Liquid Waste Management Plan

Addendum to Enhanced Environmental Impact Study



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July 31, 2025

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1. RECEIVING ENVIRONMENT MONITORING PROGRAM

The Village of Cumberland (VOC) operates a sewer system and wastewater treatment plant (WWTP) with treated effluent discharged into Maple Lake Creek (MLC). The VOC proposes to use WWTP discharge as beneficial stream flow augmentation. An enhanced Environmental Impact Study (EIS) was developed to assess the potential associated benefits and adverse effects to surrounding wetlands, MLC, and the Trent River from effluent discharge from the upgraded WWTP (Dinn *et al.* 2025). Per the Terms of Reference (TOR) provided by the British Columbia Ministry of Environment and Parks, as part of the permitting process under the *Environmental Management Act*, the proponent is responsible for developing and implementing a science-based Receiving Environment Monitoring Program (REMP) capable of evaluating treatment performance, receiving environment condition, and potential adverse effects to the environment. This report describes the proposed REMP sampling design, methods, and reporting.

The REMP was informed by the enhanced EIS, which assessed the predicted impacts to the receiving environment after proposed upgrades are made (Dinn *et al.* 2025). The REMP will assess potential effects of WWTP effluent discharge to aquatic life and monitor the effectiveness of mitigation. This REMP is designed to evaluate effects in the receiving environment only; efficacy of the wastewater treatment on effluent quality will require end of pipe monitoring as part of the Liquid Waste Management Plan or Operations Certificate.

This REMP was developed consistent with guidance provided in the following technical documents, per the TOR:

- Guidelines for designing and implementing a water quality monitoring program in British Columbia (BC MELP 1998).
- BC Field Sampling Manual (Government of BC 2013) and the updated BC Field Sampling Manual for surface water sampling (BC ENV 2024).
- Marine Monitoring Guidance (LGL Limited and BC ENV 2019), consulted for general guidance on receiving environment monitoring.
- Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (BC MOE 2016), for discussions of statistical power, relevant methods, and other general considerations.

1.1. Goals and Objectives

Water quality monitoring is proposed to assess the potential effects of WWTP effluent discharge on aquatic life and monitor the effectiveness of mitigation. As described in the enhanced EIS (Dinn *et al.* 2025), the combination of the WWTP upgrades, biochar media reed bed (BMRB) and natural wetland complex is anticipated to reduce concentrations of key water quality parameters of potential concern (e.g., nutrients, metals, temperature). However, there is uncertainty regarding the efficacy of wetland treatment to remove nutrients and certain parameters. This uncertainty will be

managed via adaptive management and will involve monitoring water quality, reviewing data regularly, and applying additional monitoring and/or mitigation (e.g., enhanced treatment systems, wetland restoration) if deemed necessary based on evaluating monitoring results and in consultation with regulators.

Thus, the goals of the REMP are to:

1. Verify the conclusions of the enhanced EIS that the future VOC WWTP effluent discharge is not predicted to adversely affect human health or the aquatic environment following the application of mitigation measures.
2. Monitor the effectiveness of the WWTP upgrades and constructed BMRB at removing nutrients and metals.

The monitoring questions are:

1. Does water quality meet guidelines to protect aquatic life and human health? If not, does water quality differ between the control and impact sites in the natural wetlands, MLC, and the Trent River? If so, do such differences indicate adverse effects of the WWTP effluent discharge on the receiving environment?
2. Does mitigation improve water quality between the end of pipe and downstream of the BMRB and the natural wetlands?

The monitoring objectives are:

1. Assess if measurements of the key parameters (physical, bacteriological, metals, nutrients, and chlorophyll-*a*) meet water quality guidelines and/or differ between the control sites (upstream MLC, Trent River, and natural wetlands) and impact sites (downstream MLC, Trent River, and natural wetlands).
2. Assess if the measurements of the parameters (physical, bacteriological, metals, nutrients, and chlorophyll-*a*) differ between the end of pipe and downstream end of the BMRB, and between the control site (natural wetlands) and mitigation site (at the downstream end of the BMRB and the reed canary grass wetland represented by CWC-03).

Monitoring objectives are designed to be addressed by making comparisons to water quality guidelines bi-annually, and evaluating differences between control and impact or mitigation sites after two years (as described in Section 1.7). Water quality parameters will be compared to guidelines developed to protect aquatic life, wildlife, and drinking water sources. If water quality measurements are found to exceed guidelines, then additional sampling such as biological monitoring (e.g., sediment sampling) will be considered. An assessment report will be prepared after five years that will provide a synthesis of all monitoring results to date and include recommendations regarding future monitoring.

The below subsections describe the following components of the REMP: 1) sampling design, 2) sampling methods, 3) sample handling, 4) analytical methods, 5) quality assurance/quality control (QA/QC) processes, and 6) data reporting.

1.2. Sampling Design

1.2.1. Approach

To evaluate potential effects on the wetlands, MLC, and the Trent River, a control-impact study design is prescribed, where an "impact" is assessed by statistically comparing measurements between upstream control and downstream impact sites. Mitigation efficacy will be evaluated by comparing measurements for sites at the downstream end of the BMRB and natural wetlands receiving environment with end of pipe water quality.

The REMP will involve sampling at 11 sites, comprising the four compliance monitoring sites required by Permit 197, three additional stream sites including two upstream control sites (one each on MLC and the Trent River), and four new wetland sites including two mitigation monitoring sites and one control site (Map 1).

The REMP sampling design is summarized by water quality parameter category in Table 1 and by sampling sites in Table 2.

1.2.2. Site Selection

The rationale for selecting each sampling site is described in Table 2. Site selection was informed by previous work: the enhanced EIS, which well characterizes wetlands and streams (Dinn *et al.* 2025); baseline studies (Hull *et al.* 2022); and 20 years of permit sampling (Appendix A of Dinn *et al.* 2025).

Stream sample sites are selected to ensure coverage of different ecological areas in each stream. Upper MLC (MLC-DSWQ01) represents a stream reach where less sensitive species are present (e.g., Threespine Stickleback) and therefore less sampling effort is recommended. Lower MLC (MLC-DSWQ03; permit Site 6) represents a stream reach that supports more sensitive species such as anadromous salmonids, and therefore long-term compliance monitoring is recommended at this site. The Trent River supports sensitive aquatic species and is a recreational use area. For this reason, sampling in the Trent River is designed to monitor potential impacts to both human health and aquatic life (described in detail in Table 2). Water quality at the most downstream Trent River site (TRT-DSWQ03) tends to be similar to that at TRT-DSWQ02 (permit Site 13) and therefore only two years of monitoring in the dry season are recommended at TRT-DSWQ03 to confirm that this area of the stream is represented by water quality measurements at TRT-USWQ02 (permit Site 8).

In wetlands, site locations were selected to monitor potential effects on wetlands by selecting a control site located upgradient of WWTP discharge (CWC-01), an impact site located approximately 100 m downstream of the discharge point within the assumed main flow path of WWTP discharge (CWC-03), and a second potential impact site at the edge of the sensitive bog ecosystem (CWC-05). If two years of monitoring confirms that the enhanced EIS conclusions that there will be no effects from WWTP operations on water quality or vegetation communities are accurate, then no additional sampling effort will be required. Mitigation efficacy will be monitored throughout the operational period at the end of the constructed BMRB (CWC-BMRB-01) and the reed canary grass wetland (CWC-03).

1.2.3. Parameter Selection

Based on the results of the enhanced EIS (Dinn *et al.* 2025), the water quality parameters proposed to be sampled comprise the following parameter categories: physical (e.g., pH, temperature), microbial (fecal coliforms and *E. coli*), metals, nutrients (forms of phosphorus and nitrogen), explanatory (chloride and dissolved organic carbon) and chlorophyll-*a*. The complete list and rationale for selecting water quality parameters included in the REMP are presented in Table 1. Not all parameters will be monitored at all sites during all sample events (Table 1). Other parameters of potential concern evaluated in the enhanced EIS, such as total suspended solids, turbidity, aggregate organics, total residual chlorine, legacy and emerging contaminants of concern, and hydrocarbons, are not proposed to be sampled as part of the REMP because they were either predicted with sufficiently high confidence to meet relevant guidelines or be below method detection limits in future effluent at end of pipe.

The monitoring will focus on parameters of most concern to each ecological area. Bacteriological parameters (fecal coliforms and *E. coli*) are anticipated to meet relevant guidelines at end of pipe but will be sampled at permit compliance sites only (MLC-DSWQ03, TRT-USWQ01, TRT-DSWQ01 and TRT-DSWQ02) because these parameters are indicators of potential human health hazard, and these four sites are considered representative of the most sensitive ecological areas. In addition, chlorophyll-*a* will be sampled at Trent River sites only, because the Trent River is considered most sensitive to phosphorus inputs which may increase periphyton biomass, which is measured indirectly by chlorophyll-*a*. Physical measurements, metals, and nutrients will be sampled at all sites.

At the wetland monitoring sites (CWC-01, CWC-03, and CWC-05), both water quality sampling and vegetation surveys will be completed in year one and year two of WWTP operations, at minimum. Vegetation surveys will be completed once per year during the growing season, concurrent with water quality sampling. This monitoring will evaluate if there have been any changes to the vegetation communities that could be attributed to changes in water quality and/or hydrologic conditions at the sites, and determine whether adaptive management strategies (e.g., water containment, change to flow pathways, targeted vegetation planting, etc.) are required to maintain the health of vegetation communities upstream (CWC-01) and adjacent to (CWC-05) the expected receiving environment of WWTP discharge, and/or improve water quality functioning of the BMRB and receiving wetland (CWC-01).

Only water quality sampling is proposed for the BRMB (at CWC-BMRB-01). If the water at CWC-BMRB-01 and/or CWC-03 does not meet the water quality improvements predicted in the enhanced EIS, additional sampling may be conducted at these sites and adaptive management strategies identified to improve water quality.

1.2.4. Sample Timing and Frequency

Water quality sampling will occur during both dry (May to September) and wet (October to April) weather months to account for seasonal variability. Sampling is proposed to occur monthly from May to September (during the most critical period to aquatic life and time of greater potential variability in

wetland water levels) and twice in winter (when conditions are expected to be less variable). The higher frequency of sampling proposed in May to September will ensure good temporal coverage during the growing season and ensure results can be compared to guidelines for Phosphorus Management in Vancouver Island Streams (BC MOE 2014).

The proposed frequency of monitoring varies by site and by parameter. Sites will be sampled either for two years (unless a potential effect is detected) or throughout the Operational Period. The sampling sites that can be discontinued from the REMP after two years are the sites 500 m downstream MLC (MLC-DSWQ01), 2.5 km downstream Trent River (TRT-DSWQ03), the natural wetlands control site (CWC-01), and the site at the edge of the bog (CWC-05) (Table 2). Only two years of monitoring are proposed to confirm no effect at these sites; if adverse effects are detected, additional monitoring will commence to further evaluate effects to biological receptors.

It is important to note that changes to vegetation communities can take time. If water quality data collected at the wetland control site (CWC-01) or potential impact site (CWC-05) shows no negative trend and there have been no negative changes to vegetation community after two years of monitoring, monitoring at these sites may be discontinued; however, it would be prudent to complete a water sampling and vegetation survey data collection program in year five of operations to confirm WWTP discharge is still having no impact to these sites.

Water quality parameters at each site will be sampled either throughout the Operational Period, or for five years; updates to the monitoring frequency after the first five years will be confirmed based on the outcomes of the five-year analysis. The sampling frequency of parameters that will be re-assessed after five years include metals, nutrients, and chlorophyll-*a*. Physical and bacteriological parameters are proposed to be sampled throughout the Operational Period (Table 1).

The sampling design incorporates regular review and reporting of annual results, as described in Section 1.7. The decision to discontinue sites/parameters from the REMP will be based on the interim evaluation of potential effects after two years of data collection (Section 1.7).

Table 1. Proposed water quality parameters and monitoring requirements for the VOC WWTP Receiving Environment Monitoring Program.

Parameter Category	Parameter[1]	Sites	Frequency	Duration	Type of Sampling	Rationale
Physical[2]	pH Temperature Dissolved oxygen Specific conductance	All	Monthly during dry period (May-Sept), twice in winter (except TRT-DSWQ03)[3]	Throughout Operational Period	Meter	Physical parameters to assess changes in water quality. Potential residual effects of temperature were assessed in the enhanced EIS and further monitoring was recommended. BC water quality guidelines are available for temperature, pH, and dissolved oxygen. Temperature, pH, and dissolved hardness are required to calculate BC water quality guidelines for various parameters.
	Dissolved hardness				Grab	
Bacteriological	Fecal coliforms *E.coli*	Permit sites (MLC-USWQ01, TRT-USWQ01, TRT-DSWQ01, TRT-DSWQ02)		Throughout Operational Period	Grab	Indicators of potential human health hazard. Guidelines are available for fecal coliforms under the Municipal Wastewater Regulation for reclaimed water and for *E.coli* under BC drinking water quality. Bacteriological parameters will be sampled at permit sites only.
Metals	Total and dissolved metals	All		5 years, then to be determined after 5 year analysis	Grab	Metals are present at various concentrations in municipal wastewater. Several metals are potentially deleterious to aquatic organisms. Potential residual effects of metals were assessed in the enhanced EIS and further monitoring was recommended. BC water quality guidelines are available for several metals parameters.
Nutrients	Ammonia nitrogen Nitrate Nitrite Total nitrogen Total phosphorus Orthophosphate	All		5 years, then to be determined after 5 year analysis	Grab	Phosphorus and nitrogen are present in municipal wastewater under various forms. High levels of phosphorus and nitrogen may cause eutrophication and harmful algal blooms. Potential residual effects of some nutrients were assessed in the enhanced EIS and further monitoring was recommended. Water quality guidelines are available for ammonia nitrogen, nitrate, nitrite, and total phosphorus.
Other	Chloride Dissolved organic carbon	All		Throughout Operational Period	Grab	Chloride and dissolved organic carbon are explanatory parameters required to calculate BC water quality guidelines for various parameters.
Chlorophyll-*a*		TRT-USWQ01, TRT-DSWQ01, TRT-DSWQ02, TRT-DSWQ03	Dry period (May-Sept)	5 years, then to be determined after 5 year analysis	Grab	Chlorophyll-*a* will be sampled at Trent River sites only. The Trent River is sensitive to phosphorus inputs which may increase the magnitude of periphyton biomass accumulation which is measured indirectly by chlorophyll-*a*.

[1]Vegetation surveys will occur during the growing season at CWC-01, CWC-03, and CWC-05 in year one and year two to evaluate whether WWTP discharge is negatively impacting the composition and health of wetland vegetation communities.

[2] Discharge from the WWTP will be monitored at end-of-pipe. The enhanced EIS study confirmed that the majority of flow to MLC in summer months is from the WWTP. Thus, no hydrometric monitoring is recommended to further prove this augmentation.

[3]TRT-DSWQ03 will be sampled in the dry period (May-Sept) only as this is the period of concern at this site.

Table 2. Existing compliance sites (Permit 197) and proposed additional sample sites for Cumberland WWTP Receiving Environment Monitoring Program.

Habitat	Site Name	Site Description/Location	Sampling Duration	Rationale
Stream	MLC-USWQ03	MLC, upstream control	Throughout Operational Period	The upstream control site representing background for the EIS (MLC-USWQ02) will be impacted by effluent discharge from the wetlands under Operating conditions. Therefore, a site further upstream in MLC is recommended to act as a control. Although the channel is split upstream, the east channel has been observed to more consistently maintain flow than the east channel and is therefore recommended.
	MLC-DSWQ01	MLC, 500 m downstream of the existing point of discharge	Two years unless potential effects from WWTP operations are detected[1]	Represents a stream reach where less sensitive species were identified (i.e., Stickleback). Therefore, only two years of monitoring are recommended to confirm no effect.
	MLC-DSWQ03/Site 6	5 km downstream of the lagoons at the end of MLC/ 100 m upstream from the confluence with the Trent River	Throughout Operational Period	Compliance site (Permit 197). Represents a stream reach that supports more sensitive species, such as anadromous salmon.
	TRT-USWQ01/Site 8	Control site on the Trent River, located 100 m upstream of the confluence with MLC		Compliance site (Permit 197). Represents background conditions in the Trent River and therefore provides an upstream control for comparison of impact sites to background.
	TRT-DSWQ01/Site 7	Trent River, 100 m downstream of the confluence with MLC		Compliance site (Permit 197). Representative of conditions in the Trent River potentially impacted by WWTP effluent because it is downstream of the confluence with MLC.
	TRT-DSWQ02/Site 13	Trent River, 400 m downstream from the confluence with MLC		Compliance site (Permit 197). Represents fully mixed conditions in the Trent River downstream of the confluence with MLC.
	TRT-DSWQ03	Trent River, ~2.5 km downstream of the confluence with MLC	Two years unless potential effects from WWTP operations are detected[1]	Represents the most downstream reach of the Trent River prior to discharge to Baynes Sound. Measurements tend to be similar to TRT-DSWQ02 and therefore only two years of monitoring to confirm this site is represented by TRT-USWQ02 are recommended.
Wetland	CWC-BMRB-01	At end of biochar media reed bed	Throughout Operational Period	Short- and long-term effectiveness monitoring of the biochar media reed bed to polish WWTP effluent discharge. Monitoring will inform any requirements for adaptive management to meet WWTP water quality objectives.
	CWC-03	Natural wetlands receiving environment		Short- and long-term effectiveness monitoring of the receiving reed canary grass wetland to perform the water quality functions anticipated in the enhanced EIS. Monitoring will inform any requirements for adaptive management or restoration to improve water quality functions.
	CWC-01	Natural wetlands control site	Two years unless potential effects from WWTP operations are detected[1]	To confirm enhanced EIS conclusions that there will be no effects from WWTP operations on water quality or vegetation communities. Monitoring will inform any requirements for adaptive management or restoration, including to prevent future impacts.
	CWC-05	Edge of bog		

[1] If potential effects are detected, additional monitoring will commence to evaluate any effects to biological receptors.

MLC = Maple Lake Creek
WWTP = wastewater treatment plant
Enhanced EIS = enhanced Environmental Impact Study

1.3. Sampling Methods

Sampling methods will be consistent with those used for previous water quality sampling as described in the enhanced EIS (Dinn *et al.* 2025) and Aquatic Assessment Report (Hull *et al.* 2022).

Water quality data will be collected using two methods: (1) *in situ* sampling at each site, and (2) collection of water samples for laboratory analysis. Sampling procedures and selection of method detection limits will be determined following the British Columbia Field Sampling Manual (Part E1: Surface Water; BC ENV 2024).

In streams, water quality samples will be collected in the main flow of the channel away from watercourse banks, avoiding areas with unusual flow characteristics (e.g., eddies or backwater areas) or floating debris. Sample sites are accessible by wading and the sampler will collect samples from upstream of where they are wading. *In situ* samples will be collected at 0.2 m below the surface with a meter (such as YSI meter) that has been bench calibrated prior to field sampling. Laboratory samples will be collected at 0.2 m depth at all sites. Field crews will ensure that the inner portion of the sample bottle and cap are not contaminated (touched) by anything other than sample water and preservative (if applicable).

In wetlands, water quality samples will be collected from monitoring wells in the BMRB and existing wetlands. A monitoring well will be installed in the BMRB (CWC-BMRB-01) once constructed, and the monitoring wells at the edge of the bog (CWC-05), control site (CWC-01), and reed canary grass meadow impact site (CWC-03) will be replaced with deeper monitoring wells following standard techniques (Government of BC 2013) (Map 1). Prior to water sampling, wells will be purged using a hand-held pump (e.g., Waterra SS-19). *In situ* sampling will occur prior to and after purging the well with a meter (e.g., YSI) that has been bench calibrated prior to field sampling. Water levels will also be measured and recorded prior to and after purging the wells, and after water sampling, using a water level meter (such as a Solinst Model 101; 1 mm accuracy). Due to the relatively small diameter and shallow depth of these wells, the equivalent of one well volume is typically needed to stabilize water level, temperature, pH, and electrical conductivity to pre-purge levels. Water will be pumped from the well directly into sample bottles for laboratory analysis. To avoid contamination between sites, the pump hose will be changed prior to purging and sampling each site (i.e., it will not be reused). There are conditions when there may be insufficient water in the well(s) to collect water samples, particularly during the driest summer months. Installation of deeper wells may remedy this issue, but if this situation occurs, a soil pit will be dug to the water table near the well site to collect *in situ* and laboratory water samples and to record water levels in relation to the ground surface.

In addition to water quality sampling in the wetlands, a vegetation survey will be conducted at the wetland monitoring sites (CWC-01, CWC-03, and CWC-05) during the growing season. Plants have specific tolerances to water quantity and quality conditions. Changes in vegetation communities (species present, abundance, health) can reflect shifts in water quality parameters like pH, nutrient levels (e.g., nitrogen, phosphorus), or water table depth. The vegetation surveys, along with the repeated collection of water quality and water table data over time and the analysis of these data will

meet the objective of evaluating whether WWTP discharge is having a negative effect on wetland function at CWC-01 and CWC-05, and whether the CWC-03 mitigation site is effectively improving water quality as predicted in the enhanced EIS.

Monitoring methods will follow a qualitative approach to assess whether WWTP discharge is impacting wetland vegetation communities outside of the expected receiving environment (i.e., at CWC-01 and CWC-05). Sites will be monitored by establishing permanent plots to record vegetation and hydrologic condition, and by comparing these data to data recorded at the mitigation sites (CWC-03 and CWC-BMRB-01), as well as baseline conditions at these plots.

Vegetation surveys will consist of evaluating plant species composition, abundance, or and health following provincial field data collection standards (MacKenzie and Moran 2004; BC MOFR 2010). Prior to WWTP discharge, a permanent plot will be established in each of the three sites. Plot data will be recorded prior to WWTP discharge. Plot locations will be selected to capture the variability of vegetation communities and microsite positions, such as shallow open water. Plots will be 100 m^2 in size with a radius of 5.54 m. Plot centers will be permanently marked with a wooden stake and the perimeter will be marked with temporary bright-coloured flagging tape or pin flags. String will be placed from plot center to the perimeter at each cardinal direction: north, east, south, and west. Within each plot, photos will be taken to capture the vegetation cover and site conditions within each quarter of the plot viewing northeast, southeast, southwest, and northwest.

At each plot, the following biophysical conditions will be monitored once during each monitoring year, at the same time each year (within one month and under the same conditions, i.e., considering whether the monitoring year is drier or wetter than in previous years of monitoring), and during a water quality sampling trip, recording:

- Vegetation species composition and structure;
- Mortality percent cover;
- Vegetation species percent cover;
- Notes on water flow and water direction (if applicable); and
- Measurements of surface water level and water table depth.

Corrective (adaptive) management actions will be implemented immediately if the QEP and/or the Ministry advises it is necessary based on monitoring results, i.e., to address any criteria that are not trending towards success (i.e., meeting the objectives of this REMP and the predictions of the enhanced EIS). Field data will be analyzed to evaluate whether success criteria have been met. The recommended success criteria for evaluating impacts of the WWTP discharge to the wetland control site (CWC-01) and potential impact site (CWC-05) are as follows:

- Water quality is comparable to (i.e., within the range of) baseline conditions and has not deteriorated;

- Water depths are typical or within the range needed to maintain the existing vegetation community, considering sampling conditions (i.e., whether it is a drought or non-drought year); and
- No more than a 5% change in vegetation community composition and abundance (a range of 1-5% annual change is often considered typical for many ecosystems undergoing natural succession or experiencing moderate environmental fluctuations, e.g., Moseley 2018; Franklin *et al.* 2016; Zweig and Kitchens 2009).

Where monitoring results show signs of conditions that do not meet the objectives, such as vegetation mortality, decreasing vegetation cover, increasing invasive plant infestations, poor water quality (e.g., extreme pH values), adaptive management strategies will be implemented.

The success criteria for evaluating mitigation effectiveness and the need for adaptive management actions at CWC-BMRB-01 and CWC-03 are as follows:

- Water quality at CWC-BMRB-01 is improved from end of pipe water quality; and
- Water quality at CWC-03 is improved from the water quality at CWC-BMRB-01.

1.4. Sample Handling

Field crews will take due care in sampling, storing, and transporting the samples to control temperature and avoid contamination, breakage, and any other factor or influence that may compromise the integrity of the samples. Field crews will ensure that sample hold-times are strictly adhered to by ensuring that samples are received by the laboratory within their designated hold-time.

Laboratory sample analysis will be completed by an accredited analytical laboratory with an ISO/IEC 17025:2017 and Canadian Association for Laboratory Accreditation certification. *In situ* and laboratory sampling procedures, chain of custody procedures, and QA/QC procedures will adhere to the guidelines of the BC Field Sampling Manual (Government of BC 2013; BC ENV 2024). Site photos will be collected and archived for all sites, and detailed information (e.g., location, date and time, persons involved) will be recorded for all data collected. In addition, data screening and management will follow the QA/QC procedures outlined below in Section 1.6.

1.5. Analytical Methods

Water quality measurements will be compared to short-term maximum BC water quality guidelines for the protection of aquatic life (BC WLRS 2025) and BC drinking water guidelines (BC ENV 2020). Several water quality parameters have BC water quality guidelines that are calculated based on an equation that depends on the value of another parameter (e.g., pH, dissolved hardness (as $CaCO_3$), dissolved organic carbon, chloride). These guidelines are calculated based on the water chemistry associated with each sampling site/date. Where applicable, triplicate *in situ* measurements of pH and water temperature will be averaged for the calculation of the guidelines.

If water quality guidelines are exceeded at the impact sites, an analysis will be conducted to assess if there are statistical differences between upstream control and downstream impact sites. It is assumed

that this analysis will use the same statistical method as used in the enhanced EIS, i.e., Wilcoxon-Mann-Whitney rank sum test (or parametric equivalent if assumptions are met) where differences are considered statistically significant if the p-value is less than or equal to 0.05 (Dinn *et al.* 2025). This statistical analysis will be conducted after two years of data collection and presented in the preliminary assessment report, described below in Section 1.7. After two years of data collection, ten samples will have been collected at each site during the dry period (monthly sampling from May to September); Conine *et al.* (2021) conducted a power analysis to determine how many samples are needed to evaluate exceedances of water quality criteria in flowing waters and found that eight samples are needed to obtain at least 80% power, which is considered sufficient at detecting effects.

1.6. QA/QC Processes

In situ water quality meters will be maintained and operated following the manufacturer's recommendations. Maintenance will include calibration, cleaning, periodic replacement of components, and proper storage. Triplicate readings will be collected for *in situ* data at each site. For grab samples, one duplicate sample and one field blank will be collected during each sampling event, consistent with the BC Field Sampling Manual (Government of BC 2013; BC ENV 2024), which suggests that one replicate sample should be collected for every ten samples and one field blank should be collected once per day.

Water quality samples for laboratory analysis will be collected in appropriate bottles provided by an accredited laboratory and filtered and preserved as required. Sample containers and preservatives will be provided by an accredited laboratory. Samples will be packaged in clean coolers filled with ice packs and couriered to an accredited laboratory within 24 hours of collection. Standard Chain of Custody procedure will be strictly adhered to. An accredited laboratory will be selected that maintains a Quality Management System that adheres to the requirements of the ISO: IEC 17025:2005 standards. Laboratory QC procedures will include replicate analysis of a subset of samples, analysis of standard reference materials, and method blanks. Samples will be analyzed to the lowest method detection limit to ensure the reliability and quality of analytical results.

Data will be entered into a database, where comprehensive QA/QC procedures are implemented. Detailed information (e.g., collection date, persons involved, analytical methods, techniques, or procedures employed) is recorded for all analyses. Sample data and QA/QC results (e.g., hold time exceedances, precision among replicates, field blank detections) will be evaluated based on the BC Guidelines for Interpreting Water Quality Data (RISC 1998) and British Columbia Field Sampling Manual (Government of BC 2013).

1.7. Data Reporting

The reporting schedule will involve bi-annual summary reports of dry weather months (May to September) and wet weather Months (October to April). These reports will present seasonal summary statistics (average, minimum, maximum, and standard deviation) calculated for each sampling location. Values below the method detection limit will be set as the method detection limit for these

calculations. The results will be compared to water quality guidelines to protect aquatic life, and to drinking water guidelines where applicable. Recommendations to modify the monitoring plan based on monitoring results will be evaluated in each bi-annual summary report as part of the adaptive management strategy. Laboratory reports will be provided in an appendix.

After two years, a preliminary assessment report will be developed that compares summary statistics at the impact sites to upstream control sites. A statistical comparison between control and impact sites will only be conducted if water quality guidelines are exceeded at the impact sites. Prior to drawing conclusions, any statistical differences will be carefully evaluated in the context of potential confounding factors and biological significance. This two-year preliminary report will evaluate the need for additional sampling at wetland sites and additional sampling at TRT-DSWQ03. If this report indicates that there is no effect (i.e., all water quality guidelines are met and/or water quality and vegetation communities at wetland sites CWC-01 and CWC-05 have not deteriorated), then select sampling sites and parameters can be discontinued from the REMP, as described in Table 1 and Table 2.

After five years, a five-year assessment report will be prepared. This assessment will evaluate whether the findings and assumptions of the enhanced EIS are accurate (i.e., do field measurements meet predictive assumptions, is mitigation performing as expected) (Dinn *et al.* 2025). The report will compare summary statistics at the control sites to those at the impact sites. Results will be compared to applicable water quality guidelines. The potential effects of WWTP discharge in the receiving environment will be evaluated and compared to the assumptions in the enhanced EIS (Dinn *et al.* 2025). In addition, the efficacy of mitigation (reed bed, natural wetlands) and WWTP upgrade efficacy will be evaluated. The REMP sample design and mitigation measures will be evaluated by a QEP and changes for improvement will be recommended if monitoring indicates effects to receptors of concern are possible or whether monitoring of some parameters can be discontinued.

Reports will include the following:

- Executive summary and introduction (with rationale and objectives clearly defined);
- Program methodology (including sampling sites, field and analysis methods, and QA/QC details);
- Summaries of results and analyses (e.g., summary statistics, comparison to applicable water quality guidelines, spatial/temporal trends, and statistical analysis);
- Conclusions of analysis;
- Recommendations; and
- Laboratory results, e.g., as appendices.

REFERENCES

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PROJECT MAPS

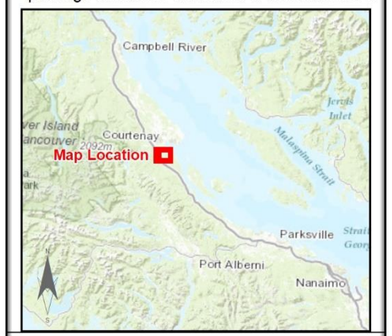
VILLAGE OF CUMBERLAND

REMP Sampling Sites

Legend

- Discharge Point
- Fish Barrier [1]
- Water Quality Site
- Biochar Reed Bed
- Streams
- Watersheds
- Wetland Complex
- Freshwater Atlas Wetland
- SEI Wetland

[1] Approximate location of the complete fish passage barrier as described in Mimulus 2001.



MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 250 500 1,000 m

Scale: 1:18,000

NO.	DATE	REVISION	BY
1	2/24/2025	1345_VOC_REMPSampling_7112_20250224	KCP
2			
3			
4			
5			

Date Saved: 2/24/2025
Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 1

Path: M:\Projects-Active\1345 Village of Cumberland\MXD\1345_VOC_REMPSampling_7112_20250224.mxd