Bridge-Seton Water Use Plan

Monitoring Program Terms of Reference

BRGMON-3 Lower Bridge River Adult Salmon and Steelhead Enumeration

Revision 2
March 28, 2022

BRGMON-3 – Lower Bridge River Adult Salmon and Steelhead Enumeration Monitoring Program Terms of Reference Revision 2

1.0 Monitoring Program Rationale

1.1 Introduction

This BRGMON-3 Terms of Reference (TOR) Revision 2 supports a submission package for an Interim Flow Decision and subsequent Order(s) anticipated from the Comptroller of Water Rights in addition to the original Bridge River Project Water Use Plan Order (Bridge WUP Order) dated March 30, 2011, Schedule A Clause 10 which specifies the requirement to:

a. Monitor how flow regimes affect spawning habitat for adult salmon and adult steelhead.

b. Monitor annual abundance of salmon and steelhead spawning in lower Bridge River and its relations with long term flow requirements at Terzaghi Dam.

c. Determine if flow releases from Carpenter Lake Reservoir have altered the life history and productivity of the Chinook salmon in lower Bridge River.

1.2 Background

1.2.1 Water Use Planning

In 1998 an agreement between BC Hydro and regulatory agencies was adopted in response to public, First Nations, and agency concerns about the lack of continuous flow releases from the Terzaghi Dam into the Lower Bridge River. The agreement specified that an instream flow release and monitoring program be developed and implemented to resolve uncertainty about response of the Lower Bridge River aquatic ecosystem to reservoir releases. The agreement specified that an experimental flow release program was to be initiated and continued until a Water Use Plan (WUP) was developed for the Bridge-Seton watershed.

On July 28, 2000, the Comptroller of Water Rights issued an Order under the Water Act (now the Water Sustainability Act) to initiate an annual water budget of three m^3/s shaped into a seasonal hydrograph plus associated monitoring studies to estimate the effect of that flow treatment on the aquatic ecosystem. Previous flow assessment studies (1993-1995) and ecological monitoring (1996-2000) provided some baseline data on zero flow from Terzaghi Dam into the Lower Bridge River to compare with the three m^3/s flow trial.

Based on the recommendations of the WUP Consultative Committee, a WUP Order was issued by the Comptroller of Water Rights on March 30, 2011 requiring a second treatment with an increase in the annual water budget to six m^3/s shaped into a seasonal hydrograph. This WUP Order also included the implementation of monitoring studies to inform future flow decision.

Aquatic productivity was to be monitored, including juvenile salmonid abundance (within BRGMON-1), the analysis of which would be supported by adult salmon and steelhead enumeration (within BRGMON-3) to examine the relationship between juvenile abundance and the instream flow regime, independent of external factors such as adult escapements.

1.2.2 Long-Term Flow Decision

The results from WUP studies on the Lower Bridge River were intended to inform a long-term flow release strategy recommendation by 2015.

In 2015 and in subsequent years leading up to 2022 when a request for an Interim Flow Decision was submitted by BC Hydro, the Comptroller of Water Rights conditionally approved delaying decision on the long-term flow release strategy.

The water management challenges posed since 2016 (see Section 1.2.3) necessitated further deferral of the long-term flow release strategy until an interim flow strategy could be developed. The Interim Flow Decision requested by BC Hydro in 2022 considers the flexibility needed for flows from Terzaghi Dam until BC Hydro infrastructure upgrades are substantially complete and water management capacity in the Bridge River-Seton system is restored.

1.2.3 High Flow Challenges in the Lower Bridge River

In 2016, BC Hydro Dam Safety issued a directive to reduce storage capacity of Downton Reservoir by ~50% to manage seismic risk. In the same year, BC Hydro advanced critical infrastructure upgrades at the Bridge River 1 and 2 Generating Stations to address the added water management risks associated with reduced storage in Downton Reservoir. The infrastructure upgrades affected the volume of water that could be diverted through Bridge River 1 and 2 from Carpenter Reservoir to Seton Lake. As a result, releases higher than the annual average 6 m^3/s (specifically in the springtime freshet period) may be discharged from Terzaghi Dam down Lower Bridge River in some years based on inflows into the reservoirs and the capacity of Bridge 1 and 2 to pass those inflows. This increased risk of higher flows into the Lower Bridge River is expected to continue until water management capacity in the Bridge River-Seton system is restored through completion of major infrastructure upgrades.

BC Hydro received variance approvals (March 14, 2016, February 16, 2017, February 22, 2018, December 19, 2018 and May 4, 2021) from the Comptroller of Water Rights to vary the Terzaghi Dam discharges from those specified in the WUP, and to implement a more flexible flow regime at Terzaghi Dam following a set of Guiding Principles to inform within season flow release decisions. The discharge variance approvals permitted BC Hydro to exceed the annual average 6 m^3/s treatment hydrograph and specifically the 15 m^3/s maximum peak discharge during the annual freshet flow period (~March to August). Outside of the freshet flow period, BC Hydro has been able to operate Terzaghi Dam according to the seasonal WUP hydrograph limits. These actions to pre-emptively release higher flows during the freshet period substantially reduce the risk of a late summer/fall high flow release which would pose a much greater impact to the aquatic life in the Lower Bridge River (i.e., spawning salmon).

1.2.4 Joint Water Management

From 2016 to 2018 the hydrograph peak and duration during the high flow period were shaped by inflow volumes, with Terzaghi Dam discharges reaching 97 m^3/s in 2016, 127 m^3/s in 2017, 100 m^3/s in 2018 and 25 m^3/s in 2021. Spring freshet flows in these years were managed using the *Guiding Principles* developed jointly in meetings with representatives from St'át'imc, BC Hydro and regulatory agencies where water management options and risks to aquatic life were discussed collaboratively.

The planning meetings were formalized in late 2019 into what is now known as the Joint Planning Forum (JPF) with membership from St'át'imc and BC Hydro, invited participants from regulatory agencies, and occasionally also invited guests from the St'át'imc communities and other supporting parties.

The JPF meets on a monthly basis (or more frequently as required) and has a mandate that includes reviewing water conveyance operations and flow management at the Bridge-Seton Generation Facilities, both on a near and long-term basis, and as part of a potential *interim long-term flow strategy*. The JPF has been successful in providing joint recommendations for water management decisions ultimately made by BC Hydro. The JPF has provided a venue for joint problem solving between St'át'imc and BC Hydro for water management and environmental mitigation projects associated with the impacts of BC Hydro operations.

Revision 2 of this Terms of Reference outlines environmental monitoring associated with the interim flow recommendations provided by the JPF to support BC Hydro's request to the Comptroller of Water Rights for an interim flow decision on the Lower Bridge River.

1.2.5 Learning from the Past

Revision 2 of this TOR seeks to streamline monitoring approaches to address both the original WUP Order objectives and the Interim Flow Decision by building on the information gathered during the first ten years of the WUP studies and acknowledging the completion of monitoring task for which management questions have been resolved or will continue under other separately funded programs.

Similarly, in recognition of the flexibility needed for flow management at Terzaghi Dam until infrastructure upgrades are substantially complete, Revision 2 is also more focussed than the original TOR on filling gaps in knowledge that relate to variable flows (i.e., instream releases that have not previously been monitored). Additional monitoring tasks implemented during periods of high flows in 2016 to 2021 provide a template for high flow conditional monitoring that continue under Revision 2.

The relevant aquatic productivity monitoring scope outlined in the original BRGMON-3 TOR will continue largely unchanged in Revision 2. Monitoring under BRGMON-3 primarily occurs during the fall spawning period which is typically unaffected by Terzaghi Dam freshet discharges. Therefore, except for 2016 when damage to the resistivity counter prevented enumeration in that year, and some overlap of the high flow period with the steelhead migration period, BRGMON-3 monitoring has been unchanged. While Revision 1 of this TOR included a change to enumeration methods for the new equipment following high flow damage, the remainder of changes in Revision 1 were primarily to improve clarity of the TOR and to address methodological gaps including the addition of spawning habitat assessments not included in the original TOR. Revision 2 will consider another enumeration method change.

1.3 Revision Rationale and Summary of Key Changes

The primary objectives of the BRGMON-3 project are to 1) generate high precision estimates for Chinook salmon, Coho salmon, and Steelhead trout escapement that are provided to BRGMON-1 to reduce uncertainty in the response of juvenile salmonid abundance to the instream flow regime, and 2) quantify the quality and quantity of spawning habitat in the Lower Bridge River.

Changes in both Revision 1 and Revision 2 ensure these primary BRGMON-3 objectives are met and are as follows:

- In Revision 1 more specific management questions and hypotheses were included BRGMON-3; however, no significant changes to management questions and hypotheses were considered in Revision 2 other than to adjust the wording to focus on flow conditions rather than a flow regime.
- In Revision 1, new enumeration techniques using an imaging sonar in addition to the existing resistivity counter were employed due to damages sustained by prior high flows; however, Revision 2 requires further review of enumeration techniques within the first year to potentially identify a new option for the following reasons[1]:
    - Operation and data analysis using the imaging sonar are costly
    - The imaging sonar equipment must be removed during high flows that flood the staging area to avoid damage and the equipment must be reinstalled once flows permit.
- Visual survey and radio telemetry tasks were extended in Revision 1 to ensure enough data are collected to meet the original BRGMON-3 objectives due to limitations in data collection during the first six years of the program as a result of the following:
    - The resistivity counter was not fully operational until 2014 after construction was completed
    - Access issues initially limited the use of a telemetry station downstream of the Yalakom River
    - No counter data were collected in 2016 due to damage to the resistivity counter during high flows
    - Limited data were collected in 2017 due to unforeseen data loss.
- In Revision 2 we have considered the number of years of simultaneous stream walk data collection and we have determined that the visual surveys and radio telemetry may no longer be required at least at the same level of

[1] Until an equal or better and more cost-effective enumeration technique is identified data collection will continue to rely on the existing resistivity and sonar counter.

effort, so a decision will be made within the first year to either discontinue or change the scope and effort required.

- Methods to quantify spawning habitat quantity and quality not specified in the original BRGMON-3 TOR were added in Revision 1 and will continue to be used in Revision 2 including spawning habitat surveys and habitat flow modelling to generate an estimate of spawning habitat quality and quantity.
- For continuity, annual Chinook salmon redd assessment will continue under Revision 2.

1.4 Monitoring for Variable Flow Conditions

While operating under the CWR approved variances, BC Hydro implemented additional monitoring (from 2016 to 2021) in response to the variable flows during freshet that was managed separately from BRGMON-3 in Revision 1.

Revision 2 rolls together approaches from both the original WUP monitoring and the supplemental high flow monitoring to create a monitoring strategy that will allow for continued variable freshet flow conditions for future years and help to inform the Guiding Principles for management of year-by-year flow conditions.

The monitoring that is conditional on high flows (initiated upon recommendation of the JPF) is as follows:

- Adult salmon and steelhead visual surveys in areas downstream of the Yalakom River (primarily Reach 2) to identify spawning locations and habitat
- Topographic and erosion/deposition surveys to quantify substrate composition and inform spawning substrate mobilization (Embark 2017; Ellis et al. 2018)
- Spawning habitat surveys in spring to estimate spawning habitat quality and quantity prior to high discharges
- Habitat modelling that will inform habitat changes associated with high flows

1.5 Management Questions

Management questions were not specified in the original BRGMON-3 TOR (dated January 23, 2012) but two uncertainties were discussed. The first uncertainty addressed the use of juvenile salmonid standing crop biomass as the primary indicator of aquatic productivity response, identifying a need to accurately quantify adult escapement to the Lower Bridge River to support this analysis. The second uncertainty addressed spawning habitat availability in the Lower Bridge River.

The management questions introduced in Revision 1 were developed to address these uncertainties. These management questions are:

1) What is the annual abundance, timing, and distribution of adult salmon and steelhead spawning in the Lower Bridge River and are these aspects of spawning affected by the instream flow conditions?
2) What is the quality and quantity of spawning habitat in the Lower Bridge River and how is spawning habitat affected by the instream flow conditions?

These management questions remain unchanged in Revision 2.

1.6 Management Hypothesis

Management hypotheses were not specified in the original BRGMON-3 TOR but were introduced in Revision 1 to help guide the selection of key response variables. The hypotheses presented here are not an exhaustive list and other hypotheses could be examined. Alternative hypotheses were not developed because explanatory variables may change with the analysis of monitoring data.

Null hypotheses to consider associated with Management Question 1 (annual abundance, timing, and distribution of spawning salmon and steelhead) are:

$H_{1.1}$: *There is no relationship between the instream flow conditions and the abundance of spawning salmon and steelhead in the Lower Bridge River.*
$H_{1.2}$: *There is no relationship between the instream flow conditions and the timing of spawning salmon and steelhead in the Lower Bridge River.*
$H_{1.3}$: *There is no relationship between the instream flow conditions and the distribution of spawning salmon and steelhead in the Lower Bridge River.*

Null hypotheses associated with Management Question 2 (quality and quantity of spawning habitat) are:

$H_{2.1}$: *Instream flow conditions do not affect spawning habitat quality in the Lower Bridge River.*
$H_{2.2}$: *Instream flow conditions do not change spawning habitat quantity or distribution in the Lower Bridge River.*

1.7 Key Water Use Decision Affected

Results of the BRGMON-3 Adult Salmon and Steelhead Enumeration program will contribute to the year-by-year operational recommendations, review and the potential for refinement of the Guiding Principles made by the JPF. They will also inform the aquatic productivity analyses carried out under BRGMON-1 and the response of adult salmon and steelhead to different instream flow conditions.

2.0 Monitoring Program Proposal

2.1 Objective and Scope

The main objective of the BRGMON-3 monitoring program is to provide rigorous estimates of the abundance and distribution of salmon and steelhead spawning in the Lower Bridge River. These data support BRGMON-1 estimates of the response of juvenile salmonid abundance to the instream flow conditions by ensuring changes in abundance are not confounded by changes in adult escapement associated with external factors such as changes in marine survival. This reduces uncertainty about the relationship between the instream flow conditions and the relative productivity of the Lower Bridge River.

The BRGMON-3 program also addresses data gaps associated spawning timing, spawning distribution, and spawning habitat quality and quantity. The scope of this program focusses on enumerating adult salmon and steelhead, monitoring spawning distribution and habitat through visual surveys and telemetry, and habitat assessments but it also includes additional monitoring scope that is conditional on high flows and as recommended by the JPF.

2.2 Approach

The BRGMON-3 program provides an annual stock assessment methodology to estimate the abundance, timing, and distribution of spawning Chinook salmon, coho salmon, and steelhead trout. Less intensive supplemental surveys are carried out to estimate the abundance of sockeye salmon and pink salmon.

The stock assessment methodology currently includes use of a counter installed upstream of the Yalakom River confluence combined with streamwalks to estimate abundance of fish spawning upstream of the counter. A review and decision will be made in the first year of implementing Revision 2 about whether to adopt a different adult enumeration method.

Radio telemetry will be typically used to estimate stream walk observer efficiency and provide data on spawning distribution and migration timing throughout the Lower Bridge River; however, a decision will be made by the JPF within the first year of implementing Revision 2 about discontinuing or adjusting scope and effort.

Spawning habitat surveys and flow modelling are used to assess how instream flow affects spawning habitat quality and quantity and detailed redd assessments used help determine spawning habitat use.

The influence of the instream flow conditions on adult abundance are qualitatively assessed by comparing the abundance trends of salmon and steelhead on the Lower Bridge River with other rivers in the Fraser River watershed.

2.3 Methods

2.3.1 Task 1: Salmon and Steelhead Enumeration

Adult Enumeration

The adult enumeration equipment and methodology will be reviewed by the JPF with assistance from contractors in the first year of Revision 2 in order to identify a potential long term more efficient and cost-effective solution.

The combination resistivity fish counter sonar imaging device, located ~0.8 km upstream of the Yalakom River confluence, are currently operated during the migration period for anadromous salmon (~August 1 to January 15) to enumerate Chinook and coho salmon, and steelhead trout (~April 1 to June 30) migrating into Reach 3 and Reach 4 of the Lower Bridge River (Figure 1).

Operation of the counter and the subsequent analysis are intended to produce high precision estimates of salmonid escapement (80% confidence intervals +/- 15% of estimate) to be compared with visual survey results and allow for back calculated estimates of whole-river spawner abundance pre-WUP (prior to 2012).

If river conditions permit, counter operations are optimized, for example, by using a fence to confine migrating salmon to limit the need to operate both the sonar and resistivity counters. Use of a fence could also be used to provide a means to support collection of adult carcasses and otoliths for BRGMON-1 studies (that will inform Chinook salmon life history analyses to be completed under BRGMON-1).

Visual Counts

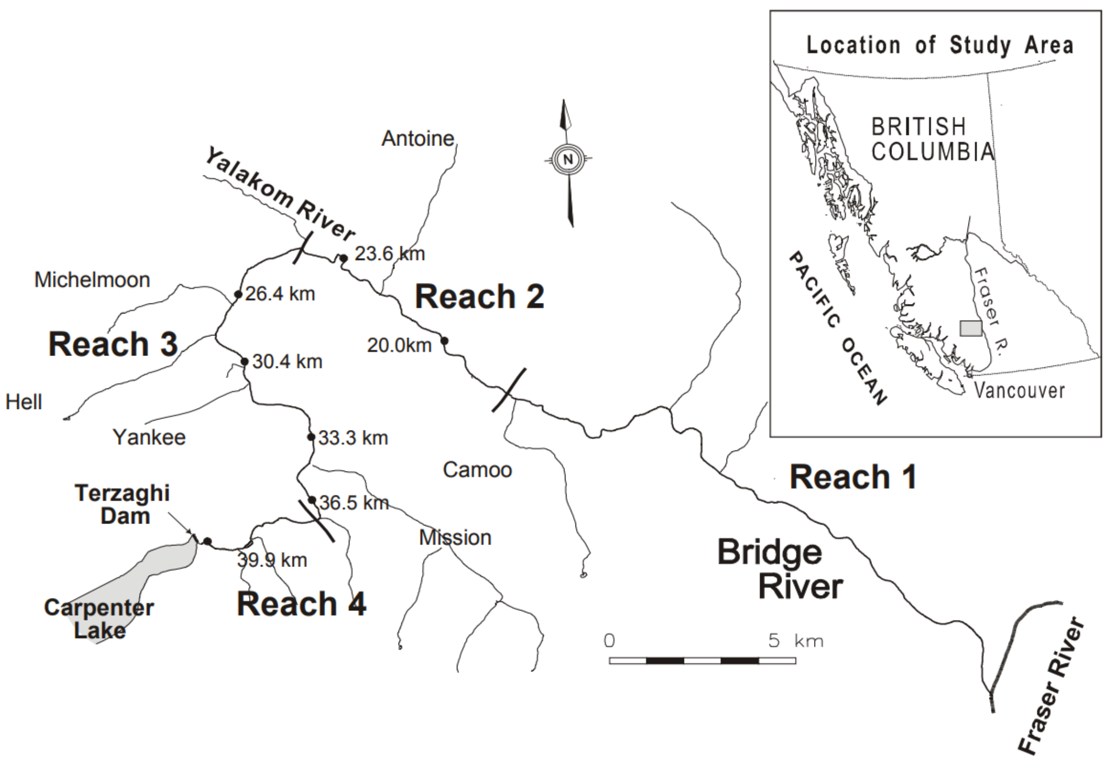
The scope of visual counts will be reviewed by the JPF with assistance from contractors in the first year of Revision 2 in order to identify potential scope adjustments if the level of data collection is no longer necessary in the long term.

Weekly visual streambank counts are undertaken for Chinook salmon, sockeye salmon, pink salmon (odd years), coho salmon, and steelhead trout in Reach 3 and 4 (Figure 1). Methods replicate those used in 2010 surveys with 3 and 4 divided into eight to ten previously defined segments to identify key areas for spawning to support assessments of spawning distribution in response to the instream flow regime. Opportunistic otolith and DNA/scale collection take place whenever adult mortalities are accessible during visual counts and GPS locations of holding location and redds are recorded.

Greater survey effort will be applied to Chinook salmon, Coho salmon, and Steelhead trout as the juveniles of these species rear in the Lower Bridge River and changes in juvenile abundance is a key indicator of the effects of the instream flow regime. Pink salmon and sockeye salmon fry do not rear in the system and therefore a lower level of effort should be applied to estimating the escapement and distribution of these species.

Escapement data for pink and sockeye salmon remains useful for understanding changes in productivity, as carcasses form these species affects nutrient dynamics in the river and high abundance of these species could also affect counter data analysis.

Figure 1: Overview of the Lower Bridge River. Breaks for Reach 1 to Reach 4 are shown.



2.3.2 Task 2: Radio Telemetry Studies

Fish Capture and Tagging

The scope of fish capture and tagging will be reviewed by the JPF with assistance from contractors in the first year of Revision 2 in order to identify whether to discontinue or adjust scope and effort.

Up to 30 Chinook salmon and 30 Coho salmon are angled for collection and radio tagging. Fish are targeted throughout the Lower Bridge River but primarily in the lower reaches to capture migration through the lower reaches of the Bridge River. Effort is made to distribute radio tags spatially, temporally, and across sexes. Sampling at the time of tagging includes fork length, sex, scales, photograph, and a DNA sample. Scales are analyzed for age to assess life history type and DNA analyses performed to confirm stock ID. Any summer-run steelhead trout captured during Chinook salmon and coho salmon angling are opportunistically sampled using the procedures, but radio tags are not applied due to the long holding time of these fish prior to spawning. Visual tags are applied to Chinook salmon and Coho salmon to allow for estimates of observer efficiency during visual count surveys.

Up to 25 steelhead trout are angled in the late-winter/spring either at the Seton River-Fraser River confluence or in the Lower Bridge River. The Seton-Fraser confluence has been found to be a holding area for steelhead trout with most steelhead trout tagged in this area entering the Lower Bridge River. A portion of the steelhead trout tagged in this area entered the Seton River, supporting WUP studies in that system (BRGMON-9). Supplemental tagging can also occur in the Lower Bridge River itself to increase tagging numbers, if required.

Telemetry

The scope of telemetry will be reviewed by the JPF with assistance from contractors in the first year of Revision 2 in order to identify whether to adjust scope and effort.

Fixed and mobile telemetry is used to track salmon and steelhead migration behaviour and timing. Five fixed stations are installed in the Lower Bridge River and Yalakom River and operated from ~August 1 to ~January 15 for Chinook salmon and coho salmon and from ~April 1 to ~June 30 for steelhead trout. Each station is installed with upstream and downstream antennas to corroborate fish location estimates during mobile tracking and refine estimates of fish migration timing and migration behaviour. Stations are installed at the following locations:

- Near the confluence of the Fraser River (~0.7 Rkm)
- Near the Reach 1/2 boundary (~19 Rkm)
- At the Yalakom River confluence (~25.5 Rkm)
- In the Yalakom River upstream of the Yalakom-Bridge confluence to assess fish use of the Yalakom River.
- Near the Reach 3/4 boundary (~37.7 Rkm)

A sixth receiver is also installed in the Seton River to support an understanding of the fate of steelhead trout tagged at the Seton River-Fraser River confluence.

Mobile tracking with a hand-held receiver is conducted over the entire river at a minimum of once per week while tagged fish are in the system. In Reach 3 and 4, mobile tracking will occur immediately prior to visual surveys to locate the number of fish in each streamwalk section and provide an estimate of observer efficiency. During the peak spawning period for each species, mobile telemetry is used to identify spawning locations and, where access permits, individual redds are located and GPS location recorded. The use of mobile telemetry to locate redds or approximate spawning locations is typically important for Coho salmon and Steelhead as increased water turbidity reduces visibility during the spawning period. Any observations of untagged fish during mobile tracking is also recorded.

2.3.3 Task 3: Spawning Habitat Quality and Quantity

Key spawning habitat areas across the Lower Bridge River are identified using radio telemetry and visual survey results, then assessed for spawning habitat quality and quantity using the using the methods outlined in Lewis et al. (2004).

Historic spawning surveys have identified Reach 3 and 4 as the key spawning habitats for Chinook salmon and up to 15 spawning areas will be assessed in Reach 3 and 4. Cross-sectional transects are conducted at each site to collect data on water depth and velocity with the number and spacing of transects determined by site characteristics. Transects also include substrate measurements including visually assessed dominant substrate type and substrate measurements to generate grain size distributions estimates along each transect.

Coho salmon spawning locations have been difficult to identify due to increased fall turbidity in the Lower Bridge River. Coho salmon also spawn later in the year when flows from Terzaghi Dam are lower (1.5 m^3/s) than during the Chinook salmon spawning period (3.0 m^3/s). As a result, where it is possible to identify Coho salmon spawning locations using visual surveys or mobile radio telemetry, additional habitat surveys may be required for Coho salmon, as spawning habitats used by Coho salmon would be different than those selected by Chinook salmon. Up to 15 additional spawning areas are surveyed for Coho salmon spawning habitat in Reach 3 and 4.

Reach 1 and 2 of the Lower Bridge River is also assessed for spawning habitat quality and quantity where spawning habitat is identified through visual surveys or mobile radio telemetry. Up to 10 spawning area surveys are carried out in Reach 1 and 2 following the same methods outlined above. Separate spawning areas may be considered for Chinook salmon and Coho salmon in Reach 1 and 2 if enough spawning activity is identified in these reaches.

Habitat flow modelling is also used to assess spawning habitat quantity throughout the Lower Bridge River. BC Hydro's Telemac2D model is used to estimate water depths and velocities across all reaches to identify key spawning areas and estimate total spawning habitat availability based upon Habitat Suitability Index (HSI) curves for Chinook salmon, Coho salmon, and Steelhead trout spawning. Substrate quality in modeled spawning habitat will be inferred using data from spawning habitat surveys or ground surveys, if required.

Detailed assessment of Chinook salmon and Coho salmon redds have been carried out under BRGMON-3 and continue with the same methods for the duration of the monitoring period to inform spawning habitat quality at identified spawning locations. Any redds identified during mobile tracking or visual count surveys are marked and detailed measurements recorded including depth and velocity, substrate size, temperature loggers, and GPS location.

2.3.4 Task 4: Analysis and Reporting

Enumeration Escapement Estimates

Currently, sonar enumeration data or resistivity/sonar data are combined to generate an estimate of Chinook salmon, Coho salmon, and Steelhead trout escapement in Reach 3 and 4. Data should be validated to remove erroneous detections and estimate (with required 80% confidence intervals +/- 15% of estimate) the number of Chinook salmon, Coho salmon and Steelhead trout that returned. Spawning timing are also estimated from the counter data and visual survey data on spawning activity.

Visual surveys are used to estimate the relative distribution of spawning throughout the streamwalk reaches of the Lower Bridge River and generate Area-Under-the-Curve (AUC) estimates for the abundance of Chinook salmon and Coho salmon. Visual surveys are also used to estimate the approximate abundance of Pink salmon (odd years) and Sockeye salmon spawning in the Lower Bridge River. Visual counts are used in conjunction with telemetry data to annually assess spawning distribution to describe any year-to-year changes in spawning locations in response to the instream flow conditions or other factors such as water temperature or changes in spawning habitat. Counter and AUC abundance estimates are compared to develop and annually update the relationship between the two abundance estimates methods that are then used to back-calculate refined estimates of spawner abundance made prior to 2012. Lower Bridge River abundance estimates are also compared to stock assessment data for other Fraser River Chinook salmon and Coho salmon populations to describe Lower Bridge River population trends relative to other populations. This comparison attempts to qualitatively assess any effects of the instream flow regime relative to external factors that affect Fraser River salmon population.

The adult enumeration equipment and methodology will be reviewed by the JPF with assistance from contractors in the first year of Revision 2 in order to identify a potential long term more efficient and cost-effective solution.

Telemetry Data

Currently, fixed and mobile telemetry data are combined with visual count surveys to generate observer efficiency estimates for Reach 3 and 4 Chinook salmon and Coho salmon surveys. Telemetry results are also used to refine spawning distribution estimates and migration timing for tagged species across the whole river to provide linkages to the instream flow regime and spawning habitat. Data on individual detection histories and spawning locations are recorded to develop a georeferenced inventory of spawning locations that can be mapped to qualitatively examine changes in spawning distribution in response to the instream flow conditions.

The scope of telemetry will be reviewed by the JPF with assistance from contractors in the first year of Revision 2 in order to identify whether to adjust scope and effort.

Spawning Habitat Quality and Quantity

Results from habitat surveys are modeled with HSI curves to generate Weighted Useable Area (WUA) estimates for spawning habitat for Chinook salmon and coho salmon. Results from habitat modelling are compared to WUA estimates generated from the Telemac2D model to assess model predictions and, if possible, extrapolate results to a whole river spawning habitat availability estimate. Redd assessment data are compared to known habitat preferences for spawning Chinook salmon and Coho salmon to assess the quality of spawning habitat used by salmon. This analysis helps inform whether spawning habitat quantity is enough in the Lower Bridge River as spawning habitat quantity may change with the instream flow conditions and in sub-optimal habitat quality could affect spawning success.

Reporting

A single technical report will be prepared annually that summarizes the key qualitative observations and empirical results from the monitoring. A component of the report will include key results synthesized annually and prepared in a simple format that summarizes data across the monitoring period and helps to support JPF recommendations and BC Hydro decision-making related to variability in annual flow conditions and to inform potential refinements to the Guiding Principles.

At the end of the current monitoring period, a final synthesis report summarizing all results will be prepared.

2.4 Interpretation of Monitoring Program Results

Escapement estimates from BRGMON-3 are provided to the BRGMON-1 program to support analyses of the relationship between the instream flow conditions, key aquatic productivity changes, and the response of juvenile salmonid populations. Escapement data is compared with regional escapement data to evaluate trends in abundance. Upon completion of the capital infrastructure improvements in the Bridge River-Seton system that require more flexible operations at Terzaghi Dam, these data will be interpreted to help define a flow release strategy for the Lower Bridge River in the longer term.

2.5 Schedule

The program will be implemented each year until the end of the BRGMON-3 monitoring review period in 2031. The timing of individual components of the work is described within the BRGMON-3 and modified operations monitoring tasks above.

Tasks	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Salmon and Steelhead Enumeration	x	x	x	x	x	x	x	x	x	x
Radio Telemetry Studies	x	x	x	x	x	x	x	x	x	x
Spawning Habitat Monitoring	x	x	x	x	x	x	x	x	x	x
Conditional Monitoring Activities	*	*	*	*	*	*	*	*	*	*
Resistivity Counter Upgrade	*	x	*	*	*	*	*	*	*	*
Workshops	x									
Final Report	x	x	x	x	x	x	x	x	x	x

* Conditional Monitoring is to be implemented at the discretion of the joint planning forum contingent on season, magnitude of flows releases, and availability of pre-existing data

2.6 Budget

Total revised program cost: $ 6,837,603.

References

Embark Engineering. 2017. Lower Bridge River Sediment and Erosion. Prepared for St'át'imc Eco-Resources and BC Hydro. July 2017. Embark No. 12999.010.

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Lewis, A., T. Hatfield, B. Chilibeck, and C. Roberts. 2004. Assessment Methods or Aquatic Habitat and Instream Flow Characteristics in Support of Applications to Dam, Divert, or Extract Water from Streams in British Columbia. Prepared for Ministry of Water, Land and Air Protection and Ministry of Sustainable Resource Management.

Appendix A: Summary of the key changes made to in this revision compared to the BRGMON-3 TOR Revision 1 dated November 2018.

Section	Changes	Rationale
	• Shifted from a focus on flow regime to flow conditions • Introduced the Guiding Principles and a shift in monitoring focus to year-by-year variable flow conditions during freshet • Introduced the role of the Joint Planning Forum and their needs to inform annual decision based on the Guiding Principles • Consolidating scope that was formerly included in high flow and mitigation monitoring within the scope of the WUP Terms of Reference	• Although the flow regime concept will be revisited at the WUP Order review and this monitoring will continue to support that, the monitoring is shifting focus to better support variable freshet flow conditions on a year by year basis that we expect to continue until BC Hydro has substantially completed facility upgrades • Acknowledge the linkages between data collected under this monitoring program and its value to applying the Guiding Principles to year-by-year recommendations for water management • Identifying that this monitoring program will now be under more direct oversight and recommendations of the Joint Planning Forum in order to support year-by-year recommendations for water management
Background	• Introduced Interim Flow Decision and discussed scheduling change of the Long Term Flow Decision • Detailed the history of high flow management in the Lower Bridge River from 2016 to 2022.	• Provides additional context for current water management approach in the Lower Bridge River.
Methods	• Core program monitoring remains unchanged • Includes planned evaluation of ongoing requirements for stream walk, visual survey and radio telemetry sampling effort within the first year of TOR Revision 2. moving forward.	• Objective of evaluation is to look for opportunities for efficiency and cost savings for remainder of Revision 2 schedule.

Section	Changes	Rationale
Budget	• Detailed budget table includes estimates for conditional high flow monitoring	• Document full program cost and clarify budget allocation between ONR and BC Hydro funded tasks.