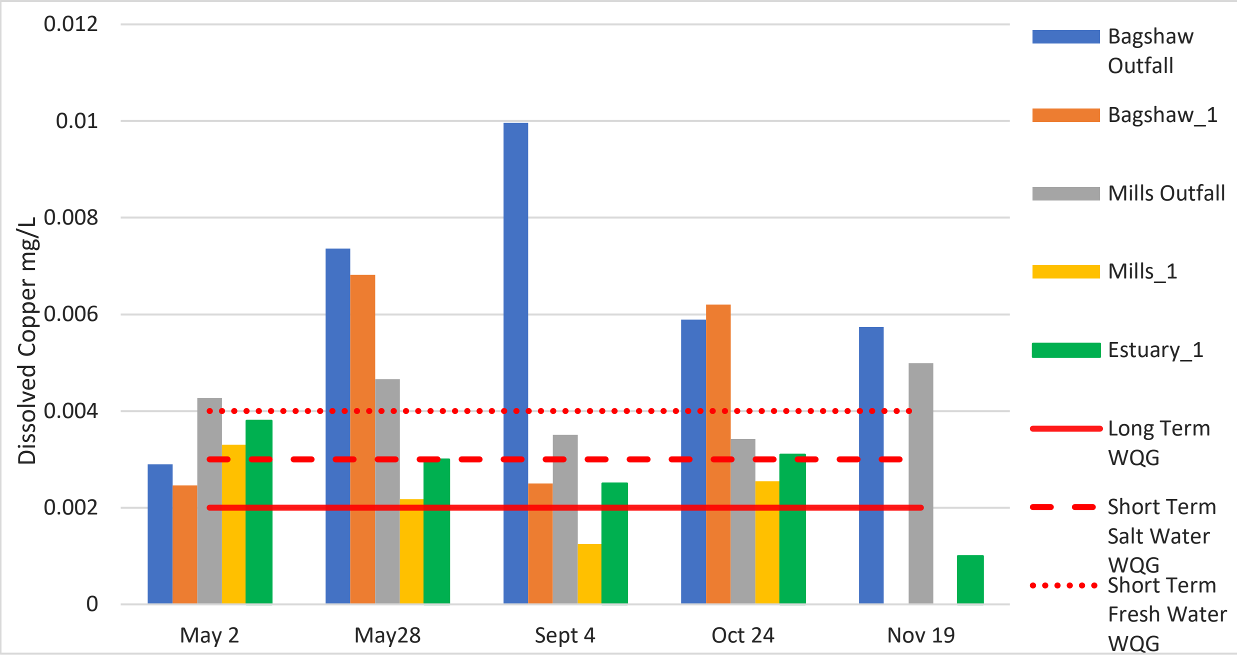


Table 3-3-1. Number of Exceedances of WQG's for Dissolved Copper

Water Sampling Site	Long term WQG (0.002 mg/L)	Short Term WQG Salt water (0.003 mg/L)	Short Term WQG Fresh Water (0.004 mg/L)	Maximum Concentration (mg/L)
Bagshaw Outfall	5/5	4/5	4/5	0.00996*
Bagshaw_1	4/4	2/4	2/4	0.00682
Mills Outfall	5/5	5/5	3/5	0.00499
Mills_1	3/4	1/4	0/4	0.0033
Estuary_1	4/5	2/5	0/5	0.0038

* Concentration is for total copper for the reason mentioned in section 2.0, so likely elevated. Highest dissolved copper concentration was 0.00736 mg/L

3.3.1.1 Tidal Influence on Dissolved Copper Concentrations

Table 3-3-2 shows the effect of tide stages on the concentrations at Estuary_1. Copper concentrations are lowest at Estuary_1 during high tides despite elevated concentrations from the Outfalls. The source of exceedances of the WQG's at Estuary_1 appears to be the Outfalls as opposed to the ocean water.

Table 3-3-2. Dissolved Copper Concentrations (mg/L) at Different Tide Stages

Water Sampling Site	Low Tide	Mid Ebb Tide	Mid Flood Tide	Low High Tide*	High High Tide
Bagshaw Outfall	0.00589	0.00290	0.00736	0.00996	0.00574
Bagshaw_1	0.00620	0.00246	0.00682	0.00250	
Mills Outfall	0.00342	0.00427	0.00466	0.00351	0.00499
Mills_1	0.00255	0.00330	0.00218	0.00125	
Estuary_1	0.0031	0.00380	0.0030	0.00250	0.0010

*Concentrations are for total copper for the reason mentions in section 2.0

3.3.2 Dissolved Zinc

Results of zinc analysis indicate there were some exceedances of WQG's (Figure 3-3-2). Table 3-3.3 shows the number of samples out of the total samples collected at each site that exceeded WQG's for dissolved zinc. All samples at the Bagshaw Outfall exceeded the Long term WQG with two exceedances of the Short Term WQG. A comparison of the number of exceedances among the sites suggests the Bagshaw Outfall is the source of exceedances detected at Estuary_1.

Figure 3-3-2. Dissolved Zinc Concentrations and Water Quality Guidelines (WQG)

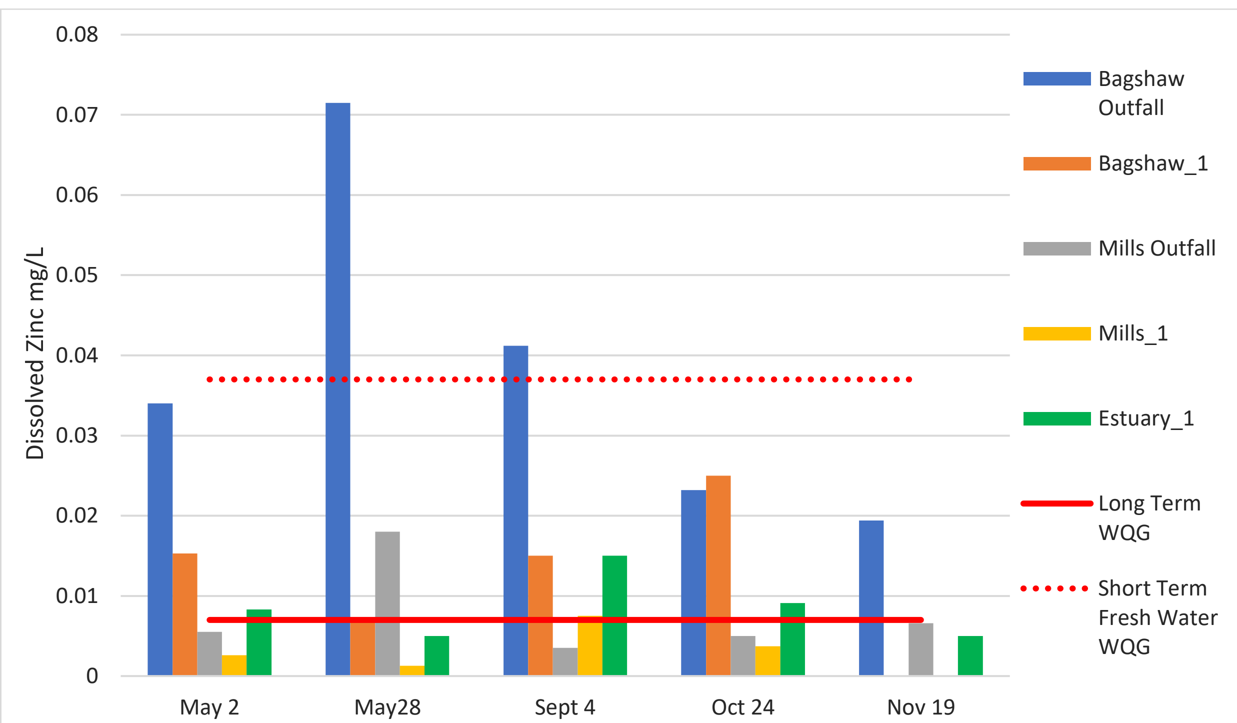


Table 3-3-3. Number of Exceedances of WQG's for Dissolved Zinc

Water Sampling Site	Long term WQG (0.007 mg/L)	Short Term WQG Salt water none	Short Term WQG Fresh Water (0.037 mg/L)	Maximum Concentration (mg/L)
Bagshaw Outfall	5/5	-	2/5	0.0715
Bagshaw_1	3/4	-	0/4	0.0153
Mills Outfall	1/5	-	0/5	0.018
Mills_1	0/4	-	0/4	0.0075
Estuary_1	3/5	-	0/5	0.015*

* Concentration is for total zinc for the reason mentioned in section 2.0, so likely elevated. Highest dissolved zinc concentration was 0.0091 mg/L.

3.3.2.1 Tidal Influence on Dissolved Zinc Concentrations

If the data for Low High Tide is eliminated, as it represents total zinc concentrations, the remaining data in Table 3-3-4 shows that dissolved zinc concentrations are highest at Estuary_1 during a Low Tide, when there is minimal ocean water. The second highest concentration at Estuary_1 is at Mid-Ebb Tide when water is exiting the channel as opposed to entering from the ocean. This further suggests that the source of WQG exceedances at Estuary_1 is the Bagshaw Outfall as opposed to ocean water.

Table 3-3-4. Dissolved Zinc Concentrations (mg/L) at Different Tide Stages

Water Sampling Site	Low Tide	Mid Ebb Tide	Mid Flood Tide	Low High Tide*	High High Tide
Bagshaw Outfall	0.0232	0.0340	0.0715	0.0412	0.0194
Bagshaw_1	0.0125	0.0153	0.0068	0.0150	
Mills Outfall	0.005	0.0055	0.0180	0.0035	0.0066
Mills_1	0.0037	0.0026	0.0013	0.0075	
Estuary_1	0.0091	0.0083	0.0050	0.0150	0.005

*Concentrations are for total zinc for the reason mentions in section 1.0

3.4 Fecal Bacteria

The levels of E. coli and Enterococcus, displayed in Figures 3-4-1 and 3-4-2, show that bacteria levels exceeded WQG's, in some cases, by several orders of magnitude. Table 3-4-1 contains the number of samples out of the total samples collected at each site that exceeded WQG's for E. coli and Enterococcus, along with the maximum concentrations. According to Table 3-4-1, the Mills Outfall had the most exceedances for E. coli with an extremely high maximum concentration of 37,000 CFU/100 ml, compared to the guideline of 200 CFU/100 ml. E. coli does not survive for long in salt water so this may explain the fewer exceedances at Mills_1 and Estuary_1. All samples at all sites exceeded the Enterococcus WQG and had high maximum concentrations.

Figure 3-4-1. E. coli Concentrations and Water Quality Guideline (WQG)

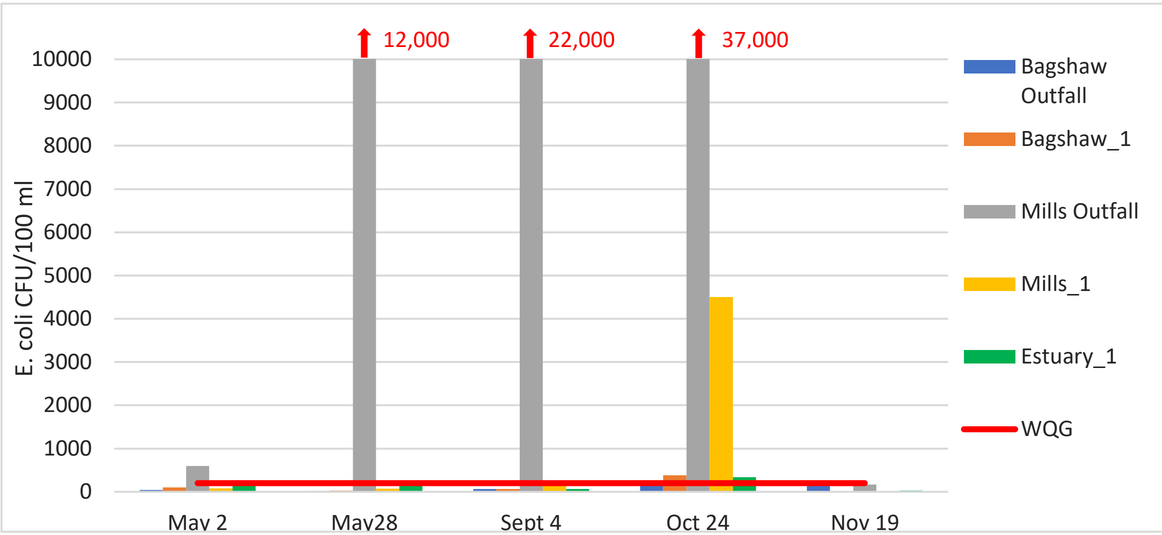


Figure 3-4-2. Enterococcus Concentrations and Water Quality Guideline (WQG)

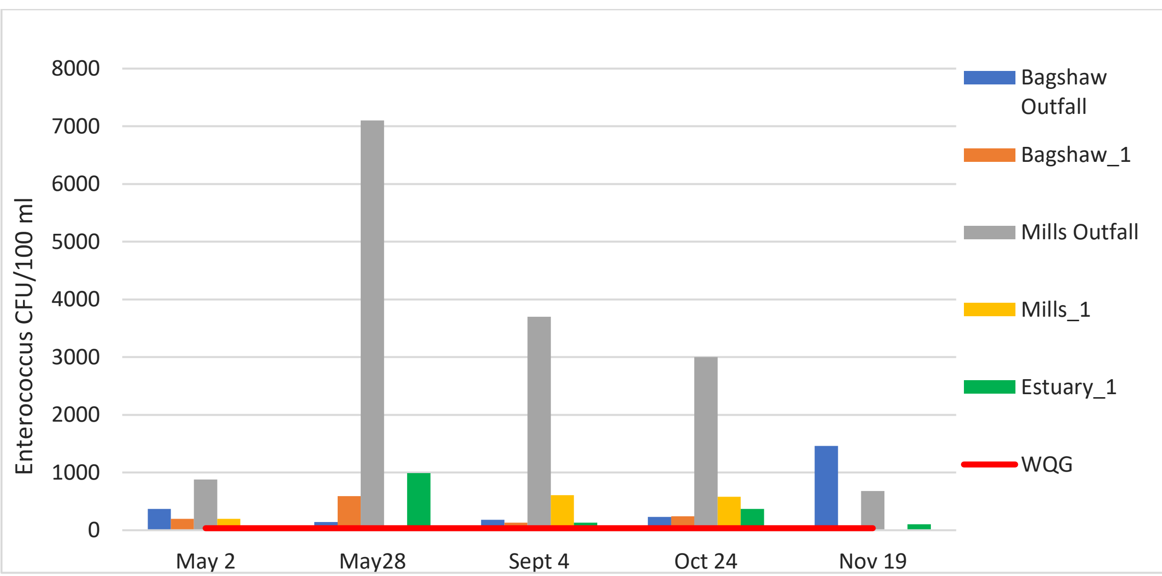


Table 3-4-1. Number of Exceedances of WQG's for E. coli and Enterococcus

Water Sampling Site	E. Coli WQG (200 CFU/100 ml)	Maximum Concentration (CFU/100ml)	Enterococcus WQG (35 CFU/100 ml)	Maximum Concentration (CFU/100ml)
Bagshaw Outfall	0/5	200	5/5	1,460
Bagshaw_1	1/5	380	4/4	590
Mills Outfall	4/5	37,000	5/5	7,100
Mills_1	2/5	4,500	4/4	610
Estuary_1	2/5	340	5/5	990

Due to the high levels of both bacteria, it was important to determine if there was a human source, such as cross connections with septic systems in the stormwater pipelines or failing septic fields. Raw sewage contains household cleaners, detergents, pharmaceuticals, and other substances that are flushed or poured down a drain which can have negative impacts on aquatic life.

3.4.1 Detection of Human Sewage

Analysis for the presence of caffeine is often used to determine if human septic is present in a water sample. On November 19, sampling occurred at the Outfalls and at Estuary_1 that included caffeine analysis. The extra cost for caffeine analysis did not allow for all five sites to be sampled.

Table 3-4-2 contains results of the analysis. Caffeine was detected in all samples with the highest concentration being at the Mills Outfall. It is interesting to note that E. coli concentrations had decreased significantly at the Mills Outfall which suggests that the high E. coli counts are seasonal and may be due in part by the presence of waterfowl, wildlife, or farming activity. However, the Enterococcus concentrations remained high and the presence of caffeine indicates that some of the bacteria has a human source.

Table 3-4-2. Concentrations of E. coli, Enterococcus and Caffeine on November 19, 2019

Water Sampling Site	E. Coli (CFU/100 ml)	Enterococcus (CFU/100 ml)	Caffeine (ug/L)
Bagshaw Outfall	160	1460	0.037
Mills Outfall	170	680	0.488
Estuary_1	28	102	0.0091

3.4.2 Tidal Influence on Bacteria Levels

Table 3-4-3 shows the effect of tide stages on E. coli concentrations at Estuary_1. Concentrations of E. coli downstream of the Outfalls and at Estuary_1 decrease in relation to increases in the volume of salt water. This is not unexpected as E. coli is short-lived in salt water, so concentrations at mid tide should be lower than those at low tide, and concentrations at high tide should be lower than mid tide.

Waterfowl and deer were observed in the West Side through out the sampling period, as were their droppings and pellets. It is likely that some of the E. coli detected at the downstream sites and Estuary_1 came from these animals.

Table 3-4-3. E. coli Concentrations (CFU/100 ml) at Different Tide Stages

Water Sampling Site	Low Tide	Mid Ebb Tide	Mid Flood Tide	Low High Tide	High High Tide
Bagshaw Outfall	200	40	21	64	160
Bagshaw_1	380	98	29	68	
Mills Outfall	37,000	>600	12,000	22,000	170
Mills_1	4,500	76	71	210	
Estuary_1	340	200	220	68	28

Enterococcus is not influenced by salt water. It is difficult to determine from the data in Table 3-4-4 a relationship between Enterococcus concentrations at Estuary_1 with the tide stages. There is one occasion when the bacteria concentration at Estuary_1 is higher than both the Outfalls downstream sites, and two occasions when concentrations at Bagshaw_1 is higher than the Bagshaw Outfall. This may be an indication that the West Side has its own source of Enterococcus in the resident wildlife.

Table 3-4-4. Enterococcus Concentrations (CFU/100 ml) at Different Tide Stages

Water Sampling Site	Low Tide	Mid Ebb Tide	Mid Flood Tide	Low High Tide	High High Tide
Bagshaw Outfall	230	370	140	183	1460
Bagshaw_1	240	200	590	131	
Mills Outfall	3,000	880	7,100	3,700	680
Mills_1	580	200	48	610	
Estuary_1	370	70	990	131	102

3.5 Physical Conditions at Sample Sites

Table 3-5 contains data collected from field measurements of temperature, dissolved oxygen, turbidity and specific conductivity. Water temperature at Estuary_1 exceeded upper threshold levels for the rearing of Coho Salmon (17 ^{o}C) and Steelhead Trout (19 ^{o}C) on May 28, when young fish of these species may have been present in the West Side (Barlak, R. 2010).

Dissolved oxygen concentrations were good for aquatic life despite the high temperatures. DO concentrations of 3.0 mg/L and less are considered lethal to salmonids (Dave Clough, personal communication). One DO concentration approached the lethal limit at 3.74 mg/L. The remaining DO concentrations ranged between 5.6 and 12.98 mg/L which is suitable for most aquatic life.

The WQG for turbidity is 2 NTU. Of the twenty-three measurements taken for turbidity, only eight measurements were below 2 NTU. The remaining measurements ranged between 2.11 and 10.32 NTU. Turbidity is used to measure the amounts of suspended solids in the water column which are assumed to come from erosion and sedimentation and can clog fish gills. Bacteria, algae and decomposing organic matter and can also increase turbidity (Minnesota Pollution Control Agency, 2008). The source of turbidity at the sample sites appeared to be due to the latter, based on field observations of the water.

Specific conductivity did not prove to be a useful parameter for water quality since it is affected by salinity. It did, however, demonstrate that tidal waters reach the downstream sites of the Outfalls.

Table 3-5. Field Measurements for Physical Conditions at Sample Sites

Water Sampling Site	Low Tide (October 24, 2019)				Mid Ebb Tide (May 2, 2019)				Mid Flood Tide (May 28, 2019)				Low High Tide (September 4, 2019)				High High Tide (November 19, 2019)			
	Temp °C	D.O. mg/L	Turb NTU	Cond µs/cm	Temp °C	D.O. mg/L	Turb NTU	Cond µs/cm	Temp °C	D.O. mg/L	Turb NTU	Cond µs/cm	Temp °C	D.O. mg/L	Turb NTU	Cond µs/cm	Temp °C	D.O. mg/L	Turb NTU	Cond µs/cm
Bagshaw Outfall	14.4	9.34	0.99	289.8	11.4	8.40	3.24	627.7	14.5	8.17	1.25	502.8	18.4	7.02	1.21	541.6	12.0	8.30	3.36	369.1
Bagshaw_1	13.2	5.33	0.95	10,997	15.50	6.40	1.18	32,275	19.0	12.98	5.90	1,483	20.6	7.81	5.27	12,350				
Mills Outfall	14.4	7.66	4.87	499.3	11.50	8.60	1.53	430.2	15.0	4.08	2.64	496.2	18.0	8.25	1.56	600.0	11.5	9.24	10.32	319.2
Mills_1	13.9	6.65	4.54	933.0	14.4	10.7	2.11	3,221	20.3	7.5	4.66	21,573	16.9	3.87	3.74	28,689				
Estuary_1	12.2	6.70	3.75	311.0	15.6	8.76	3.94	12,237	24.5	11.8	5.54	11,706	18.4	5.6	1.23	32,834	8.6	8.61	3.16	22,365

Temp = Temperature, D.O. = Dissolved Oxygen, Turb = Turbidity, Cond = Specific Conductance

4.0 CONCLUSIONS

1. Dissolved copper concentrations in discharge from the stormwater outfalls (Bagshaw Outfall, Mills Outfall) caused exceedances of Long Term and Short Term Water Quality Guidelines for the Protection of Aquatic Life in the West Side. Negative impacts to aquatic life may have occurred.

2. Dissolved zinc concentrations in discharge from the Bagshaw Outfall caused some exceedances of Long Term Water Quality Guidelines for the Protection of Aquatic Life in the West Side. Negative impacts to aquatic life may have occurred.

3. Discharge from the stormwater outfalls was a source of high E. coli and Enterococcus concentrations, with the Mills Outfall having the highest concentrations. Caffeine analysis showed that some of the bacteria in both Outfalls comes from a human source. Although these bacteria do not affect aquatic life, the presence of pollutants contained in human septic (detergents, cleaning products, pharmaceuticals) could have negatively impacted aquatic life in the West Side.

4. The Engineering Department for the City of Parksville was notified of the water quality results. A quarterly sampling program for all the stormwater outfalls in Parksville was developed by the City, along with a plan for an investigation into the source of human septic in the Mills Outfall. The program was implemented in May 2020.

5. Only one of twenty-three samples contained hydrocarbons. Concentrations were below WQG's.

6. Water temperatures in the West Side can reach levels that exceed thresholds for rearing salmonids in the spring. At the time of the study, there was no shade along the channel. Addition of shade would be beneficial to aquatic life in the West Side.

7. Dissolved oxygen levels are generally suitable for aquatic life. High turbidity levels are most likely due to the presence of bacteria, algae and decomposing organic material so not detrimental to aquatic life.

5.0 REFERENCES

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