Project Proposal

Project Title: Assessment of Groundwater – Surface Water interactions along the Coldwater and Nicola Rivers, Merritt, BC

Creation Date: May 11, 2020

Proponent: Fraser Basin Council, on behalf of the Nicola Basin Collaborative Research & Technical Cttee

1.0 Project Description

The Coldwater and Nicola Groundwater and Surface Water Interaction Study (the "Project") is an initiative to monitor the interaction between surface water and groundwater along the Coldwater and Nicola Rivers in the Merritt, BC area, and the effects of pumping from groundwater wells on these rivers.

There is considerable interest in the Merritt area regarding these interactions, particularly how river flows contribute to the aquifers in the area and how pumping from wells may impact the flow in the river. Groundwater pumping from shallow wells can reduce the amount of groundwater that flows to the adjacent rivers. Shallow groundwater in aquifers and surface water are generally interconnected in the Coldwater and Nicola area, and drawing down water in wells may cause water levels in neighbouring streams to drop as well, potentially impacting ecosystems and other water users.

In 2018 and 2019, drought conditions and low flows in the Coldwater, required the province to consider restricting water withdrawals, which led to the City of Merritt to implement water restrictions. Also, recent research and water budget projects have raised questions of aquifer sustainability. This has prompted a need for a better understanding of these interactions to assist with water use planning to preserve needed flow volumes in the Coldwater River during critical periods.

The various parties with interest in this initiative include:

1. City of Merritt (CoM);
2. BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD);
3. BC Ministry of Environment and Climate Change Strategy (ENV);
4. Thompson Nicola Regional District (TNRD);
5. Scwexmx Tribal Council (STC);
6. Fraser Basin Council (FBC);
7. Nicola Basin Collaborative Research and Technical Committee (RTC);
8. Nicola Valley Institute or Technology (NVIT); and,
9. Department of Fisheries and Oceans (DFO).

This project will be guided by a technical advisory committee, with representation from all of the interested parties through the Research and Technical Committee (RTC), with primary input from CoM, FLNRORD, ENV, and STC. FBC provides secretariat and coordination support to the RTC.

2.0 Project Purpose

The overall purpose of this Project is to build on recent work to continue our understanding of the interaction between the Nicola and Coldwater Rivers and the underlying groundwater system, and how pumping from wells impacts adjacent rivers.

3.0 Objectives

The objective of this Project is to monitor surface water and groundwater interactions along the Coldwater and Nicola Rivers, to enhance our understanding of pumping induced effects and to inform the hydrogeology of the area for future modeling use.

The study will meet multiple objectives:

- to better understand groundwater availability;
- for infrastructure planning and water management by local water purveyors;
- to support FLNRORD groundwater licensing decisions;
- for environmental flow needs determinations;
- for the Coldwater and Nicola River Restoration Initiatives;
- for the NTA and DFO ongoing fisheries enhancement activities; and,
- for research by faculty and students at NVIT.

The longer-term objectives are to provide a network of monitoring points for on-going measurements of flow in the rivers and water levels in the adjacent aquifers, which will aid both water governance and future research initiatives.

4.0 Background

Groundwater and surface water are linked in the hydrologic cycle – both are supplied by precipitation, and they are often in direct hydraulic connection. Many streams demonstrate a direct correlation between flows and groundwater levels. Often groundwater provides flows to surface water and surface water recharges the aquifers, which establishes co-dependent ecosystems (e.g., salmon and other species rely on cooler and cleaner groundwater at critical times in their lifecycle). However, in most studies of hydrologic systems, each system component (groundwater, surface water, etc.) is analyzed and/or modelled individually, treating the other interconnected component as a source or sink. In reality, these components are intricately linked and must be considered simultaneously. Because of the interchange of water between these two components of the hydrologic system, understanding the basic principles of the interaction of groundwater and surface water is needed for effective management of water resources. Groundwater abstractions can have detrimental impacts on streamflow in connected aquifer-stream systems. Therefore, knowledge of the hydraulic connectivity between groundwater and streams is essential for management of both resources.

Previous work in the area has included:

- Aquifer Mapping (2017-2018): Completed in March 2018, the aquifer mapping project resulted in 13 additional mapped aquifers, increasing the total number of provincially mapped aquifers

to 25 within the study area (Golder Associates Ltd., 2018. 1772201-001-R-RevA Nicola Watershed Aquifer Mapping and Classification).

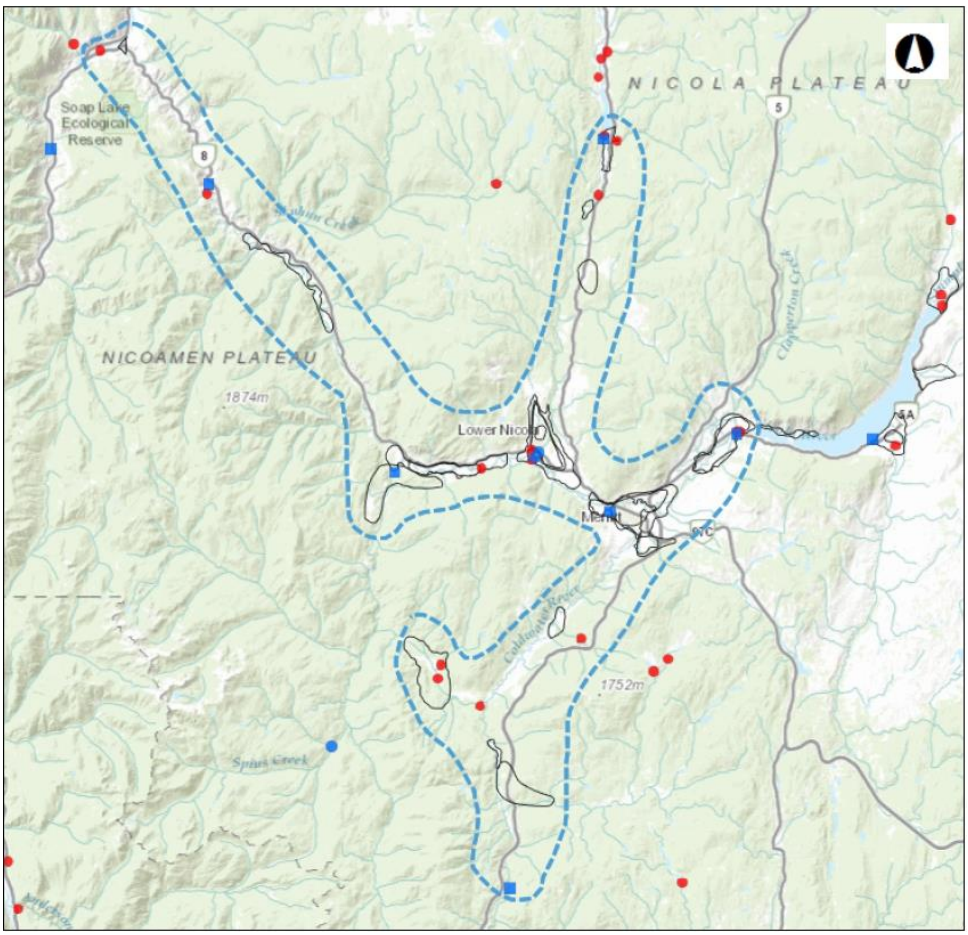
- Development of a Conceptual Groundwater Model (2017-2018): Working with the Fraser Basin Council, a conceptual groundwater model of the project area was produced.
- Data Compilation Plan (June 2018): To support the development of a regional numerical flow model, a data compilation plan was outlined, that included the compilation and analysis of existing data, updated the conceptual hydrogeological model for the project area, identified key data gaps and uncertainties, and discussed the implications of those data gaps.
- Technical Memorandum (March 2019): the memorandum addressed some preliminary data analysis, defined groundwater units, compiled and interpreted key data gaps – all are necessary for the development of a groundwater flow model.
- Numerical Groundwater Flow Model for the Nicola Watershed (May 2020): A steady state numerical groundwater flow model for the Nicola watershed was submitted to the province as a preliminary step to understanding the groundwater system.
- Coldwater River Groundwater/Surface Water Interaction Study Phase 1 (March 2020): A preliminary review of the Coldwater River to identify priority reaches for further assessment.

The proposed project outline below builds on these previous studies to refine, update, and collect additional data to address key gaps from the Numerical Groundwater Flow Model for the Nicola Watershed (Golder, 2020) and the Coldwater River Groundwater/Surface Water Interaction Study Phase 1 (Golder, 2020). Both previous studies identified critical data gaps related to the seasonal effects on the water balance. The following work plan addresses some of these key data gaps.

5.0 Study Area

The project boundaries were delineated as part of previous studies to incorporate local interests and stakeholder engagement, as well as populations and area of interest for fisheries, hydrology and groundwater within the Nicola Watershed. The project boundaries within the Nicola Watershed are the Nicola River from below the Nicola Dam (WSC 08LG065) to the confluence with the Thompson River near Spences Bridge; the Coldwater River from the Brookmere (WSC 08LG048) to the confluence with the Nicola River; and Guichon Creek from Mamit Lake (WSC 08LG041) to the confluence of the Nicola River. **A localized area of more focused data collection will be in the City of Merritt and immediate surrounding area**.

Project Boundary Map:



6.0 Proposed Work Scope

This Project will undertake field work to address data gaps identified during the calibration and development of the regional groundwater numerical model to better understand groundwater flow interactions between aquifers and surface water flows. There is a need to understand groundwater flow dynamics to determine the cause of seasonal fluctuations within the aquifers underlying the City of Merritt; identify aquifer recharge mechanisms; and impacts from groundwater pumping on local rivers. Collecting data to address these uncertainties will allow refinement in existing models that predict the flow of water in groundwater systems, and develops scenarios of water use and the impacts of rivers and aquifer sustainability. There will also be further work to determine the availability of existing datasets that may be used to refine the current understanding and help inform the development of a localized groundwater model for the City of Merritt area. It will be critical for the City of Merritt to provide data regarding historical usage of surface water and the various groundwater wells they operate for the success of the project

The proposed work scope will include the following:

1. Measure incremental river flows using handheld flowmeter at 15 locations distributed relatively evenly along the Coldwater River as part of a 5-day snap-shot monitoring event. Where tributaries are observed, measurements of tributary inflows will be measured also.

2. Install short-term hydrometric stations to monitor stage and river flows in the Coldwater River from June to November 2020.
3. Survey all the measurements points associated with the temporary hydrometric stations and functional provincial hydrometric sites located on the Coldwater River and Nicola River to obtain accurate (cm-scale) geodetic water elevations. Any flood damaged stage gauges will be reinstalled prior to undertaking the survey work.

4. Perform a wellhead survey of the City of Merritt wells (with well records) to obtain geodetic water elevations. The survey would ideally include all the active production wells and a representative sample of the shallow City's monitoring wells. The wells surveyed would be determined in consultation with the City of Merritt representative.

5. Wellhead survey of additional wells, outside the boundaries of the City of Merritt, with a well record, including provincial observation well number 296, to obtain geodetic water elevations.

6. Assessment of any existing wells in the study area for short- and long-term water level monitoring.

7. Collect major ion water chemistry and isotope (H, O) samples from at least 20 sites between Brookmere and Spences Bridges.

8. Agricultural Groundwater Use data input layer: build a Digital Agricultural Land Use Inventory (ALUI) mapping layer which outlines properties used by agriculture (within the Agricultural Land Reserve, ALR) and also includes information on activity and land cover (crop type, type of livestock, natural area, trees etc). In the current model, irrigated farmland was roughly estimated using Google Earth imagery and all farmland was assumed to grow hay, the primary crop type. ALUI mapping together with estimates of water demand by crop type specified in the Agricultural Demand Report for the Nicola Region, could be used to improve the estimated groundwater usage for farmland irrigation in the current model.

9. Addition of Domestic Groundwater Users: The model currently does not account for domestic groundwater use. Its proposed to use digital Zoning and Land Inventory mapping and metered data being collected within the study area (i.e. City of Merritt or regional water systems, if available) that may be shared with the Province to assign a nominal groundwater usage rate to these residential properties based on land use and typical household water use rates for the region.

10. Development of a Local Hydrogeological Model at the City of Merritt Well field:
    - There are limitations on the types and accuracy of predictions that are possible with a regional model, whether it is run in steady state or transient mode. A local, refined groundwater flow model would be developed for the area around the City of Merritt. This model would reduce uncertainty in its predictions with the collection of sufficient, accurate calibration data (local hydraulic heads and flow) and developed local geology/hydrogeology and conceptual model. Results from the regional model would be used to support the development of the local model; specifically, the upgradient inflow and downgradient outflow estimates from the regional model would be used as boundary conditions in the local model. With enough data there may be the potential to simulate a scenario to assess

Stream Vulnerability, hypothetically using a new pumping well to assess the potential vulnerability of the nearby river reach and the nearby shallow groundwater level to long-term pumping from the unconfined aquifer.

7.0 Project Deliverables

Following the recommendations of recent reports (Section 4), the Numerical Groundwater Flow Model for the Nicola Watershed (Golder, 2020) and the Coldwater River Groundwater/Surface Water Interaction Study Phase 1 (Golder, 2020), this project proposes:

- To collect critical data on river flows and groundwater levels from June – November 2020 at a minimum (pending ongoing resourcing and durability of hydrometric stations);
- Support the collaborative engagement between project partners and the Nicola Research Collaborative, delivering on a common need among Nicola water users and water purveyors to improve the understanding of availability and environmental flow needs of the Coldwater and Nicola Rivers and supporting aquifer(s);
- A report will be generated at the end of the year with information on the results of all monitoring, spatial and temporal analysis of data, updated model inputs, and the development of a Local Hydrogeological Model in the vicinity of the City of Merritt Well field. The report will describe the fieldwork completed, analysis and interpretation of the data, and provide recommendations for improved water management.

8.0 Budget

The requested budget is $25,000 from Gas Tax funds to help realize the work scope above. FLNRORD has submitted a separate funding request for matching funds, for a total project value of $50,000. In-kind project support will be provided by project partners.

9.0 Extension

Groundwater is under stress from increasing, often competing, groundwater demands (e.g., agricultural, industrial, municipal activities), environmental flow needs (EFN), and the growing impact of climate change, among other factors. The extraction and use of groundwater can result in lowered water levels in adjacent water bodies (i.e., a decrease in base-flow to streams affecting aquatic ecosystems and species), rise in water temperatures, water quality and habitat degradation and conflicts between water users (i.e., lowered water levels in neighbouring wells).

Regulating extraction and use of groundwater is a key to hydrologic sustainability and will provide the opportunity to better integrate surface and groundwater planning, allocation, and decision making. With the implementation of the *Water Sustainability Act*, decision makers are dealing with increasingly complex water authorization decisions related to groundwater withdrawals, requiring guidance and tools to support science-based allocation decision-making.

The proposed project would lead to a better understanding of hydraulic connectivity (groundwater – surface water interaction), including how it varies temporally and spatially, and how it varies with geologic/hydrologic environment.

Water is critical to all aspects of our lives. Protecting water sources is important because it ensures there is enough safe water for all of our uses - now and in the future. Source water protection is the protection of water resources such as lakes, rivers and groundwater from contamination or overuse.

Ideally, the analysis of sustainable groundwater extraction is completed through the development of complex groundwater-surface water numerical flow models. However, the provincial government faces several challenges in developing numerical flow models: a lack of necessary hydrogeologic/hydrologic data; insufficient resources to collect the necessary data; and a lack of personnel/expertise to develop or update numerical models. Therefore, the overall objective of the study is to collect information that empowers science-based decision making, based on more reasonable data requirements. This will ensure that source water can be protected by employing effective planning that involves all major water users in the process.

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