Nicola Watershed Characterization

A preliminary evaluation of watershed issues and priority recommendations for the Nicola Forum

March 2019

Prepared for The Nicola Government to Government Forum

Fraser Basin Council

ESSA

Prepared for:

Nicola Government to Government Forum, with project administration provided by the BC Ministry of Forest, Lands, Natural Resource Operations and Rural Development

Contacts:

Heike Lettrari
Water Policy Advisor
Heike.Lettrari@gov.bc.ca
T: 778 698-4394

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Lead Authors:
Donald Robinson
Patricia de la Cueva Bueno
Andrew Thompson
Erica Olson
Mike Simpson

FLNORD Contract: NR19NRH0303

Suggested citation:
ESSA Technologies Ltd. and Fraser Basin Council. 2019. Nicola watershed characterization - a preliminary evaluation of watershed issues and priority recommendations for the Nicola Forum. Report prepared by ESSA Technologies Ltd. and Fraser Basin Council for the Nicola Government to Government Forum, Merritt, BC. 43 p. + Annexes.

Cover Photo: April 2019 at the confluence of the Coldwater and Nicola Rivers

ESSA Technologies Ltd.
Vancouver, BC Canada V6H 3H4
www.essa.com

Table of Contents

List of Figures

List of Tables

Acknowledgements

We would like to thank the 28 individuals who participated in the interviews for sharing their time, knowledge, thoughts and valuable perspectives. We are grateful to the Nicola Forum for the opportunity to play a part in the opening stages of implementing the Memorandum of Understanding between the Province and Upper Nicola Band, Lower Nicola Indian Band, Coldwater Indian Band, Nooaitch Indian Band and Shackan Indian Band. We would also like to thank David Lawrence and Nadia Joe at the Nicola Forum for their advice, and Gail Smith at the Merritt FLNRORD office, for guidance in understanding and navigating the contents of the DataBC geospatial data portal.

Disclaimer

This report has been reviewed for accuracy. However, this report is not intended to and does not limit, abrogate, replace or define any inherent, aboriginal, or other right of the Nlaka'pamux or Syilx Nations, including any right of a constituent band or member thereof. The authors assume responsibility for the methods, views, findings, and recommendations presented within this report, and acknowledge that such have not been endorsed by, and may not reflect the views of, the Nlaka'pamux or Syilx Nations, constituent bands and members thereof, the Forum, or the Province of British Columbia.

EXECUTIVE SUMMARY

The Nicola Government to Government Forum ('Nicola Forum' or 'Forum') was established in March 2018 as the result of the signing of the Memorandum of Understanding (MOU) between the Province and the Chiefs of Upper Nicola Band, Lower Nicola Indian Band, Coldwater Indian Band, Nooaitch Indian Band and Shackan Indian Band. This Forum is a platform for collaborative watershed governance in the Nicola; a watershed where a growing population, climate change, forestry activities, extensive ranching, and landscape disturbances (e.g., pine beetle infestation) put pressure on limited water and related fishery resources and the sustenance of the communities relying on them.

As a priority to support collaborative governance, the Forum has identified the need to take stock on the existing knowledge and information on the watershed and set priorities for action. To this end, this Nicola Watershed Characterization project set out to support the Forum by assessing and reviewing available information on the watershed, identifying current water management issues, limitations and conflicts, and based on these findings, providing recommendations on priority actions for collaborative watershed management.

To better understand the knowledge-context of the Nicola Valley, we compiled and analyzed three types of information: interviews with stakeholders and Indigenous community members, existing documents and reports about the Nicola watershed, and relevant geospatial data. For both the documents and geospatial data sets, we developed a logical metadata framework to catalogue and collect key features of each data source. Recorded in Excel spreadsheets, these metadata framework tables are a separate outcome of this project. Section 2 of the report provides a detailed description of the approach taken for the project.

In order to understand the local perspectives on key issues affecting watershed management in the Nicola, we conducted 28 semi-structured interviews with members of Upper Nicola, Lower Nicola, Coldwater, Shackan and Nooaitch, provincial and federal staff and others with an interest in the Nicola Basin. The feedback from these interviews is summarized in Section 3. Overall, the participants agreed on four major concerns for the Nicola watershed:

- The hydrology and water balance of the Nicola watershed, characterized by a marked spring freshet followed by a long dry summer, and the hydrological alterations it has been experiencing in the last decades (increasing water withdrawal, forestry and development, climate change) constrain water use in the Valley. All participants expressed concern about the long-term sustainability of water resources in the Nicola.
- Balancing water uses is a main challenge in a watershed where ecological, agricultural and municipal uses compete for limited water resources. The lack of consistent measurement of water use compounds this problem by preventing accurate estimations of water demand.
- The sustainability of fish and aquatic/riparian habitats in the face of mounting pressures in the watershed (e.g., development, increasing water demand, climate change, etc.) is a major concern shared by most participants.
- Lack of coordination and collaboration and conflicting interests have resulted in a history of ineffective watershed governance in the Nicola watershed. Indigenous interviewees highlighted the lack of input from their communities into decisions made by the federal and provincial agencies.

Section 4 presents the available knowledge base for the Nicola watershed based on our review of existing knowledge sources on the Nicola watershed: Indigenous Knowledge, literature review on relevant documents and spatial information. This review of information should not be considered an

exhaustive and detailed documentation of available knowledge but rather as a preliminary overview and mapping of knowledge sources that can be further explored and integrated in the initiatives of the Forum.

In terms of Indigenous Knowledge (Section 4.1), interviewees discussed how Indigenous communities in the Nicola Valley have acquired knowledge on the use and care for water and other natural resources in the watershed through generations. This wealth of knowledge, encompassing stories, cultural practices, ceremonies, traditional harvesting of foods and medicinal plants, etc., has been passed orally by Elders and other knowledge holders in the communities. Water stewardship and management principles are embedded in Indigenous Knowledge. Indigenous participants agreed on the need to integrate Indigenous Knowledge for the successful collaborative management of the watershed but emphasized that First Nations need to be in control of the process.

Regarding existing literature (Section 4.2), a substantial body of knowledge on the Nicola watershed has been produced. Issues regarding conflicts between off-stream and in-stream uses in the basin have been documented since the early 1980s. However, documentation on watershed issues has significantly increased in the last two decades, coinciding with emerging problems such as climate change effects, deterioration of water quality, etc. We compiled and classified over 500 documents covering various themes relevant for watershed management in the Nicola Valley.

Most of the research and data collection has focused on documenting the impacts of increasing water demand (mainly for the agricultural sector) on aquatic habitats and fisheries, an important value in Nicola basin. Numerous studies evaluate either specific fish species or concerns about fish or fish habitat at specific locations. Nevertheless, there is still a research gap in terms of finer scale studies on how changes in flows affect fish productivity and sustainability.

We identified 368 spatial data layers (Section 4.3) that are pertinent to water resources management in the Nicola Watershed. Of these, 70% are open access; the remainder are restricted to certain users (predominately, these are restricted to government or First Nations users). Most of the 368 layers are hosted on the provincial DataBC repository.

Spanning most of the watershed themes and issues there is the overarching theme of “information” and how it is needed to support decision-making. Our review of the interview feedback and the available knowledge revealed important gaps that will need to be addressed (Section 5.1). A critical gap is the lack of consistent water metering and the fact that groundwater licenses remain for the most part unregulated, creating significant information gaps on actual water use.

Section 5.2 puts forward our priority recommendations for the Forum:

- Improve the use of Indigenous Knowledge (IK) in decision making: The Nicola Forum should adopt a formal process that will guide how IK contributes to decision making. This process should be developed, owned and undertaken by Nicola First Nations, in respect of Syilx and Nlaka’pamux governance principles and protocols. This process would represent the ways that they would like to see their knowledge inform decision-making processes.
- Improve understanding of water balance and water use: Understanding the water budget of the Nicola Valley hydrosystem is necessary to resolve uncertainty about groundwater dynamics, to gain a fuller understanding of the sustainability of water use in the Valley and to support maintenance of cold water refugia that are necessary to a variety of fish species. The lack of water metering is a serious gap in understanding how water is extracted from surface and groundwater sources.
- Upgrade protocols for balancing instream flow and drought management: Instream flow needs have been talked about for at least the past two decades, including the need to establish flow requirements at the sub-basin level, incorporate cold water inputs, make

more intelligent use of ground and surface water during low flow periods, make better use of irrigation water, and implement the comprehensive licensing of surface and ground water. Among other needs, what is missing is the development and adoption of voluntary and mandatory protocols that will balance the trade-offs that are necessary during drought, through agreed-upon staged water use cut-backs.

- Develop a prioritization framework for restoration projects: Restoration of selected habitats and populations supports the recovery and health of ecosystems and populations that are at risk or degraded due to water scarcity, development or other stressors. Because funding is always one limitation (knowledge is another), a prioritization framework will help to identify the most important projects and provide a rationale for choosing or sequencing possible restoration activities.
- Develop a Nicola Watershed Monitoring Program: Communities and stakeholders may value different aspects of the Nicola Valley and its water system. Some of those values might include water quality, quantity, timing, cultural sites, recreation, fisheries, cold water refugia and riparian areas. These values are not yet adequately incorporated into a monitoring program that is developed, adopted and shared by all water users. Development of a monitoring plan for these valued resources and its implementation will, over time provide a better baseline of consistent information for detecting trends and making water allocation decisions.
- Create a Nicola Watershed Data Portal: Technical information about the Nicola Valley and watershed is usually publicly available but is scattered across organizations. This project has organized most of the existing technical and geospatial data, creating a good foundation for organizing this information to support the Forum. These documents should be made more widely available through a data portal.

1 Introduction

1.1 Context of the Nicola Watershed

Its geography and climate make the Nicola watershed (Figure 1) a unique basin in British Columbia with diverse ecosystems and natural resources. The valley is the ancestral home of several First Nations communities (i.e., Upper Nicola Band, Lower Nicola Indian Band, Coldwater Indian Band, Nooaitch Indian Band, and Shackan Indian Band) and has supported a growing population and human activities in the last decades. Internal and external factors, such as climate change, forestry activities, extensive ranching, and landscape disturbances such as a large mountain pine beetle infestation put pressure on limited water and related fishery resources and the sustenance of the communities relying on them. These shared water management issues require a new approach to water stewardship in the Nicola watershed.

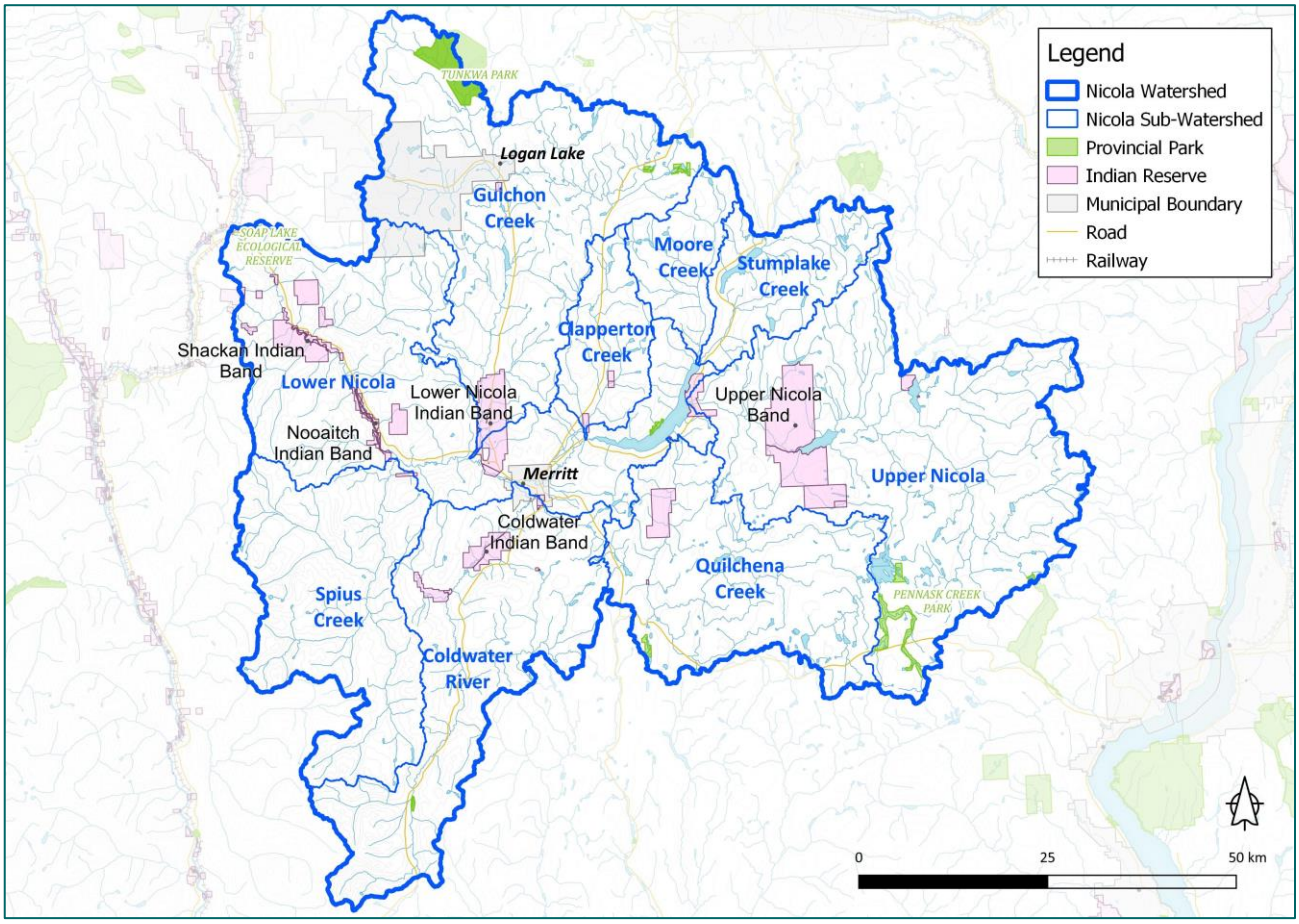


Figure 1: A map of the Nicola Valley showing sub-basins (blue), First Nation communities, parks and municipalities.

Building on the history of collaboration in the watershed, the Memorandum of Understanding (MOU) signed by the Province and the Chiefs of Upper Nicola Band, Lower Nicola Indian Band, Coldwater Indian Band, Nooaitch Indian Band, and Shackan Indian Band in March 2018, catalyzes a new mandate for the Nicola Government to Government Forum ("Nicola Forum" or "Forum") to

collaboratively address watershed governance in the Nicola watershed. The Nicola Forum marks a new relationship between the Upper Nicola, Lower Nicola, Nooaitch, Shackan and Coldwater Bands and the ministries of Forests, Lands, Natural Resource Operations and Rural Development, Environment and Climate Change Strategy, and Indigenous Relations and Reconciliation. Under the Forum's direction, the purpose of the Nicola Watershed Characterization project is to identify priorities for collaborative water resource management in the Nicola Watershed. Given the creation of a collaborative framework to manage the watershed, there is an urgent need to integrate existing quantitative and qualitative knowledge so that the Forum can set priorities and its members can begin to work together.

The five first nations represent two peoples: the Nlaka'pamux (Shackan, Nooaitch, Coldwater and Lower Nicola) and the Syilx (Upper Nicola). The Nicola Valley is the western boundary of Syilx territory and the northern boundary of Nlaka'pamux territory. Water plays a special and sacred role for both groups, exemplified by the Syilx Water Declaration endorsed by the Okanagan Nation Alliance in 2014,[1] a living document that outlines the relation and responsibilities of Syilx peoples with water (*siwɬkʷ*).

Water is limiting much of the year in the Valley, with a large spring freshet followed by summer drought. Because there are limited options for above-ground water storage during dry periods, water scarcity is a prominent issue, particularly because of the more recent presence of ranching, agriculture and irrigation. Changes to forest cover aggravated by the mountain pine beetle epidemic, have also contributed to changes in water availability. So far, additional water demand has been met by enhancing surface-water storage where possible and drawing upon ground-water sources.

Figure 2: Nicola Chiefs, March 2018 Memorandum of Understanding signing ceremony.

The Forum represents an attempt by the Indigenous and Provincial governments to work collaboratively, drawing upon Tmixʷ principles. The objective of this project is to provide the Forum with a set of recommendations for high priority actions to be discussed, developed and implemented collaboratively, including the perspectives of all water users. This report and its related products (spreadsheets and document library) provide the Forum with a comprehensive review and assessment of the information available about the physical, ecological, hydrological, social and management systems relevant to the Nicola Basin, and their inter-relationships. Based on interviews with members of the 5 Nicola First Nations, provincial and federal staff, and others with an interest in the Nicola Basin, the report also identifies current water management issues, limitations and conflicts. Combining these two components the report identifies areas the Forum should further consider when shaping collaborative efforts as Forum members seek to improve

[1] https://www.syilx.org/about-us/syilx-nation/water-declaration/

decision making over water resources in the Nicola. The report's Recommendations consist of an initial list of high priority activities ("pilot projects") that the Forum may choose to support and promote.

1.2 Rationale and scope of the Nicola Watershed Characterization

With the creation of the MOU the Nicola Forum saw the need to take stock of the knowledge that already existed within the Nicola Valley before establishing its future directions. This taking stock included a review of all available documentation (e.g., technical reports, management plans, meeting notes, quantitative data, communications, etc.) from academic, government and other sources about:

- The physical setting of the Valley, climate, soils, surface and hydrology,
- The plant and animal communities, ecosystems and biodiversity of the Valley, and
- Land use, infrastructure, cultural resources, recreational resources and protected areas.

Additionally, the Forum wished to hear directly from a representative sample of community members, stakeholders and scientific experts about the issues facing the Nicola Valley.

Our response to this need was to develop the two-part approach described in Section 2. First, we created a framework for collecting and organizing knowledge sources relevant to water management in the Valley. These knowledge sources include Indigenous Knowledge and its resources, and a similar framework for collecting existing spatial information directly relevant for the most pressing water management issues in the Valley (e.g., fish, land use planning, various base maps, etc.). The findings of these documents and spatial data analysis are discussed in Section 4.

Secondly, to document the issues facing the Nicola Valley, we conducted 28 semi-structured interviews with stakeholders, experts and First Nations community members. Based on the feedback from these interviews, we identified the main issues and concerns in the Nicola Valley, discussed in detail in Section 3 of the report.

Finally, Section 5 presents the outcome of the analysis of the interviews and available information in the form of a series of recommendations or 'project concepts' that will support the Nicola Forum in addressing key issues in the Valley and help improve water management.

2 Approach

2.1 General Method

To better understand the knowledge-context of the Nicola Valley we compiled and analyzed three types of information: (1) interviews with stakeholders and community members, (2) existing documents and reports about the Nicola watershed, and (3) relevant geospatial data (Figure 3). Hence, our search incorporated two broad kinds of knowledge: human knowledge and experience (elicited through semi-structured interviews); and a review of literature (documents) and data sources (principally geospatial (GIS) files).

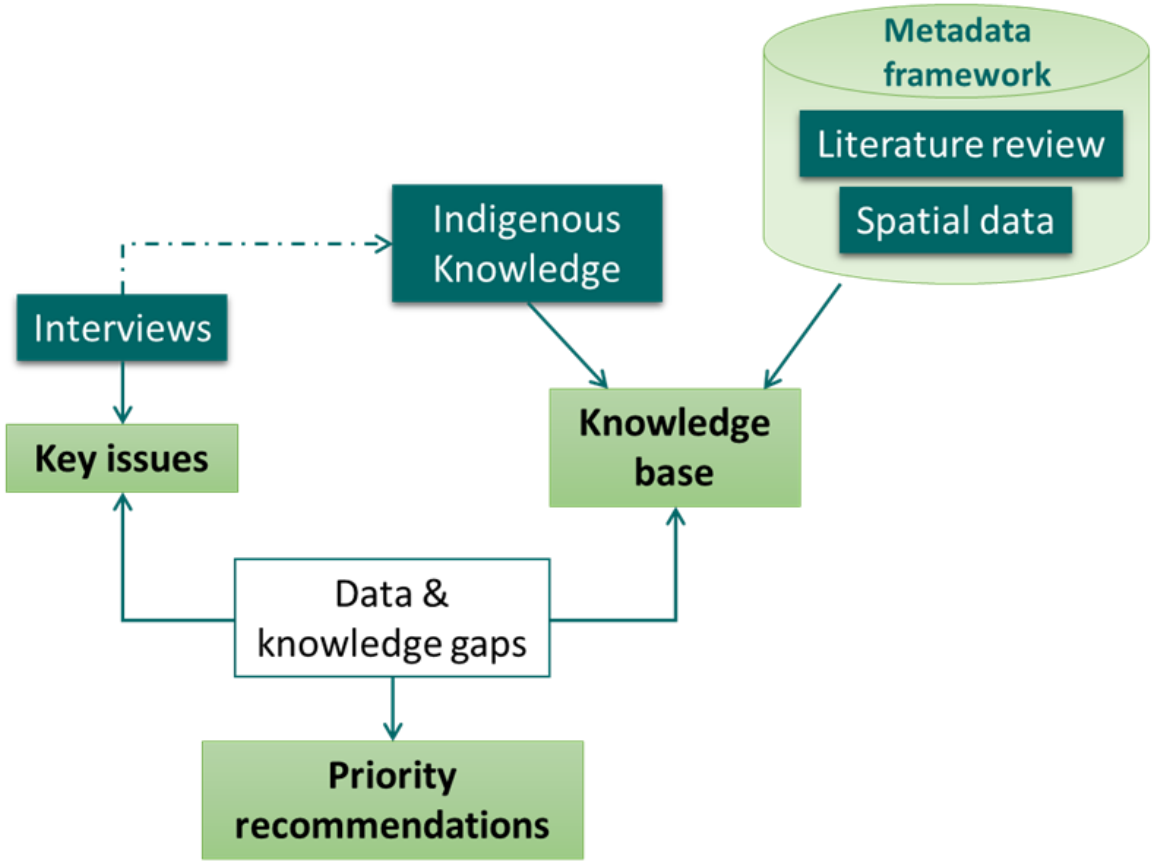


Figure 3: General outline of the process and types of knowledge integrated during the project.

Our analysis of the knowledge categories provided by documents and GIS coverage was compared to the key themes that emerged from the structured interviews to uncover where there were high priority gaps in understanding which might naturally benefit from further study by the Forum.

2.2 Interviews

We conducted 28 semi-structured interviews with members of Upper Nicola, Lower Nicola, Coldwater, Shackan and Nooaitch, provincial and federal staff and others with an interest in the

Nicola Basin. Each interview lasted about two hours (a few were done in groups). Prior to the interviews, interviewees signed consent forms and received a note describing the intent and context of the interviews as well as the questions that would be discussed. Table 1 shows all these supporting documents, including the interview questionnaires, which have also been included in the appendices of this report.

To encourage openness in the discussion, each participant was offered the option of remaining anonymous and of having their affiliation remain anonymous. Participants were also asked whether they wanted their thoughts to be quoted exactly, or whether we could paraphrase their ideas. Some participants requested anonymity and most participants agreed to have their ideas paraphrased while remaining accurate. In order give consistent answers to the questions that might arise during our discussions, we also prepared two documents with the assistance of the Nicola Forum to help us.

A draft list of 54 possible interviewees was developed with the help of the Nicola Forum and key individuals to interview were selected based on achieving coverage over a range of interests (e.g., cultural understanding, Indigenous Knowledge, groundwater, fisheries, forestry, agriculture), along with availability within the project timeline. From an initial list of 29 possible interviewees, 12 interviews were conducted with First Nation members and 16 interviews were conducted with non-Indigenous experts and stakeholders.

Table 1: Supporting documents used for the interviews.

Document	Purpose	Location
Interviewees	Listing of interview subjects	Appendix A
Interview Consent Form	Agreement on use of the interview responses	Appendix B
Anticipated Question and Answers	Background information about the project and the Nicola Forum	Appendix C
Key Messages	Background information about the project and the Nicola Forum	Appendix D
Interview Questions	Questions	Appendix E
Interview Questions	Questions for FN communities	Appendix F

After each interview, handwritten interview notes were transcribed into an Excel table. We then conducted a detailed review of interview comments to identify key issues. Based on two independent readings of the interview notes, we identified the 4 common issues described in Section 3. In addition, we used the NVIVO language analysis software[2] to identify major response categories using high level synthesis questions that were discussed toward the end of each interview:

- What are your top three concerns for the Nicola watershed? Why? What contributed to these issues arising?

[2] https://www.qsrinternational.com/nvivo/what-is-nvivo

- Based on the water management issues we've discussed, what do you see as the most pressing issue within the Nicola watershed? Why?

We compared our first-screening of the interviews with the NVIVO screening, to identify any further concerns. Overall, we found the key phrases identified with NVIVO fell within the key issues identified by our own independent analysis of the interview notes.

2.3 Metadata Framework

2.3.1 Literature Review

We collected and summarized numerous existing reports and documents provided to us by FLNRORD (Appendix G). In addition, we undertook a search for more recent quantitative and qualitative literature and reports held by governments, academic groups and other stakeholders, leveraging the expert knowledge on our team about the content matter and the Nicola watershed. During interviews we also inquired about relevant documents that we might otherwise have missed. In all we located over 500 documents and were able to obtain copies of all but 31.[3]

We developed a logical framework to catalogue document features and collect key metadata features of each document where possible (see Table 2). Documents were received from the sources described above and metadata were recorded in an Excel spreadsheet created for the project ("Document data framework (May 2019).xlsx"). Document themes were noted and assigned wherever possible, and the documents themselves were stored in a logical filesystem structure that is distributed with this report.

In terms of the type of document, the most common data type consists of photographs, with reports comprising the second largest category. Together these two types of documents account for 67% of all documents. We assessed the relevance of the documents in a qualitative manner (i.e., high, medium or low) taking into account the completeness of the information presented in the document, the level of analysis and its significance (e.g., the Nicola Basin Strategic Plan from 1983 and the Nicola Water Use Management Plan from 2010 are considered two highly relevant documents as they are milestones in the planning process of the basin).

The spreadsheet was designed and configured so that future users can easily add new documents and categories and can easily revise and update document metadata. Categories and sub-categories can also be filtered to help locate relevant documents. A screen capture of part of the document metadata file is shown in Figure 4.

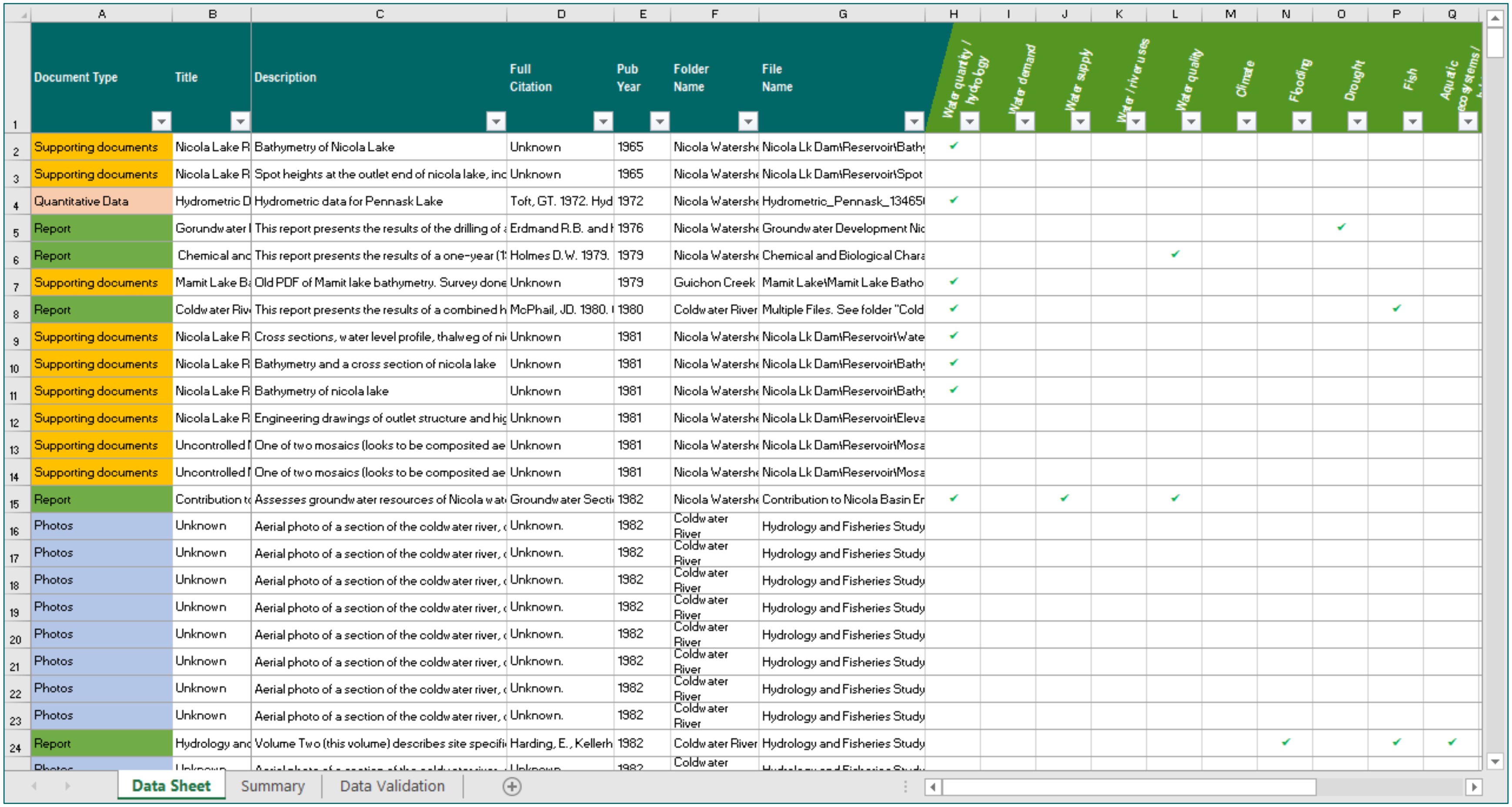
Table 2: Major categories of the document metadata framework

Column	Description / Sub-categories
Document Type	Report Quantitative data Qualitative data Supporting documents Photos

[3] Documents that we were unable to obtain are marked in the with grey cell shading Filename column of the document metadata spreadsheet.

Column	Description / Sub-categories
	Email / communication
Title	The title of the document.
Description	A short description of the document.
Citation	A full citation for the dataset, including Author(s), Date, Year, Title, and Source.
Publication Year	Year document was published.
Folder & File name	These two columns can be used to locate the document.
Water quantity / hydrology Water demand Water supply Water / river uses Water quality Climate Flooding Drought Fish Aquatic ecosystems / habitats Groundwater Water governance Dams / water infrastructure	Themes: A checkmark was assigned if the theme applied to the document
Plans	An ancillary theme (not used for analysis). A checkmark was assigned if the document contained any sort of engineering plans or designs.
Sub-watershed	Clapperton Creek Coldwater River Guichon Creek Lower Nicola Middle Nicola Moore Creek Quilchena Creek Spius Creek Stump Lake Creek Upper Nicola
Confidential	A checkmark was assigned if the document was confidential.
Relevance	Low; Medium; or High was assigned to each document, based on a qualitative assessment of its importance and relevance to the Nicola Watershed.
Management actions	A short summary of management actions recommended in the document.
Science and Data Needs	A short summary of scientific or data needs that the report documented.

Column	Description / Sub-categories
Additional Notes	Any additional notes that were pertinent to the document, but which did not fit in any other column.



	Document Type	Title	Description	Full Citation	Pub Year	Folder Name	File Name	Water quantity / hydrology	Water demand	Water supply	Water / river uses	Water quality	Climate	Flooding	Drought	Fish	Aquatic ecosystems /
2	Supporting documents	Nicola Lake R	Bathymetry of Nicola Lake	Unknown	1965	Nicola Watershe	Nicola Lk Dam\Reservoir\Bathy	✔									
3	Supporting documents	Nicola Lake R	Spot heights at the outlet end of nicola lake, inc	Unknown	1965	Nicola Watershe	Nicola Lk Dam\Reservoir\Spot										
4	Quantitative Data	Hydrometric D	Hydrometric data for Pennask Lake	Toft, GT. 1972. Hyd	1972	Nicola Watershe	Hydrometric_Pennask_134650	✔									
5	Report	Gorundwater I	This report presents the results of the drilling of a	Erdmand R.B. and I	1976	Nicola Watershe	Groundwater Development Nic								✔		
6	Report	Chemical and	This report presents the results of a one-year (1	Holmes D.W. 1979.	1979	Nicola Watershe	Chemical and Biological Chara					✔					
7	Supporting documents	Mamit Lake Ba	Old PDF of Mamit lake bathymetry. Survey done	Unknown	1979	Guichon Creek	Mamit Lake\Mamit Lake Batho	✔									
8	Report	Coldwater Rive	This report presents the results of a combined h	McPhail, JD. 1980. (	1980	Coldwater River	Multiple Files. See folder "Cold	✔								✔	
9	Supporting documents	Nicola Lake R	Cross sections, water level profile, thalweg of ni	Unknown	1981	Nicola Watershe	Nicola Lk Dam\Reservoir\Wate	✔									
10	Supporting documents	Nicola Lake R	Bathymetry and a cross section of nicola lake	Unknown	1981	Nicola Watershe	Nicola Lk Dam\Reservoir\Bathy	✔									
11	Supporting documents	Nicola Lake R	Bathymetry of nicola lake	Unknown	1981	Nicola Watershe	Nicola Lk Dam\Reservoir\Bathy	✔									
12	Supporting documents	Nicola Lake R	Engineering drawings of outlet structure and hig	Unknown	1981	Nicola Watershe	Nicola Lk Dam\Reservoir\Eleva										
13	Supporting documents	Uncontrolled I	One of two mosaics (looks to be composited ae	Unknown	1981	Nicola Watershe	Nicola Lk Dam\Reservoir\Mosa										
14	Supporting documents	Uncontrolled I	One of two mosaics (looks to be composited ae	Unknown	1981	Nicola Watershe	Nicola Lk Dam\Reservoir\Mosa										
15	Report	Contribution to	Assesses groundwater resources of Nicola wat	Groundwater Secti	1982	Nicola Watershe	Contribution to Nicola Basin Er	✔		✔		✔					
16	Photos	Unknown	Aerial photo of a section of the coldwater river, c	Unknown.	1982	Coldwater River	Hydrology and Fisheries Study										
17	Photos	Unknown	Aerial photo of a section of the coldwater river, c	Unknown.	1982	Coldwater River	Hydrology and Fisheries Study										
18	Photos	Unknown	Aerial photo of a section of the coldwater river, c	Unknown.	1982	Coldwater River	Hydrology and Fisheries Study										
19	Photos	Unknown	Aerial photo of a section of the coldwater river, c	Unknown.	1982	Coldwater River	Hydrology and Fisheries Study										
20	Photos	Unknown	Aerial photo of a section of the coldwater river, c	Unknown.	1982	Coldwater River	Hydrology and Fisheries Study										
21	Photos	Unknown	Aerial photo of a section of the coldwater river, c	Unknown.	1982	Coldwater River	Hydrology and Fisheries Study										
22	Photos	Unknown	Aerial photo of a section of the coldwater river, c	Unknown.	1982	Coldwater River	Hydrology and Fisheries Study										
23	Photos	Unknown	Aerial photo of a section of the coldwater river, c	Unknown.	1982	Coldwater River	Hydrology and Fisheries Study										
24	Report	Hydrology and	Volume Two (this volume) describes site specifi	Harding, E., Kellerh	1982	Coldwater River	Hydrology and Fisheries Study							✔		✔	✔

Data Sheet | Summary | Data Validation

Figure 4: Screen capture of part of the file ("Document data framework (May 2019).xlsx") containing document metadata. Note that documents can include multiple themes.

2.3.2 Collection of Spatial Data

Knowledge embodied through spatial data were also identified as a key data component. At the commencement of the work we were not certain whether GIS data would be held by a wide variety of agencies and governments. However, as we met with provincial experts we discovered that virtually all spatial data is available through the BC government GIS portal.[4] Notwithstanding, other GIS coverage may be held (or may be held in the future) by First Nation governments in independent repositories, but over the course of this watershed characterization project we were unable to identify such knowledge. With valuable assistance from FLNORD (Gail Smith, pers. comm. 2019) we identified 368 spatial data layers, of which 258 are open-access with the remainder restricted to government employees or authorized users.

Following the logic and concepts of the document metadata framework, we created a geospatial metadata framework ("GIS data framework (May 2019).xlsx") to summarize the many spatial data sources and make them easily searchable and extendable. The columns and 10 major themes of these spatial data layers are shown in Table 3,[5] and a screen capture of part of the file is shown in Figure 5.

[4] The DataBC portal is found here:https://catalogue.data.gov.bc.ca

[5] As we developed the content for the geospatial framework we found that "Category" assignments provided by DataBC for each GIS layer were not always helpful. We therefore developed our own "Themes" grouping as a better synthesis of the geospatial data but have retained DataBC's "Category" in the metadata framework file.

Table 3: Description of the columns found in the spatial metadata framework.

Column	Description
Title	The title of the dataset
URL	The URL to access the dataset online
Type	Datasets are either spatial datasets (e.g. ESRI Shapefile, geodatabase, etc.) or applications (e.g. an interactive map)
Description	A short description of the dataset. Descriptions are mostly copied verbatim from their source.
Theme	Datasets were grouped into themes which give a description of the nature and purpose of each dataset. The following 10 themes were developed and manually assigned to each dataset, to meaningfully group datasets into useful categories: 1. Archaeology 2. Basemapping 3. Fish 4. Human/Cultural/Economic 5. Land and Natural Resources 6. Land Use Planning 7. Water 8. Wildlife 9. Tenure 10. Environment
Category	This column simply extracts the category assigned to each dataset by DataBC.
Provider	The organization or ministry that produced the data.
Date Published	The date the data was first published.
Date Last Updated	The date the data was last updated.
Access	Either "Open," "Government Only" or "Government; First Nation; Tribal Council only". Open datasets are accessible to all users. Other datasets are accessible only to qualified users.
Additional Notes	Miscellaneous additional notes.

	A	B	C	D	E	F	
1	Title	URL	Type	Description	Theme	Category	Provid
2	Thompson-Nicola Regional Atlas	http://cmnmaps.ca/NICOLA/NicolaLa	Application	The purpose of the Nicola Lake Habitat Atlas is to provide baseline information for future decision-making about proposed shoreline developments and a detailed accounting of existing shoreline development. The project will help agencies identify and monitor the ecological condition of the shoreline, evaluate resource values and explore conservation and restoration opportunities associated with shoreline habitats.	Water	Water Management	Commu Networ
3	BC Water Portal	https://kwt.bcwatertool.ca/streamflow	Application	The BC Water Portal was developed for the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, and the BC Oil and Gas Commission to be a map-based water information tool designed to provide public access to a wide range of water-related data and information in British Columbia. The data is displayed with flexible charts and analytical tools to help users understand and use the data. Data	Water	Water Management	British Tool
4	Remote Access to Archaeological Data RAAD	https://www.for.gov.bc.ca/archaeolog	Application	RAAD is a web based application that enables authorized users to view, select, and download information about archaeological sites in British Columbia. Users can browse the data for specific site information using the online mapping and query utilities and download the information they want in a variety of data formats. The primary purpose of RAAD is to serve clients who require archaeological information on a frequent basis	Archaeology	Archaeology	British of Fore Natura
5	BC Wild Mountain Sheep Registry - Distribution	https://catalogue.data.gov.bc.ca/data	Spatial Data	A spatial representation of the general distribution of wild mountain sheep (bighorn and thinhorn sheep) in British Columbia. Populations that extend into neighbouring provinces and states are also included.	Wildlife	Wildlife Management	Minist Lands Operat
6	Water Rights Applications - Public	https://catalogue.data.gov.bc.ca/data	Spatial Data	This is a province-wide SDE spatial layer displaying water rights licence application data, administrated under the Water Sustainability Act which includes application data for both surface water and groundwater Points of Diversions. Point of Diversion types include surface water Points of Diversion (PDs) groundwater Points of Well Diversion (PWDs) as well as Points of Groundwater diversion (PGs), non-well groundwater	Water	Water Management	Ministry Lands Operat
7	Water Rights Licences - Public	https://catalogue.data.gov.bc.ca/data	Spatial Data	This is a province-wide SDE spatial layer displaying water rights licence data administrated under the Water Sustainability Act which includes data for both surface water and groundwater Points of Diversions. Point of Diversion types include Surface water Points of Diversion (PDs) Groundwater Points of Well Diversion (PWDs) as well as points of Groundwater diversion (PGs), non-well groundwater diversion points such	Water	Water Management	Ministry Lands Operat
8	Recreation Sites, Reserves, and Interpretive Forests Details and Closures	https://catalogue.data.gov.bc.ca/data	Spatial Data	The data contained within this spatial layer is an amalgamation of information for trails, Sites, Reserves, and Interpretive Forests derived from Forest Tenure Administration (FTA). The point is derived from the coordinates linked to each recreation number example (REC1567). That coordinate will identify either the trail head or the camping location or access point to the area. Larger areas will be a central point to the	Tenure	Forest Tenure	Ministry Lands Operat
9	Wildlife Habitat Areas - Approved (Secure)	https://catalogue.data.gov.bc.ca/data	Spatial Data	The dataset contains approved legal boundaries for wildlife habitat areas and specified areas for species at risk and regionally important wildlife.	Wildlife	Wildlife Management	Ministry Lands Operat
10	FADM - Tree Farm License Current View (TFL)	https://catalogue.data.gov.bc.ca/data	Spatial Data	This view is a snapshot in time and is a summary layer displaying the current boundary of the Tree Farm License, during the life of the agreement.	Basemapping	Administrative Boundaries	Ministry Lands Operat
	Historic Environment Spatial Layer	https://catalogue.data.gov.bc.ca/data	Spatial Data	The Historic Environment Spatial Layer contains polygons and related attributes representing post-1846 historic places in British Columbia that are recorded on the provincial heritage register. It does not include any archaeological site information.	Human/Cultural/Economic	Human/Cultural/Economic	Ministry Lands Operat

List of Datasets | Data-Summary | Dataset-Pivot | Theme-Category-LUT | Notes

Figure 5: Screen capture of part of the file ("GIS data framework (May 2019).xlsx") containing spatial metadata.

3 Key Issues and Concerns Identified Through Interviews

An important way to understand the environmental issues and concerns of the Nicola Valley watershed is to hear from the people who live there. More than a collection of documents, reports and maps, the perspectives of people living in the Nicola Valley integrate long experience with insights into how to better manage the Valley's resources.

Twelve of the interview participants are members of Indigenous communities or organizations (Nicola Tribal Association, Nicola Valley Institute of Technology, Lower Nicola Indian Band, Upper Nicola Band, Shackan and others[6]). These participants have a wide range of expertise: forestry, land and resource management, fisheries management, habitat mapping, cultural heritage, Syilx and Nlaka'pamux culture and law, and Indigenous Knowledge.

Sixteen participants were selected from the agricultural, federal and provincial government, and consulting sectors. These individuals have expertise in ranching (Nicola Stockbreeders Association), fisheries management, ecology, hydrology and water management, engineering and cumulative effects. As noted in Section 2.2, these 28 interview subjects were drawn from an initial list of 54 potential interviewees. Our final selections were based on our goal of including a broad range of expertise and the availability and willingness of individuals to participate. The key water management issues raised by the interviewees are described below.

[.)Based on our reading of the 2010 Nicola Water User Management Plan, we found that the main issues align with issues previously identified in the WUMP : insufficient water for both irrigation and fish, new development pressures with associated increase in water demand, inadequate groundwater regulations, economic impacts to surface water license holders during periods of water extraction restrictions, and poor water quality from land-based activities. All these issues continue to be important and are largely unresolved.

3.1 Water Balance and Hydrology

Hydrology experts we interviewed pointed out that the watershed is characterized by a rapid spring melt creating an intense freshet with possible flooding, followed by a long dry summer with little additional water. As climate change takes place, the upland winter snow pack is becoming more variable, the freshet is earlier, and the summer drought lasts longer. A fishery expert added that in addition to the direct effects of climate change there are related changes in natural disturbance agents such as mountain pine beetle. Mortality caused by mountain pine beetle coupled with subsequent salvage logging, has led to a "broken" runoff pattern where most of the water is released at one time rather than in the historical pattern beginning with lower elevation, gradually moving to higher elevation.

Against this changing "normal" many participants expressed great concern about uncertainty in the availability of two kinds of water – surface water and ground water – that underpin the Valley's hydrology. The two sources are obviously connected but because of a lack of data there is uncertainty about the dynamics of both sources. In the case of ground water there is also

[6] Some interviewees requested anonymity and their expertise and community affiliation is not listed here.

uncertainty about the location and extent of groundwater sources, as well as the overall mass balance of incoming and extracted water.

Besides the need for environmental flows that can support ecosystem, fish, riparian, cultural and recreational needs, development from the agricultural, industrial and municipal sectors all require additional water. Most participants believe that water is over-allocated and not adequately monitored, and that without accurate data about supply and demand it is impossible to decide what levels of water use are realistic and sustainable, to regulate growth and development, and to prioritize seasonal instream flow needs with the needs of water users. Others felt that there is enough water but that seasonal shortages occur because there are no viable options to capture the freshet for use in later summer.

Most participants strongly advocated for improved monitoring of actual use through monitoring wells with comprehensive licensing and monitoring/measurement/metering of use (including improved compliance and enforcement when necessary) applied to both ground water and surface water users.

3.2 Balancing Water Uses

Many interviewees pointed out the problem of a limited water supply that must be allocated for ecological, agricultural and municipal use. The growth in new residential homes and lack of metering was also mentioned by many as a source of concern. As noted above the need for the consistent measurement of water use through metering, coupled with comprehensive licensing of ground and surface water, was pointed to as a first step in understanding water demand and working within the limits of the whole hydrologic system.

Several interviewees pointed to the usefulness of the Nicola Water Management Tool (NWMT), citing the need to make more use of this tool and provide ongoing support for its use. The NWMT is a web-based tool designed to facilitate the synthesis of a broad suite of biophysical, ecological, and socio-economic considerations into water management decision-making to facilitate clearer communication of flow targets, guidelines and limits. For example, when additional water releases are needed for fish migration, the tool is used to communicate these needs with downstream water users who are encouraged to reduce withdrawals. The synthesis of data provided by the NWMT also provides a simple method for these same water users to see the flow and ecosystem effects.

In addition to water licensing and allocation, some interviewees pointed to the different needs of agriculture and resident fishes, with fishes preferring cold water and irrigation water not being constrained by temperature. These respondents pointed out that there needs to be more flexibility in water allocation during droughts, and that drawing ground water to maintain fish habitat and using warmer surface water for irrigation would be an intelligent way to provide benefits to both.

Cattle were also noted as contributing to a reduction in water quality and the availability of drinking water. Pollution from spills (e.g. the existing or proposed expansion of Trans Mountain pipeline, transport trucks on highways) were also mentioned as a concern in the event of a spill.

3.3 Aquatic Ecosystem Habitats & Flows

Numerous respondents drew attention to the variety of fish species found in the Valley, including Kokanee, steelhead, Chinook and burbot, and expressed concern over the sustainability of these populations in the face of increased encroachment by residential development, water demand and the impacts of flooding on channel stability, spawning and rearing habitat. Improvements to habitat restoration projects was suggested as one response to these pressures.

Some participants expressed concern over changes to the aquatic and riparian habitats of the Valley's rivers and streams (Figure 1 shows the 9 sub-basins). These changes stem from a variety of sources, including upland forestry operations which change the timing of snow melt and alter sediment loads, contributing to a more intense freshet, channel movement and bank erosion. Better reforestation practices, implemented sooner, were suggested as a mitigation measure. Some respondents also cautioned about over reliance on engineering solutions such as dikes and berms as a response to flood risk.

Others pointed to changes and losses in the location of cold-water holding areas preferred by fish, resulting from channel alteration as well as low summer flow and the loss of shade from the removal of riparian vegetation in valley bottoms rivers due to agricultural development. In-season allocation of more groundwater was suggested as a mitigation measure for improved fish habitat, switching agricultural users to warm surface water.

3.4 Watershed Governance

The federal and provincial governments have overlapping responsibility for the natural resources (fish, riparian, water management) of the Valley. With the creation of the March 2018 MOU, First Nations in the area are working towards sharing a greater role in the governance of the natural resources now share with the provincial government. The federal government is not formally part of the MOU, which is seen by some participants as an important missing piece of the management picture. Many participants noted that there is a history of poor relationships between the users: First Nations, federal and provincial agencies, agricultural, forestry and domestic users. One Indigenous expert in Syilx law expressed concern and that there is distrust of the process and intent of the MOU, which may be perceived as a treaty-like arrangement for the unceded lands of the Syilx and Nlaka'pamux. The adoption of individualized interviews may have reinforced this perception since the it conflicts with the more consultative approach to discussion and decision making found in the Indigenous communities.

At an important workshop recently held during the development of this report,[7] an observer from the project team noted that all the chiefs who spoke pointed to the connection between the collaborative management of the Valley's water and the ongoing process of reconciliation to address past injustices; and that the Forum should keep reconciliation in mind as one of its broad objectives.

A lack of coordination of actions within portions of the watershed, lack of integration of different decisions in different sectors, including how those decisions would affect other resources and users, and lack coordination of development decisions by local governments (Merritt, TNRD) was noted by many participants, and First Nations participants noted their communities' lack of input into decisions by the federal and provincial agencies, in spite of the knowledge they hold, along with their own need for capacity building and compensation to participate fully.

Several interviewees pointed out that there needs to be better awareness of the timing of water availability and of the multiple values embodied in water management. Some mentioned that a shared vision or "common land ethic" needs to be developed, including a balance among all the users. Some also felt that agricultural and forestry interests had too much influence on water use

[7] Nicola Watershed Community and Collaborators Engagement Workshop, convened by the Nicola Government to Government Forum 14-15 March 2019, held at Nicola Valley Institute of Technology, Merritt, BC.

decisions. It was suggested by many that since water is the resource that limits growth and development in the Nicola Valley, water should also be use as a common decision-making value. Because water connects all the parts of the watershed, development in one part of the watershed directly affects downstream areas. This reality should be more clearly recognized in decision-making.

On a practical note, some participants noted that the current in-season water management is not flexible enough. For example, they felt there should be better use of groundwater to maintain cool temperatures in temperature sensitive streams, using warmer surface water for irrigation.

Spanning most of the preceding topics is the overarching theme of “information” and how it is needed to support decision-making. Many of the interviewees felt that part of the current management predicament is due to past decisions made without good information. These limitations derived from information and knowledge gaps are discussed in more detail in Section 5.1.

Some interviewees from First Nations stressed the historic and long-term disregard for (or ignorance of) the protocols, policies and principles of the Syilx; and that disregard for the “Syilx way of doing things” constitutes a critical loss of knowledge and experience. They believe that without proper integration of the collaborative and consultative Tmix^{w} principles of the Syilx, there will not be real progress. They and others point out that many governance issues are fundamentally related to resolving values conflicts. For example, in interviews with Indigenous participants, values such as fish and fisheries, cultural sites and access to resources were identified by most participants, as detailed in Appendix H. Serious consideration of these values and issues would benefit from adopting or incorporating Indigenous decision-making practices.

As it pertains to governance, the state of knowledge of local people, including Indigenous Knowledge, is not always documented, but has the potential to supplement existing documentation and provincial and federal data. Lack of documentation is a complex subject, but can stem from not asking, not considering knowledge that is offered, and making inappropriate use of knowledge that is offered. Some respondents from outside the First Nations support the role of Indigenous culture and knowledge, commenting that the Indigenous communities are in the best position to make informed decisions, and that their elders should be listened to and more involved in making decisions.

4 Knowledge Base

One of the main goals of the present report is to support the Nicola Forum in taking stock on existing knowledge about the watershed that can inform and support future initiatives on watershed management. This section summarizes our findings from the review of three knowledge sources: (1) insights on Indigenous Knowledge as discussed during the semi-structured interviews with First Nation participants, (2) available reports and documents, and (3) geospatial information.

4.1 Indigenous Knowledge

Indigenous Knowledge (IK) (also termed 'traditional knowledge' specific to Indigenous people) refers to both the body of knowledge as well as the way of acquiring this knowledge from the accumulation of experiences and traditions shared and passed down orally among people who have lived within and as part of a natural environment for many generations (Berkes et al 2000; Berkes 2018). IK encompasses the knowledge, practices, and beliefs that are interconnected with culture, spirituality, tradition, and worldview of a group of people and their landscape (Berkes 2018).

As part of this project's aim to understand existing knowledge about the Nicola Valley, a key body of knowledge is Indigenous Knowledge. The use of IK to inform water management must be undertaken by knowledge holders. Thus, the focus in understanding this body of knowledge was to understand the types of existing IK that may be relevant for water management decision-making rather than acquisition of information as is done in the subsequent sections. To this end, we included several questions pertaining to IK in the questionnaire for Indigenous interviewees (Appendix F). This section, which should not be considered an exhaustive study of IK in the Nicola Valley, summarizes interviewee feedback and provides a preliminary glimpse at IK sources in the Nicola watershed.

Interviewees discussed how Indigenous communities in the Nicola Valley have acquired knowledge on the use and care for water and other natural resources in the watershed through generations. They expressed how transmission of knowledge has been primarily oral, with communities passing on histories, ceremonies and practices from one generation to the next. Knowledge resides within the families, which share and transmit different stories and have specific insights on various aspects of the communal knowledge. As one participant described for the Syilx people, they have inhabited the watershed since time immemorial (Quasipi times) and through their connection to Tmix^{w} – a concept that refers to the interconnectedness of nature – have stories (*captikwł)* that need to be heard.

Some participants referred to specific stories related to the management of resources in the watershed. For instance, one participant mentioned the Nlaka'pamux story that identifies the outlet of Nicola Lake as the location of the battle of the animal (Syilx) and the fish (Nlaka'pamux) people. Animal people won this battle and, since then, certain fish species (sockeye, sturgeon) were banned from the area. Other participants referred to the foundational story of the Four Chiefs, which describes how food was made available to people from the four food Chiefs; land (black bear), water (salmon), underground (bitterroot) and plants (Saskatoon). This is a complex story on stewardship of resources and one of the participants noted that it can take a whole week for the story to be told.

Knowledge is also shared and transmitted through ceremonies. Participants mentioned the First Fish ceremony and other water ceremonies that take place at various creeks and places in the

watershed. These ceremonies are conducted by Elders and are a vehicle for conveying to young people the principles and wisdom involved in water stewardship. One participant commented that water ceremonies have been gaining more attention in recent years.

Participants pointed out that Elders are the main knowledge keepers of the communities and play a key role in knowledge transfer through story telling and ceremonial practices. Various participants also highlighted the important role played by women in the transmission of knowledge about stewardship and respect for water and other resources to younger generations. For instance, mothers tell their children which tributaries to fish and teach them about the specific indicators for tracking seasonal changes (e.g., when yellow flowers come up, springs are running in streams). In families with a matrilineal structure, as one of the participants pointed out, women are the history holders. Several interviewees identified women as leaders in water protection. IK in the Nicola Valley includes knowledge about traditional foods and harvesting practices.

Many participants identified traditional foods and medicinal plants, such as bitterroot, Labrador tea, berries, etc., as key values in the watershed. As one of the participants described, community members who practice traditional harvesting are selected at a young age to play this role and trained to be holders of history and to learn about the protocols of harvesting and cultural practices. These knowledge holders have the obligation to pass on their knowledge to family members and others in the community interested in learning.

Some participants discussed how there have been initiatives in the Nicola Valley to document IK. For example, the Nicola Tribal Association (NTA) has documented IK in multiple instances as a part of specific studies, assessments, or Traditional Use Studies (TUS) that have been conducted in relation to project development proposals. Organizations such as Esh-kn-am Cultural Resources Management Services,[8] co-owned by three Nlaka'pamux First Nation Bands (Coldwater, Cook's Ferry and Siska), have collected information on the communities' traditional and cultural uses, practices and protocols through individual and group interviews and processed this information into mappable formats to inform planning processes, educational purposes, and negotiations. Also mentioned during the interviews is the Traditional Land Use Plans recently developed for the Coldwater and Coquihalla areas, which have been informed by IK.

Regarding principles for how the watershed should be managed, many participants discussed the sacred nature of water and how it needs to be managed in a sustainable way that considers future generations. Participants noted that these principles exist in mostly oral formats, coded in words, and transmitted through ceremonies and stories. Elders and language speakers are the most knowledgeable about these principles.

When asked about the recognition and integration of IK in decision-making in the watershed, most participants pointed to the historical lack of consideration of Indigenous Knowledge and how this is one of the main issues preventing problems in the watershed from being resolved. Participants expressed how including IK in watershed management requires Indigenous people are in control of the entire process to avoid potential expropriation and misuse of their knowledge.

4.2 Literature Review

A substantial body of knowledge on the Nicola watershed has been documented. As discussed in Section 2.3.1, we compiled and classified 514 documents covering various themes relevant for

[8] https://www.eshknam.com/

watershed management in the Nicola Valley. These documents vary in their format (e.g., reports, quantitative data, photos, etc.) as well as their geographic scope (whole Nicola watershed or specific sub-watersheds) and type of information discussed, which includes quantitative and qualitative analysis and also planning and policy documents.

The earliest documents date back to the 1960s but research and publication has increased significantly since the 2000s, as shown in the graph in Figure 6 which shows the evolution in the number of reports, from the documents we reviewed.

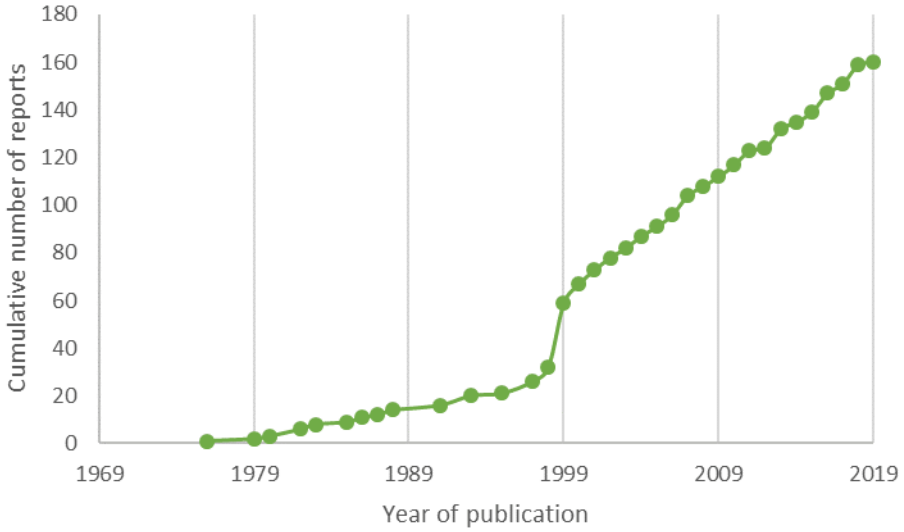


Figure 6: Cumulative number of reports on the Nicola watershed

Water is clearly the fundamental theme of the documents, with 28% identified as having a "water quantity / hydrology" theme, and 19% identified with "aquatic ecosystems / habitats." Dams, water supply and fish are the other common themes. To facilitate the classification of these documents, we identified 15 main themes discussed in these materials: water quantity and hydrology, water demand, water supply, water/river uses, water quality, climate, flooding, drought, fish, aquatic ecosystems/habitats, groundwater, water governance, dams/water infrastructure and plans.

Table 4 shows the numbers and types of documents classified under each of these themes and Table 5 provides a summary overview of the main themes we identified in the literature.

Table 4: Number of Nicola watershed documents discovered and obtained, categorized by document type and by content theme (if assigned). Some documents (such as photos) have not been assigned themes but all documents are accounted for in the right-most Total column. A few documents have not been assigned a type; usually because we were unable to obtain the document. Shaded cells in the bottom row and right column mark the most comment themes and categories, respectively.

	Content Theme														
	Water quantity / hydrology	Water demand	Water supply	Water / river uses	Water quality	Climate	Flooding	Drought	Fish	Aquatic ecosystems / habitats	Groundwater	Water governance	Dams / water infrastructure	Plans	**Total**
Report	76	27	42	25	39	10	11	10	58	82	22	37	23	2	179
Quantitative data	19	4	4	3	10							2	7		38
Spatial data															3
Supporting documents	26	9	15	8	4	1	2	9	7	12	6	19	26	19	66
Photos															174
Email / communications	19	4	11	2			2	2	9	6	2	10	24		42
Not classified															12
Total	140	44	72	38	53	11	15	21	74	100	30	68	80	21	514

Table 5: Summary of the themes, actions and data gaps found in the literature review

Theme	Summary of Available Information	Management Actions	Gaps
Water quantity/hydrology	Since 1965, bathymetric studies were conducted in the Nicola Lake and other lakes in the watershed. Other early studies include investigations on groundwater resources in the basin in 1982 (Groundwater Section, Water Management Branch, Ministry of Environment 1982), as part of the Nicola Basin Environmental Plan. As a supporting study to the 2010 Water Use Management Plan (WUMP; Nicola WUMP Multi-Stakeholder Committee 2010), a water budget analysis of instream flow requirements for fish and water needed for off-stream use (e.g. irrigation) was conducted. It concluded that for most years the watershed has a net surplus but during typical drought periods (1 in 10 year event), every sub-basin in the Nicola Watershed has a water deficit through the summer and fall (July to October) and therefore there is insufficient water to meet irrigation and instream flow requirements (Water Management Consultants 2008).	Work towards the implementation of a water licensing system for all new water supply wells (Rosenau and Angelo 2003). Support condition of no new permanent water licenses unless backed by storage (Rosenau and Angelo 2003).	**Date**: Hydrological studies started in the Nicola in the mid 1960's but most of the research and data collection has concentrated post- 2010. **Data Availability**: There are in total 140 documents on data quantity and hydrology; including 76 reports and 26 supporting documents. 16 of these sources are considered of high relevance. **Identified Data and Research Gaps**: The 2010 Nicola WUMP identified the critical need to develop a monitoring program to better determine baseline conditions for water quantity and its trend. It was recommended that the water budget study from 2008 be updated.
Water demand	In preparation of Nicola Water Use Management Plan, a watershed-level study documented current (Summit Environmental Consultants Ltd. 2007) based on water license information was prepared. The report revealed that agricultural sector dominates water in use in volume; demanding 76% of the water balance volume annually. This study also explored future demand for 2020 and 2050 different growth scenarios and climate change. The combined effects of climate change and high projected growth result in a growth in water demand of 124% by 2050. A series of reports from 2000 documented important waterbodies and watercourses for First Nations communities living in the watershed (i.e., Upper and Lower Nicola Bands, Coldwater Indian Band, Nooaitch Band, and Shackan Indian Band). These reports describe how water rights of the bands have been determined, historically and to the present (Babcock 2000a, 2000b; Mogus 2000a, 2000b; Mogus and Abrams 2000).	Establish moratorium on further water licensing (Rosenau and Angelo 2003) Implement water conservation measures at the municipal level (Urban Systems 2003) and broadly in the watershed for the various sectors (Summit Environmental Consultants Ltd. 2007).; e.g., conversion to more efficient irrigation practices Resolve long-standing questions about instream flow requirements in specific sub-basins with complex water demands (2010 Nicola WUMP)	**Date**: From 1983 (Nicola Basin Strategic Plan; Planning and Assessment Branch and Thompson-Nicola Region - Ministry of Environment 1983.) to the present. Most of the studies have been conducted since 2000. **Data Availability**: 44 document sources address, to some extent, issues related to water demand. Most of these sources are reports (27), followed by supporting documents (9), quantitative data (4) and email/communications (4). 7 of the documents are considered of high relevance. **Identified Data and Research Gaps**: To support water demand accounting, obtain detailed population, land use and water use information Encourage metering, improve agricultural water demand estimations and integrate water data in a central data warehouse (Summit Environmental Consultants Ltd. 2007). Update fisheries flow

Theme	Summary of Available Information	Management Actions	Gaps
	At the municipal level, a water conservation strategy was prepared in 2003 by Urban Systems for the City of Merritt. The Agriculture Water Demand Model (AWDM) developed by van der Gulik et al. (2013) was applied to the Nicola watershed to explore the evolution of agricultural water demand under various crop and climate scenarios.		requirements (Water Management Consultants 2008).
Water Supply	In the 1980s and 1990s, documents on this theme focused on the enumeration of groundwater resources, development of instream flow needs for fish, and included attempts to evaluate instream flow needs against water allocation (e.g., Kosakoski and Hamilton 1982; DFO 1998; etc.). Work in the past two decades has focused largely on revising and refining the work from the 1980s and 1990s. This recent work includes research into additional water storage sites (the WUMP Additional Storage Sites Study), a fish-water management tool, water budget modeling (e.g. Hatfield 2009), assessments of groundwater resources (BC Groundwater Consulting Services Ltd. 2011), and revised dam release plans. Much of this recent work has been driven by public and stakeholder consultations which form strategic plans. These consultation documents are available in the document library and focus on building a shared understanding of the concerns about water supply in the Nicola Valley.	Management actions identified in the literature include: (a) Develop a hydrologic budget to transparently and sustainably allocate water to fish and agriculture (2010 Nicola WUMP); (b) Establish a moratorium on water licensing for diversion or extraction; (c) Develop models to explore various water management scenarios; (d) Implement a water licensing system for new water supply wells; (e) Data collection to develop a hydraulic model of select Nicola rivers (f) Encourage water conservation in private industry; and (g) Continue monitoring aquifers.	**Date**: From the early 1980s to the present. Most of the literature has been published between the late 2000s to the present from the late 2000s to the present. **Data Availability**: There are 72 documents in this category. 42 of these are reports, and another 15 are supporting documents. 16 documents were marked as high importance, and another 23 are considered medium importance. **Identified Data and Research Gaps**: There is a need to revise instream flow needs for various fish. Further, research into the effects of flow augmentation on fish productivity is requested. A finer resolution quantification of groundwater storage is called for.
Water/river uses	Issues regarding conflicts between off-stream and in-stream uses in the basin have been documented since the 1983 Nicola Basin Strategic Plan. Most of the research and data collection has focused on documenting the impacts of increasing water demand (mainly for the agricultural sector) on aquatic habitats and fisheries. Multiple reports address the development of instream	Ensure stewardship of the water resources according to various plans (e.g., the 1983 Nicola Basin Strategic Plan; the 2010 Nicola WUMP) Harmonize licensing for industrial and environmental flows (Rosenau and Angelo 2003).	**Date**: From 1983 to 2017. Most of the literature was published after 2010. **Data Availability**: There are 38 documents discussing water use-related issues; most of them (25) are reports. Nine of these data sources are considered of high importance and 14 of them of medium importance.

Theme	Summary of Available Information	Management Actions	Gaps
	flow needs for fish as well as water needed for alternative uses (e.g. Hatfield et al 2003; Hatfield 2009). Several studies have looked at issues related the different uses of the water and the river system; either looking at specific features of the watershed, such as the Foreshore Inventory and Mapping (Ecoscape Environmental Consultants Ltd. 2012) which determined the effects of cumulative shoreline modifications. At the sub-watershed level, a recent report (Epp 2016) assessed the environmental/ agricultural flow needs in the area of influence of Mamit Lake (Guichon Creek sub-watershed) and recommended reservoir levels and releases McFarlane (2014) evaluated the amount of water licensed from Nicola lake in comparison to its storage capacity and environmental demands (fish flows) and provided recommendations for the management of outstanding water licenses. There are also communications pertaining to meetings between Mamit Lake and Guichon Creek license holders, from 2016.	Develop collaborative watershed governance for the Nicola watershed (Water Management International 2007	**Identified Data and Research Gaps**: The need to measure water use from mainstem licenses was identified (McFarlane 2014).
Water Quality	Deteriorating water quality was identified as an issue in the Nicola watershed, deriving from pollution from agricultural runoff, the Merritt sewage treatment plant, and open-pit mining in the Guichon watershed (Holmes 1979, 1988; Klohn-Crippen. 1993). At this time, concerns about impacts to fish are raised, but have not been observed. Multiple reports document the value and importance of water quality to all individuals in the Nicola, one report specifically describes the importance of water to the Syilx (ONA 2014). Water quality was again raised as an important issue in the early 2000s, in order to maintain existing values in the Nicola (e.g. clean water for drinking, healthy aquatic ecosystem, minimized disturbances from development),	Management actions identified in the literature include: (a) upgrade the quality of effluent from the sewage treatment plant; (b) develop water quality objectives for priority streams, and increase monitoring capacity; (c) encourage farms to undertake nutrient management plans to reduce nutrient loadings; (d) encourage industry to adopt best management practices around water conservation and use; (e) implement measures to manage shoreline erosion of Nicola Lake; (f) assess potential water storage sites to maintain flows through Nicola Lake to	**Date:** Reports have been published from the late 1970s to the present. The bulk of publications are from the late 1990s to the present. **Data Availability:** there are 53 documents that pertain to water quality. Of these, 39 are reports. In total, only 6 documents were classified as high importance. **Identified Data and Research Gaps**: Better understand effect of agriculture on water quality. Develop monitoring programs to understand baseline water quality conditions and trends to better understand changes in the future, especially in the context of cumulative effects.

Theme	Summary of Available Information	Management Actions	Gaps
	and accommodate additional pressure on the Nicola. New pressures were identified, including shoreline developments and wastewater discharge (NWCRT 2004; Urban Systems Ltd. 2005). Numerous studies have measured lake, river, and groundwater quality, using indicators like temperature, pH, hardness, total dissolved solids, coliform counts, PCBs, etc. These studies have been conducted in numerous contexts, including measuring impacts from existing and proposed industrial developments, quantifying to drinking water, understanding impacts to fisheries, and establishing baseline conditions (e.g. Holmes 1988; Walls 2010; Ecoscape Environmental Consultants Ltd. 2012; etc.). Research demonstrates that in the Nicola, high temperatures act as a limiting factor for salmonids (Walthers and Nener 2000). High temperatures are aggravated by altered land uses and the loss of riparian vegetation (which provides shade), especially during periods of low flow. A cumulative effects framework considered water quality in the context of other pressures within the Nicola watershed (Valdal and Lewis 2015).	keep temperatures down; (g) develop proactive watershed planning programs; (h) inventory invasive species.	
Climate	Climate change is an important concern for rights- and stake-holders in the Nicola watershed. There is recognition that climate change will have a broad impact on all aspects of water resources and aquatic ecosystems, and that the cumulative impact of climate change and other pressures needs to be addressed. In the literature, data that indicates that novel weather patterns are being observed, meaning that the predictability of flows is being degraded (suggesting that existing models will require revisions) (Associated Environmental 2017). Climate change's effects on the hydrologic cycle is predicted to alter water availability and demand seasonally (it is expected to increase the frequency of summer low flows, and decrease ice-cover in the winter, and otherwise alter precipitation and	Management actions recommended in the literature include: (a) water conservation measures; (b) studies to assess impacts of climate change on water resources; (c) revising the Nicola lake dam plan to better accommodate for the effects of climate change on hydrology; (d) designate Nicola streams as Temperature Sensitive Streams to secure protections for aquatic species and habitats; (e) impose water conservation and efficiency measures in the region; (f) develop a drought management plan; incorporate climate change planning into	**Date**: Literature on this topic has been published between 2003 and the present, with most in the 2010s. **Data Availability**: There are 11 documents which pertain to climate. Of these, 10 are reports, and one is a supporting document). Five of are high importance. **Identified Data and Research Gaps**: The need to better understand how future climate change will impact all aspects of hydrology in the Nicola watershed has been identified.

Theme	Summary of Available Information	Management Actions	Gaps
	hydrology (e.g. earlier peak flows)). There are concerns about being able to meet water needs during regular drought occurrences (e.g. during a 1 in 10-year drought) (Golder Associates Ltd. 2017). It has been observed that stream temperatures are rising due to both climate change and land use changes. Tolerable temperatures for fish species have been exceeded (Peatt 2013).	ministerial planning (FLNRORD)	
Flooding	Throughout the literature, flooding is identified as an issue that affects residents of the Nicola watershed. Flooding causes damage to properties and infrastructure, as well as to the environment. The literature discusses how certain floods river-courses and documents the specific impacts of various floods (e.g. scouring, specific damage to infrastructure), and how they were managed at the time. The literature also includes an assessment of how alternative management options could mitigate flooding impacts. Literature also includes revised run-off calculations for tributaries of the Guichon, floodplain mapping (for select regions), a revision of the Nicola Lake inflow forecasting model following the flooding events of 1990 and 1991 (Costerton 1993), and a flood risk assessment for the City of Merritt (Associated Engineering 2013).	Management actions identified in the literature include: (a) revise the Nicola Lake dam plan so that it incorporates uncertainty and future climate change; (b) assess the vulnerability of stormwater system in Merritt to spring and winter flooding and ensure no stormwater infrastructure is outside of the flooding damage area.	**Date**: Literature was published between 1982 and 2017. Much of the work was published from the early 1980s to the early 1990s, and since 2010. **Data Availability**: 15 documents pertain to flooding, of which 11 are reports. Only three documents were marked high importance, and four were marked medium importance. **Identified Data and Research Gaps**: Additional data required to adequately model runoff for certain creeks. Research is required to better understand flood hydrology and how it is changing, in order to manage for floods in the Nicola
Drought	The 2003 drought raised public awareness of how droughts threaten the integrity of Nicola watershed resources (especially fish), prompting action, and the commencement of the Nicola Water Use Management Plan. Literature of this era discusses the challenges of water allocation, especially in dry years, in the Nicola. There is research into how drought conditions affect Nicola region hydrology, as well as aquatic species and habitats (considering the multiple uses of water; e.g., Schick et al 2016); the sensitivity of Nicola sub-basins to extreme droughts; and how droughts will affect water availability.	Management actions identified in the literature include: (a) develop an integrated drought management plan; (b) develop a new rule curve to manage droughts for the Nicola Lake Dam; (c) develop study designs to understand how summer low flows combine with other environmental variables (e.g. increased temperature) to impact various stages of fish life history.	**Date:** Literature was published between 1976 and 2017. The bulk of the work was published from mid 2000s to the present. **Data Availability:** There are 21 documents pertaining to drought, of which 10 are reports. Eight are marked high importance and four were marked medium importance. **Identified Data and Research Gaps**: Additional drought monitoring and research is suggested to understand the effects on hydrology.

Theme	Summary of Available Information	Management Actions	Gaps
			Increase research to understand how drought conditions affect salmonids.
Fish	The vulnerability of fish in the Nicola watershed is a topic that was raised in the early 1980s and remains relevant. With increasing pressure on water resources (e.g. increasing withdrawals competing with environmental needs for fish, combined with water quality) low flows will become an issue for various fish species. More recently, there is recognition that climate change will exaggerate these pressures on fish. Numerous studies evaluate either specific fish species or concerns about fish or fish habitat at specific locations. Other scientific studies assess the flow and other environmental needs of Nicola fisheries (e.g., Kosakoski and Hamilton 1982; Hatfield 2006; etc.). There are also generalized overviews of the fisheries resource within the Nicola (e.g. Millar et al 1997). Other reports include recovery strategies, plans for monitoring and evaluation (e.g. Nelson et al 2001), and research into environmental flow needs. Multiple studies evaluate cumulative impacts within the Nicola. Though none of these are centred on fish, many evaluate the impact on fish among other receptors due to proposed industrial projects (e.g. EIAs for transmission lines, roads, etc.) or existing industry (irrigation) and other disturbances like the Mountain Pine Beetle (e.g., Dobson Engineering Ltd. 1999; Valdal et al. 2015). The Nicola Water Management Tool was developed to increase transparency of the Nicola Dam management, promote cooperation and learning among water and fish managers, and better manage flows to benefit anadromous salmon while balancing water use needs and resident fish. The NWMT provides information to managers to facilitate making decisions about trade-offs among various objectives, and the science and	Management actions identified in the literature include: (a) ensure stewardship of the riparian zone and surrounding watersheds; (b) implement best practices for land use activities to reduce impacts to fish habitat; (c) restoration of watersheds (and especially riparian zones) to rehabilitate fish habitat; (d) develop management practices to reduce periods of low flows; (e) harmonize water allocations with environmental flow needs. (f) Map the location of cold-water inputs to Nicola streams.	**Date:** Literature was published between 1980 and 2018. The majority of the of the work on this topic was published from late 1990_s to the present. **Data Availability:** There are 74 documents pertaining to fish, of which 58 are reports. 16 documents were considered high importance and 27 were considered medium importance. **Identified Data and Research Gaps**: Research is required to develop a finer scale understanding of how changes to flow impacts fisheries productivity. Enumerate salmonid populations.

Theme	Summary of Available Information	Management Actions	Gaps
	values that underpin them. Multiple documents pertaining to the design of the NWMT can be found in the document library (e.g. Alexander and Poulsen 2015; Alexander et al 2018; etc.). As part of the WUMP process there are numerous documents which document the concerns about fish held by Nicola residents, and recommend actions to ameliorate these concerns. In the document library there are also numerous communications between provincial staff with regards to managing for environmental flows at various points in time.		
Aquatic Ecosystems / Habitats	The health of aquatic ecosystems and habitats is a concern that is repeatedly raised at numerous workshops and meeting summaries. A common theme is the conflicting needs of the various industries for water and environmental flow needs to maintain healthy aquatic habitats. Included are numerous communications between BC government staff regarding dam releases, erosion to Nicola rivers, and other concerns. There are many research reports, many of which focus on evaluations of the health of fisheries in the Nicola (e.g. Rood and Hamilton 1995; Millar et al 1997; Willms and Whitworth 2017). Numerous studies evaluate the causes and effects of low flows, and especially the causes and effects of high temperatures. Numerous studies concern the establishment of environmental flow needs for various fish species (e.g., Hatfield 2006). There are many assessments of fish habitat, which include recommendations for habitat management to recover fish species (e.g., Wildstone Resources Ltd. 1997; Gronsdahl 2019). There is research on the impacts of various stressors including timber harvesting, pulp and paper, riparian development, sewage / wastewater, agriculture and irrigation, sedimentation, direct habitat	Management actions identified in the literature include: (a) Support continued research into aquatic ecosystems; (b) Understand how forest regrowth affects hydrology; (c) Support ecosystem enhancement initiatives; (d) Develop riparian setback for new water supply wells; (e) Ensure instream flow needs are taken into account in planning and development processes; and (f) Identify and protect cold-water inputs to streams.	**Date:** Literature on this topic was published between 1982 and 2018. Most of the reports have been published since the mid 1990s. **Data Availability:** There are a total of 100 documents in this theme, of which 82 are reports and 12 are supporting documents. 11 documents were marked high importance, while 51 were marked medium importance. **Identified Data and Research Gaps**: Conduct additional aquatic habitat assessments to better understand these environments. Develop more nuanced hydrological models to support water resource management. Better understand cumulative impacts to aquatic habitats, and how to rehabilitate them

Theme	Summary of Available Information	Management Actions	Gaps
	loss, contamination, high temperatures, mountain pine beetle, recreational vehicle use, climate change, and even the effects of natural processes like freeze-up / break up on salmon eggs. Numerous sub-watershed hydrologic assessments were published in the late 1990s which are used to understand the scope and severity of water-related problems within a watershed and understand the implications to hydrology of additional forestry activities. There are also numerous site-specific impact assessments that detail impacts to aquatic habitats including consequent impacts to indigenous rights and title from proposed development projects and other activities.		
Groundwater	Exploration of groundwater resources for water supply started in the watershed in the 1970s. Despite being a critical resource (e.g., the water system of the city of Merritt is entirely supplied by groundwater), the functioning of the aquifer system in the Nicola is not completely understood. Research into the groundwater budget and hydrogeological modeling in the Nicola Watershed is recent, with most studies being conducted since 2016 (Golder 2016 and 2018, Gorski et al. 2018). These recent research efforts have focused on understanding the functioning of the aquifers in the valley bottom areas. Reports have been commissioned by the City of Merritt, local First Nations, the Nicola Community Roundtable, and the Province of B.C. Management of groundwater resources and associated regulations were identified as inadequate in the Nicola's WUMP (2010); for example, only if the capacity of a new well exceeds 75 litres per second, an environmental assessment is required. Reduced groundwater flows affect the river base flow and habitat conditions for fish (Douglas 2006).	The WUMP recommended some actions in relation to groundwater: (a) harmonize surface water allocations/licenses with groundwater use/demand/licenses; and (b) ensure Instream Flow Needs are considered.	**Date:** Literature on this topic was published between 1978 and 2018. Most of the work has been published between the mid 2000s and the present. **Data availability:** There are 30 documents related to groundwater resources, including 22 reports.9 documents were identified as of high importance and 10 were identified as medium importance. **Identified Data and Research Gaps**: Improve the estimation of annual groundwater use (add more observation wells). Obtain information to support the development of a numerical groundwater flow model (i.e., higher resolution elevation model, riverbed conductance, pumping rates, etc.).
Water governance	Much of the literature concerns the conflicts over the	Management actions identified in the	**Date:** From late 1990s to the present. Most of the

Theme	Summary of Available Information	Management Actions	Gaps
	various uses of water in the Nicola watershed, and the limited availability of water for all of those uses. Research and documentation on conflicting water uses and needs in the Nicola watershed, especially between agricultural water demand and flow needs for aquatic habitats, started in the early 1980s. A report by in 1982 (Kosakoski and Hamilton 1982) pointed to high water temperatures as a limiting factor for salmonid production in certain parts of the watershed. The 1983 Nicola Basin Strategic Plan, led by the provincial government, contained provisions for the protection and recovery of salmon and steelhead through safeguards and proactive management of the area's water resources. Many reports and supplementary documents concern dam release plans (including workshop summaries and other communications). These documents pertain to how to manage releases for numerous uses.	literature include: (a) Establish community-driven water governance; (b) Secure funding to support water governance; (c) Support compliance and enforcement for WUMP monitoring program and review the WUMP after 5 years, (d) Develop a hydrological budgeting process to harmonize environmental flow needs with water licensing; and (e) Update dam release plans.	literature on this topic has been published since the mid 2000s. **Data availability:** There are 68 document sources pertaining to water governance, of which 37 are reports, 19 are supporting documents and 10 are communications. Eleven were marked high importance and 17 were marked medium importance. **Identified Data and Research Gaps**: Obtain finer resolution data on water usage in the Nicola; and better understand baseline water conditions in the Nicola.
Dams/Water Infrastructure	Literature on this topic pertains to documentation of Dams and other infrastructure in the Nicola watershed and its impact on the water resources. Included in the literature is research pertaining to hydrologic forecasting, the impact of additional storage on fisheries resources, conflicts between industrial water uses and environmental flow needs, the sustainability of groundwater and aquifer wells, natural hazards to municipal infrastructure, dam storage and releases, as well as impact assessment associated reports on Nicola watershed hydrology and ecology (including technical diagrams). There are also extensive communications between the BC government and Nicola watersheds stakeholders and rights-holders pertaining to the management of dam releases.	Management actions identified in the literature include: (a) Develop a hydrological budgeting process throughout the watershed in order to allocate water to fish and agriculture in a fair, transparent and legal manner; (b) update the Nicola Lake Dam flow-release regime and review operations of other small dams; and (c) Revisit and identify potential new storage dams	**Date:** Documents have been published between 1980 and 2018. Most of the work has been published in the past decade. **Data Availability:** There are a total of 80 documents in this category, of which 23 are reports,26 are supporting documents, and 24 are communications (e.g. emails). Of the total number of documents, 13 were marked high importance, and 14 were marked medium importance. **Identified Data and Research Gaps**: Delineate the aquifers in the Nicola Watershed. Better understand how flow augmentation affects fish populations and aquatic habitat. Develop more sensitive flow forecasts.
Plans	The theme "Plans" was developed in order to tag documents which included engineering, topographic, or other technical diagrams that did not properly fit into	NA	NA

Theme	Summary of Available Information	Management Actions	Gaps
	other categories. These diagrams pertain primarily to dams and other built infrastructure in the Nicola watershed.		

4.3 Mapped Data

We identified 368 spatial data layers that are pertinent to water resources management in the Nicola Watershed. Of these, 70% are open access; the remainder are restricted to certain users (predominately, these are restricted to government or First Nations users). Most of the 368 layers are hosted on the provincial DataBC repository. The remainder are hosted elsewhere by the provincial government or elsewhere on the web by private companies. We were not able to identify GIS data that may be held separately by First Nation governments in independent repositories. The ten major themes of the spatial data are shown in Table 6, along with summaries of the kinds of information held under each thematic group.

Table 6: Summary of spatial datasets.

Themes	Datasets	Summary of Available Information
Archaeology	7	Spatial data pertaining to archaeological features in BC. Data includes: known archaeology sites and relevant site information; model derived potential for archaeological features (for areas that have not been surveyed); relevant base-data; and known historic places.
Basemapping	102	Spatial data of base-features in BC. Data includes: aerial photography; utilities; transportation networks; topography; water features; administrative delineations (cities, natural resource regions, management zones, forestry regions, etc.)
Fish	13	Spatial data pertaining to fish and fish related environmental features. Datasets include: bathymetry for select lakes; observations of aquatic invasive and non-invasive species; stream and lake inventories; an inventory of culverts (and related meta-data); fish distributions; and sensitive watersheds.
Human / Cultural / Economic	6	Spatial data pertaining to human, cultural, and economic interests. Datasets include: historic / heritage sites; First Nations culturally sensitive sites; model derived potential for culturally modified trees (for areas that have not been surveyed); and proposed major developments (e.g. mines, pipelines, plants).
Land and Natural Resources	47	Spatial data pertaining to BC lands and natural resources. Datasets include: spatially delineated livestock regulations; agricultural land commission and agricultural land reserve data; conservation lands; terrestrial ecosystem information (e.g. terrestrial/predictive ecosystem mapping, sensitive ecosystems, bioterrain mapping, soil mapping); shore-zone features, hydrology; protected areas; fire management features; and First Nations treaty features.
Land Use Planning	15	Spatial data pertaining to land use planning activities. Datasets include: old growth forest areas; land use planning features; landscape units; and strategic land and resource use plans.

Themes	Datasets	Summary of Available Information
Water	55	Spatial data and applications pertaining to water management. Datasets include: water rights (e.g. allocations, withdrawals, works); water-related infrastructure (private water utilities; flood protection, dams, groundwater wells); reservoirs, aquifers, and springs; water vulnerability; hydrology (e.g. peak flow, minimal flow, runoff); historic water and snow data; and water quality information. **Applications include:** real-time flow data; an atlas of water resources; a water information tool; and a Nicola Lake Habitat Atlas.
Wildlife	22	Spatial data pertaining to wildlife management. Datasets include: species distributions and incidental observations; locations of wildlife features (e.g. mineral licks); guiding areas; traplines; and game management areas
Tenures	68	Spatial data and applications pertaining to provincial crown lands. Datasets include: forestry activities and areas (e.g. cutblocks, silviculture activity); parks and protected areas; recreation areas; land surface ownership; mineral occurrences and tenures; other land tenures (e.g. tourism, economic development, etc.). **Applications include:** a map that shows how parcels of land are used; and a map showing extensive mineral and geology data.
Environment	33	Spatial data and applications pertaining to environmental management. Datasets include: soils data; forestry inventories (e.g. tree composition; forest height and age); at risk species and ecosystems; pest features; Biogeoclimatic Ecosystem Classification; and climate stations. **Applications include:** a regional environmental data analysis portal; and a catalogue of environmental reports.

5 Analysis and Recommendations

5.1 Data & Knowledge Gaps

We contrasted the gaps in knowledge and information discussed by the interviewees with the data gaps our team identified during the literature review of document sources. This section discusses what we consider the key data and knowledge gaps that the Nicola Forum should address in priority to advance better water management in the Valley. The recommendations proposed in Section 5.2 would contribute to partly addressing these gaps.

5.1.1 Water quantity and hydrology

A number of interviewees noted that water balance conditions and the hydrogeological functioning of the watershed is not completely understood; especially the relation between groundwater and base flows and how this dynamic affects cold water refugia for fish. For groundwater specifically, there is a need to better understand this resource in the watershed. Research is currently underway to develop a numerical groundwater flow model (Golder 2016, 2018). With a more complete understanding of the hydrology, it might be possible to identify better water use and water management options, including mitigating water loss and maintaining cold water refugia. Low flows during drought years are another main concern for many of the participants, who characterize it as a problem for all water users in the Nicola watershed. Many studies on drought in the Valley express the need for further research into drought conditions in the Nicola and their impacts on hydrology, including the need for a sensitivity analysis of each Nicola River sub-basin to extreme drought conditions.

Climate change is already putting additional stress on water resources in the Valley and its hydrological consequences are not well understood. The effects of climate change are already being observed in the form of more frequent and intense droughts, rising water temperatures and increased flooding events. Both the literature and the interviewees agreed on the need to conduct research and carry out hydrological flow monitoring at the sub-watershed scale, to understand how hydrology is changing in the Valley, and how to better manage for droughts and floods.

5.1.2 Water uses

Information on instream and off-stream water use in the Nicola watershed is incomplete. Because water metering is not consistently practiced, and groundwater licenses remain for the most part unregulated, there is a significant information gap on actual water use. The perception of most interviewees is that water management cannot be improved without having this information across the watershed, and that measurement of actual water use is an important step toward managing its use. Apart from the interviews, literature studies on the water balance in the Valley have also identified the key need to quantify water use from mainstem licenses to manage it fairly.

Other data gaps related to water demand identified in the literature pointed to the need for improved agricultural water demand estimations and for a central data warehouse that integrates data on water use across the watershed.

5.1.3 Baseline conditions

There is a need to develop monitoring programs to understand baseline water quality conditions and trends to better predict future changes, especially in the context of cumulative effects and climate change. Over time, consistent collection of water quality data (e.g., flow, temperature, chemistry, contamination) using a statistically based monitoring plan, will allow water quality trends to be identified and managed.

Although there has been substantial research on some of the values of the Nicola watershed (e.g., fish, water quality, etc.), there is a fragmentation in the information, since these studies and research initiatives have been developed for various purposes and with different scopes. The document library produced by this project is an important step toward collating this information and making it searchable.

The interviews confirmed that fish and fisheries are an important value for both Indigenous and non-indigenous communities. There are critical remaining information gaps on salmonid populations and on the location and dynamics of cold-water refugia in the watershed, which are critical for survival of fish during sensitive life-stages.

Water quality is another topic that has been raised in the literature and interviews as not being sufficiently documented in the watershed.

5.1.4 Cumulative effects on fish and other key watershed values

Cumulative effects were mentioned by some interviewees as an important aspect of managing water in the Nicola Valley, and that a cumulative effects perspective needs to be developed, which recognizes the multiple linkages among water users. Feedback from the interviews indicates that participants were concerned about the unknown consequences of multiple increasing pressures (e.g., increased water demand, development encroachment, etc.) and altered hydrology on aquatic and fish habitats in the watershed. Multiple studies have evaluated cumulative impacts within the Nicola, although none of these have centred on fish. There is a need to develop a detailed understanding of how changes to flow (which come from multiple stressors such as water withdrawal, forestry activities, etc.), impacts fisheries productivity. There is a lack of coordination over in-stream flow needs at different times and places, and, as discussed previously, incomplete knowledge of cold water refugia locations and dynamics.

Multiple participants also expressed concern over changes to the aquatic and riparian habitats of the Valley's rivers and streams. These riparian habitats are impacted by different activities (e.g., development, agriculture) and would benefit from a cumulative impact assessment to better understand their status, impacts and better design restoration or mitigation measures.

5.2 Recommendations

Based on our analysis of the interviews and our synthesis of hundreds of documents and spatial data layers, we have identified what we believe to be high priority needs for the Forum to consider as pilot projects. Our recommendations are made at a high level, since we feel that it is the work of the Forum to work to flesh out more detailed plans after discussing and deciding the options within each recommendation. We view the first recommendation as the most important, since it will influence how each of the other recommendations is considered. In the project team's opinion, the next four recommendations have similar urgency and could be addressed in any order. The final recommendation is of the lowest immediate urgency.

Each recommendation is presented with a brief introduction, followed by a table which begins with a brief overview that provides the context for the recommendation. This is followed by a list of some of the main themes and values addressed by the recommendation, which highlights the linkages among the recommendations. Next, we make brief statements about how each recommendation relates to water governance and planning. Finally, each table briefly states what information is available about the recommendation, and what knowledge and data gaps exist, which would be addressed if the recommendation were acted upon through development of a project.

5.2.1 Improve the Use of Indigenous Knowledge in Decision Making

As an overarching recommendation the Forum should improve the use of Indigenous Knowledge (IK) in all its decision-making processes. Nicola First Nations and their IK have historically been excluded from Nicola Valley decision-making processes. As the first inhabitants of the Nicola Valley, and its stewards since time immemorial, Nicola First Nations' IK should play a core role in resource management decision making. This process should be driven by Nicola First Nations themselves.

Improve Use of Indigenous Knowledge in Decision Making
Overview: An extensive body of IK about the Nicola Valley exists in documented form (e.g. reports, governance protocols, declarations, etc.) as well as "undocumented" forms, meaning that it is held by Nicola First Nations members themselves. IK pertains not only to knowledge of lands and resources but to governance and management systems, ethics, values, spirituality, as well as world views as a 'knowledge-practice-belief complex' (Berkes et al 2000; Berkes 2018). Since the establishment of Canada and the Province of British Columbia, Nicola First Nations have been excluded from decision-making processes about the Nicola Valley. To better steward the resources of the Nicola Valley (as Nicola First Nations have done since time immemorial), it is critical that the Nicola Forum consider IK as a core component in all their decision-making processes. The Nicola Forum should adopt a formal process that will guide how IK contributes to decision making. This process should be developed, owned and undertaken by Nicola First Nations, in respect of Syilx and Nlaka'pamux governance principles and protocols. This process would represent the ways that they would like to see their knowledge inform decision-making processes. In these processes it is critical that knowledge is not separated from knowledge holders and their worldviews. The role of women as history holders in Syilx and Nlaka'pamux culture should be maintained as part of IK inclusion. To treat IK as a data point to be evaluated within a western-scientific framework is to strip certain bits of knowledge from its broader context and not acknowledge the necessity of having IK holders determine how IK should inform decisions (Berkes 2018).
Related themes and values: Indigenous Knowledge, information sharing, decision-making processes
Planning and management context / Links to water management: This recommendation should be considered an umbrella recommendation that applies to all the other water management processes in the Nicola. The involvement of IK, as guided by Nicola First Nations in Nicola Valley will ensure the consideration of Indigenous viewpoints and worldviews in

managing water. Development of a significant cross-cultural approach will contribute to reconciliation between Indigenous nations and non-Indigenous residents and the Provincial government.
Available information: Historically the documentation of IK has largely been done by visiting academic researchers, or in the context of consultation for proposed industrial projects (i.e. Traditional Use Studies for Environmental Impact Assessments). During this project, First Nations interviewees shared their knowledge and concerns about the Nicola watershed and identified sources of IK that are documented as well as ones that are not documented, both of which are important in comprising the collective body of knowledge held by the Nicola First Nations.
Knowledge and data gaps: This report is not designed to present a comprehensive account of the various forms of IK that exist within the Nicola watershed. It is important to remember that IK should not be separated from its context; use of IK by the Forum should be done within a framework or process (developed by Nicola First Nations) that ensures that it is used respectfully.

5.2.2 Improve Understanding of Water Balance and Water Use

The Forum should work to improve the understanding of water balance and water use in the Valley. This understanding will enable the Forum to manage water scarcity based on the best available science, including development of monitoring plans to measure changes. A recurring theme of our interviews and review of the literature is the need to have a better understanding the hydrosystem dynamics in order to manage the water better, especially during times of scarcity. Modeling work carried during the development of the Water Use Management Plan (Summit 2007) included landscape level weekly water use estimates by sub-basin, and more recently Golder (2016) has reported on groundwater dynamics in portions of the Valley. The Nicola Water Management Tool (Alexander and Poulsen 2015) is the most recent software system that can be used to evaluate water use scenarios and should be updated as new information becomes available.

Water Balance & Water Use
Overview: Understanding the water budget of the Nicola Valley hydrosystem is necessary to resolve uncertainty about the groundwater dynamics, to gain a fuller understanding of the sustainability of water use in the Valley and to support maintenance of cold water refugia that are necessary to a variety of fish species. This need is particularly urgent because of climate change and residential and commercial development. The need for hydrological understanding is coupled to the urgent need for metering of water extraction by all users.
Related themes and values: cold water, ground water, flood, development
Planning and management context: The lack of metering of existing water user and license holders is a serious gap in understanding how water is extracted from surface and groundwater sources. When linked to tools like the NWMT, improved groundwater dynamics and surface and groundwater supply could be incorporated into real time decision making.
Links to water management: Water management should be linked to a monitoring plan (Section 5.2.5) that includes comprehensive measurement of water consumption from above

and belowground sources, and protocols for water restrictions during drought (Section 5.2.3). Water licensing needs to be tied to water consumption using sustainable consumption limits.
Available information: Quantitative water budget studies by Summit (2007) and Golder (2016) are found in the document library and are a good starting point for developing or extending a hydrosystem model. The NWMT provides a working real-time system that could be leveraged with improved information.
Knowledge and data gaps: Missing information about water consumption creates a serious gap in the understanding of above and belowground water availability and dynamics. Water metering is an essential next step, recognizing that it may not be widely supported.

5.2.3 Improve Protocols for Balancing Instream Flow & Drought Management

The Forum should advocate for and lead in the development of protocols for balancing instream flow and drought management, including water metering. Flow management rules need to be worked out among the water users in the Valley which account for the limited capacity of surface and ground water to meet environmental flow needs during periods of drought. This was a recurring theme from our interviews and from our review of the literature and is particularly urgent because of climate change and ongoing residential and commercial development in the Valley. The problem is caused by providing ongoing increases in domestic and industrial water is aggravated by the absence of a comprehensive metering system that would quantify water extraction by users and sources.

Instream Flow & Drought Management
Overview: The need to maintain fish habitat by providing for adequate environmental flow during periods of drought has been widely recognized for many years. Similarly, the twin pressures of climate change and development are also recognized. Developing protocols to balance these needs, recognizing that hard trade-offs will be required, has not been adequately incorporated into the water management system, which is currently focused on minimizing flooding at Merritt and managing water levels in Nicola Lake.
Related themes and values: cold water, ground water, flood, riparian encroachment, development, water licensing, water measurement, monitoring, Indigenous Knowledge
Planning and management context: Instream flow needs have been talked about for at least the past two decades, including the need to establish flow requirements at the sub-basin level, incorporate cold water inputs, make more intelligent use of ground and surface water during low flow periods, make better use of irrigation water, and implement the comprehensive licensing of surface and ground water. Among other needs, what is missing is the development and adoption of voluntary and mandatory protocols that will balance the trade-offs that are necessary during drought, through agreed-upon staged water use cut-backs.
Links to water management: Meeting instream flow needs is an important aspect of maintaining natural populations of native fish species and healthy ecosystems. Improved governance would include all water users participating in the development of protocols for allocating water during periods of drought, including identifying instream flow requirements, monitoring of water extraction through metering and developing an allocation and monitoring

plan for periods of drought, at adequate spatial and temporal scales and including flow and temperature.
Available information: There are numerous reports related to water demand in the document repository, with 7 of high relevance and 17 of medium relevance.
Knowledge and data gaps: Water licenses exist for many users, but water licensing is necessary to manage allocation and instream flow, particularly during drought.

5.2.4 Prioritization Framework for Restoration Projects

All restoration activities can be beneficial, but those that provide more benefits or are more urgent should be done first. In order to decide upon which projects our activities should be made first, the project team recommends that the Forum develop a prioritization framework for restoration activities. This step will help the Forum's decision-making criteria and recommendations more accessible and defensible for all residents of the Valley. Restoration of selected habitats and populations supports the recovery and health of ecosystems and populations that are at risk or degraded from water scarcity, development or other stressors. Because funding is always one limitation (knowledge is another), a prioritization framework will help to identify the most important projects and provide a rationale for choosing or sequencing possible restoration activities.

Prioritization Framework for Restoration Projects
Overview: Development of a framework for identifying restoration opportunities would build upon the development of a monitoring program (described in Section 5.2.5), since similar priorities would probably apply across projects. As shown in Figure 7, consideration of projects in a restoration framework should include priority, rationale, site specificity, goals, activities, cost and support estimates (Olsen et al. 2018).
Related themes and values: monitoring, habitat restoration, bank erosion, channel movement, riparian areas, fisheries, forestry, fire, disturbance, recreation, agriculture, possible Indigenous training and employment
Planning and management context: Development of a restoration framework is a component of the watershed planning process. All communities, agencies and stakeholders play a role in initial development of a framework, populating it with restoration opportunities, and supporting those activities as they support the overarching goals of watershed management.
Links to water management: Indigenous Knowledge, monitoring program
Available information: The document library developed in the project will help identify existing technical knowledge
Knowledge and data gaps: Indigenous knowledge is not yet incorporated into this process.

Site Name				
Prioritization results				
Ecological value	Socio-economic value	Cultural value	Pollution Condition	Restoration Potential
High	Medium	Yes	Low	High
Site description				
Restoration activity				
Restoration goals				
Restoration activities				
Estimated costs				
Potential sources of funding				
Opportunities for collaboration/partnerships				
References				

Figure 7: A suggested template for the development of a restoration framework (from Olson et al. 2018).

5.2.5 Water Use & Ecological Monitoring Program

The Forum should lead on the development of a sustainable monitoring program for the Valley's water resources. Monitoring is a necessary part of management of the Nicola Valley water system and over time will create a shared body of baseline knowledge and trends that will guide work undertaken by the Forum.

The Nicola WUMP also identified the need for monitoring, learning and adapting to the changing conditions in the watershed as a key principle for effective water management (Nicola WUMP Multi-Stakeholder Committee 2010).

Monitoring was also identified as a pressing need by the interviewees. Several participants highlighted the need to monitor watershed management actions in order to evaluate their effectiveness, pollution and spills events.

This program includes deciding upon which characteristics are the most important to the many communities and stakeholders living in the Valley, developing a statistical plan to implement the long-term monitoring, building capacity, providing stable funding and staffing, and consistent reporting.

Monitoring Program
Overview: Communities and stakeholders may value different aspects of the Nicola Valley and

its water system. Some of those values might include water quality, quantity, timing, cultural sites, recreation, fisheries, cold water refugia and riparian areas. These values are not yet adequately incorporated into a monitoring program that is developed, adopted and shared by all water users. Development of a monitoring plan for these valued resources and its implementation will, over time provide a better baseline of consistent information for detecting trends and making water allocation decisions.
Related themes and values: prioritization framework, cumulative effects, adaptive management, Indigenous Knowledge, possible Indigenous youth-elder training and employment
Planning and management context: Planning is not possible without reliable information collected for the explicit purpose of measuring environmental or ecological values. Discussion and agreement about what should be measured are steps in the development of a monitoring plan. When coupled to the implementation of the monitoring plan with consistent leadership, reporting, support and communication, better decision-making results.
Links to water management: Multiple agencies (First Nations, municipal, federal, provincial, industry) must cooperate to identify the values they hold or are responsible for, including priorities and identifying trade-offs; and develop a plan to monitor those values.
Available information: Many existing data sources have been identified in this project, particularly spatial data. These existing sources might be leveraged into the monitoring plan at little cost. Data related to some fish populations may also be monitored by DFO and should be incorporated or leveraged. Other data collection efforts might be more expensive to implement and would require a higher priority to be included.
Knowledge and data gaps: Identification of data gaps is part of the development of a monitoring plan and over time (possibly using an adaptive management approach), will reduce those gaps.

5.2.6 Create a Nicola Watershed Data Portal

The Forum should incorporate the technical knowledge located and organized in this project into a widely available data portal. Part of the mandate of this project was to summarize available data to support decision making by the Nicola Forum. We created two Excel files that categorize, summarize and provide links to over 500 documents and over 300 geospatial files. These should be made more widely available from a centralized data and information sharing location.

Watershed Data Portal
Overview: Technical information about the Nicola Valley and watershed is usually publicly available but is scattered across organizations. This project has organized most of the existing technical and geospatial data, creating a good foundation for organizing this information to support the Forum. These documents should be made more widely available through a data portal.
Related themes and values: information management, prioritization framework, monitoring program
Planning and management context: Having an easily accessible collection of data makes

planning tasks more efficient.
Links to water management: accessible data makes decision making more efficient
Available information: found in the companion Excel files created by this project, the document library and the reference list in this report.
Knowledge and data gaps: Over 30 documents were identified but were not accessible, for various reasons (e.g., the document could not be found online; confidentiality; etc.). It is likely that other relevant documents and files exist but were not identified during this project. These gaps can be addressed and filled over time.

5.3 Next Steps

This report represents a synthesis of many published and unpublished reports, as well as a selection of interviews with members of the Indigenous communities and stakeholders. Recognizing the need to synthesize many voices, our analysis and recommendations have emphasized major topics and needs.

The Nicola Forum should convene a meeting to discuss the high-level recommendations provided here. This meeting should include a discussion of each recommendation's importance to the Forum members and their constituents, and its priority. The Forum should then engage in brainstorming to develop possible specific activities that could be initiated, beginning with the first recommendation and working through to the end. Those ideas could then be prioritized and delivered to a single (or multiple) working group(s), to develop further ideas and plans. Those plans could take a variety of forms including regulatory changes, creation of a monitoring plans, modeling, communication and consultation and physical remediation. The Forum should include a communication element (public meetings, workshops, web-site content, etc.) to measure the response of the various communities and stakeholders to their proposed activities, and to adjust the priorities based on feedback from the communities and stakeholder groups.

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Appendix A – List of Interviews

Table 7: Names of most of the 28 interviewees. Some participants requested anonymity for themselves and their affiliation. These individuals are denoted as "Participant."

Name	Community or Affiliation	Expertise
John Anderson	NSA	Ranching
Leona Antoine	LNIB	Land and Resources, Forestry
Richard Bailey	DFO	Coho program head
Jeptha Ball	Province	Engineering
Kevin Bennett	Golder	Hydrology
Michael Crowe	DFO	Section head, SEP
Kim DeRose	FLNRORD	water management
Brian Holmes	UNB	Lands and Resources
Kim Hyatt	DFO	Fisheries management
Lennard Joe	NTA, Shackan	Forestry
David Lawrence	Nooaitch	Land and Resources
Doug Lewis	Province	Cumulative Effects
Laurie Lyons	Province	GW
Rich McCleary	FLNRORD	Aquatic Ecology
Paul Mitchell-Banks	Esh-kn-am	Cultural Heritage
Stewart Murray	NSA	Irrigation, Ranching history
George Saddleman	UNIB	Cultural heritage, TEK, Syilx culture and law
Lee Spahan	Chief Coldwater	Water values
Terry Spahan	Coldwater	Cultural heritage, TEK, Nlaka'pamux culture and law
Neil Todd	NTA	Fisheries
Amelia Washington	Elder	Cultural Knowledge and Heritage
Tom Willms	NVIT	Sensitive habitat mapping, Nat. Resources Instructor
Tracy Wimbush	NTA	Fisheries
Participant 24	-	-
Participant 25	-	-
Participant 26	-	-
Participant 27	-	-
Participant 28	-	-

DFO – Canada Department of Fisheries and Oceans
FLNRORD – BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
NSA – Nicola Stockbreeders Association
NTA – Nicola Tribal Association
NVIT – Nicola Valley Institute of Technology
LNIB – Lower Nicola Indian Band
UNB – Upper Nicola Band

Appendix B – Interview Consent Form

CONSENT FORM

NICOLA WATERSHED GOVERNANCE PROJECT
2019 NICOLA WATERSHED CHARACTERIZATION

The Nicola Watershed Characterization is being undertaken jointly by the PROVINCE OF BC and THE NICOLA NATIONS[9], collectively referred to as the Nicola Forum. The Nicola Forum is seeking broad input from across the five First Nations and key watershed organizations, in order to:

1. To gain a holistic understanding of the various watershed components and their inter-relationships;
2. To identify a complete range of key water management issues, impairments and conflicts experienced in the watershed; and
3. To inform collaborative water management and governance priorities.

The information will be used to inform the Nicola Forum's collaborative water management and governance priorities.

I,_____, agree to participate in the watershed characterization project. I agree that the Nicola Forum may use the information I provide only in those manners specified in information sharing protocols and/or knowledge governance processes agreed to by the Nicola Nations and Province for the purposes of the Nicola Watershed Governance Project.

In signing this form, I consent to the information I provide during my interview being shared in the following way (circle one or none):

A. Use my exact words, (include/exclude) my name and (include/exclude) the name of my First Nation/Organization/Affiliation.
B. Paraphrase my words and summarize what I share, (include/exclude) my name and (include/exclude) the name of my First Nation/Organization/Affiliation.

Signature of Respondent_____ Date _____

Signature of Interviewer _____ Date _____

[9] The Nicola Nations refers to the Coldwater, Lower Nicola, Upper Nicola, Shackan and Nooaitch Bands.

Thank you for your participation in the Nicola Watershed Characterization.

If you have additional questions about the contract, please contact Mike Simpson at msimpson@fraserbasin.bc.ca or 250 314-9660.

Appendix C – Anticipated Questions & Answers

Anticipated Questions and Answers and Key Messages

Nicola Watershed Characterization

January 29, 2019

What is the Nicola Watershed Characterization?

- The Nicola Watershed Characterization is a project being undertaken jointly by the Province of BC and the Nicola Nations, collectively referred to as the Nicola Forum.
- The project has three objectives:

  1. To gain a holistic understanding of the various watershed components and their inter-relationships;

  2. To identify a complete range of key water management issues, impairments and conflicts experienced in the watershed; and

  3. To inform collaborative water management and governance priorities.

Why is the Nicola Watershed Characterization being undertaken?

- The NWC is intended to support the Nicola Forum in identifying priorities for collaborative water resource management in the Nicola Watershed.
- There is a recognized need to strengthen the collective knowledge of the watershed to support watershed planning and improve decision-making over water resources in the Nicola Watershed.
- This is one of several opportunities for input into the broader Nicola Watershed Governance Project.

How long will the NWC last?

- The NWC is planned to last until the end of March 31, 2019, though it may be extended.

What will happen with the information that I share during an interview?

- The information you share during the interview will be used to inform the Nicola Forum's collaborative water management and governance priorities.
- The information will be handled as specified in information sharing protocols and/or knowledge governance processes agreed to by the Nicola Nations and Province for the purposes of the Nicola Watershed Governance Project.

Will there be a final report made public?

- There is an interest in doing some public reporting from this project, though what the final product will be has not yet been determined.

Who else will be interviewed as part of the NWC?

- A variety of people are being interviewed for this project, including members of the five Nicola First Nations, provincial government staff, and other stakeholders across a variety of organizations in the Nicola Watershed.

What is the Nicola (G2G) Forum?

- G2G refers to the government to government relationship between the five Nicola Bands and the Province of BC
- The Nicola Forum is three-year project being co-led between the Province and five Nicola First Nations governments, collectively known as the Nicola Forum.
- Leadership members representing the Provincial government and Nicola First Nations' governments comprise the Nicola Forum

What does the Nicola Forum mean for decision-making?

- The Nicola Forum will work together to decide how the Nicola Watershed Governance Project will be developed and make decisions based on feedback and information from advisory groups and/or stakeholders.
- To date, decisions about long-term decision making have not yet been discussed but are likely to be discussed at some point.

Will there be other opportunities for me to participate in the work of the Forum?

- Yes. As the work of the Forum is just beginning, the opportunities for broader and longer term engagement are still being assessed. The NWC will help inform this as it may depend on the issues the Forum decides to work on.
- A spring workshop with communities and stakeholders is also being planned to help inform future engagement opportunities.

Appendix D – Key Messages

Key Messages

From an approved Communications Plan from the Nicola Forum

Shared as background information

General key messages about the Nicola Forum include:

- The Provincial government and the Nicola Chiefs are working in partnership under a Memorandum of Understanding (MOU) to engage our communities in the management of our shared watershed.
- This partnership represents an important step and opportunity to go beyond consultation towards advancing reconciliation with First Nations and the adoption of the United Nations Declaration on the Rights of Indigenous Peoples
- The foundation of the partnership brought together by the MOU between the Province and the five Nicola First Nations governments is based on principles related to partnership, inclusivity, accountability, consensus-based decision making, watershed sustainability, co-learning and adaptability.
- The MOU is about the relationship of working together between the Province and the First Nations governments. The G2G Nicola Forum established through the MOU provides a platform to invite broad community, public and stakeholder engagement and work towards resolving priority watershed issues.

General key messages about the Nicola Watershed Governance Project include:

- Water is the lifeblood of our communities. The Nicola watershed already experiences significant water issues including: flooding, drought and quality concerns that are impacting local economies and ways of life.
- As per provincial regulations and legislation, the Province will continue to address water issues in the Nicola River Watershed. Moving forward, as priority issues are identified through community, public, and stakeholder engagement processes, the Province and five Nicola First Nations governments will jointly explore possibilities to achieve sustainable watershed outcomes.
- This watershed governance project presents a unique opportunity to ensure that the communities and people living in the watershed and affected by the decisions made can work together to proactively address water issues in the Nicola Watershed.
- The Nicola Watershed Governance Project further supports key government directions for reconciliation with First Nations and adoption of the United Nations Declaration on the Rights of Indigenous Peoples.

- Nicola Watershed Governance Project also supports government direction for modernization of land use planning.

First Nations Communities

- We know that First Nations experience impacts and changes to the water more profoundly and there is a need to develop solutions that consider the relationships of Indigenous Peoples with the waters in their traditional territories.
- The signing of the MOU is the first step to building a partnership that can help us identify priorities together, learn together, and work together.
- The provincial government is committed to true and lasting reconciliation with Indigenous Peoples and through the Nicola Watershed Governance Project, will work respectfully with First Nations governments to implement a new approach to watershed governance.
- The foundation of the partnership brought together by the MOU between the Province and the five Nicola First Nations governments is based on jointly developed principles related to partnership, inclusivity, accountability, consensus-based decision making, watershed sustainability, co-learning, adaptability and watershed sustainability.
- Funding from the BC Freshwater Legacy Initiative and the Province will help to ensure that First Nations governments and communities can meaningfully and equitably participate in this partnership.
- With a knowledge of and responsibility to the lands and waters of the Nicola Valley, First Nations communities need to be actively involved in helping to identify priority issues and values, particularly those that have been overlooked in the past, within the watershed.
- As many governments struggle to understand and define the path towards reconciliation, First Nations are uniquely positioned to lead what the journey can and should look like moving forward.

Local and federal governments

- The Nicola Forum acknowledges the important role that Local Governments and the Federal Government play in managing watersheds.
- There are key roles for both Local government and Federal government in the Nicola Watershed Governance Project that the Nicola Forum would like to explore with you in the coming weeks and months.

Agriculture Industry

- The agriculture industry has an important role to play in finding and implementing solutions to the water quality and availability issues facing the Nicola watershed.
- The Nicola Forum has not yet made any decisions about how to move forward on priority issues within the watershed.

- The government to government relationship with the five Nicola First Nations was formed to collaboratively lead and decide on how a new collaborative watershed governance model could work in the Nicola Watershed.
- We encourage your input to identify priority issues in the watershed and potential ideas to address them.
- As a valued stakeholder within the watershed your participation is important and you will have opportunities to be involved in future conversations and decisions about the Nicola watershed.

Appendix E – Phase 1 Interview Questions

Interview Questions for the Nicola Watershed Characterization

January 29, 2019

Background: In March, 2018, the Province and the five Nicola Chiefs signed a Memorandum of Understanding agreeing to move forward to collaboratively address watershed governance in the Nicola Watershed. This was the start of the relationship between the Province and the five Nicola Nations culminating in the Nicola Government to Government Forum (Nicola Forum). Still early into building relationship and developing ideas about how to move forward together with other stakeholders in the watershed, there is a need to strengthen the collective knowledge of the watershed, support watershed planning and improve decision-making over water resources in the Nicola.

Purpose of the Interviews: The interview component of the Watershed Characterization is intended to:

- Supplement the information gathered from the document review to identify new, or changing, interests and concerns with regard to water management issues; and
- Provide an opportunity for a broad range of community members, stakeholders, interest groups and technical experts to express their values, interests, concerns and recommendations regarding water management and watershed governance in the Nicola.

Interviews are anticipated to take about 1.5 – 2 hours, but will go no longer than 2 hours. It is not expected that every participant will speak to every question.

Materials for the interview: List of questions, consent form, list of literature, and map of the Nicola watershed.

Relationships and Values

Objectives:

- To establish the interviewee's relationship to/experience in/ knowledge of the Nicola Watershed
- To identify core watershed values and relationships

1) Can you tell me about your connection to the Nicola Watershed?
   PROMPTS: Previous/current work; living in the community(s); relationships to the lands and waters

2) What do you think makes the Nicola watershed special or unique?

   PROMPTS:
   a. Are there key features – such as fish/animal/plant species; archaeological sites; cultural sites; specific water bodies; sensitive habitats – in the watershed that are culturally or ecologically significant?
   b. Are these features protected (or do they need protection)?
   c. Are these features unique to the region, BC, Canada?

d. Are you aware of any special considerations or cultural protocols for treating/showing respect for these features?
e. Where are these features generally located in the watershed? (Feel welcome to refer to the map if you like.)

Existing Information

Objective:

- To identify existing, and relevant, documentation, studies, reports of the Nicola Watershed that can support in assessing the state and character of the watershed

3) Is there any documentation available that speaks to cultural practices or protocols for using or caring for water?
4) What information is already available and/or what analyses have been performed to either i) Assess the issue(s) or impairment(s); or ii) Support the development of a watershed plan or a specific water objective?
5) What efforts are you aware of that have been made (or are being made) to manage water and watersheds?
6) Where or to whom do you go to for the best information about the state of the watershed? PROMPTS: specific archives or libraries; specific places on the land during certain times of the year; specific individuals

Watershed Management

Objectives:

- To identify key individuals and/or organizations to participate in watershed management
- To identify some high-level indicators for a healthy watershed

7) Who do you see as the key players in the watershed? And what do you think their role is (or should be) in watershed management?
8) As you may be aware, the Nicola Government to Government Forum is exploring opportunities for a Nicola Watershed advisory committee. If an advisory body is created, which organizations would you expect to be represented on such a committee?
9) When you think of a "healthy watershed" what comes to mind? Where do you think is an example of a watershed being managed well? And why do you think that is?

Watershed Issues

Objectives:

- To establish trends or patterns in the watershed
- To identify key watershed issues, water impairments, and key risks or vulnerabilities

10) From your perspective, how has the watershed changed over time?
11) What do you see as the top three water management issues in the watershed?
    a. Why those three?
    b. What do you think has contributed to these issues arising?
12) What do you see as a risk (or threat) to future conditions in the Nicola watershed? (Examples: accelerated development, major industrial or commercial development, climate change, changes to land use, etc.)
13) Are there any additional concerns for the watershed that you believe need to be addressed?

Priorities and Recommendations

Objective:

- To explore priorities, recommendations and opportunities for improved watershed management

14) Based on the water management issues we've discussed, what do you see as the most pressing issue within the Nicola Watershed? Why?
15) Do you have any specific suggestions for managing, or resolving, these issues?
16) What would your top three recommendations be for collaborative watershed management in the Nicola? Why?
17) Do you have any suggestions to ensure Indigenous Knowledge is included and recognized in shared decision-making processes?
18) Are there any additional opportunities you can suggest for the Forum to engage with other key players in the watershed that should be considered?
19) Blue sky thinking: with an unlimited budget, what would you focus on for improvements within the watershed (related to the current water management issues we've discussed)? (What would those look like?)

Appendix F – Phase 2 Interview Questions

Interview Questions for the Nicola Watershed Characterization

v.4 January 29, 2019

Background: In March, 2018, the Province and the five Nicola Chiefs signed a Memorandum of Understanding agreeing to move forward to collaboratively address watershed governance in the Nicola Watershed. This was the start of the relationship between the Province and the five Nicola Nations culminating in the Nicola Government to Government Forum (Nicola Forum). Still early into building relationship and developing ideas about how to move forward together with other stakeholders in the watershed, there is a need to strengthen the collective knowledge of the watershed, support watershed planning and improve decision-making over water resources in the Nicola.

Purpose of the Interviews: The interview component of the Watershed Characterization is intended to:

- Supplement the information gathered from the document review to identify new, or changing, interests and concerns with regard to water management issues; and
- Provide an opportunity for a broad range of community members, stakeholders, interest groups and technical experts to express their values, interests, concerns and recommendations regarding water management and watershed governance in the Nicola.
- Increase understanding of the available information (e.g., Indigenous Knowledge) that can inform water management in the Nicola. [*Note: for IK, there are some questions here that are asking to document IK (e.g., how the participant as noticed a change in the watershed and why – how being observation and why being inference) and others that are just asking about the existence of IK (i.e., who are other knowledge holders and what types of knowledge do they hold)*]

Interviews are anticipated to take about 1.5 – 2 hours, but will go no longer than 2 hours. It is not expected that every participant will speak to every question.

Materials for the interview: List of questions, consent form, list of literature, and map of the Nicola watershed.

Relationships and Values

Objectives:

- To establish the interviewee's relationship to/experience in/ knowledge of the Nicola Watershed
- To identify core watershed values and relationships

20) In your own words, how the Nicola Watershed important to you and your family?
    PROMPTS: Harvesting? Cultural spiritual importance? Living in the community? Connection to the land and waters
21) What do you think makes the Nicola watershed special or unique?

22) Are there key features (e.g. fish, animal, plant species) or places (e.g. culturally / spiritually important places; specific water bodies; sensitive habitats) – in the watershed that are important to you?
    PROMPTS:
    a. Are these protected (or do they need protection)?
    b. Are you aware of any special considerations or cultural protocols for treating/showing respect for these features or places?
    c. If you are comfortable, could you share with us the general location of these features in the watershed? (Feel welcome to refer to the map if you like.)
    d. Are there stories that describe or explain the importance of these places or features?
        i. If you feel comfortable, can you share?

23) Are there cultural practices or protocols for using or caring for water?
    a. Is this documented (e.g. in a report)?
    b. If not, would you feel comfortable sharing with us OR telling us who we should speak to, to learn these protocols?
24) Are there individuals (you?) that hold special roles (e.g., stewardship) with regards to stewardship of the watershed?
25) Do you feel that you have a special role and/or responsibility to protect or take care of the watershed?

Existing Information

[For this version of the questionnaire, we have embedded questions related to existing information into other sections that accompany questions relevant to that type of knowledge/information. For interviewing Elders and community members it seemed more appropriate not to have a section dedicated to asking about engineering / consultant / government reports.]

Watershed Information & Issues

Objectives:

- To understand important trends or patterns in the watershed
- To identify existing documentation, studies, reports, or undocumented IK relevant to the Nicola Watershed that can support in assessing the state and character of the watershed?
- To identify key watershed issues, water impairments, and key risks or vulnerabilities

26) Could you describe the condition of the watershed during your youth (e.g. associate with approximate time period / decade)?
    PROMPT: Water amount and quality, fish and wildlife health and amount, integrity of cultural / sacred places
27) In your own words, how was the watershed changed since then?
    PROMPT: Are there places that you used to be able to use but no longer can?
28) If it has changed, why has the watershed changed?
    a. Are there specific factors (e.g. human activities) that lead to this change?

29) Are there others in the community who may also have knowledge about the watershed? (e.g., specific knowledge about the environment like fish populations or water quality, but also information about culture, stories, how to act in the watershed, etc.)
    a. If you feel comfortable, can you share who these individuals are and the types of knowledge they hold?
30) Do you know of projects that have documented knowledge of Elders or community members?
    a. If so, are there reports that could be shared?
31) What are your top concerns when it comes to water management in the watershed?
    a. Why?
    b. What do you think has contributed to these issues arising?
32) What are the greatest threats facing the Nicola watershed?
    PROMPT: Development, industry, climate change, land and water use practices?
33) Do you know of projects that have documented concerns of Elders or community members related to the Nicola watershed?
    a. If so, are there reports that could be shared?

Watershed Management

Objectives:

- To identify key individuals and/or organizations to participate in watershed management
- To identify some high-level indicators for a healthy watershed
- To identify priorities or principles to guide watershed management

34) When you think of a "healthy watershed" what comes to mind?
35) Can you think of an example of a watershed that you think is being managed well?
    a. If so, what are the factors that make it well managed?
36) Are there guiding principles for how a watershed should be managed?
    a. If so, are there specific individuals that know these principles?
    b. Are the principles documented somewhere?
37) In your community, are there particular individuals that hold knowledge about how to act within the watershed? [don't need to ask if it was covered when talking about information or issues – this is just another opportunity to ask about this]
38) What efforts are you aware of that have been made (or are being made) to manage water and watersheds?
39) Are there documents or reports that hold information (or raw data) you think would be relevant for water management in the Nicola watershed?
40) Who do you see as the key people/organizations in the watershed? And what do you think their role is (or should be) in watershed management?
41) As you may be aware, the Nicola Government to Government Forum is exploring opportunities for a Nicola Watershed advisory committee. If an advisory body is created, which organizations should be represented on such a committee?

Priorities and Recommendations

Objective:

- To explore priorities, recommendations and opportunities for improved watershed management

42) Do you have any general suggestions for how to manage or resolve the issues that we have been discussing?
43) [Refer back to specific issues] – do you have any specific suggestions to manage or resolve this issue? [Repeat for each issue raised]
44) With regards to the proposed Nicola Watershed advisory committee, what principles should be employed to guide collaborative watershed management in the Nicola? Why?
45) Are there any important considerations to ensure that Indigenous people and Indigenous Knowledge are included and recognized in a shared decision-making processes?
46) Are there any additional opportunities for the Forum to engage with other key people/organizations in the watershed that should be considered?
47) Blue sky thinking: with an unlimited budget, what would you focus on for improvements within the watershed (related to the current water management issues we've discussed)? (What would those look like?)

Appendix G – Reports provided by FNLRORD

Report Name	Date	Author
Lower Nicola Valley Groundwater Budget Golder 2016	2016	Golder
Nicola Basin Strategic Plan Summary-MOE 1983	1983	MOE
Nicola River Aquatic Habitat Index Memo 2016	2016	Ecoscape
Nicola River Basin Management Strategy Scoping Study-Urban Systems 2005	2005	Urban Systems
Nicola River Watershed-WUMP Instream Flows Needs for Fish Hatfield 2006	2006	Hatfield
Nicola Rover Watershed Present and Future Water Demand Study Summit 2007	2007	Summit
Nicola Valley Water Use Management Plan- Nicola WUMP Committee 2010	2010	Nicola WUMP Committee
Nicola Watershed Water budget Analysis 2008	2008	Water management Consultants
Partial Inventory and Preliminary Evaluation of Ditch Irrigation Systems in Nicola Valley- Petrie 1986	1986	Petrie
Preliminary Assessment of Governance Options-WMI Water Management International Inc 2007	2007	Water Management International
Review of Groundwater-Salmon Interactions in BC-Tanis Douglas 2006	2006	Douglas
Strategic Review of Fisheries Resource for Thompson Nicola-DFO 1998	1998	DFO
Summer Drought in Kamloops Region-Doyle 2004	2004	Doyle
Surface and Groundwater Supply and Interaction Study for Nicola Watershed Phase 1 and 2 2008	2008	Water management Consultants
The Completion of the Nicola Lake Dam Project feasibility Study- Urban Systems 2006	2006	Urban Systems
Water Quality of Tributaries of Nicola Lake- Holmes MOE 1998	1998	MOE
Water Requirements for Fisheries Resource of the Nicola River- Kosakoski and Hamilton 1982	1982	Kosakoski and Hamilton
A Study of Governance Models WUMP- Guichon 2006	2006	Guichon
Addendum- Present and Future water demand study Summit 2007	2007	Summit

Report Name	Date	Author
Chemical and Biological Characteristics of the Nicola and Coldwater Watershed- Holmes MOE 1979	1979	MOE
Development of instream flow thresholds as guidelines for reviewing proposed water uses Hatfield et al 2003	2003	Hatfield
DRAFT Nicola Watershed Water licencing Report March 2014	2014	MOE
Figures for Surface and Groundwater Supply and Interaction Study 1998	1998	Water management Consultants
Hydrology and Water Use for Salmon Streams in the Thompson River Watershed Rood and Hamilton 1995	1995	Rood and Hamilton
Nicola Lake Input Hydrology Review Golder 2017	2017	Golder
Flood Assessment / Monitoring of Fisheries Concerns in the South-Central Interior British Columbia Spius Creek, Coldwater, Nicola and Bonaparte Rivers	1991	Maricle & Associates
Contribution to Nicola Basin Strategic Environmental Plan from Groundwater Section	1982	MOE
Evaluating Suitability of FRPA Temperature Sensitive Streams for Nicola Watershed	2013	Bearfoot Resources
Groundwater Development Nicola Lake IR1	1976	Erdman & Reed
Nicola Lake Forecasting Model Review	1993	Costerton
Nicola Dam - Bathymetric Plan and Profile of Outlet	1989	MOE
Nicola Dam - Bathymetric Map of Lake Outlet	1985	MOE
Nicola Dam - Bathymetric map of outlet end	1965	MOE
Nicola Dam - Bathymetric map of lake outlet showing shallows	1981	MOE
Nicola Dam - Cross sections of fill site in District Lot 195	1991	MOE
Nicola Dam - Elevation and Dimension of outlet structure and highway bridge	1991	MOE
Nicola Dam - mosaic 1 of 2	1981	MOE
Nicola Dam - mosaic 2 of 2	1981	MOE
Nicola Dam - Plan showing fill site in district lot 195	1991	MOE
Nicola Dam - Bathymetric map of outlet end vicinity of control structure	1981	MOE
Nicola Dam - plan of reservoir 1 of 3	1981	MOE
Nicola Dam - plan of reservoir 2 of 3	1981	MOE
Nicola Dam - plan of reservoir 3 of 3	1981	MOE

Report Name	Date	Author
Nicola Dam - spot heights outlet		MOE
Nicola Dam - Topo plan	1985	MOE
Nicola Dam - water level profile, thalweg and cross sections of outlet channel	1981	MOE
Contribution to Nicola Basin Strategic Environmental Plan from Groundwater Section	1982	MOE
Nicola Basin Strategic Plan Summary-MOE 1983	1983	MOE
DFO report 2306, 2158 - check WAVES website	late 1990s	DFO Walther and Nener
Interim report on Thermal refugia	2018	Tom Willms
Watershed priorities and needs for Thompson Okanagan Region (may not be exact title)	2016	FLNRORD
Cumulative Effects Assessment reports done by Doug Lewis	circa 2016	FLNRORD
Report on the TSA by MIRR	unknown	MIRR
Integrated Silviculture Strategy for Merritt TSA by watershed		
Water release plan for Chapperon by FLNRORD	2018	FLNRORD
Watershed assessments and IWAPs from licensees, others - funded by FRBC, FIA - check Ecocat website	mid-late 1990s	various
Burbot study funded by HCTF, still being worked on	current	FLNRORD - Andy Morris
Independent Review of the Science and Management of Thompson River Steelhead	2014	David Levy
Thompson Steelhead Working Group - draft recovery and management plan - see www.thompsonsteelhead.ca	2016	FBC for Thomson Steelhead WG
Effects of logging on summertime low flows and fish habitat in small, snowmelt-dominant catchments of the Pacific Northwest - See http://hdl.handle.net/2429/68320	2018	Stefan Gronsdahl
Environmental farm plans, irrigation plans done for individual ranches - not public	various	various
groundwater work on Coldwater River, for Coldwater Indian Band - not shared, not public	various	BC Groundwater, and others
Nicola Dam Safety Review - currently being completed	2019	Northwest Hydraulic Consultants
LiDAR information collected from Nicola Lake down to Spence's Bridge - will go to GeoBC	2018	FLNRORD
Water budget studies - various	1970s-80s	various

Report Name	Date	Author
Ice Forecasting on the Coldwater River	1990s	Doyle and Costerton
Agriculture Water Demand Model	2013	5 Authors, prepared for Nicola Watershed Roundtable
Water Temperature Monitoring in Selected Thompson River Tributaries 1996: Implication of Measured Temperatures for Anadromous Salmonids	2000	Walthers & Nener for DFO
Draft - Nicola River Sensitive Stream Profile (Temperature Profile)	2000	
Hazard Screening - GARP - Hotel Well and Community Well Douglas Lake Ranch, Quilchena	2016	KALA
Level 2 Source Water Investigation, Water Well Decommissioning and Wellhead Upgrade Douglas Lake Ranch, Quilchena	2016	KALA
Groundwater Evaluation (Miller's Sunshine Valley Estates CPCN)	1993	SEACOR
Nicola Watershed Aquifer Classification and Mapping	2017	Golder
Data Compilation Plan to Support Numerical Flow Modelling Strategy, Nicola River Project	2018	Golder
Report Name	Year Created	Author
Hydrology and Fisheries Study Coldwater River 1981	1981	Harding, Kellerhals and Miles
Addendum to the Surface Water and Groundwater Supply and Interaction-Coldwater 1998	1998	Water Management Consultants
City of Merritt Groundwater Report June 2009	2009	Bennett and Caverly MOE
Coldwater River Storage Feasibility Study 2002-Summit	2002	Summit
Coldwater River Watershed Salmon Recovery Plan	2001	LGL Limited
Low Altitude Thermal Imaging of the Coldwater River-Henderson Environmental 2001	2001	Henderson Environmental
Mamit Lake Release Plan - May 31	2016	Epp MFLNRO
Mamit Lake Batho	1978	Fish and Wildlife
Guichon Creek Hydrology Study	1987	Obedkoff

Appendix H – Values Identified in Interviews

A key output of the interviews with 12 members of Indigenous communities in the Nicola Valley was the identification of the values and watershed features that matter most for them. *Table 8* presents an overview of these values, the risk and pressures that impact them, the locations within the watershed where these values are mostly found and emergent management and research priorities that could help preserving them.

To evaluate the level of consensus amongst the participants responses, we have applied the following qualitative qualifiers:

- Some: Less than 50% of responses agreed with the idea/opinion
- Many: Between 50 and 75% of the responses were in accord regarding the idea/opinion
- Most: High level of agreement; more than 75% of responses expressed the idea/opinion

Participants agreed on the sacredness of water, which supports life and values in the Valley. Fisheries and associated aquatic habitats were identified by most of the interviewees as one of the key values in the watershed. Fish are harvested for food, recreation and cultural purposes. Populations of most fish species in the Nicola have been declining as habitat and flow conditions have deteriorated.

Table 8: Watershed values identified by Indigenous interviewees.

Value	Risks/pressures	Geographic areas most at risk/pressure	Emergent priorities
Aquatic Habitat Healthy aquatic (river and riparian) habitats are key for maintaining ecosystem functions, support fisheries and diverse environments and culturally important resources, mainly fish and other traditional food and medicinal resources	Habitat degradation is driven by multiple stressors. Participants identified the following: - Water over-extraction - Road building, especially for forestry activities - Residential and industrial development (e.g., pipelines) - Logging and insufficient and not timely restoration of logged areas - Climate change, including more frequent and intense droughts - Recreational activities done in the proximity of streams and/or within riparian areas - Land use conversion to agriculture, increased sedimentation and runoff from agricultural activities - Invasive aquatic species (e.g., bass, carp) - Poor watershed management practices Population growth in the Nicola Valley increases the residential area and exacerbates all the previous pressures.	Areas with especially important aquatic habitats: • Wetlands and at the confluence of Spius and Maka Creeks • Headwaters in forestry areas	The Nicola Watershed Stewardship and Fisheries Authority (NWSFA), as well as some ranchers, has undertaken aquatic habitat restoration projects. However, most participants identified the need for actions on habitat restoration and protection, including the following: - Regulations for habitat protection, guided by Indigenous laws - Mapping of riparian areas and restoration for increased shade - Involve agricultural stakeholders in restoration planning - Mapping of groundwater upwelling zones - Bioengineering and protection of riverbanks and stream channels

Value	Risks/pressures	Geographic areas most at risk/pressure	Emergent priorities
Fish Fish are very important for the First Nations in the Nicola Watershed and were identified as a key value for most respondents. They are harvested for recreational and food purposes, but they also play an important cultural role. Fisheries are needed for First Nations communities to exert their Aboriginal rights and .to maintain the traditional economy. Important fish species in the Nicola include Coho, chinook, kokanee, and steelhead.	Most of the participants reported declining fish populations in the Nicola watershed. Multiple risks to fish populations were identified, including: - Low flows - High water temperatures - Increasing development, including roads and population growth - Infrastructure that might impede migration (e.g., the Nicola dam has impacted Coho and steelhead migration).	• Upper Nicola: kokanee • Coldwater: Coho • Important chinook areas include Coldwater upstream of Larson Hill, and Spius and Maka Creeks • Chaperon Lake (also important for traditional foods) • Nicola Lake supports 13 types of fish • Steelhead and Coho in Quilchena Creek • Peter Hope Lake was an important fishery (especially about mid-April • Guichon Creek is important for 5 species of fish	Most participants agreed that fisheries (e.g., steelhead, chinook) require protection. First Nations have voluntarily reduced their harvesting, but other protection actions are needed: - Address over-licensing - Update environmental flows needs EFNs (currently too low for fish). - Improve monitoring of fish populations - Long-term restoration of fish habitats - Collaborative research - Repurpose Spius Creek for First Nations use - Watershed education - Nicola dam fishway needs to be modified to allow fish to travel upstream

Value	Risks/pressures	Geographic areas most at risk/pressure	Emergent priorities
Water Quality Good state of water quality parameters is necessary for the sustenance of ecosystems and human communities.	Many participants pointed to a declining trend for water quality throughout the watershed. They pointed to how they could directly drink from creeks in the past and how this is currently not possible. Development pressures in the watershed are main factors driving the deterioration of water quality: - Forestry activities impact water quality of streams: higher temperatures and siltation - Growth in population and increase in sewage water - Recreational uses (vehicles) cause erosion of riverbanks and riparian areas, affecting the water quality of streams - Future development proposals (e.g., pipeline) - Invasive species	• Agricultural areas around Chapperon Lake impact water quality • Algae blooms in Douglas Lak	Develop water stewardship plans informed by Aboriginal rights and that document successful stories. Coldwater Band developed a water stewardship plan after many years of work. Groundwater refuge/upwelling areas need protection because they provide cold water to hot surface water. - Implement temperature sensitive watershed GAR order (additional protections). - Update BC drought response planning to address water temperature issues. - Restore riparian areas, increase shade cover of streams.

Value	Risks/pressures	Geographic areas most at risk/pressure	Emergent priorities
Water Quantity / Flow This value is important for fish, ecosystem function, and to support other values (e.g., recreation).	- Over-allocation of water: amount and timing of water withdrawals - Forestry and agriculture are placing additional demands on water availability - Climate change, including more frequent extreme weather events and droughts - Development in the floodplain (e.g., Merritt) - Overuse of groundwater resources - High road density	• Surface water from Kwinshatten Creek is now gone in late summer (first year ever) • Flows in the Coldwater and Upper Nicola are highest priority • Water storage around Nicola dam is not sufficient	- Flows from Spius and Coldwater need to be protected. - Update socioeconomic analysis for increased restrictions on water users. - Enforce water licenses, and meter users. - Upgrade hydrometric stations for better real-time data availability. - Temperature sensitive stream designation. Increase storage around Nicola dam. - For flood response, re-do sensitive habitat inventory mapping (SHIM) and use bioengineering. - Need more research into groundwater / surface water interactions. - Protect flows in headwaters from forestry operations. Ensure monitoring of flows.
Recreation	With reduced water availability and flows, enjoying creeks and lakes is becoming challenging. Threats include development, agriculture, clearing of wetlands, low flows and flooding.		Change recreational use regulations to protect cultural places

Value	Risks/pressures	Geographic areas most at risk/pressure	Emergent priorities
Cultural Sites These include sites of spiritual importance sites associated with stories sites with culturally significant species gathering places sites that support cultural practices and access to cultural sites	Development and land use threaten cultural sites and access to cultural sites. For example, Nicola Eagle Rock was moved when Hwy 8 was built. Forestry and increased access (building of roads, recreational activities) have significantly impacted spiritual sites (*xa xa*) through erosion, tree canopy removal, etc.	The whole watershed is important, but some participants identified specific locations: • Juliet Creek (ceremonies) • Surface water from Kwinshatten Creek • Minnie Lake (trout fishery ceremony) • Creek bottoms are important as they are habitat for cedar which is used for cultural purposes • Pennask Mountain • Hoodoos in lower part of Nicola River	There are ongoing efforts to develop Cultural Sensitive Area (CSA) protocols. Additional protective actions suggested by participants included: • The public needs to be informed of Aboriginal Rights and be taught to respect the land • Maintain access to cultural sites • Adapt land use practices • Elders need to be decision-makers, especially regarding watershed stewardship • Integrate into CSA the Indigenous protocols for resource management

Value	Risks/pressures	Geographic areas most at risk/pressure	Emergent priorities
Watershed Stewardship The whole watershed is important for First Nations communities. It provides sustenance and resources.	- Lack of planning for local development (i.e., housing development on flood plain, increased water demand) - Land use changes; agriculture, forestry - Lack of environmental enforcement - Poor coordination amongst federal, provincial and local governments - Development without stewardship ethic		- Many respondents described the endpoint of responsible stewardship of the watershed: stable channels that can move and bend, healthy aquatic species populations, natural functions of aquatic and wetland ecosystems restored, naturalized flows, sustainable timber harvesting and reforestation (with native species), reduced pollution, sufficient water for multiple uses, fish are prioritized, responsible use of lands and water, forward-looking planning, good data collection, sufficient protected areas, safe drinking water throughout the watershed. - Most respondents noted that watershed research (e.g., on drought response, groundwater interactions) and tools (e.g., the NWMT) have aided efforts to better stewardship the watershed. - Multiple respondents argued that it would be important that watershed stewardship decision making include First Nations (including departments and organizations like Tmixw), government (DFO, BC, Merritt), and other stakeholders (e.g., agriculture, Fraser Basin Council, NWCRT, NVIT). Governance needs commitment and follow through. - Some respondents emphasized the need to integrate and apply Indigenous protocols and stewardship values, such as the Tmixw Protocol and the Syilx Water Declaration. Indigenous values need to be front and centre and given more weight.

Value	Risks/pressures	Geographic areas most at risk/pressure	Emergent priorities
Access to Resources This value includes access to traditional foods and medicinal plants, and other resources that are culturally important for Indigenous communities. Communities have traditionally harvested and hunted food resources in the Nicola Valley, using the variety of ecosystems present in the watershed.	- Ranching and other agricultural activities have reduced the abundance of bitterroot; an important medicinal plant used for cardiovascular health - Forestry pressure near Stoyoma Mountain despite the current agreement for not harvesting in the area - Forest fire suppression has turned grasslands (*Pimainus*) into forest areas	• Most people go to Keremeos to collect bitterroot. Some left near Guichon Ranch, east side Hwy 5A • Wetlands east of Shackan Creek are used for traditional food gathering • Klu Klu camp north of Styoma was used for elk hunting and huckleberry gathering • Klekemax Creek: huckleberries, strawberries and rattlesnakes	- Educate younger generations in harvesting and gathering protocols - Strengthen protection of Stoyoma Mountain