SUMMIT
ENVIRONMENTAL CONSULTANTS INC.
A Member of the Associated Engineering Group of Companies

Report

Regional District of Okanagan Similkameen and Similkameen Valley Planning Society

Similkameen Watershed Plan: Phase 1 Report

Project: 2013-8017

January 2014

SUMMIT
ENVIRONMENTAL CONSULTANTS INC.
A Member of the Associated Engineering Group of Companies

Summit Environmental Consultants Inc.
Suite 200, 2800 29 Street
Vernon, B.C., Canada, V1T 9P9

TEL: 250.545.3672
FAX: 250.545.3654
www.summit-environmental.com

January 31, 2014

File: 2013-8017

Liisa Bloomfield, P.Eng.
Project Manager
Regional District of Okanagan Similkameen
Public Works Department
101 Martin Street
Penticton, B.C. V2A 5J9

Re: FINAL REPORT: PHASE 1 - SIMILKAMEEN WATERSHED PLAN

Dear Ms. Bloomfield:

Summit Environmental Consultants Inc. is pleased to provide the final report for Phase 1 of the Similkameen Watershed Plan (SWP), as well as the first version of the Similkameen Water Information Database (SWID).

The main body of the report includes a review of the existing water management related information base for the Similkameen River watershed and identifies the technical and socio-economic information needs that should be addressed to support development of the SWP. A draft communications plan to support public and stakeholder consultation on the plan is also included. Appendices include a detailed review of the available water supply and demand information (Appendix A), a series of "backgrounder" reports to support the public/stakeholder consultation process (Appendix B), a list of the SWID record (Appendix C), and outlines of the recommended high priority technical studies (Appendix D).

We trust this completes our current assignment to your satisfaction. Please contact the undersigned if you have any questions.

Yours truly,

Hugh Hamilton, Ph.D., P.Ag.
Senior Environmental Scientist

HH

Executive Summary

The Similkameen Valley Planning Society (SVPS) and the Regional District of Okanagan Similkameen (RDOS) are developing a non-regulatory Watershed Plan which will be a guidance document for decision making authorities, resource managers, water users and residents to help make more informed and integrated decisions regarding the watershed (RDOS and SVPS 2012). **The Similkameen Watershed Plan** (SWP) is intended to be integrated into other local planning documents, bylaws, policies and Best Management Practices, but decision-making authority will remain distributed among local, First Nations, regional, provincial and federal governments within their respective jurisdictions.

The overall framework of the SWP emphasizes an integrative, holistic approach that links water quality, water quantity, wetlands, riparian habitat, and biodiversity with the economic and social priorities for the watershed. It is intended to facilitate collaborative water management and make water conservation a permanent ethic. The major water management issues that were identified during development of the SWP terms of reference (TOR) include:

- Effects of future climate change on the hydrologic cycle and the ecological, traditional use, and economic functions that rely on water.
- The adequacy of water supply and potential constraints on existing and future land use, water use, and economic activities.
- Protection of the ecological functions of the Similkameen Valley, which would include protection of water quality, maintenance of adequate flows for aquatic life, and protection and restoration of aquatic, wetland, and riparian habitats.
- Balancing water supply and water use.

The SWP will be developed using a phased approach. This report describes the outcomes of **Phase 1** of the Plan. The overall objective of Phase 1 is to research and compile available baseline information needed to support completion of the objectives specified in the TOR. The major Phase 1 tasks included development of a searchable information database that will be accessible for stakeholders and other interested parties; assessment of information gaps and setting priorities for action to address the gaps; development of a communication plan to support the planned public consultation process; and preparation of Backgrounder Reports on water issues to support public and stakeholder engagement.

The search for existing information built on the 2011 Scoping Study (Summit 2011a) and included searches of government databases, other on-line databases, and contacts with persons and agencies working in the watershed. In addition, the water suppliers in the watershed were contacted and requests made for available water use data. The following points summarize the quantity and quality of the existing information database that is available to support future phases of the SWP.

- **Streamflow (Water Quantity):** The number of streamflow monitoring stations (hydrometric) is above average for B.C. and the stations are well distributed throughout the watershed. In total, 12 Water Survey of Canada hydrometric stations are active in the Similkameen River watershed, with four of these recording streamflows on the mainstem of the Similkameen River. Two active stations are on the Tulameen River, and there is one operating on each of the Ashnola River, Ewart, Hedley, Keremeos, Pasayten, and Siwash Creeks. With the exception of Ewart Creek, the active stations have more than 35 years of data and four have more than 60 years of data. Although the hydrometric network is well suited for regional studies, for specific investigations (i.e. groundwater-surface water interaction investigations and aquatic resource assessments) some additional monitoring at site specific locations may be necessary.
- **Water Demand and Use**: A total of 831 current licences (at 690 points-of-diversion) have been issued on streams, springs, and lakes within the Canadian portion of the Similkameen River watershed. Licences have been issued for off-stream uses, including: domestic, irrigation, waterworks, stockwatering, enterprise, mining, and processing purposes, as well as for storage, power, and conservation purposes. Most of the main water suppliers within the Similkameen River watershed hold surface water licences; however, based on available water use records, most water suppliers are currently using groundwater for supply. Outside of water use information provided by water suppliers, the Agricultural Water Demand Model developed by the B.C. Ministry of Agriculture and Agriculture and Agri-Foods Canada provides estimates of agriculture (including both crop irrigation and livestock watering) water demands (by surface and groundwater) on a property by property or watershed basis for the Canadian portion of Similkameen River watershed.
- **Groundwater**: There are three active groundwater level observation wells monitored by the B.C. government with “real time” data – Cawston (#203), Mt. Kobau (#264), and Keremeos (#75). There are data for four other observation wells, but they are no longer actively monitored. Beyond the basic water level monitoring, data analyses and reporting to date has been focussed on a few specific water supply systems (Keremeos, Princeton, and Olalla). No valley-wide assessment of groundwater-surface water interaction has been completed.
- **Lakes, Wetland and Riparian Areas**: There is a good set of information on fish stocking, fish populations, and fish habitat for key angling lakes in the Similkameen Valley; however, limnological data (e.g. water quality, plankton) on these lakes are quite limited. Within the habitat atlas and sensitive ecosystem inventory, there is a small amount of information about wetlands and riparian areas. However, this information focusses on the warmer and drier parts of the watershed and information on higher elevations areas in the Similkameen watershed is lacking.
- **Climate and Climate Change**: There is relatively good understanding of the climate throughout (and adjacent to) the Similkameen River watershed, based on the current climate and snowpack monitoring network as well as now discontinued stations. However, there is considerable bias in the climate monitoring towards lower elevations locations where most development is concentrated. Currently, 10 active climate stations and six snow survey stations are in operation within the Similkameen River watershed. In addition, recent climate change modeling by the University of Victoria’s Pacific Climate Impacts Consortium, the University of Washington’s Climate Impacts Group, and Agriculture and Agri-Foods Canada is directly applicable to the Similkameen River

watershed. Overall, the region is predicted to warm, and annual precipitation is predicted to increase. However, late fall, winter and early spring flows are forecast to be greater; while late spring, summer and early fall flows will be smaller

- **Water Quality**: There is a very good set of water quality data for the mainstem of the Similkameen River and for Hedley Creek, and a reasonable amount of information for the Tulameen River and Ashnola Creek. Less is known about water quality in tributary streams and in lakes. The relative abundance of Similkameen River data is due to its status as an international river and because of monitoring that was and is carried out related to mining and municipal wastewater discharges.
- **Fish, Fish Habitat and Instream Flows**: Concerns have been expressed since the 1980s over the effects of summer low flows on fish. Although low flows and warm water temperatures natural limit fish production and survival, water withdrawals have been thought to exacerbate this situation (DFO et al. 2005). Detailed analyses of in-stream flow needs for fish have not been completed for the Similkameen River although MOE completed a screening analysis of the Similkameen-Boundary region to identify and prioritize streams considered to be flow-sensitive for fish using summer flows less than 20% of mean annual discharge as the criterion used to identify sensitivity. The results indicate that most streams in the Similkameen are considered flow-sensitive for fish.
- **Species at Risk**: There is a reasonable amount of information regarding the evaluation of important habitats to species at risk, habitat inventory and ecosystem mapping, and species at risk profiles for the South Okanagan and Lower Similkameen valleys. In addition, there is detailed sensitive ecosystem and species at risk information available for Area H (Rural Princeton). The inventories and mapping in the lower part of the watershed have typically been completed as part of the assessments for the South Okanagan, so there is not a single document that addresses the Similkameen watershed in its entirety.
- **Traditional Use**: There is some information on traditional ecological information related to water resources and fish in the public domain, but little is specifically about the Similkameen watershed. It is understood that the Lower and Upper Similkameen Indian Bands have accumulated a body of information on traditional knowledge and values, but agreements for sharing this information with RDOS have yet to be established.

  Land Use and Economic Development: Watershed planning documents include general B.C., local government and First Nations guides as well as primers and toolkits relating to water conservation and management. Examples of watershed plans from other jurisdictions are also included in the database for reference. A few Similkameen-specific planning documents related to groundwater and agriculture water demand provide background information for specific water issues. Many of the governance documents are focussed on water reform as BC is currently undergoing a process to modernise the *Water Act*. To date, planning
- **Planning for Flood and Drought**: Ministry of Environment has published floodplain maps for the Keremeos-Cawston area and for the Princeton Areas. Floodplain mapping has not been completed outside of these areas. The maps show that area that can be expected to flood once in every 20 years and once in every 200 years (the designated floodplain limit). These maps were last updated in 1995. There has been high-level drought management planning for the BC Southern Interior, but a watershed-specific drought management plan is not in place for the Similkameen Valley.

- **International Waters and Treaty Obligations**: A variety of documents have been identified that address international waters and treaties. However, few have direct application to the Similkameen River. The International Osoyoos Lake Board of Control Order of Approval under the International Boundary Waters Treaty, primarily guides management Osoyoos Lake but considers how the Similkameen River influences Osoyoos Lake management. Another document indicates that the establishment of the Columbia River Treaty did not lead to the settlement of other water issues and elaborates on Similkameen River flood control as one example (Hallauer 1979). Additional documents related to trans-boundary management of water in the Columbia and Similkameen include the Columbia River Treaty, the Pacific Salmon Treaty, *and International Rivers Improvement Act*.

A series of Backgrounder Reports have been prepared to augment the information compiled into the Similkameen Water Database. The Backgrounders summarize the available information for eight topics of interest and direct readers who want more detail to the key reports and documents that will be available from the database.

A communication plan has been developed to support SWP development. It includes a number of techniques to: 1) inform public and stakeholders about the availability of the Backgrounders and database, and, 2) facilitate two-way communication during subsequent phases of the SWP.

Based on the review of the available information, a number of information gaps have been identified that should be addressed to support water management decision-making in the Similkameen Valley. The gaps have been ranked according to their priority for action (High, Moderate, and Background). The highest priority gaps (rank “High”) are those that should be addressed in the short term since the information is needed to support the first version of the SWP. The Moderate priority gaps will provide information important for future decision making, but can be deferred until the first version of the SWP has been completed, while the gaps identified as “Background” will provide for a more detailed understanding of watershed characteristics, but do not presently constrain water management to a significant degree. The high and moderate-rated priorities are listed in the following table.

Information Gap Priority Summary

Number	Description	Priority Rating*	Schedule Rating**
WSD-1	Set Planning Scenarios for Population, Economic Development, and Climate	H	2***
WSD-2	Assessment of Water Availability and Risk of Inadequate Supply	H	1
WSD-3	Review Storage Option and Preliminary Feasibility Assessment	M	2
WSD-4	Additions to the Water Quantity Monitoring Network	B	3
GW-1	Review and update aquifer mapping	M	2
GW-2	Groundwater-Surface Water Interaction	H	1
GW-3	Reconnaissance-level groundwater quality inventory	M	2
WQ-1	Surface Water Quality Status and Trends Analysis	H	1
WQ-2	Reconnaissance Survey of Water Quality in Selected Tributary Streams and Lakes	M	2
F-1	Updated Overview Report on Fish and Fish Habitat in the Similkameen Watershed	H	1
F-2	Instream Flow Needs Assessment	H	3
RW-1	Establish Riparian Areas & Wetlands Working Group to identify and map restoration work completed to date and set priorities for further assessment and restoration.	M	2
RW-2	Desktop Inventory of Riparian Areas and Wetlands	M	2
TEK-1	Work with LSIB, USIB and ONA to assemble, review and summarize traditional ecological knowledge, cultural information, and field studies related to water and aquatic/riparian habitats.	H	2
SE-1	Economic Sector Business Projections to 2050	H	2
SE-2	Research Planning Tools for Water Conservation	H	2

* Priority ratings: H – High; M – Moderate; B – Background
** Schedule ratings: 1 – Within 6-12 months; 2 – Within 24 months; 3 – As resources allow.
***Tasks rated H-2 should be completed early in the formal WSP planning process

Acknowledgements

Summit Environmental Consultants Inc. thanks those persons and agencies that provided information that was compiled for this report and/or provided insight into on-going water management initiatives and research in the Similkameen Valley. In particular we thank the water suppliers who took the time to provide the water use records that are summarized in Appendix A.

The Phase 1 project was directed by Liisa Bloomfield and Doug French at the Regional District of Okanagan Similkameen. The report was prepared by Hugh Hamilton, Drew Lejbak, Jana Tondu, Kellie Garcia, and Brent Phillips of Summit and Jillian Tamblyn of Waters Edge Consulting. Brian de Jong prepared the maps and completed the spatial analyses for the water use components. Ron Fretwell (RHF Systems Ltd.) completed the customized runs of the Agricultural Water Demand Model.

Some of the graphics found in Appendix B (Backgrounders) were created using the Integration and Application Network, University of Maryland Centre for Environmental Sciences image library.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AGWMN	Ambient Ground Water Monitoring Network
B.C.	British Columbia
BCEAA	British Columbia Environmental Assessment Act
BMP	Best Management Practice
CABIN	Canadian Aquatic Bio-monitoring Network
DFO	Fisheries & Oceans Canada
EC	Environment Canada
EDQA	Environmental Data Quality Assurance
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EMS	Environmental Management System (a database)
FHID	Fairview Heights Irrigation District
GCM	General Circulation Model
IDZ	Initial dilution zone
IFN	In-stream Flow Needs
IPP	Independent Power Project
LSIB	Lower Similkameen Indian Band
MAL	Ministry of Agriculture and Lands (now Ministry of Agriculture)
MMER	Metal Mining Effluent Regulation (*Fisheries Act*)
MOE	Ministry of Environment
MOFLNR	Ministry of Forests, Lands & Natural Resources Operations (also MOF, MOFR)
MWR	Municipal Wastewater Regulation
NPS	Non-point source (pollution)
NWUMP	Nicola Water Use Management Plan
ONA	Okanagan Nation Alliance
OWN	Observation Well Network
OWNI	Observation Well Network Information database
OWSDP	Okanagan Water Supply & Demand Project
PDO	Pacific Decadal Oscillation
QA/QC	Quality Assurance/Quality Control
RDOS	Regional District of Okanagan Similkameen
SID	Similkameen Improvement District
SVPS	Similkameen Valley Planning Society
SWID	Similkameen Water Information Database
SWP	Similkameen Watershed Plan
TEK	Traditional Ecological Knowledge
TMDL	Total Maximum Daily Load

Continued next page.

USEPA	United States Environmental Protection Agency
USIB	Upper Similkameen Indian Band
USGS	United States Geologic Survey
WQG	Water Quality Guidelines
WQO	Water Quality Objectives
WSER	Wastewater Systems Effluent Regulations
WSC	Water Survey of Canada

1 Introduction

1.1. PROJECT BACKGROUND

The Similkameen River is a tributary of the Okanogan River, joining it just south of the Canada-United States border at Oroville, Washington (Figure 1-1). The Similkameen River watershed, which is part of the traditional territory of the Sylix (Okanagan) Nation, is mostly located within Canada in the Regional District of Okanagan Similkameen (RDOS), although portions of the headwaters and the lower watershed are in the U.S.

In 2010, the Similkameen Valley Planning Society (SVPS)[1] completed the development of a Strategy for a Sustainable Similkameen Valley, 2011-2020 ("the Strategy"), which is detailed in a report by Glorioso, Moss and Associates (2010). The Strategy includes the intention to significantly improve water management including the ability to adapt to climate change (Strategic Means #7). As a first step in implementing this Strategic Means, SVPS retained Summit Environmental Consultants Inc. (Summit), to carry out a scoping study as the first part of the water planning study for the Similkameen River watershed (Summit 2011a – "the Scoping Study"). The Scoping Study identified a number of key data gaps that should be addressed. In addition, it recommended that stakeholders and the general public be brought into the process as soon as possible. This recommendation was based on the high level of community interest in water resources issues in the Similkameen Valley, as well as on the experience of other watershed planning groups where such input resulted in plans that achieved high levels of community acceptance.

Through the remainder of 2011 and 2012, SVPS and RDOS retained Ms. Janice Johnson to facilitate the consultation and watershed planning processes, by striking Technical (TAC) and Stakeholder (SAC) Advisory Committees, and to develop a detailed Terms of Reference (TOR) for the **Similkameen Watershed Plan** (SWP or "the Plan"). The final TOR was published in October 2012. As the next step in completing the SWP, Summit was retained through a competitive proposal process to assemble and catalogue the information needed to proceed with the SWP, identify potential partnerships and funding sources, outline the future priority technical studies, and develop the SWP communications plan ("the Phase 1 Study"). This document presents the results of the Phase 1 Study.

1.2. WATERSHED PLAN OBJECTIVES AND KEY WATER MANAGEMENT ISSUES

As outlined in the TOR, SVPS and RDOS are developing "a **non-regulatory** Watershed Plan which will be a **guidance document** for decision making authorities, resource managers, water users and residents to help make more informed and integrated decisions regarding the watershed" (RDOS and SVPS 2012). The SWP is intended to be integrated into other local planning documents, bylaws, policies and Best Management Practices, but will not commit agencies to actions which conflict with existing statutory

[1] The seven members of the SVPS are the Village of Keremeos, the Town of Princeton, the Lower Similkameen Indian Band, the Upper Similkameen Indian Band, and Rural Areas B, G and H of RDOS,

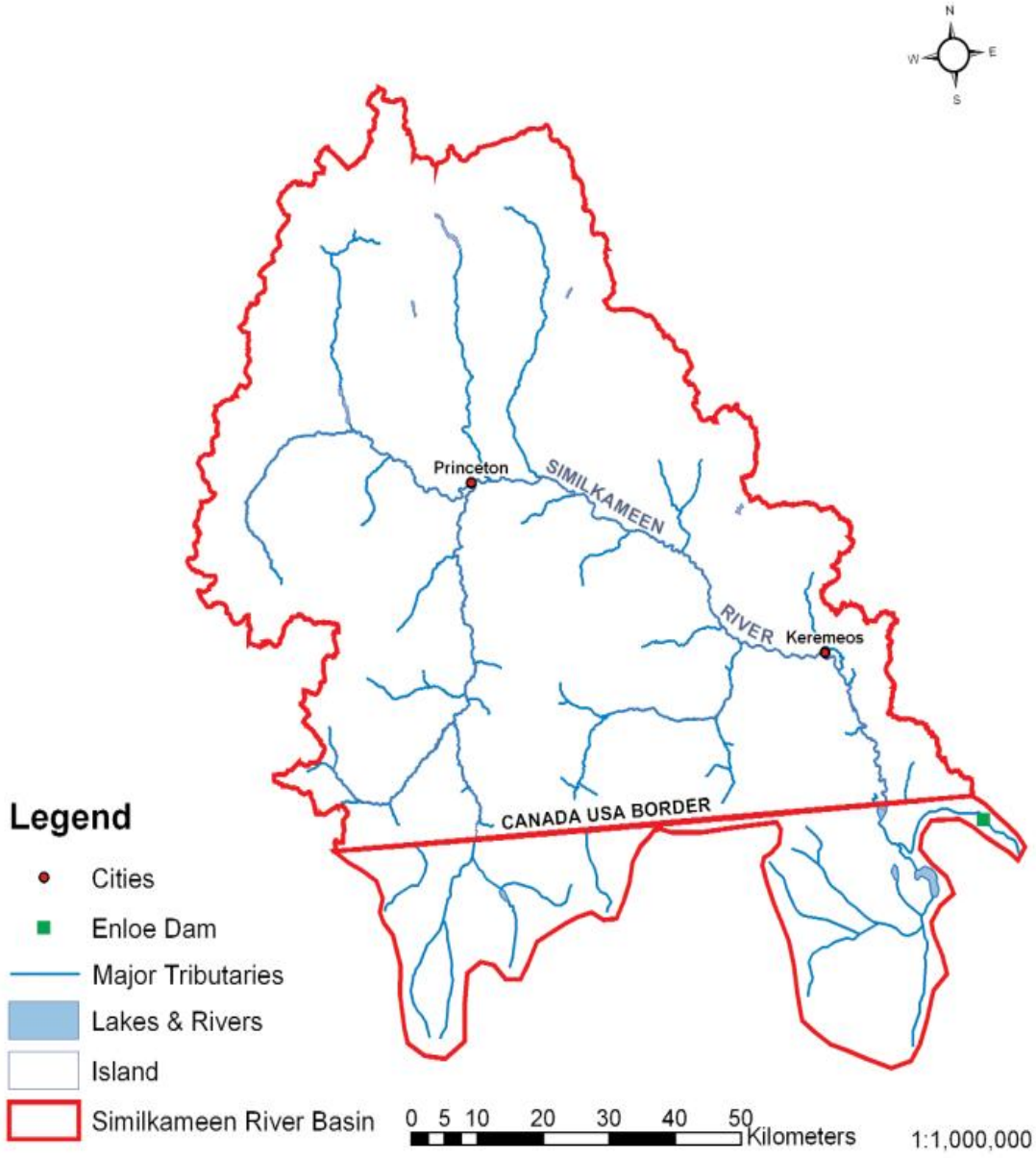


Figure 1-1
The Similkameen River Basin

requirements. Decision-making authority will remain distributed among local, regional, provincial and federal governments; and First Nations through the referral process.

The SWP mission statement is: ***The SWP will provide the long-term direction and actions necessary to achieve its overall mission, to preserve and protect the quality and health of the Similkameen watershed.***

In setting the overall framework for the SWP, the SAC and TAC emphasized the need for the plan to take an integrative, holistic approach to link water quality, water quantity, wetlands, riparian habitat, and biodiversity with the economic and social priorities for the Watershed. The major water management issues that were identified during development of the TOR and in the scoping study include:

- Effects of climate change on the hydrologic cycle and the ecological, traditional use, and economic functions that rely on water.
- Concerns that the adequacy of water supply could constrain existing or future economic activity.
- Balancing water supply and water use.
- Protection of the ecological functions of the Similkameen Valley, which would include protection of water quality, maintenance of adequate flows for aquatic life, and protection and restoration of aquatic, wetland, and riparian habitats.
- Facilitating collaborative water management.
- Making water conservation a permanent ethic.

Since the SWP TOR were developed, Fortis Inc. has begun to assess the environmental feasibility of a hydro-power project on the Similkameen River upstream of Princeton. As a result, the potential for effects (both positive and negative) of a dam and reservoir at that location has emerged as a key water management issue.

1.3. PHASE 1 PROJECT OBJECTIVES

The overall objective of Phase 1 is to research and compile available baseline information needed to support completion of the objectives specified in the TOR. The specific Phase 1 goals are to:

1. Develop a basic information database in MS-Access. The database is to be searchable and accessible for stakeholders and other interested parties.
2. Complete a search for existing reports and data files, building on the information already compiled during the scoping study. The search will include both on-line and library searches as well as telephone discussions with persons familiar with the watershed.
3. Compile the existing documents and data sets into electronic format (e.g. PDF for report, Excel for data files), organized and cross-referenced by Watershed Plan Objectives.
4. Compile available water use data from the water suppliers in the watershed.

5. Enter the information into the database, which is referred to hereafter as the Similkameen Water Information Database (SWID).
6. Assess whether there are adequate data to meet the plan objectives and identify and prioritize remaining data gaps.
7. Research and identify funding and partnership opportunities for Sections 2.3, 3.1 and 3.2 of the TOR.
8. Develop a communication plan to support the planned public consultation process.
9. Compile a list with contact information of conservation groups, industry groups, recreational groups, major water users, and other stakeholders that should receive SWP materials.
10. Prepare Backgrounder Reports on water issues to support public and stakeholder engagement.
11. Prepare outlines for the Requests for Proposals for the technical studies that are needed to address the key data gaps identified in the Summit scoping study and in the current (Phase 1) study.
12. Develop recommendations for the next steps in the Similkameen Watershed Plan.
13. Prepare a report with the Phase 1 findings and recommendations for next steps.

1.4. REPORT FORMAT

This Phase 1 report includes the following components:

- **Section 2** provides a brief description of the Similkameen Watershed.
- **Section 3** describes how the search for available information was carried out and describes the format of the Similkameen Watershed Information Database that houses the reports and data files that were obtained. Section 3 also includes brief assessments of the quantity and quality information that currently exists for the major technical and socio-economic components of the watershed plan. Since an understanding of the information on water use was judged to be a priority for Part 1, a detailed description and summary of the available water use data is provided in **Appendix A**. Backgrounder reports for a number of key water management topics that summarize the available information, are provide as drafts in **Appendix B**.
- **Section 4** describes the information gaps that were identified from the review of available information and discusses how those gaps may constrain watershed planning. Recommendations are made on the scope of studies that would be completed to address those gaps.
- **Section 5** describes the recommended communication plan for subsequent phases of the Similkameen Watershed Management Plan. The draft communication plan has been developed based on the understanding that plan development will be as collaborative as possible.
- **Section 6** outlines the suggested next steps in Plan development based on the TOR and the findings of Phase 1.
- **Section 7** summarizes the major recommendations for subsequent phases of the Plan.

The Similkameen Watershed Information Database is provided as an attachment to this report. The database will eventually be housed within RDOS and made available on the Internet for all users. The mechanism for on-going database updates is to be determined.

2 Watershed Description

A detailed description of the characteristics of the Similkameen River watershed is provided in the Scoping Report (Summit 2011a). The following summary provides a brief overview of the Similkameen River watershed.

2.1. LOCATION, ADMINISTRATIVE JURISDICTIONS AND POPULATION

The Similkameen River watershed is located in the Southern Interior of B.C., between the Coast Range Mountains and the Okanagan valley. Highway 3 passes through the watershed from northwest to southeast, and Highway 5A goes north-south through the western part. The Similkameen River joins the Okanogon River south of the outlet of Osoyoos Lake near Oroville in the U.S.A. There are no dams on the Similkameen River in B.C., however the Enloe Dam was previously operated in Washington State (from 1923 to 1958) and applications have been filed for its reactivation for electricity production.

The Similkameen River watershed includes lands under the jurisdiction of the Village of Keremeos, the Town of Princeton, Areas B, G, and H of the RDOS, the Lower Similkameen Indian Band (LSIB), and the Upper Similkameen Indian Band (USIB). In addition, there are six irrigation and improvement districts that operate under the authority of the B.C. *Local Government Act*. They are:

- Cawston Irrigation District (CID)
- Fairview Heights Irrigation District (FHID)
- Keremeos Irrigation District (KID)
- Similkameen Improvement District (SID);
- Hedley Improvement District (HID); and
- Allison Lake Improvement District (ALID).

Population estimates for the Similkameen watershed were obtained from B.C. Stats (2013) and shown in Table 2-1. For areas outside the two major communities of Keremeos and Princeton, BC Stats provides data based on Local Health Areas, so the populations shown in Table 2-1 for “Lower Watershed (excluding Keremeos)” and “Upper Watershed (excluding Princeton)” are the populations of the Local Health Areas with the town populations subtracted. The total valley population in 2012 was estimated to be approximately 10,600 persons.

Table 2-2 shows BC Stats (2013) predictions of population change for the two Local Health Areas in the watershed in 2024 and 2036 compared to the 2000 and 2012 populations. They show a modest 2012-2036 increase in the Keremeos area (4.1%) but a projected decline in the Princeton area (-21%) results in a projected overall population decline of -8.3%. The implications for water supply and demand analysis are discussed in Section 4.2.1.

Table 2-1
Estimated Similkameen 2012 Population

Community	2012 Population	% of Total
Keremeos	1,540	15%
Lower Watershed (excluding Keremeos)	3,719	35%
Princeton	3,101	29%
Upper Watershed (excluding Princeton)	2,231	21%
Similkameen Valley Approximate	**10,591**	**100%**

Source: BC Stats (2013)

Table 2-2
Similkameen Valley Population Change: 2000, 2012, 2024, and 2036

Year	Local Health Area 16 – Keremeos and Area	Local Health Area 17 – Princeton and Area	Total
2000	4,605	4,729	9,334
2012	5,259	5,332	10,591
2024	5,506	4,915	10,421
2036	5,473	4,236	9,709
Projected Change: 2012 to 2036	214	-1,096	-882
% Change: 2012 to 2036	4.1%	-21%	-8.3%

Source: BC Stats (2013)

2.2. GEOLOGY, PHYSIOGRAPHY AND SOILS

The Similkameen watershed is underlain by bedrock from several geologic ages (Ministry of Energy Mines and Petroleum Resources 2005). The bedrock types are generally resistant to water erosion, form uplands and mountain ranges, and where strongly fractured, may contain bedrock aquifers. The Copper Mountain area south of Princeton, the Hedley gold mining district, and coal deposits in the Princeton and Tulameen areas were previously mined but have not been active since about 1992 or before. Some of these mining operations were close to the Similkameen and Tulameen Rivers. The former Similco open pit copper mine and concentrator facility south of Princeton has been re-opened as the Copper Mountain mine in 2011.

The Similkameen River watershed is included in the Thompson Plateau physiographic area (Holland 1976). The Thompson Plateau is a gently undulating upland of low relief, with some hills of more resistant bedrock. This upland is a very old erosion surface cut into by the major rivers. The Similkameen headwaters are in the Hozameen Range of the Cascade Mountains, in Manning Provincial Park, southwest of Princeton. The Okanagan Range of the Cascade Mountains is located along the U.S.A. border. The landscape consists of wide, flat-floored valleys, and rugged mountain ranges and plateau areas with dry land vegetation and forest.

The watershed was glaciated with later ice stagnation and melting about 10,000 years before present, leaving glacially-shaped bedrock features, glacial till and meltwater channels and deposits (Holland 1976). The modern agricultural and forest soils have been formed in these glacial till deposits overlying bedrock, in colluvial deposits below steep slopes, in glaciofluvial sands and gravels deposited by the meltwater streams, and in modern fluvial deposits beside rivers (Wittneben 1986). Most soils developed under a grassland-forest vegetation type, and dry climatic conditions.

2.3. CLIMATE AND BIOGEOCLIMATIC ZONES

The Similkameen River watershed is located in the rain shadow from the Coast and Cascade Mountains, and the western section is cooler and moister while the southeastern section is warmer and drier. The climate across the entire watershed varies, but it is generally characterized by warm summers and cooler winters with a relatively even distribution of precipitation throughout the year. Based on Environment Canada climate station 1971-2000 averages (i.e. climate “normals”), mean air temperatures at Keremeos (Station No. 1124112; Elevation = 435 m) can range from -2.5°C in January to 20.9°C in July, while at Princeton (Station No. 1126510; Elevation = 702 m) temperatures can range from -6.2°C in January to 17.7°C in July (Environment Canada 2013). Air temperatures are on average below freezing from December to February within the watershed and have been recorded as low as -43°C. Approximately 20-40% of the total annual precipitation of 340 mm falls as snow.

The Similkameen River watershed is included in the Southern Interior Ecoprovince, with these biogeoclimatic zones present: Bunchgrass (BG), Ponderosa Pine (PP), Interior Douglas Fir (IDF) on the valley floors, and Montane Spruce (MS) and Englemann Spruce-Subalpine Fir (ESSF) at the higher elevations and Alpine Tundra (AT) at the mountain peaks (Ministry of Forests and Range 2008).

2.4. HYDROLOGIC REGIME

The Similkameen River is about 196 km long, with headwaters in Manning Park. The watershed includes 7,566 km^2 in B.C. and 1,704 km^2 in Washington State. The river flows north to Princeton, southeast through Keremeos, and across the border just south of Cawston. The Tulameen River is the largest tributary. Other notable tributaries include Pasayten River, Ashnola River, Allison Creek, Wolfe Creek, Hedley Creek, Keremeos Creek, Hayes Creek and Otter Creek. The watershed is located mainly in the

Southern Thompson Plateau hydrologic zone, with the western headwaters in the Eastern South Coast Mountains hydrologic zone (Obedkoff 1998; 2003). Normal annual runoff is in the order of 200 to 1,000 mm per year in the wetter western parts of the watershed, with runoff of roughly 100 mm to 200 mm (or less) in the drier eastern section.

The tributary and mainstem streams in the Similkameen watershed are supplied mainly by snowmelt. Annual peak flows commonly occur during May to July during snowmelt, with discharge at Similkameen River at Hedley ranging from typically less than 15 m^3/s during winter to more than 275 m^3/s during the spring snowmelt period. The Similkameen River has an average baseflow (i.e. flow from groundwater discharge) that ranges from 2 m^3/s near the east boundary of Manning Park, to 6 m^3/s above the Tulameen River confluence, to 10.5 m^3/s near Hedley, and 11 m^3/s at Cawston, just north of the border. From July through April, after the high snowmelt-generated flows have subsided, water flow is generally low on average – this period includes the peak irrigation months, and the peak fish spawning periods (Glorioso *et al.* 2010).

2.5. GROUNDWATER

Aquifer mapping by MOE identifies 18 aquifers within the Similkameen River watershed (see Section 3.2.2 and Section 4 of Appendix A). Aquifer #259 (Similkameen River, International border to Princeton) is the primary aquifer used for water supply, relative to population. MOE (2013) reports that the nature of the surficial deposits filling the Similkameen River valley is known mostly from water wells that have been constructed in this near-surface aquifer. In particular, the upper aquifer which extends from near surface to 43 m is very productive; therefore, it is currently the only one being exploited for water supply requirements. MOE (2013) also reports that aquifer recharge is mostly from the Similkameen River, which has a coarse gravel bottom and an average gradient of approximately 0.3%.

Groundwater is the primary or secondary source of water utilized by water suppliers and private individuals for domestic, irrigation, and other purposes in the Similkameen River watershed. A review of the available well information indicated that there are 1,873 groundwater wells on record. There are also three MOE observation wells within the watershed that are utilized for trend monitoring of groundwater levels and quality characterization. The MOE observation wells are located in Keremeos, Cawston, and at a height of land near Mount Kobau (Section 3.2.2).

2.6. LAKES AND WETLANDS

There are an estimated 153 lakes in the Similkameen watershed, most of which are small, with maximum depths ranging from 4 to 74 meters. Lakes located at lower elevations within open aspen-ponderosa pine parkland are productive lakes that support fisheries. Medium elevation lakes are surrounded by spruce and lodgepole pine vegetation and are lower in productivity. Medium elevation lakes usually have lower concentrations of plankton and macrophytes and produce fish that are smaller in size. A majority of lakes and wetlands in the Similkameen Valley are located in the high mountain plateaus area. These high

elevation lakes are low in productivity and are associated with slow fish growth. Lakes are mainly used for recreation and angling; 68 lakes (a total of 84 lakes were stocked in the past) in the Similkameen Valley are stocked with rainbow and brown trout for sport-fishing. Only 29 lakes (of the 68 managed lakes) in the Similkameen naturally support high fish production.

There are four main wetland ecosystems in the Similkameen area: marshes, swamps, wet meadows, and shallow open water. Wetland and riparian habitat in the South Okanagan has been reduced to <4% due to development pressures and flood control measures (MOE 1998). In the Princeton area, wetlands cover about 1% of the landscape, with most occurring in the Chain Lakes area. Wetlands can also be found in the vicinity of Otter Lakes (0.5% of the area) and East Gate (0.3% of the area) (Timberline 2009).

2.7. FISH AND FISH HABITAT

The Similkameen River and its tributaries provide about 500 km of fish-supporting habitat. There are 17 different types of fish found in the Similkameen Basin, some occur naturally, while others have been introduced. There are no anadromous fish in the Canadian portion of the Similkameen River due to Enloe Dam and Coyote Falls acting as a fish barrier. The Similkameen River was historically stocked with surplus hatchery fish (i.e. rainbow and brown trout); however, due to concerns that this could adversely affect wild fish populations stocking is now limited to areas with high fishing pressure. In general, the Similkameen River watershed has low fish population densities.

The Similkameen River watershed generally has low levels of phosphorous and nitrogen, and cool temperatures, which limits the growth rate of fish in the area. While the Similkameen River has high value side-channel habitat that is suitable for fish spawning, rearing, and reproduction, naturally low water levels in the fall and winter may contribute to low fish productivity by limiting habitat availability and/or reducing fish survival. Tributaries along the Similkameen River from Hedley to the international border provide spawning and juvenile rearing habitat for river-resident fish, as well as stream-residents.

2.8. LAND USE AND ECONOMIC DEVELOPMENT

There are two main municipalities in the watershed: Princeton (population 2,677) and Keremeos (1,289). The 2006 census (Province of British Columbia 2011) indicated that about 9,200 people lived in the Similkameen River watershed, with about 5,600 living in the population centres of Princeton, Hedley, Keremeos, Cawston, and Olalla. Between 2001 and 2006, the population of the Simillkameen Valley increased 5.9%, and from 2006 to 2011 the population was reported to decrease by 2.3%.

Agriculture is a mainstay of the Similkameen Valley economy. Cattle-ranching is the largest agricultural activity based on the area of crop land, with about 83% of the land in Areas B, G and H of the RDOS in alfalfa, alfalfa mixtures or hay. Fruit growing, including apples, cherries, grapes, and peaches, is the next most significant activity. Average farm sizes increases moving from east to west. The average is 82 ha in Area B, 143 ha in Area G, and 276 ha in Area H.

Other land use activities in the watershed include forestry, range, and mining. The area surrounding Princeton is included in the Cascades Forest District, while Keremeos and area is included within the Okanagan Shuswap Forest District. Additionally, in vicinity of Princeton, Hedley, and other local areas, most Crown land is under mining claim or licence tenure.

3 Available Information and Similkameen Information Database

3.1. METHODOLOGY

3.1.1. Information Search and Assembly

The process of information identification and collection began with the compilation of key information sources known to the study team. These sources are as follows, and are detailed below:

- The Ecological Reports Catalogue;
- The Cross-linked Information Resources Database;
- Google web search; and
- Personal interviews with experts

The Ecological Reports Catalogue (EcoCat) was used to search for any digital publications that were produced within the Similkameen Valley that were relevant to water science (climate, hydrology, hydrogeology, water quality, fish and fish habitat, aquatic species, riparian areas) and planning (water supply and demand, governance, policy, legislation, land development, industry, agriculture, traditional knowledge). EcoCat was searched by main geographic areas and watersheds within the Similkameen Valley. In addition to the names of streams and lakes, the keywords used in the EcoCat search included the names of the inhabited communities in the valley. Key words included: Similkameen, Princeton, Hedley, Cawston, Keremeos, Manning Park; Tulameen, Pasayten, and Ashnola Rivers; Allison, Wolfe, Hayes, Otter, Shinish Creeks; and the names of known lakes.

The Cross-Linked Information Resources (CLIR) database was also used to search for relevant documents. The CLIR search engine differs from EcoCat in that it searches multiple sources of environmental and natural resource information simultaneously through various Ministry of Environment e-libraries including: BC Species and Ecosystems Explorer, Biodiversity/Environmental Information Resources, Environmental Protection Information Resources, EcoCat, Ministry of Forests and Range Library, and Species Inventory Web Explorer (part of the Species Inventory Data System). To refine the search on CLIR, the following keyword pairings were used:

- Similkameen and water;
- Princeton and water;
- Hedley and water;
- Cawston and water;
- Keremeos and water;
- Similkameen and hydrology
- Similkameen and hydrogeology;
- Similkameen and in-stream flow needs;
- Similkameen and riparian;
- Similkameen and snowmelt;

- Similkameen and channel;
- Similkameen and climate change
- Similkameen and dams;
- Similkameen and drainage;
- Similkameen and fish;
- Similkameen and fish habitat;
- Similkameen and flooding;
- Similkameen and groundwater;
- Similkameen and water conservation
- Similkameen and water demand;
- Similkameen and water pollution;
- Similkameen and water supply;
- Similkameen and water quality;
- Similkameen and watershed;
- Similkameen and wastewater; and
- Similkameen and wetlands.

A Google Web Search was also performed to find any additional information of importance to the Similkameen watershed. Keywords used in the Google search included:

- Similkameen fish habitat;
- Similkameen river water;
- Similkameen river water level;
- Similkameen river water quality;
- Similkameen river water supply;
- Similkameen valley water supply;
- Similkameen water demand; and
- Similkameen watershed.

Further to these online searches, the following individuals were contacted (by phone or email)[2] to determine if there were additional reports, data files or documents relevant to the Similkameen:

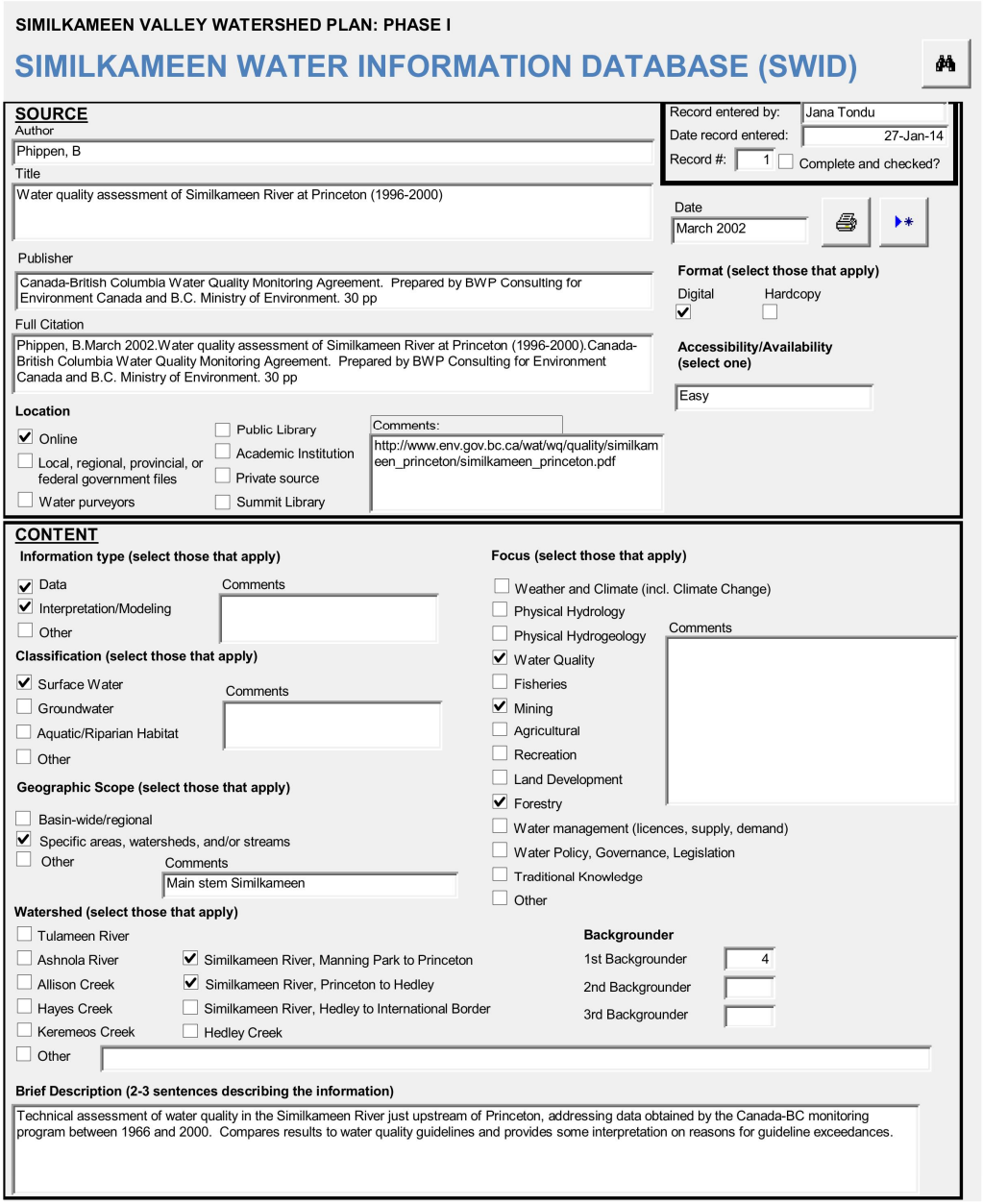
- Andrea Ryan* – Senior Water Quality Scientist – Environment Canada
- Bob Wilson – Chairman, Allison Lake Improvement District
- Brian Mennell – Fairview Heights Irrigation District
- Carl Withler - Ministry of Agriculture, Kelowna
- Dr. Denise Nielsen – Research Scientist, Agriculture and Agri-food Canada
- George Bush – Chairman, Cawston Irrigation District
- Giselle Bramwell* – Regional Services Climatologist, Meteorological Services of Canada, Environment Canada
- Jim Cornish, Board Member, Osprey Lake Waterworks District
- Jordy Bosscha - Public Works and Parks Foreman, Village of Keremeos
- Kevin Huey – Public Works Manager, Town of Princeton
- Kevin Huey – Water Operations Manager, Keremeos Irrigations District
- Markus Schnorbus – Lead, Hydrologic Impacts, Pacific Climate Impacts Consortium
- Michael Noseworthy – Dam Safety Engineer, Ministry of Forest, Lands & Natural Resources Operations (MFLNRO), Penticton
- Neil Goeller – Regional Hydrologist, MFLNRO, Penticton

[2] Several of the listed persons provided comments and additional sources of information after reviewing the Phase 1 draft report (identified with *).

- Richard Tarnoff – Water Operations Manager, Hedley Improvement District\
- Roger Mayer – Chairman, Similkameen Improvement District
- Shawn Witty – Water Operations Manager, Apex Mountain Resort
- Skye Thompson* – Regional Hydrogeologist, MFLNRO, Penticton
- Stephen Juch, Subdivision Supervisor, RDOS Engineering Division
- Tarik Dessouki – Section Head, Surface Water, Groundwater and Snow Networks. Ministry of Environment, Victoria
- Ted van der Gulik – Senior Engineer, Ministry of Agriculture, Abbotsford
- William Sawchuck – Custodian, Missezula Lake Waterworks District

3.1.2. Database Description and Data Entry

A straightforward and user-friendly information database was developed in Microsoft Access to facilitate organization, recording and summarizing of the information compiled. The Similkameen Water Database (SWID) design is simple (Figure 3-1) and includes a user-friendly interface with the ability to create customized summary reports. This flexible design also allowed for the expansion of fields and the addition of extra features easily during the data entry phase. A short Users' Manual is provided in Appendix C.



SIMILKAMEEN VALLEY WATERSHED PLAN: PHASE I

SIMILKAMEEN WATER INFORMATION DATABASE (SWID)

SOURCE

Author: Phippen, B

Title: Water quality assessment of Similkameen River at Princeton (1996-2000)

Publisher: Canada-British Columbia Water Quality Monitoring Agreement. Prepared by BWP Consulting for Environment Canada and B.C. Ministry of Environment. 30 pp

Full Citation: Phippen, B.March 2002.Water quality assessment of Similkameen River at Princeton (1996-2000).Canada-British Columbia Water Quality Monitoring Agreement. Prepared by BWP Consulting for Environment Canada and B.C. Ministry of Environment. 30 pp

Record entered by: Jana Tondu
Date record entered: 27-Jan-14
Record #: 1 Complete and checked?

Date: March 2002

Format (select those that apply): Digital ☑ Hardcopy ☐

Accessibility/Availability (select one): Easy

Location:
- ☑ Online
- ☐ Local, regional, provincial, or federal government files
- ☐ Water purveyors
- ☐ Public Library
- ☐ Academic Institution
- ☐ Private source
- ☐ Summit Library

Comments: http://www.env.gov.bc.ca/wat/wq/quality/similkameen_princeton/similkameen_princeton.pdf

CONTENT

Information type (select those that apply):
- ☑ Data
- ☑ Interpretation/Modeling
- ☐ Other

Comments:

Classification (select those that apply):
- ☑ Surface Water
- ☐ Groundwater
- ☐ Aquatic/Riparian Habitat
- ☐ Other

Comments:

Geographic Scope (select those that apply):
- ☐ Basin-wide/regional
- ☑ Specific areas, watersheds, and/or streams
- ☐ Other

Comments: Main stem Similkameen

Focus (select those that apply):
- ☐ Weather and Climate (incl. Climate Change)
- ☐ Physical Hydrology
- ☐ Physical Hydrogeology
- ☑ Water Quality
- ☐ Fisheries
- ☑ Mining
- ☐ Agricultural
- ☐ Recreation
- ☐ Land Development
- ☑ Forestry
- ☐ Water management (licences, supply, demand)
- ☐ Water Policy, Governance, Legislation
- ☐ Traditional Knowledge
- ☐ Other

Comments:

Watershed (select those that apply):
- ☐ Tulameen River
- ☐ Ashnola River
- ☐ Allison Creek
- ☐ Hayes Creek
- ☐ Keremeos Creek
- ☐ Other
- ☑ Similkameen River, Manning Park to Princeton
- ☑ Similkameen River, Princeton to Hedley
- ☐ Similkameen River, Hedley to International Border
- ☐ Hedley Creek

Backgrounder:
- 1st Backgrounder: 4
- 2nd Backgrounder:
- 3rd Backgrounder:

Brief Description (2-3 sentences describing the information):
Technical assessment of water quality in the Similkameen River just upstream of Princeton, addressing data obtained by the Canada-BC monitoring program between 1966 and 2000. Compares results to water quality guidelines and provides some interpretation on reasons for guideline exceedances.

Figure 3-1
Example of Data Record in the Similkameen Water Information Database

The interface has three main data-entry sections, Source, Content, and Evaluation.

- The Source section contains the reference information, including citation, the location and available format (hardcopy or digital) of the document and the difficulty of accessing the document.

- The Content section delineates the information by information type (data, interpretation, or other), classification (surface water, groundwater, aquatic/riparian habitats, or other); geographic scope (Basin-wide/regional, specific areas, or other); watershed and focus (e.g. hydrology, water quality, fisheries, mining, land development, water management, traditional knowledge, etc.). A brief summary and description of the information found in the resource is also provided in this section of the database.

- The Evaluation section allows users to rate the usefulness of the document and provide additional remarks about their overall impression (relating to consistency, accuracy, precision, standardization, credibility, and scientific rigour). Three categories ("directly relevant", "useful background", and "marginal") of usefulness were developed in order to filter the available information for future watershed management and planning. Information sources deemed "high" and "moderate" were considered valuable watershed planning and comments are provided in the database to justify these decisions, which are based on consistency, accuracy, precision, standardization, credibility, and scientific rigour. Information sources deemed "marginal" usefulness are generally not relevant or valuable to watershed planning.

Within SWID, a user can view, enter, search, filter, or sort any of these fields through the interface. The database is a valuable tool for summarizing the variety of data sources and identifying the most useful resources for a given topic or geographic area within the Basin. Data gaps are also identifiable through simple queries.

A summary of the references contained in the database (and reference to the database record number) is attached in **Appendix C**. Since the database is fundamentally a digital tool, a digital copy is provided on CD1.

3.2. DESCRIPTIONS OF AVAILABLE INFORMATION RESOURCES – SIMILKAMEEN

The following Sections 3.2.1 to 3.2.11 provide brief summaries of the state of knowledge for the major aspects of water management in the Similkameen watershed. The available information for a number of key topics has been summarized in a series of Backgrounder Reports that are provided in **Appendix B**. The Backgrounder Report topics were specified in the Part 1 terms of reference issued by RDOS.

3.2.1. Streamflow (Water Quantity)

The detailed review of available information on water supply and demand in the Similkameen River watershed (located in **Appendix A**) summarizes the results of the information search that was completed to determine how much streamflow data and interpretive reports were in the public domain. Based on this review, it was determined that streamflow monitoring (hydrometric) in the Similkameen River watershed is above average for B.C. and the stations are well distributed. The following is a brief description of the available information:

- In total, 62 hydrometric monitoring stations have been operated historically by the Water Survey of Canada (WSC) within the Canadian portion of the Similkameen River watershed. However, only twelve (12) WSC hydrometric stations are currently active, with four of these recording streamflows on the mainstem of the Similkameen River. Two active stations are on the Tulameen River, and there is one operating on each of the Ashnola River, Ewart, Hedley, Keremeos, Pasayten, and Siwash Creeks. With the exception of Ewart Creek, the active stations have more than 35 years of data and four have more than 60 years of data.
- Four (4) of the active WSC hydrometric stations within the Similkameen River watershed are "real-time" stations, where water levels and flows can be viewed online. Two (2) of the stations are on the Tulameen River (WSC Station No. 08NL024 and 08NL071) and the other two (2) are located on the Similkameen River at Princeton and Hedley (WSC Station No. 08NL007 and 08NL038, respectively).
- The discontinued stations operated from less than a year up to more than 80 years. The discontinued stations that have more than 20 years of data and have enough data to support a number of hydrologic analyses.
- The active hydrometric station "Similkameen River near Nighthawk" (WSC Station No. 08NL022; United States Geological Survey (USGS) Station No. 12442500) represents the hydrometric station closest to the international border. This station is located approximately 15 km downstream from the international border and is jointly operated by the WSC and USGS.
- The active (and discontinued) hydrometric network is generally well equipped to monitor (and summarize) the spatial variation of streamflow and water supply throughout the watershed and on the Similkameen River. For water supply investigations, the four (4) active stations present on the Similkameen River and the eight (8) active stations present on major tributary creeks (within both wetter and drier climates) should provide adequate natural and regulated streamflow information.

The key report for readers interested in streamflow (water quantity) is a review of the hydrology of the Similkameen River by Obedkoff (1973), which includes a review of hydrometric stations, and peak and low flows throughout the watershed. In addition, a basin-scale water quality assessment completed by Swain (1985) provides a detailed summary of the streamflows (and locations of hydrometric stations) of selected sub-basins.

Dr. Adam Wei of the University of British Columbia-Okanagan is currently carrying out a four-year (2013-2017) study on the effect of climate and land cover changes on water resource sustainability in the Similkameen watershed. The research looks at the integrated effects of climate change and land use change (e.g. related to Mountain pine beetle) on watershed hydrology. Interim results will be available to inform the SWP.

3.2.2. Groundwater

The detailed review of available information on groundwater supply in the Similkameen River watershed (located in **Appendix A**) summarizes the results of the information search that was completed to determine how much groundwater data and interpretive reports were in the public domain. The following is a brief description of the available information.

- Eighteen aquifers have been mapped by MFLNRO within the Similkameen River watershed (Appendix A and Map 2). The largest aquifer in unconsolidated deposits is Aquifer 259 in the Similkameen River valley bottom extending from the international border to Princeton[3].
- The main valley Aquifer 259 is an unconfined Class IIA aquifer, which means it has moderate demand, high productivity, and high vulnerability to contamination. The classifications of the other aquifers are in Appendix A in Table 4-1.
- There are three active and four inactive MFLNRO observation wells in the Similkameen River watershed. The three active wells are located in Keremeos (#75) and near Cawston (#203 and Mount Kobau #264), while the inactive wells were located in Keremeos (#76 and #77) and near Princeton (#220 and #221).
- A review of the available well information indicated that there are 1,873 groundwater wells on record in the watershed. Approximately 40% of the registered wells are relatively shallow (less than 50 m deep) and about a third of the wells are more than 100 m deep. In addition, about a quarter of the wells on record have no yield data and those that do have yield data show wide variation.
- Most of the main water suppliers within the Similkameen River watershed hold surface water licences; however, based on available water use records, most water suppliers are currently using groundwater for supply.
- The Village of Keremeos and the Keremeos Irrigation District developed a joint groundwater protection plan, while Olalla and Princeton have begun developing their own protection plans. Collectively, these plan areas include a significant portion of the valley population that obtains its drinking water from groundwater.
- An assessment completed by Golder Associates Ltd. (2012) on the hydraulic connection between the Keremeos Irrigation District wells and the Similkameen River represents the only surface-groundwater interaction investigation that has been completed within the Similkameen River watershed.

[3] Note that MoE only delineates and classifies aquifers that have some level of groundwater well development. Other aquifers in the watershed may be capable of supporting further development but they have not been assessed.

The key reports for readers interested in groundwater are the groundwater protection plans for the Keremeos area developed by Golder Associates Ltd. (2004; 2005; 2006; 2008; 2009). The plans provide good information on the aquifers, the potential sources of contamination, and the recommended steps to reduce risk.

3.2.3. Lakes, Wetlands and Riparian Areas

Results of the information search have revealed limited data on lakes, wetlands and riparian areas, although there is adequate spatial information.

- Surface water covers approximately 1.7% of the landscape of the Okanagan-Similkameen (Areas A through H). Large lakes cover 1.3% (13,848 ha) of the landscape, small lakes cover 0.2% (2,559 ha) of the landscape, and rivers occupy approximately 0.2% (1,346 ha) of the landscape (Caslys, 2011).
- Most lakes are mesotrophic, however a 1986 report identified that Allison, Chain, Link and Osprey Lakes were sensitive to nutrient loading and were transitioning to eutrophic lakes due to the release of phosphorous from bottom sediments and shoreline development.
- In the Regional District of Okanagan-Similkameen, riparian and wetland ecosystems represent an area of 6.1% (14,634 ha) and 1.4% (3,366), respectively (of the total area that was mapped in Iverson and Haney 2008) and are both identified as sensitive ecosystems.
- A sensitive ecosystem inventory (SEI) including wetland and riparian habitats was completed within Area H (Rural Princeton) near the Chain Lakes, Otter Lakes, and East Gate area (Timberline 2009) as well as the South Similkameen.
- Wetland and riparian habitat modeling was completed for the entire RDOS in 2011 (Caslys)
- Wetland inventory mapping was completed in three Similkameen corridors - - Summerland to Princeton, Princeton to Keremeos and Keremeos to Okanagan Falls (Robins 2009).
- The LSIB and USIB are understood to have also carried out riparian habitat assessment and restoration activities on reserve lands.

There are no known documents that summarize the available information on the ecological status or limnological conditions of lakes within the Similkameen Valley.

Key information about wetlands and riparian habitats in the Similkameen Valley can be found in Schebel (2005), Robins (2009), Timberline (2009), and Caslys (2011). The Okanagan Valley Sensitive Ecosystem Inventory (Iverson and Haney 2008) and subsequent updates (2010, 2012) includes a good background on wetlands and riparian areas that may appeal to readers interested in this topic. Ecological assessments conducted by the Nature Conservancy (2006) and SOSCP (2012) also contain information on wetlands and riparian areas, although these reports cover a broad area that includes parts of the Similkameen.

3.2.4. Climate and Climate Change

The detailed review of available information on water supply and demand in the Similkameen River watershed (located in **Appendix A**) summarizes the results of the information search that was completed to determine how much climate and climate change data and interpretive reports were in the public domain. Based on this review, it was determined that a relatively good understanding of the climate throughout (and adjacent to) the Similkameen River watershed exists. In addition, recent climate change modeling by the University of Victoria's Pacific Climate Impacts Consortium (PCIC), the University of Washington's Climate Impacts Group, and Agriculture and Agri-Foods Canada is directly applicable to the Similkameen River watershed. The following is a brief description of the available information. A summary of what is known about predicted climate change in the Similkameen River watershed is provided in **Backgrounder #6**, which is included in **Appendix B**.

- A significant amount of climate data has been collected by various agencies in the Similkameen watershed and is available. In total, 112 active and discontinued meteorological stations from the following six agencies were identified: B.C. Ministry of Agriculture, Agriculture and Rural Development Act Network, Environment Canada, B.C. Ministry of Environment, MFLNRO, and B.C. Ministry of Transportation and Infrastructure. Overall there is relatively good characterization of the climate throughout the Similkameen River watershed with the current and discontinued climate monitoring network. This includes both geographically from west to east as well as with elevation, although there is considerable bias towards lower elevation locations where most development is concentrated.
- Environment Canada (EC) is the primary meteorological data collector, and they have collected information at 27 locations in the Similkameen River watershed. However, Environment Canada is actively collecting data only at five (5) locations currently within the watershed, which include: Jellicoe (Station No. 1123721), Princeton A (Station No. 1126510), Princeton CS (Station No. 112FN0M), Hedley N (Station No. 1123370), and Hedley NP Mine (Station No. 1123390). The EC monitoring network meets World Meteorological Organization standards for all of the parameters that are monitored, whereas data collected by others does not meet those standards for all parameters.
- The B.C. Ministry of Transportation and Infrastructure is actively collecting climate data at three (3) locations: Allison Pass (Station No. 15392), Red Bluffs (Station No. 24225), and Apex Roadside (Station No. 24126).
- B.C. Ministry of Agriculture and Lands, as part of the Farmwest program, is collecting climate data at two (2) locations: Cawston (Station No. SBC24) and Keremeos (Station No. SBC25).
- A total of eleven (11) snow survey stations have been operated by the B.C. River Forecast Center within the Similkameen River watershed; however, only six (6) remain in operation. In addition, one (1) active station is located in the U.S. portion of watershed (Harts Pass), operated by the Northwest River Forecast Center.

- As part of the development of the Agriculture Water Demand Model for the Similkameen watershed (van der Gulik *et al.* 2012), the B.C. Ministry of Agriculture, along with Agriculture and Agri-Food Canada, have developed spatial datasets to represent the climate of the Similkameen River watershed at a 500 m grid resolution. A GIS climate dataset (for 1961-2003 for each grid cell) is currently available and includes information on air temperature, total precipitation, and calculated evapotranspiration for the entire Similkameen River watershed. Future datasets are also available for various time periods and under different emission scenarios.
- Recent work by PCIC and the University of Washington's Climate Impacts Group is directly applicable to the Similkameen River watershed. PCIC has developed the 'Plan2Adapt' tool, which provides estimates of future primary climate variables such as temperature and precipitation, as well as more complex parameters derived from these primary variables, for specified geographic areas, including the Similkameen River watershed. Additionally, the University of Washington has also recently completed a major study of climate change in the Columbia River Basin, which includes the Similkameen River watershed.
- Based on the available climate change information and studies, the Similkameen region is predicted to warm, and annual precipitation is predicted to increase. However, late fall, winter and early spring flows are forecast to be greater, while late spring, summer, and early fall flows will be smaller.

A key report on climate and climate change is the final report of the University of Washington's Columbia Basin Climate Change Scenarios Project by Hamlet *et al.* (2010), which provides an excellent summary of climate and projected changes for the 21st century. In addition, a report completed for the International Joint Commission (IJC) by Summit (2011b), includes a detailed literature review (and summary) of past and future climate and hydrologic changes in the Okanagan and Similkameen River watersheds. Finally, Neilsen *et al.* (2010) provides a detailed summary on the development and verification of gridded climate datasets for the Okanagan Basin; whose techniques were applied in the development of climate datasets for the Similkameen River watershed.

3.2.5. Water Quality – Similkameen River and Other Streams

The Similkameen Scoping Report (Summit 2011a) summarized the results of the information search that was completed to determine how much surface water quality data and interpretive reports were in the public domain. The updated information search for this report did not locate a significant amount of additional or new information. Following is a brief description of the available information. A summary of what is known about water quality is provided in **Backgrounder #4**, which is included in **Appendix B**.

- The results of the search of the EMS data base indicated that there were 22 sites in the watershed with adequate water quality data to characterize conditions at those sites, although at a number of those sites no data had been collected for about a decade.
- Included in the list of surface water quality sites are **two long-term water quality monitoring sites** – one at Princeton (#BC08NL0001) and one located 10.5 km north of the Canada-US border (#BC08NL0005) at Chopaka Bridge; that are part of the British Columbia-Canada Water Quality Monitoring Agreement program. Both sites have more than 40 years of data, which is very valuable for assessing trends and temporal variability.
- The other water quality sites with relatively large data sets are located near the now closed Nickel Plate Mine (Hedley Creek), the Princeton wastewater lagoon, Keremeos wastewater treatment plant, and the Copper Mountain mine (all on the Similkameen River). These locations include at least one "upstream" and one "downstream" sampling site to monitor effects of specific discharges to those streams. The Hedley Creek data set is large, with about 5,000 sampling points.
- The Canada-BC program periodically reviews the data that has been collected and prepares a water quality assessment. This was last done in 2007 based on the 1979-2006 data at the US Border (Swain 2007a) and 1984-2006 at the Princeton site (Swain 2007b). The monitoring results are compared to the Water Quality Objectives (WQO) that were set for the Similkameen River (Swain 1990; MOE 1990) and to the B.C. generic water quality guidelines. Some water quality parameters in these reports have been collected on shorter time periods.
- In addition to the assessment reports, Environment Canada periodically calculates a Water Quality Index value for all the Canada-BC sites. This was last done in 2007 using 2000-2004 data (Environment Canada et al. 2007). Water quality at both sites was rated as "good", the same as the previous assessment in 2000 (the possible ratings are poor, marginal, fair, good, and excellent). No significant trends were noted.
- American government agencies have also assessed Similkameen River water quality. To meet their obligations under the *Clean Water Act,* the responsible agencies assessed the loads of arsenic in the section of river that is south of the border (Washington DOE and EPA 2004.
- The Copper Mountain Mine began its aquatics monitoring in 2012 with the following components: a benthic community survey, fish health and population assessments, fish habitat assessments and sediment quality assessments (Hatfield Consultants 2013). Reports on the monitoring results will be available in the future since they are part of the mine's operating conditions.
- Environment Canada (contact: Stephanie.Strachan@ec.gc.ca) samples benthic invertebrates at a number of sites in the Similkameen Valley using the Canadian Aquatic Bio-monitoring Network (CABIN) protocol.

The key reports for readers interested in surface water quality are the most recent Canada-BC reports are Swain (2007a, 2007b). Arsenic is a contaminant of concern in the Similkameen River,

and the Washington State Department of Ecology has evaluated the influence of arsenic in the Similkameen River (Johnson 2002) and in fish tissue (Era-Miller 2007).

3.2.6. Fish, Fish Habitat and Instream Flow Needs

There are many existing records that pertain to fish and fish habitat in the Similkameen that include general correspondence, fish permits, fish and fish habitat investigations, technical and overview reports. Collectively, these documents provide an important source of information on fish and fish habitat. Information regarding fish and fish habitat has been summarized in **Backgrounder #5**, which is included in **Appendix B**.

- The BC Ministry of Water, Land and Air Protection completed fisheries assessment and management plans on 10 lakes in the Similkameen Valley between 2000 and 2005 (Boss Lake, Cliff Lake, Davis Lake, Harvey Hall Lake, Osprey Lake, Prosser Lake, Rick Lake, Silver Lake, Spukune Lake, Thalia Lake) and commissioned 6 fisheries assessments between 2001 and 2003 on Allison Lake, Barton (Hart) Lake, Borgeson Lake, Deadman Lake, Rampart Lake, and Nickel Lake.
- Detailed fish and fish habitat information is available Allison, Hays, Hedley, Cahill, Keremeos, Winter, Susap and Shingle Creeks as well as various parts of the Tulameen, Ashnola and Similkameen River, beginning in the early 1980s.
- In 2000, the Similkameen River Planning Committee commissioned a large literature review and study to provide an up-to-date inventory on fish and fish habitat in the Similkameen watershed (Glenfir Resources 2000; Wildstone Engineering 2001).
- A fisheries assessment of protection focus areas, restoration needs, and impacts (agriculture, urban, temperature, flows) to upper and lower watersheds was conducted for the entire watershed in 2003 (Matthews and Bull 2003).

For the most up-to-date summary information on fish and fish habitat in the Similkameen Valley, readers should referrer to Rae (2005). The literature review completed by Glenfir Resources (2000) provides a detailed and comprehensive review of fisheries data. Wildstone Engineering (2001) provides good background information on fisheries as well as a reconnaissance level survey of fish habitats and remediation recommendations. Readers interested in fish and fish habitat within the entire Okanagan Region (including the Similkameen) can refer to Mathews and Bull (2003).

3.2.7. Species and Ecosystems at Risk (Aquatic, Wetland & Riparian)

There is a reasonable amount of information regarding the evaluation of important habitats to species at risk, habitat inventory and ecosystem mapping, and species at risk profiles for the South Okanagan and Lower Similkameen valleys. In addition, there is detailed sensitive ecosystem inventory information available for three areas within Area H (Rural Princeton).

- A compilation of species at risk in the Princeton area revealed that there are four at-risk species of fish (Chiselmouth, Umatilla Drave, Mountain Sucker, Mountain Sucker and Columbia Sculpin), four at-risk amphibians (Northern Leopard Frog, Western Toad, Great Basin Spadefoot and Tiger Salamander), and one at-risk reptile (Painted Turtle) that rely on lakes, wetland, and riparian areas. Many at-risk invertebrates, plants and birds that depend on wetland and riparian areas were also identified in the Princeton Area (Timberline 2009).
- The BC Species and Ecosystems Explorer and Species at Risk & Local Government websites can be used to generate up to date lists of known and potential species and ecological communities at risk occurrences.
- Wetlands within the entire Okanagan Valley (including the south Similkameen) have four red-listed and five blue-listed ecological communities. There are 11 red-listed and 10 blue-listed plants species, of which the Mexican Mosquito Fern is listed as Threatened, the Giant Horsebane as Special Concern, and the Rusty Cord-Moss as Endangered. There are 22 at-risk wildlife commonly found in wetland habitats, of which six are red-listed, 17 are blue-listed (Western Toad is listed as a species of Special Concern, but not listed provincially). Six of these are federally listed as Special Concern (2), Threatened (2), and Endangered (2) (Iverson and Haney 2008).
- Riparian areas within the Okanagan Valley (including the south Similkameen) include 11 at-risk ecological communities (seven are red-listed and three are blue-listed). There are 41 listed at-risk species of riparian plants in the Okanagan Valley; 27 are red-listed, 14 are blue-listed, and seven have been given a federal status. Riparian areas also have much at-risk wildlife, seven are red-listed, 16 are blue-listed, one is yellow-listed, and of these, 12 are federally recognized as at-risk (Iverson and Haney 2008).
- A habitat atlas was generated for the South Okanagan and Lower Similkameen in 1998 that extended from Naramata and Summerland south to the US border and east to Keremeos. Wildlife at risk for wetland and riparian habitats included both red-listed (Tiger Salamander, Sandhill Crane, Yellow-breasted Chat, Western Screech-Owl, Western Red Bat) and blue-listed (Great Basin Spadefoot Toad, Painted Turtle, American Bittern, Great Blue Heron, and Bobolink) species.

Further information about at-risk ecological communities, plants, and wildlife of riparian and wetland ecosystems can be found in the Sensitive Ecosystem Inventory (Iverson and Haney 2008) and subsequent updates (2010 and 2012). However, the listed at-risk ecological communities, plants, and wildlife in this report are for the entire Okanagan Valley and are not specific to the Similkameen Valley watershed. Key SEI and species-at risk information for areas surrounding Otter Lake, Chain Lake, and East Gate Lake near Princeton can be found in Timberline (2009). The South Okanagan Habitat Atlas also provides key information on species-at-risk in the South Okanagan Lower Similkameen Area (MELP 1998).

3.2.8. Water Supply and Demand

The detailed review of available information on water supply and demand in the Similkameen River watershed (located in **Appendix A**) summarizes the results of the information search that was completed to determine how much water supply and demand data and interpretive reports were in the public domain. The following is a brief description of the available information. A summary of what is known about water supply and demand is provided in **Backgrounder #3**, which is included in **Appendix B**.

- A total of 831 current licences (at 690 points-of-diversion) have been issued on streams, springs, and lakes within the Canadian portion of the Similkameen River watershed. Licences have been issued for off-stream uses, including: domestic, irrigation, waterworks, stockwatering, enterprise, mining, and processing purposes, as well as for storage, power, and conservation purposes.
- Storage licences are generally used to support irrigation and waterworks requirements and of note is that only 6.6% of the total licensed off-stream volume in the Similkameen River watershed is supported by storage.
- There are no major dams along the Canadian portion of the Similkameen River; however, the Enloe Dam is located on the Similkameen River downstream of the international border (near Nighthawk, WA), but it ceased operations in 1958. A search of the provincial dam database found that there are 45 dams (earthfill and concrete) on record in the watershed. Of these, 25 are classified as a “regulated” dam.
- Most of the main water suppliers within the Similkameen River watershed hold surface water licences; however, based on available water use records, most water suppliers are currently using groundwater for supply.
- Outside of water use information provided by water suppliers, the Agricultural Water Demand Model developed by the B.C. Ministry of Agriculture and Agriculture and Agri-Foods Canada provides estimates of agriculture (including both crop irrigation and livestock watering) water demands (by surface and groundwater) on a property by property or watershed basis for the Canadian portion of Similkameen River watershed.

For the most up-to-date summary information on water supply and demand, readers are referred to Appendix A for a summary of each water supplier, their distribution area and infrastructure, and actual water use records. In addition, van der Gulik *et al.* (2012) provides a summary of the Agriculture Water Demand Model that was created for the Similkameen River watershed and estimates of irrigation and livestock water demands throughout the watershed. Swain (1985) provides a detailed summary of water supply and use (although dated) within selected sub-basins of the watershed and the Ministry of Environment (1986) identifies sustainable water supply and demand objectives for strategic planning purposes within the watershed.

3.2.9. Water Planning and Governance

Resources for watershed planning can tend to overlap with governance resources as jurisdiction varies between levels of government and a variety of legislative mechanisms allow different types of planning.

Watershed planning documents include general British Columbia, local government and First Nations guides as well as primers and toolkits relating to conservation, rainwater, groundwater, and soils management. Examples of watershed plans from other jurisdictions are also included for reference. A few Similkameen planning documents related to groundwater and agriculture water demand provide background information for particular water issues.

Many of the governance documents are focussed on water reform as BC is currently undergoing a process to modernise the *Water Act,* a key piece of provincial legislation. The 2011 Fraser Basin Council *Rethinking Our Water Ways* guide provides helpful overviews of jurisdictional roles and types of water and watershed plans. Although not technically governance documents or guides, the *First Nations Water Rights In BC* documents document the history of water rights, and with that, governance of water in relation to First Nations, provincial and federal governments.

3.2.10. Land Use and Economic Development Planning

3.2.10.1. Land Use

Land use planning managed by multiple levels of government. The RDOS and the communities of Keremeos and Princeton primarily address private land. The provincial government generally addresses crown land management. The Upper and Lower Similkameen Indian Bands and Aboriginal Affairs and Northern Development Canada address First Nations lands, while the Okanagan Nation Alliance works on many issues at the territorial scale.

The Official Community Plans and Zoning Bylaws for RDOS Electoral Areas ‘H’ and ‘G’ and Princeton have been included in the data base. The draft Official Community Plans or supporting documents for RDOS Electoral Area ‘B’ and Keremeos are also included. Generally these documents guide development in relation to watercourses for flood hazards and riparian protection. Along with subdivision servicing bylaws, they also provide guidance on potable water and sewage disposal requirements. Other documents related to amenity migration and sustainability, which were generated by the Similkameen Valley Planning Society, are included in the database.

Provincial strategic land use planning has been done in the southern portion of the watershed as part of the Okanagan-Shuswap Land and Resource Management Plan (BC Government 2001). Similar planning has not been completed in the rest of the watershed.

Range Use and Range Stewardship Plans are developed for crown grazing and hay cutting and include protection of water resources. Range plans were generally not available for open access. There are no tree farm licences in the watershed. However, plans or statements have been developed for nine provincial parks plans, two protected areas and one ecological reserve.

Additional planning documents are related to biodiversity conservation throughout the watershed and the assessment of the potential national park reserve in the South Okanagan and Lower Similkameen.

Documents regarding the national park reserve are both First Nations and federal, and relate to non-band lands. The ONA has several internal documents providing perspectives and values as well as a vision and guide for resource management and development planning. The Upper and Lower Similkameen Indian Bands manage land use planning on their reserves.

3.2.10.2. Economic Development

Joint economic development work is primarily coordinated through the Similkameen Valley Planning Society. The 2012 Tourism Plan is included in the data base and additional tourism branding information is on Thompson Okanagan Tourism Association website http://www.totabc.org/corporateSite/community-info739/476-similkameen-valley

The feasibility study for the national park reserve has also considered the potential positive and negative economic impacts of the establishment of a national park reserve.

3.2.11. Emergency Response – Flood and Drought

The Similkameen Scoping Report (Summit 2011a) summarized the results of the information search that was completed to review flood and drought management strategies within the Similkameen River watershed. The updated information search for this report did not locate a significant amount of additional or new information. The following is a brief description of the available information.

- The Ministry of Environment (1986) reports that seventeen (17) floodplain mapping sheets covering the area from Princeton to the international border were completed in 1973. Note that these mapping sheets were not located for this study.
- More recent floodplain mapping by the Ministry of Environment was completed on portions of the Similkameen and Tulameen Rivers. The existing floodplain mapping includes the Similkameen River in the Keremeos – Cawston area and in the area near Princeton and the Tulameen River in the Tulameen area and in the area near Princeton. Note that the

Similkameen River mapping was completed in 1995 and portions of the Tulameen River mapping were completed in 1987. The available floodplain mapping includes estimates of the river elevations (including freeboard) and areas that can be expected to flood under a 1-in-20-year and 1-in-200-year peak flow return period.

- Dykes have been constructed along the Similkameen River in the Keremeos-Cawston area to provide a measure of flood protection for the town site (RDOS 2011). In addition, diking is also present along portions of the Tulameen River near Coalmont and Princeton, along portions of the Similkameen River near Princeton and upstream of the international border, and on a small section of the Ashnola River alluvial fan.
- There has been high-level drought management planning for the B.C. Southern Interior, but a watershed-specific drought management plan is not in place for the Similkameen Valley.
- The Keremeos Irrigation District developed a specific drought management plan for their distribution area, which includes water restrictions and conservation measures during periods of low flows. Similarly, the Town of Princeton implements staged water use restrictions (Bylaw No. 834) under varying levels of drought.
- As outlined by the International Joint Commission (IJC) (2013), calculated or forecasted volumes of flow within the Similkameen River at Nighthawk, WA (WSC Station No. 08NL022; USGS Station No. 12442500), between the period April to July, is one of three criteria utilized for the declaration of drought conditions for the management of Osoyoos Lake. If the calculated or forecasted volume of flow in the Similkameen River is less than approximately 1,233,500 ML (or 1.0 million acre-feet), drought conditions are declared by the IJC for Osoyoos Lake.

The key reports for readers interested in flood management are all of the floodplain mapping sheets available online from the Ministry of Environment, in addition to the floodplain mapping design brief by Hay & Company Consultants Inc. (1995) that outlines the development of the floodplain mapping sheets for the mapped portions of the Similkameen, Tulameen, and Ashnola Rivers. For information on drought planning measures in B.C., refer to Econnics (2010).

3.3. RELEVANT INFORMATION FROM OTHER WATERSHEDS

3.3.1. Approaches used in other Watershed Plans in B.C.

The SWP Scoping Study included a discussion of the watershed planning processes used at other locations in B.C., Alberta, Ontario, and Washington State (Summit 2011a). A number of the key technical studies and planning report that are relevant to the issues and process in the Similkameen watershed have been included in SWID as background information[4].

[4] Public access to the information database created for the Okanagan Water Supply and Demand Study is through the Okanagan Water Supply and Demand Viewer at: fttp://www.okanaganwater.ca

3.3.2. International Waters and Treaty Obligations

A variety of documents have been identified that deal with international waters and treaties. However few documents have direct application to the Similkameen River. The International Osoyoos Lake Board of Control, Order of Approval under the International Boundary Waters Treaty, International Joint Commission, primarily manages Osoyoos Lake but considers the Similkameen River as part of Osoyoos Lake management. Another document *Agreements and Aftermaths: The British Columbia-Washington State Boundary* (Hallauer 1979) identifies that the establishment of the Columbia River Treaty did not lead to the settlement of other water issues and elaborates on Similkameen River flood control as one example.

Additional documents related to trans-boundary management of water in the Columbia and Similkameen are included as are the Columbia River Treaty, the Pacific Salmon Treaty, *and International Rivers Improvement Act*. Other documents regarding Enloe Dam on the Similkameen River in the United States have also been incorporated, as some proposals for redevelopment have had the potential to create a reservoir into Canada.

3.3.3. Examples of First Nation Participation Protocols

This section is not attempting to address the legal complexities and governance roles of First Nations and local governments. Instead it covers examples of agreements and organisations that address water management primarily with First Nations and local governments. It also provides resources to support building relations between the two levels of government. While it is important to be aware of the differences and similarities with the governments and the legal contexts in which they are working, often the key to moving forward is building effective relationships on common interests. The RDOS is encouraged to seek opportunities to gain an understanding of local First Nations' relationships with water including cultural, spiritual, economic, stewardship, governance and rights-based aspects.

Although it is under review by the provincial government and the Mining Association of BC, the Collaborative Watershed Governance Accord has the support of the Union of BC Municipalities, First Nations Summit, Union of BC Indian Chiefs, and the BC Assembly of First Nations. The principles in this accord could act as a starting point for building an agreement. Furthermore, the Okanagan Nation Alliance, and the eight member communities it represents, is in the process of developing a Syilx Water Strategy, and this may be a timely opportunity for further relations building.

3.3.3.1. Existing Agreements

There are a variety of local government and First Nations agreements on managing water and watersheds which may be useful to developing agreements in the Similkameen. These agreements are described below and the supporting documents are in the database.

Capital Regional District, the T'sou-ke Nation

- Signatories include: Capital Regional District, the T'sou-ke Nation, federal and provincial governments
- Agreement is related to increasing the reservoir side on Sooke River and diversion of Leech River
- Addresses needs for fish flows, and a commitment to work towards a Water Management Plan
- Identifies funding commitments and support

Cowichan Valley Regional District (CVRD) and the Cowichan Tribes

- Cowichan Basin Water Management Plan (Westland Resources Group 2007) partners - CVRD, Fisheries and Oceans Canada, Ministry of Environment, Catalyst Paper Corporation, Cowichan Tribes, and the Pacific Salmon Commission
- Cowichan Water Board members, CVRD, Cowichan Tribes, Fisheries and Oceans Canada and Ministry of Environment – joint announcement from CVRD and Cowichan Tribes (2010)
- Cowichan Watershed Technical Advisory Committee – supports the Board

Sunshine Coast Regional District and Sechelt Indian Band

- Watershed Accord related to the provision of potable water
- Shared responsibility and decision making for management of the watershed

District of North Saanich and Tseycum First Nations

- Description of how the relationship developed over time both formally and informally
- Use of the medicine wheel as a conceptual framework
- Outcomes including: collaboration to restore Tseycum Creek, co-management and support

Okanagan Basin Water Board

- Legislated in 1970 as a regional water governance body for the Okanagan watershed
- Established with regional districts within the watershed
- Representation later expanded to include the Okanagan Nation Alliance
- Okanagan Water Stewardship Council (OWSC) 2006 provides technical advice
- Okanagan Sustainable Water Strategy 2008 developed by the OWSC

Canadian Okanagan Basin Technical Working Group

- Okanagan Nation Alliance, federal and provincial governments (no local governments)
- Work relates to enhancement and restoration of fish stocks and associated habitat in the Okanagan River basin within Canada
- Works on technical issues that addresses or supports management

Some of the key aspects of these agreements are:

- recognition of mutual goals and benefits of working together
- recognition of governance, cultural and operational differences for each organisation
- separation of political /governance and technical roles
- co-development agreements and work plans with clear scopes
- collaborative funding support for each member organisation, joint and individual proposals

3.3.3.2. Guidance Documents

Although guiding documents about building relations between First Nations and local government are often focused on land claims and self-government, many of the concepts apply to other situations. Several of documents have been included in the database for further reading and support for staff and elected officials seeking to build relations, notably those by Lower Mainland Treaty Advisory Committee (2006), Tamera Services Ltd. (2002), and Wells (2004). Other documents that provide insight into first Nations involvement in watershed management and planning include reports by Fraser Basin Council (2011) and Centre for Indigenous Environmental Resources (2011).

The RDOS is also encouraged to explore database documents with recommendations and success stories from other related sectors including natural resource management, parks management, fisheries and environmental impact assessments.

4 Information Gaps and Priorities

4.1. WATER MANAGEMENT OBJECTIVES AND RELATED INFORMATION NEEDS

As outlined in the SWP Terms of Reference and described in the introduction, the SWP will take an integrative, holistic approach that links water quality, water quantity, wetlands, riparian habitat, and biodiversity with the economic and social priorities for the watershed. The SWP will also facilitate collaborative water management and make water conservation a permanent ethic. The major water management issues that were identified during the development of the SWP TOR include balancing water supply and water use, effects of future climate change on achieving that balance, the role of water on land use and economic development, and protection of the ecological functions that rely on water.

The following Sections 4.2 through 4.4 describe the existing information gaps that may constrain future water management decision making. A number of these gaps were first identified in the Scoping Study (Summit 2011a) and were carried over, if the information review for this report determined that those information needs still remained. Of the identified gaps, only a few are likely to limit development of the first version of the SWP. Therefore, Section 4.5 ranks the information gaps, and provides recommendations on which gaps should be addressed in the short term to facilitate SWP completion.

4.2. SCIENCE AND ENGINEERING INFORMATION NEEDS

4.2.1. Surface Flow, Water Supply, and Water Demand

WSD-1 – Set Planning Scenarios for Population, Economic Development and Climate

Further Development of the Similkameen Watershed Plan requires the definition by the SAC and TAC of a limited number of reasonable future planning scenarios on which to base the estimates of future water demand. These scenarios would include some combination of population change, economic growth, and the adoption (or not) of water conservation technologies. Definition of the scenarios can build on previous work by the SVPS (Glorioso et al. 2010) and official community planning by RDOS and member municipalities, as well as the available population projections published each year by BC Stats. As described in Section 2.1, the total watershed population is projected to have declined in 2036 compared to 2012. Those predictions could serve as the “base case”, but other scenarios that consider the potential for growth should be developed, so that water demand predictions can be made that are prudent yet based on realistic estimates of population.

The steps in this task would include:

- Preparation of a short briefing document for the SAC and TAC outlining the most recent population and climate change projections, as well as known or reasonably foreseen

economic developments. The document would also summarize the planning scenarios used in other watershed plans in B.C.
- A facilitated half-day workshop to review the population, climate, and economic projections and to set the planning scenarios.

With respect to climate change, the climate projections that have been developed by Agriculture and Agri-Foods Canada for the watershed should form the basis of future irrigation and other water demands in the watershed.

Section 4.4 includes a task that would see the completion of more detailed economic projections for a number of key business sections (SE-1). That task, when complete, would be used to refine the projections for changes in water demand from task WSD-1.

WSD-2 – Assessment of Water Availability and Risk of Inadequate Supply

A detailed summary of what is known about stream flows, water licencing, water use, and dam storage in the Similkameen watershed is provided in Appendix A. The major data gaps that should be addressed to help move the SWP forward are:

- Development of estimates of the natural ("naturalized") flow in the Similkameen River watershed at the outflow locations of the 10 sub-basins. This would involve an accounting of the current surface water withdrawals to determine what the flow would be in a natural state if no surface extractions were taking place, and is therefore the baseline against which to consider demands on water (including in-stream flow needs for fish). Naturalized estimates would be calculated for the current normal (30-year average), median, and 1-in-10 year and 1-in 50-year return period low flows, and well as for the projected (e.g. 2050) flows under climate change (see Appendix A).
- Check the Ministry of Agriculture's Agricultural Water Demand Model against the records of actual use obtained for the Phase 1 study, beginning with the larger individual irrigation licenses as well as a representative sample of smaller licenses. Work with the Ministry to adjust the model, as necessary.
- Use the Agricultural Water Demand Model to predict future agricultural demand for a number of scenarios that incorporate climate change predictions, changes in agricultural land use (e.g. increases wine grape production), and changes in water conservation technology. The future planning scenarios should be developed by the TAC and SAC.
- Since the type and magnitude of future economic development in the Similkameen watershed is unknown, there would be planning value in determining the typical water demand for a number of potential development activities (e.g. an 18-hole golf course, a 50-unit retirement community, and a new mine comparable to the former Nickel Plate mine).

These four tasks would be completed together as a project. They are necessary to complete the instream flow needs study (Section 4.2.4) and are therefore a high priority for completion in the near-term (Section 4.5).

WSD-3 – Review Storage Option and Preliminary Feasibility Assessment

In the past a number of private companies and public agencies have examined options for creating and managing storage in the Canadian portion of the Similkameen River watershed[5]. Most recently, FortisBC assessed the feasibility of a hydro-electric generation facility on the Similkameen River and holds a storage water licence for 300,000 acre-feet, and has initiated studies to support a potential future application for project approval under the B.C. *Environmental Assessment Act* and, if applicable, the *Canadian Environmental Assessment Act* 2012. As of the end of 2013 Fortis had not formally initiated the environmental assessment process with the agencies responsible for these acts[6]. There are several other storage licences in the watershed, but they are comparatively small (Appendix A).

Although assessments of storage options and potential benefits for downstream water users may have been assessed in the past, an overview-level update would be of benefit since previous studies would not have been aware of current climate change forecasts and would not have considered recent legislation like the *Fish Protection Act* and forthcoming *Water Sustainability Act*. The assessment would not need to address the FortisBC project since the proponent will be responsible for assessing its implications for fish and all water users as part of the required environmental impact assessment (EIA).

The general steps in an overview-level storage assessment would include:

- Review previous studies for proposed locations of new or expanded reservoirs and evidence of supporting hydrologic analyses. Map existing and proposed dam and reservoir locations;
- Consult with watershed stakeholders to obtain their ideas on potential storage locations;
- Using GIS, map the previously proposed sites and identify other potential sites based on the catchment area and topographic suitability (i.e. where a dam could be built to take advantage of the natural terrain and create adequate storage).
- Do a preliminary hydrologic analysis for each one to confirm water availability to fill the storage;
- Complete field assessments to examine likely infrastructure needs (e.g. volumes of concrete for building dams, potential geotechnical and safety concerns, environmental constraints, and access)
- For the sites that show some potential, complete preliminary estimates of construction cost; and

[5]The Shanker's Bend project in the US would create storage, but only the high dam option would have potential to meet any water needs in Canada.

[6] The BCEAA registry is at http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_home.html

- Rank the opportunities against the constraints and costs.

The results of this overview assessment would be used by the TAC, SAC and regulators to determine if more detailed assessments of the highest-ranked options are worth completing. This review should consider Fortis' plans for hydro-electric development, since the potential storage from such a facility would likely overshadow the effects on the timing of flows from the smaller storage opportunities that are identified.

WSD-4 – Additions to the Water Quantity Monitoring Network

As outlined in Appendix A, the active hydrometric monitoring network in the watershed is relatively strong and there is a solid database of discontinued stations that can be used to address specific management questions. However, depending on the issues that emerge from the next phase of SWP development, the current monitoring system could be augmented at a number of key locations (Appendix A). Estimates of flows at other ungauged locations may also be of value.

- Re-activate the former hydrometric station on the Similkameen River at Keremeos (WSC no. 08NL022). Data obtained at this site would support groundwater-surface water interaction studies and allow an assessment of changes since the station was operational.
- Establish a station at the Canada-US border to document cross-border flows. Both countries use data from the station in the US at Nighthawk, but there is little information on water extraction between the border and the Nighthawk station.
- Develop estimates of flows in Allison and Hayes Creeks, using existing local and regional data.

Appendix A provides a number of other suggestions for adding to the information base on water supply and demand that can likely be delayed until the initial SWP is complete, although the priority may change depending on the management issues that emerge from the community during plan development.

4.2.2. Groundwater

GW-1 – Review and Update of Aquifer Mapping

To date, 18 aquifers have been mapped by MOE in the Similkameen watershed (Section 3.2.2). The largest, Aquifer 259, is the deposit of sands and gravels in the main Similkameen River valley bottom extending from the US border to Princeton. It is rated as a Class IIA aquifer meaning that aquifer demand is moderate relative to productivity, but that it is highly vulnerable to contamination from surface contamination. The characteristics of the other mapped aquifers are provided in Appendix A.

The current MOE aquifer mapping was based on priorities for management; and other aquifers exist in the watershed beyond the two that are currently mapped. In addition, the physical

characteristics of Aquifer 259 exhibit considerable spatial variation, based on the well records, and it could be sub-divided into a number of smaller management units based on physical properties and demand. This would be accomplished through a review of available geological maps, aerial photographs, and well logs; discussions with well owners; and field reconnaissance. It would be best done in parallel with the first phase of the groundwater-surface water study (GW-2), which is described next. The review should also consider the potential for confined aquifers to exist in the valley, located beneath the unconfined surface aquifer (259). It should also assess the possible presence of unmapped bedrock aquifers based on the locations of well logs.

GW-2 – Groundwater – Surface Water Interaction

The known water wells in the watershed are heavily concentrated near the Similkameen River and other surface water bodies. Aquifer 259, as mapped by MOE, runs in a narrow band along the Similkameen River and is comprised of unconsolidated sediments deposited in post-glacial times. The concentration of wells in that aquifer, although considered to exert only moderate demand, has raised the question as to whether or not groundwater pumping reduces the flow in the Similkameen River either by intercepting groundwater recharge that would normally reach the river or by pulling river water into the aquifer. Furthermore, the water supply inventory completed for this report (Appendix A) has shown that most of the water suppliers in the watershed now obtain most of their water from groundwater wells in or near the valley bottom. The existing MOE observation wells are located within or near communities, so there are large sections of river without groundwater level data from which to draw inferences about groundwater-surface water interaction. Previous assessments of groundwater-surface water interaction are limited to the Keremeos area.

Ultimately, characterization of groundwater-surface water interaction may require installation of new wells, pumping tests and other investigations, and numerical modelling. As a first phase, before moving directly to installing additional observation wells, the existing hydrometric, water use, and groundwater data should be analyzed for evidence of groundwater withdrawal effects on streamflows. If the evidence points in this direction, then a groundwater study can be designed to assess surface water-groundwater interaction in more detail.

The initial assessment using existing data will include:

- Compiling the hydrometric data from several key locations along the river, and if necessary, standardizing the data to a common time period to eliminate variability due to the El Nino cycle and the Pacific Decadal Oscillation (PDO);
- Computing the runoff (i.e. discharge per unit area) at each of the key locations on a monthly basis, both for specific years and for an average year;
- Analyzing downstream changes in runoff along the river to identify any anomalies, and compare to the locations of known wells including the community wells;

- Plotting the existing observation well groundwater level data against the WSC water level data from the nearest stations to see if there is any apparent linkage, and to determine the nature of the linkage (e.g. inflowing, out-flowing, or varying throughout the year);
- Investigating the possible use of shallow groundwater in any areas where runoff results seem anomalous; to confirm the potential for a groundwater withdrawal effect on surface water; and
- Review the available water quality data (from the river and adjacent wells) to confirm the potential for a surface/groundwater linkage.

Based on the outcome of the first phase, the next step could involve the design of one or more site-specific studies in locations where the data suggests the potential for a surface/groundwater interaction that could be significantly reducing surface flow. The study design could likely make use of existing groundwater wells in data, but additional wells may be needed.

GW-3 Reconnaissance-level Groundwater Quality Inventory

Compared to surface water quality, there is relatively little information on groundwater quality in the public domain. The available data should be acquired and summarized. MOE's Ambient Ground Water Monitoring Network (AGWMN) is a starting point (access is available through the Penticton MOE office). In recent years, a number of local communities have undertaken groundwater protection planning and will have compiled some groundwater quality data. In addition, the USIB and LSIB have been investigating additional groundwater sources for domestic use and would have completed potability testing. RDOS may also have potability data from groundwater assessments done to support applications for subdivision. The information review should be supplemented with a sampling program aimed at filling in spatial gaps and assessing any areas with previously identified contamination concerns.

4.2.3. Water Quality

WQ-1 – Status & Trends Analyses of Existing Water Quality Data.

Water quality monitoring is on-going (every two weeks) at the two Canada-BC long-term monitoring stations on the main stem of the Similkameen River. However, summary reports were last completed in 2007 using data from up to 2006, focussing primarily on how the data compared to water quality guidelines. Since then, the Copper Mountain mine has re-opened and there have been several years with relatively low summer flows when the concentrations of some metals may be elevated because of limited dilution. We recommend that an analysis of the available water quality data from the two Canada-BC stations be completed and a new summary report be prepared to provide stakeholders with a current understanding of water quality status and trends. The analyses should include:

- Calculation of descriptive statistics;

- Comparison of the results to water quality guidelines and determination of the frequency of guideline exceedances. The applicable guidelines are those for aquatic life protection, drinking water, recreation, and irrigation.
- Assessment for trends (i.e. statistically significant changes over time), including seasonal trends. To assess the potential influences of climate change, the trend analyses should consider whether there have been changes in the past 10-15 years when effects of climate change are possible.
- Assessment of the relationships between river flow and water quality, and an assessment of variations in dissolved and total metals, including the role of total suspended sediment concentrations on total metal concentrations.

In addition, the data that are available from sites other than the two Canada-BC sites should be compiled and summarized, and compared to the Canada-BC data. The report should also summarize the water quality and aquatic ecosystem information that has been collected in recent years by industrial operators in the valley.

WQ-2 – Reconnaissance Survey of Water Quality in Selected Tributaries and Lakes

As discussed in Section 3.2.5, there is currently good understanding of water quality in the Similkameen River mainstem. There are also good historical water quality data sets from monitoring related to mining operations near Princeton (Similkameen River) and the former Nickel Plate Mine (Hedley Creek and Similkameen River); and from the wastewater treatment facilities at Keremeos and Princeton (Similkameen River). However, less is known about water quality in tributaries (other than Hedley Creek and, to a lesser extent, the Tulameen River) and in lakes. Some lake inventory work was completed in the 1980s, but an update would be of value to assess the current status of the lakes.

For the **tributary streams**, the information gap would be addressed by conducting a reconnaissance-level water and sediment quality monitoring program to characterize current conditions in the major tributaries where mining or other major developments could occur. Streams of interest include Pasayten, Tulameen and Ashnola Rivers and Otter, Siwash, Wolfe, and Keremeos Creeks because they were listed as recommended water quality monitoring tributaries in the Similkameen Strategic Environmental Plan (MOE 1986). Streams that are potentially affected by non-point sources of contamination (i.e. areas with intensive agriculture and livestock grazing) such as Allison, Summers, and Hayes Creeks should also be included in the water quality survey. Other areas of interests include sub-basins identified as having moderate, high, and very high conservation value (Freshwater priority map in Nature Conservancy 2006). The water quality parameters would include routine variables (conductivity, temperature, pH, alkalinity, etc.), suspended sediment, nutrients, hardness, fecal coliforms, and total and dissolved metals. Quarterly water sampling over two years would be adequate since there are some historical data that can be

built upon. The water sampling should be augmented by sampling the sediment in nearby pools once during low flow with analyses for total metals, grain size, and total organic carbon.

The **lakes** that should be assessed include the 16 lakes that MELP has completed fisheries assessments and management plans on (Allison, Barton (Hart), Borgeson, Boss, Cliff, Davis, Deadman, Harvey Hall, Nickel Plate, Osprey, Prosser, Rampart, Rick, Silver, Spukune, and Thalia Lakes). Virtually no limnological data are available on these lakes, which are stocked with fish, and basic trophic assessments should be done to assess nutrient supply (phosphorous and nitrogen), plankton, and zooplankton as well as general water quality analysis (dissolved oxygen, pH, total suspended solids, temperature, alkalinity, ion content, etc.). Limnological data was collected from Chain Lake in 1967 and between 1972 and 1976, thus this lake would be an ideal consideration for a comparison study to assess changes in lake water quality and aquatic ecology. Key parameters that were collected in this study that should be repeated include: water chemistry, phytoplankton, aquatic macrophytes, and zooplankton.

Several lakes (e.g. Allison, Missezula, Chain, Link and Osprey) have also been identified as being sensitive to nutrient loading, thus future monitoring should prioritize nutrient chemistry and focus in these areas. Lakes that are sensitive to nutrient loading may be susceptible to eutrophication under warmer climatic conditions. Therefore, lake-level water quality assessments along an elevation gradient would provide a broad perspective of lake conditions within the watershed and how they differ between biogeoclimatic zones to help determine areas that require more adaptive water management strategies.

4.2.4. Fisheries and Instream Flow Needs

F-1 – Prepare an Updated Overview Report on Fish and Fish Habitat in the Watershed

Over 60 different fish inventories and assessments have been completed on lakes and sections of the Similkameen River and its tributaries. However, the most recent fish and fish habitat data compilation is more than a decade old and should be updated with the more recent government and industry assessments. In addition, the data should be evaluated to determine whether they could be used to prepare reasonable population estimates and identify population trends; for specific locations or sub-basins. As well, habitat assessment and land use data should be compiled to aid in the identification of habitat restoration and protection initiatives. Such information would support fisheries management decisions, and the aid in the identification and prioritization of information gaps. This summary report should include a map of all previously assessed areas in the Similkameen River watershed.

F-2 – Instream Flow Needs Assessment

Detailed analyses of in-stream flow needs (IFN) for fish have not been completed for the Similkameen River and there is no system of tracking the quantity of water that licence holders

withdraw. A screening analysis of the Similkameen-Boundary region completed by MOE considered streams that have summer flows less than 20% of mean annual discharge to be flow-sensitive to fish, indicating that most streams in the Similkameen are considered flow-sensitive. The need for an IFN study is captured in Section 3.2 Objective 2 of the TOR. That objective states that the plan "will determine objectives for minimum and optimal/desired flow levels that are considered adequate for the protection of fish…. For the Similkameen River, this will be looked at in the context of historic water flows, as the Similkameen River may have never had sufficient in stream flows during low water flow periods to meet the requirements for abundant fish populations." The IFN study should also determine the implications of implementing minimum in-stream flow objectives on water users.

An initial assessment of IFN is warranted, and should apply the standard BC IFN method (Hatfield et al. 2003), considering the other factors that contribute to the Similkameen River's relatively low fish productivity (e.g. low nutrient levels, limited spawning habitat, anchor ice, and water temperature) as well as the natural capacity of the river before agricultural and urban development occurred in the watershed. This will provide a general overview that will identify areas of the watershed that have the potential for conflict between extractive needs and fish needs. Once these areas of potential conflict are identified, a more site-specific study, including a field-based fish and fish habitat investigation to identify appropriate minimum in-stream flows for the survival of fish and other key aquatic organisms, could be completed. The highest priority should be given to Keremeos Creek owing to the low-flow induced fish kill that occurred in 2001. Reaches of the Similkameen River that support fish spawning and rearing and streams where low water flow impairs fish productivity, yet are important for angling, should also be deemed as high priority.

4.2.5. Riparian Areas and Wetlands

RW-1 Establish Wetlands and Riparian Areas Working Group

There is a reasonable amount of information on the status and function of riparian areas and wetlands in the Similkameen watershed, but that information is scattered among different agencies and stakeholder groups, and there may be some duplication of effort. Therefore it would be beneficial to convene a workshop of riparian stakeholders to update what is known about riparian function in the watershed and set priorities for further action.

Depending on interest, the workshop participants may choose to form a working group within the overall SWP structure that focusses on riparian and wetland issues. This would include confirming the scope of the next information gap, RW-2, which is outlined in the following paragraphs.

RW-2 – Desktop Inventory of Riparian Areas and Wetlands

Given the potential for a warming climate and changes in the hydrologic regime of the watershed (e.g. earlier and higher spring peak flows), there would be benefit in having a more complete

understanding or riparian and wetland function, which will help support watershed management decisions. This would include filling in some of the spatial gaps of riparian areas not yet covered by SEI mapping, as well as a high-level inventory of non-riparian wetlands based on air photos and published information.

There is a variety of Sensitive Ecosystem Inventory (SEI) and wetland inventory data as well as riparian habitat modelling available for parts of the Similkameen watershed. Areas with data include:

- SEI data in three sections near Otter, East Gate and Chain Lakes;
- Wetland inventory mapping in a narrow corridor from Summerland to Princeton, along the Similkameen River between Princeton and Keremeos, and Keremeos to Okanagan Falls;
- SEI data for the lower part of the Similkameen River between Keremeos and the US border;
- Riparian and wetland habitat modelling data for the entire RDOS;
- The LSIB and USIB are understood to have also carried out riparian habitat assessment and restoration activities on reserve lands.

The data presented in each of these studies should be amalgamated and reviewed by the Working Group, as described in the previous section, to fully understand the spatial extent of riparian and wetland data and identify gaps and priority areas.

4.3. TRADITIONAL KNOWLEDGE INFORMATION NEEDS

TEK-1 Work with LSIB, USIB and ONA to Summarize Traditional Knowledge on Water

There is some information on traditional ecological information related to water resources and fish in the public domain, but little is specifically about the Similkameen watershed. It is understood that the Lower and Upper Similkameen Indian Bands have accumulated a body of information on traditional knowledge and values, but agreements for sharing this information with RDOS have yet to be established. This information is important for development of the SWP for a number of reasons, including obtaining an understanding of historical variations in biophysical conditions in the watershed and developing an inter-cultural understanding of the value of water and aquatic life to the residents of the Similkameen Valley. It is recommended that RDOS and SVPS work with LSIB, USIB, and ONA to assemble, review and summarize traditional ecological knowledge, cultural information, and field studies related to water and aquatic/riparian habitats. If acceptable to LSIB and USIB, that information would be compiled into the Similkameen Water Information Database.

4.4. SOCIAL AND ECONOMIC INFORMATION NEEDS

SE-1 Economic Sector Business Projections to 2050

Planning for future water demands will require good information on anticipated changes in the economic sectors operating or potentially operating in the Similkameen Valley over the project planning period (e.g. to

2050). The key sectors with implication for water supply and demand include agriculture, forestry (woodlands), forest products, mining, power generation, natural gas (coal bed gas), and land development (including resort and recreational). Since agriculture is the current largest user of water, that sector would be divided into major commodity groups such as beef, poultry, tree fruits, grapes, and vegetables; and consideration would be given to both conventional and organic agriculture. Development of the economic sector projections should be completed with the involvement of representatives of the various business groups to ensure that the process makes use of existing studies and initiatives, and so that realistic local projections are generated. The projections would consider industry-wide trends, changes in local markets, trade regulations, new technologies, and the sensitivity of each sector to climate change.

SE-2 Planning Tools for Water Conservation

Development of options for promoting water conservation within the SWP will require an understanding of the planning tools that are available for local governments and First Nations communities in B.C. This includes both regulatory tools and incentives. This subject has been addressed in other watersheds and at a higher-level by the provincial and federal governments, so there is a solid information base on which to work with the seven local government and the improvement districts in the Similkameen Valley to identify the appropriate mix of planning tools to balance individual rights with water conservation goals.

4.5. INFORMATION GAP SUMMARY AND DRAFT PRIORITY RATINGS

The information gaps identified in Sections 4.1 to 4.4 are listed in Table 4-1 along with a draft preliminary rating of their relative priority for action. The priority rating includes two elements:

1. Potential to constrain water management decision making; and
2. Schedule – when the information would be required.

These are defined as follows:

Priority based on Constraints on Decision Making	Schedule from January 2014
High (H) – These information gaps would likely constrain the development of the Similkameen Watershed Plan unless completed.	**1** – Complete within 6-12 months
Moderate (M) – These information gaps are important for decision making but could be deferred until the first version of the Plan is in place. They would appear as action items in the SWP.	**2** – Complete within 24 months
Background (B) - These items do not significantly constrain decision making but the information would be of value to help the community have a better understanding of water resource values and issues.	**3** – Complete when resources are available

The priority ratings in Table 4-1 should be considered as draft until reviewed and adjusted by the TAC and SAC at the beginning of Phase 2 of the SWP.

Table 4-1
Information Gap Priority Summary

Number	Description	Priority Rating*	Schedule Rating**
WSD-1	Set Planning Scenarios for Population, Economic Development, and Climate	H	2***
WSD-2	Assessment of Water Availability and Risk of Inadequate Supply	H	1
WSD-3	Review Storage Option and Preliminary Feasibility Assessment	M	2
WSD-4	Additions to the Water Quantity Monitoring Network	B	3
GW-1	Review and update aquifer mapping	M	2
GW-2	Groundwater-Surface Water Interaction	H	1
GW-3	Reconnaissance-level groundwater quality inventory	M	2
WQ-1	Surface Water Quality Status and Trends Analysis	H	1
WQ-2	Reconnaissance Survey of Water Quality in Selected Tributary Streams and Lakes	M	2
F-1	Updated Overview Report on Fish and Fish Habitat in the Similkameen Watershed	H	1
F-2	Instream Flow Needs Assessment	H	3
RW-1	Establish Riparian Areas & Wetlands Working Group to identify and map restoration work completed to date and set priorities for further assessment and restoration.	M	2
RW-2	Desktop Inventory of Riparian Areas and Wetlands	M	2
TEK-1	Work with LSIB, USIB and ONA to assemble, review and summarize traditional ecological knowledge, cultural information, and field studies related to water and aquatic/riparian habitats.	H	2
SE-1	Economic Sector Business Projections to 2050	H	2
SE-2	Research Planning Tools for Water Conservation	H	2

* Priority ratings: H – High; M – Moderate; B – Background
** Schedule ratings: 1 – Within 6-12 months; 2 – Within 24 months; 3 – As resources allow.
***Tasks rated H-2 should be completed early in the formal WSP planning process

4.6. DRAFT OUTLINES FOR PRIORITY TECHNICAL STUDIES

Outlines of the recommended scopes of work for the high priority technical studies (H-1) that would be completed in Phase 2 are provided in **Appendix D.**

5 Communication Plan

5.1. WHY IS A COMMUNICATION PLAN NEEDED?

An effective communication plan provides relevant technical and non-technical information to members of the public, First Nations, stakeholders and those with the authority to make decisions related to the Similkameen Watershed Plan.

This draft Communication Plan builds on the work completed by the Similkameen Valley Planning Society to engage members of the public and stakeholders in communication and consultation processes resulting in the *Strategy for a Sustainable Similkameen Valley, 2011-2012* (Glorioso et al. 2010). The Communication Plan identifies communication objectives, target audiences and methods designed to convey timely and accurate information to specific target audiences to support the development of the SWP. As a result of implementing the communication plan the public and stakeholders will:

1) have an understanding of the watershed and watershed management planning;
2) have access to technical and policy information and the views and interest of other stakeholders; and
3) be informed of opportunities to provide input and shape the direction of the SWP through the public consultation process.

Members of the public and stakeholders, who are informed, consulted, educated, and engaged throughout the SWP development are more likely to support the final plan. A communication plan outlines how the information going out will be disseminated and how information coming in from public and stakeholders will be utilized. Communication activities must occur on an on-going basis throughout SWP development and be relevant. This draft communication plan describes a number of strategies to inform, educate and engage stakeholders and the public throughout the planning process.

5.2. COMMUNICATION TEAM

As specified in the TOR, a communication team should be established to finalize this draft plan and guide the implementation of the final communication plan. The recommended composition of the communication team is:

- A representative from each of the TAC and the SAC;
- A representative from the SVPS Steering Committee;
- An “at-large” member who is a Similkameen Valley resident; and
- A communication specialist who is either a consultant or a RDOS staff member.

Consideration should be given to inviting USIB and LSIB to join the communication team once protocols for participation in the SWP have been established.

The first task of the communication team will be to confirm the target audiences identified in Section 5.3. The second task of selecting the appropriate communication activities will be undertaken once the objectives have been clearly established. To the extent possible, understanding the needs of the audience will help the communication team to select the appropriate activities depending on the objective(s) to be met.

5.3. STAKEHOLDER GROUPS AND RECREATIONAL ACTIVITIES

A stakeholder can defined as a person, group or organization with an interest in a project. A number of stakeholders were identified through the SVPS process. Table 5-2 is a list of known community, environment and conservation, outdoor recreation, and agricultural groups in the Similkameen Valley who are stakeholders and who should be included in all communication initiatives. The various representatives of local government, water suppliers, and federal and provincial agencies identified in Section 3.1.1 are also stakeholders and would be included in WSP communications. The Table 5-2 list will need to be further developed and refined by the communication team to include community groups that perhaps lack a formal organization but would still be considered stakeholders with a particular interest in water management. This would include recreationists who make use of stream, lakes and wetlands, such as paddlers, fishers, gold panners, and bird-watchers.

Communication plans benefit from the inclusion of both formal and informal agencies organization. There are often individuals who can assist with the further distribution of information and often the organization is willing to include information on their website or distribute newsletters or other information directly to their members or staff. Recreational user groups can also disseminate information to their members.

Table 5-1
List of Community Stakeholder Groups

Group	Contact person	email	Phone	Type
Chain Lake Conservation Society		ratepayers@ospreylake.ca		EC
Friends of Osprey Lake	Terry Tellier	terry4184@gmail.com	250-295-7354	EC
Keremeos - Cawston Sportsmen Association	Doug Boult	doug@k-csa.com	250-499-2229	OR
Keremeos Stock Breeders Association	Mark Quaedvlieg		250-499-5559	A
Missezula Lake Property Owners	Gerry St. Laurent	Missezula@shaw.ca		C
Okanagan Similkameen Conservation Alliance		chair@osca.org	250-492-4422	EC
Okanagan Similkameen Parks Society		anglerem@telus.net	250-494-8996	EC
Osprey Snowheelers Club	Rob Miller	snowheelers@ospreylake.ca	250-295-6420	OR
Otter Valley Fish and Game Club	Ann Jones		250-295-3642	OR
Princeton Fish and Game	George Klassen	cwiren@telus.net	250-295-6918	OR
Similkameen Naturalists	Lee McFadyen		250-499-5559	EC
Similkameen Okanagan Organic Producers Association (SOOPA)	Yuri Zebroff		250-499-7040	A
Similkameen Valley Riders ATV Club	Mike Jacobs	svr.atvclub@live.ca	250-292-8348	OR
South Okanagan Similkameen Conservation Program	Bryn White	bryn.white@gov.bc.ca	250-490-8225	EC
Southern Interior Cattlemen's' Association	Andy Rupp		250-499-5730	A
Timberline Cruisers 96 Snowmobile Club	Chris Hassell		250-295-0112	OR
Tulameen Community Club		info@tulameenbc.com		C
Vermilion Forks Field Naturalists	Janis Wright or Trish Reid	janis.don@gmail.com, trishmaryreid@yahoo.ca	250-295-7560; 250-295-6002	EC

Types: A - Agriculture; C – Community; EC – Environment & Conservation; OR – Outdoor recreation

5.4. COMMUNICATION PLAN OBJECTIVES & STRATEGIES

A communication plan is designed to achieve a specific set of objectives. Once the communication objectives are identified the messages, target audiences, methods, and activities to meet those objectives will be finalized with the assistance of the communication team. The objectives outlined in Table 6-3 below were identified in the *TOR*. The public consultation plan, described in TOR Section 11.2, will flow out of the communication plan. Further work should be done by the communication team to ensure each objective contributes in a meaningful way and can be measured for monitoring and evaluation purposes.

Table 5-2
Communication Plan Objectives

Objectives
To convey timely and accurate information on the watershed to stakeholders, decision makers, and the general public.
To provide an understanding of the watershed.
To provide an understanding of water conservation
To provide an understanding of the effect of BMPs on the ecosystem and biodiversity
To collect input into the development of recommendations detailed in the SWP
To identify and address issues of concern
To promote effective communication between agencies responsible for watershed management, stakeholders and residents, to identify the best strategies for developing a sustainable watershed.

These objectives should be reviewed by the communications team after they have become familiar with the contents of SWID and the backgrounders.

Communication tools and activities will be confirmed for the identified target audiences by the communication team in order to achieve the objectives. Each objective should be tested by conducting a means test. This involves asking the question, “Why is this important?” In this way, objectives address specific concerns and activities are focussed. Communication tools are selected as required for the planned activities. Activities are generally organized around the overall purpose of the communication plan:

- to provide information relevant to the planning or implementation of the SWP;
- to involve in order to gauge the level of support, to solicit feedback, or to engage in a decision-making process; and
- to educate, when specific skills or knowledge must be imparted in order for stakeholders and the public to comply with changes in policies or practices that will support the SWP.

5.5. INFORMATION & EDUCATION

The provision of information is the first step in a communication and public consultation process. Information is ‘pushed’ out to the various target audiences using a broad range of tools and activities. The

intent is to advise individuals and groups of work being conducted through the SWP process and to announce activities or decisions. When the intention is to educate then the more specific activities such as workshops or community events may be offered. Information activities include: newsletters; community open houses; workshops or "town hall" events; or technical reports or summaries made available for all community members. Methods include announcements in the media for conservation measures such as alternate watering days in urban centers or a SWP newsletter. In addition to face-to-face meetings, and printed materials there are many tools available through the use of electronic media.

5.5.1. Project Web Site

The project website should be developed as a stand-alone site in order to provide the SWP with a separate identity from RDOS. This will help avoid potential misunderstandings about the purpose of the SWP and the role of the public in contributing to the plan. Links to the web site would be placed on the sites of the SVPS members and the RDOS, allowing viewers of those sites to be easily directed to the SWP site.

A website is an effective tool to both provide information and solicit feedback. PlaceSpeak (www.placespeak.com and MetroQuest (www.metroquest.com) are two examples of excellent communication and consultation platforms with the capacity to conduct surveys and provide project updates such as e-newsletters that are sent automatically to subscribers. These sites also tabulate survey results and provide summaries of comments to provide objective information to decision-makers.

Another key function of the web site is to provide the gateway to the Similkameen Water Information Database. Users should be asked to register to have access to the database, which would also generate contact names for newsletters (Section 5.5.3).

5.5.2. Media (Newspapers, Radio and Local Television)

The local media has shown a keen interest in water management issues in the Similkameen Valley and in southern B.C. in general, and are therefore likely to assist SWP communication. Media tools include press releases, feature articles, and community events listings. Reporters should be invited to all SWP events and provided with information packages in advance to assist with publicity and communication of SWP goals.

5.5.3. Newsletters and E-newsletters

Regular newsletters are recommended to provide 'brand' recognition for the project. Stakeholders and members of the public typically use newsletters that are either mailed, provided at public buildings, or made available electronically as their primary source of information. In the case of mail outs, no action on the part of the recipient is required. For electronic newsletters recipients must either subscribe or unsubscribe through the web site or by e-mail. The information newsletters can

support the consultation plan by including short “response forms” (surveys) that can be filled out and returned.

There are several methods to provide electronic newsletters in addition to those described above. The basic requirement is that you will need a list of subscribers. The benefit of incorporating an e-newsletter into an existing website is that subscribers self-select. An invitation to join can be sent to existing or stakeholders as identified in Table 5-2 above. Subscribers will then be automatically updated by the website administrator. In addition, sign-in sheets should be placed at all public events.

5.5.4. Social Media

Social media feeds such as Facebook and Twitter are often embedded in websites to make it easy for subscribers to join. The challenge of such tools is that someone on the communication team would need to frequently monitor the communication and insert updates. However the content of social media sites like Facebook or LinkedIn can be linked to the main web site so that updates in one are automatically made in the other, thereby saving effort and ensuring consistent messaging.

The top ten most popular Canadian social media sites as identified by www.webfuel.ca are:

1. Facebook www.facebook.com - networking and comment
2. YouTube www.youtube.com – information videos and comments
3. Wikipedia www.wikipedia.org – an on-line free encyclopedia that is open to outside editing
4. Twitter www.twitter.com – share information in real time
5. WordPress www.wordpress.org information and comment
6. LinkedIn www.linkedin.com – business and organization networking
7. Flickr www.flickr.com – photos and comments
8. MySpace www.myspace.com – interactive communication
9. Photobucket www.photobucket.com – photos and comments
10. Blogger www.blogger.com – information and comment

As a start, establishing a presence on Facebook is recommended because it is the most commonly used social networking platform and has the greatest recognition. This would involve creating a SWP Facebook page under the “Cause or Community” category. The page could initially be used primarily to direct viewers to the SWP web site, although postings made by viewers to the page result in a notification being sent to the page manager. This enables traffic and comments to be monitored. The Cawston Post is an example of an existing local Facebook community page.[7]

[7] See https://www.facebook.com/pages/The-Cawston-Post/145637592165689

5.5.5. Libraries

Libraries provide a well-known source for information and tend to be very cooperative with providing information and communicating with the public. They are also the traditional and comfortable place for people who may not have computer access. The scoping report, backgrounders prepared for this report, and future technical reports should be made available in hard copy through the Okanagan Regional Library branches in Princeton, Hedley, Keremeos, and Penticton. Copies of a number of the key background documents in SWID should also be placed in the libraries, if they are not already there.

5.5.6. Open Houses and Public Meetings

Public open houses should be held at key stages in the SWP development process (e.g. early on to confirm issues that should be addressed in the SWP, when proposed water management actions have been developed, and when the draft SWP is complete). The open houses will provide current information through displays and give the public the opportunity to speak with committee representatives and technical experts. Sign-in sheets should be provided at the open houses to gather names and email addresses to populate the distribution list for newsletters, announcements, and other project-related communication materials and to register for access to the Water Information Database. Short surveys could be provided at each open house to gather specific information from the public.

A public meeting may also be beneficial for the project if a specific issue or concern arises. A public meeting differs from an open house because generally focuses on one issue and consists of a technical presentation followed by a question and answer period. It starts and ends at a specific time and is more structured than an open house.

Experience elsewhere has shown that it works well to have an open house format for the first half of the event followed by a public meeting format for the second half. This is because it combines the best features of each while giving attendees the opportunity to participate in a way that suits their needs.

5.6. ASSESSING COMMUNITY COMMUNICATION EFFECTIVENESS

Actively involving stakeholders and members of the public is the second stage in an effective communication process as it become intertwined with the project community consultation process. It is important to provide stakeholders and the public with opportunities to comment on the effectiveness of the communication plan to ensure that it is meeting their needs. This would include a short on-line questionnaire for those who access the web site and a hard-copy questionnaire at open houses. The newsletters would also include an invitation for readers to comments on how they feel about the communication and consultation process.

6 Next Steps - the Path Forward

6.1. DATABASE AND INFORMATION ACCESS

The development of the Similkameen Water Information Database (SWID) and preparation of the Backgrounders are steps that were taken in Phase 1 to assist the Similkameen Valley community to participate in subsequent phases of watershed plan development. The intent of the Backgrounders and Phase 1 report is to provide a common basis of understanding of what is known about water resources, aquatic life, and related issues in the watershed; while the intent of SWID is to provide the public, stakeholders, and government agencies equal access to the reports and data files that are available. As such, it is recommended that the database and backgrounders be made available on the RDOS web site as soon as possible. As recommended in Section 5, a stand-alone SWP web site should be developed in advance of the start of the public consultation process and the database and backgrounders ported over to the web site.

The SWID has been developed so that it can be readily updated as new information becomes available. Therefore a “web master” should be appointed with responsibility to maintain and update the database as needed. Although the database should be accessible to all as a cornerstone of the public communication and consultation process, RDOS may wish to have users register and obtain a password as a way to document the level of interest in the information. This also allows for periodic users surveys to determine if the database content and format is meeting users’ needs. Those users not comfortable with providing their contact information should still be allowed to register anonymously as a guest. They would, however, be asked to fill out a short questionnaire as a condition of access.

6.2. TECHNICAL STUDIES

The technical studies that are rated as High Priority in Section 4 of this report should be initiated concurrent with the next phase of WSP development so that the results are available as the first version of the plan is finalized. The High Priority technical studies (from Table 4-1) are:

WSD-1	Set Planning Scenarios for Population, Economic Development, and Climate
WSD-2	Assessment of Water Availability and Risk of Inadequate Supply
F-1	Updated Overview Report on Fish and Fish Habitat in the Similkameen Watershed
F-2	Instream Flow Needs Assessment
GW-2	Groundwater-Surface Water Interaction
WQ-1	Surface Water Quality Status and Trends Analysis

SE-1	Economic Sector Business Projections to 2050
SE-2	Research Planning Tools for Water Conservation
TEK-1	Work with LSIB, USIB and ONA to assemble, review and summarize traditional ecological knowledge, cultural information, and field studies related to water and aquatic/riparian habitats.

Of these, WSD-2, F-1, WQ-1, and GW-2 should be initiated in the first half of 2014 since the results will be needed in advance to inform SWP development. The remained would be completed early in the plan development process, with WSD-1 being at the forefront.

6.3. FIRST NATIONS PARTNERSHIPS

The RDOS is encouraged to continue to seek opportunities to gain an understanding of local First Nations' relationships with water including cultural, spiritual, economic, stewardship, governance and rights-based aspects. As stated in the draft Collaborative Watershed Governance Accord for B.C. that is included in the SWP TOR, water management decisions should be guided by both the best available scientific information and First Nations' traditional ecological knowledge.

6.4. STAKEHOLDER AND COMMUNITY ENGAGEMENT

The TOR includes a number of objectives for public consultation (11.2 Objectives 1 and 2). However, the details of the consultation process could not be specified until there was a better understanding of the available information and potential limitations on water decision-making. With WSID in place, it is now possible for the SVPS and the SAC to develop the details of the consultation plan for each stage of plan development. The communication plan that supports the consultation process is described in Section 5.0.

The key steps in the early stages of Phase 2 that would benefit from public, First Nations, and stakeholder input are:

- Confirmation and further definition of the key of the key watershed management questions that the SWP is intended to address. The definition of management questions should be done at a higher level of detail than what is currently expressed in the TOR in order to provide focus to the remaining technical studies and through development of the SWP.
- Development and final definition of the population, economic, land use and climate change scenarios on which the plan is to be based. This includes setting the planning horizon. In this report 2015-2050 has been used as a reasonable timeframe for the plan, but the public should be consulted to determine whether other future milestones should be considered.

The communication plan should be initiated in advance of the formal consultation activities. The action items for the further development of the communication plan include:

1. Select the Communication Team members and prepare a detailed implementation plan.
2. Refine the draft communication plan outlined in this report including:
   - Confirm target audiences and prepare contact lists
   - Clarify objectives and develop performance metrics
   - Confirm the communication methods appropriate for the target audience and the intended outcomes for each of the selected communication process. For example, a project website will be developed to provide regular updates, host surveys and deliver newsletters to subscribers
   - Develop a communication plan budget for all the selected communication tools and activities.

7 References

BC Ministry of Environment, Lands and Parks (MELP). 1998. Habitat atlas for wildlife at risk South Okanagan & Lower Similkameen. South Okanagan Conservation Society

BC Stats. 2013. Population and Population Projections. http://www.bcstats.gov.bc.ca/Home.aspx

British Columbia. 2001. Okanagan-Shuswap Land and Resource Management Plan.

Caslys Consulting Ltd. 2011. Keeping nature in our future: Volume 1 - a biodiversity conservation analysis for the South Okanagan-Similkameen Region. Prepared for South Okanagan-Similkameen Conservation Program

Centre for Indigenous Environmental Resources. 2011. First Nations Integrated Watershed Planning: Getting started. http://ppw.ca/information-and-resources/publications-and-products.aspx?id=2084

Comox Valley Regional District and Cowichan Tribes. 2010. Cowichan Watershed Board Members Announced.

Department of Fisheries and Oceans Canada (DFO), Okanagan Nation Alliance, and BC Ministry of Water, Land and Air Protection. 2005. The State of Fish and Fish Habitat in the Okanagan and Similkameen Basin. http://www.obwb.ca/fileadmin/docs/state_of_fish_habitat_obwb.pdf

Econnics. 2010. British Columbia Drought Response Plan. Prepared for the Ministry of Environment on behalf of the Inter-Agency Drought Working Group. June 2010.

Environment Canada. 2013. Canadian Climate Normals: 1971-2000. Online at http://climate.weather.gc.ca/climate_normals/index_e.html

Environment Canada, BC Ministry of Environment and Yukon Environment. 2007. British Columbia and Yukon Territory Water Quality Report (2001–2004): An Application of the Canadian Water Quality Index. March 2007. http://www.env.gov.bc.ca/wat/wq/bcyt_wqrep_01_04/bcytwqrep_01_04.pdf

Era-Miller, B. 2007. Similkameen River and Palmer Lake investigation of arsenic in fish tissue. Washington State Department of Ecology. Publication No. 07-03-034.

Fraser Basin Council. 2011. A guide to water and watershed planning for BC communities in the face of climate change and other challenges. http://www.rethinkingwater.ca/.

Glenfir Resources Ltd. 2000. Similkameen watershed fisheries information and action plan. Prepared for Similkameen River Planning Committee and Fisheries Renewal BC.

Glorioso, Moss & Associates 2010. Strategy for a Sustainable Similkameen Valley (2011-2020). Prepared for Similkameen Valley Planning Society. Final Report 14 April 2010. http://www.rdosmaps.bc.ca/min_bylaws/contract_reports/CorpBd/2010/13July8/SSS_Final_Report_041510.pdf

Golder Associates Ltd. (Golder). 2004. Phase One Groundwater Protection Planning, Keremeos, B.C. Prepared for the Corporation of the Village of Keremeos. July 2004.

Golder Associates Ltd. (Golder). 2005. Preliminary Steps in the Development of a Groundwater Protection Plan, Village of Olalla. Prepared for the Regional District Okanagan Similkameen. March, 2005.

Golder Associates Ltd. (Golder). 2006. Phase Two Groundwater Protection Planning, Keremeos, B.C. Prepared for the Corporation of the Village of Keremeos. June 2006.

Golder Associates Ltd. 2008. Phase Three Groundwater Protection Planning, Keremeos, BC. Report prepared for Keremeos Irrigation District. May 8, 2008.

Golder Associates Ltd. 2009. Phase Four Groundwater Protection Plan – Long-Term Action Planning and Preliminary Contaminant Inventory Update, Village of Keremeos and Keremeos Irrigation District. April 16, 2009.

Golder Associates Ltd. (Golder). 2012. Groundwater under the Direct Influence of Surface Water Assessment, Keremeos, B.C. Prepared for the Keremeos Irrigation District, January 2012.

Hallauer, W. G. 1979. Agreements and aftermaths: The British Columbia-Washington State Boundary. Canadian Water Resources Journal, 4:3, 46-51.

Hamlet, A.F., Carrasco, P., Deems, J., Elsner, M.M., Kamstra, T., Lee, C., Lee, S., Mauger, G.S., Salathe, E.P., Tohver, I. and Binder, L.W. 2010. Final Report for the Columbia Basin Climate Change Scenarios Project. http://www.hydro.washington.edu/2860/report/

Hatfield, T., A. Lewis and D. Ohlson. 2003. Development of in-stream flow thresholds as guidelines for reviewing proposed water uses. Prepared for British Columbia Ministry of Sustainable Resource Management, and British Columbia Ministry of Water, Land, and Air Protection.

Hay and Company Consultants Inc. 1995. Floodplain Mapping Program: Similkameen and Tulameen Rivers at Princeton and Similkameen and Ashnola Rivers at Keremeos. Design Brief. Prepared for Environment Canada and the Ministry of Environment, Lands, and Parks. June 1995.

Holland, S. S. 1976. Landforms of British Columbia: A Physiographic Outline. British Columbia Department of Mines and Petroleum Resources, Bulletin 48, 138 p.

International Joint Commission (IJC). 2013. In the Matter of the Application of the State of Washington for Approval to Construct a Control Structure near the Outlet of Osoyoos Lake. Supplementary Order of Approval. January 2013.

Iverson, K. and A. Haney. 2008. An updated terrestrial ecosystem map (TEM) for the South Okanagan Valley (with sensitive ecosystems inventory - SEI). Prepared by Iverson & MacKenzie Biological Consulting Ltd. and Ophiuchus Consulting for the Ministry of Water, Land and Air Protection

Johnson, A. 2002. A total maximum daily load evaluation for arsenic in the Similkameen River. Washington State Department of Ecology. Publication No. 02-03-044.

Lower Mainland Treaty Advisory Committee (LMTAC). 2006. Building Relations with First Nations: A Handbook for Local Governments.

Mathews, S., and C.J. Bull. 2003. Selection of focal watersheds for the protection and restoration of fish stocks and fish habitat in the Okanagan Region. Prepared by Ministry of Water, Lands and Air Protection and Glenfir Resources.

Ministry of Energy, Mines and Petroleum Resources 2005. B. C. Geological Survey, Geoscience map 2005-3, South Sheet. Compiled by Massey, N.W.D., MacIntryre, D.G., Desjardin, P. J. and Cooney, R. T.

Ministry of Environment (MOE). 1986. Similkameen Strategic Environmental Plan. Planning and Assessment Branch and Okanagan Sub-Region. February 1986.

Ministry of Environment (MOE). 1990. Ambient water quality objectives for the Similkameen River Okanagan area.

Ministry of Environment (MOE). 2013. Ground water resources of British Columbia. http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/gwbc/C131_Agriculture.html

Ministry of Forests and Range 2008. Biogeoclimatic Zones of British Columbia. Forest Science Program. ftp://ftp.for.gov.bc.ca/HRE/external/!publish/becmaps/PaperMaps/BGCzones.8x11.pdf

Nature Conservancy. 2006. Okanagan ecoregional assessment: volume 1. Prepared by the Nature Conservancy of Canada, the Nature Conservancy of Washington and the Washington Department of Fish and Wildlife.

Neilsen, D., Duke, G., Taylor, B., Byrne, J. M., and van der Gulik, T. (2010). Development and Verification of Daily Gridded Climate Surfaces in the Okanagan Basin of British Columbia. Canadian Water Resources Journal. 35(2): 131-154.

Obedkoff, W. 1973. Similkameen Basin Hydrology. Water Investigation Branch, B.C. Department of Lands, Forests, and Water Resources. File No. 0163999.

Obedkoff, W. 1998. Streamflow in the Southern Interior Region. Ministry of Environment, Lands and Parks, Water Inventory Section, Resources Inventory Branch, December 1998. With 2003 Supplement.

Province of British Columbia 2011. BC Stats compilation of Canada 2006 Census. http://www.bcstats.gov.bc.ca/index.asp

Rae, R. 2005. The State of Fish and Fish Habitat in the Okanagan and Similkameen Basins. Prepared for the Canadian Okanagan Basin Technical Working Group, Westbank, B.C. Working Group: Okanagan Nation Alliance, Fisheries and Oceans Canada, B. C. Ministry of Water, Land and Air Protection. http://www.obwb.ca/fileadmin/docs/state_of_fish_habitat_obwb.pdf

Regional District Okanagan Similkameen (RDOS). 2011. Electoral Area “B” – Cawston Official Community Plan Background Report. April 2011.

Robins, K. 2009. Wetland inventory project. Prepared by Ministry of Environment

Schebel, Wendy. 2005. South Okanagan puddle project. http://a100.gov.bc.ca/appsdata/acat/documents/r34978/Puddleproject_1358550150440_3f8ef5d27bb57c1d468a5278cd6b77f21608e7ffe688432316c1dc6af9b52465.pdf

South Okanagan Similkameen Conservation Program (SOSCP). 2012. Keeping Nature in Our Future: A Biodiversity Conservation Strategy for the South Okanagan-Similkameen.

Summit Environmental Consultants Inc. (Summit). 2011a. Similkameen River Water Management Plan: Part 1 – Scoping Study. Prepared for Similkameen Valley Planning Society, September 2011.

Summit Environmental Consultants Inc. (Summit). 2011b. Osoyoos Lake Plan of Study – Study 6: Climate Change and its Implications for Managing Water Levels in Osoyoos Lake. Prepared for the International Joint Commission. April 2011.

Swain, L.G. 1985. Okanagan Area – Similkameen River Sub-Basin Water Quality Assessment and Objectives. Ministry of Environment, Resource Quality Section. November 1985.

Swain, L.G. 1990. Water quality assessment and objectives for the Okanagan area Similkameen river sub-basin. BC Ministry of Environment. Technical appendix.

Swain, L.G. 2007a. Water quality assessment of Similkameen River at U.S. border (1976-2006). Prepared by the Ministry of Environment and Environment Canada.

Swain, L.G. 2007b. Water quality assessment of Similkameen River at Princeton (1984-2006). Prepared by the Ministry of Environment and Environment Canada.

Timberline Natural Resource Group Ltd. 2009. Sensitive ecosystems inventory (SEI) for the East Gate, Otter Lakes and Chain Lakes areas Regional District of Okanagan South (RDOS) (aka Princeton SEI). Prepared for the Regional District of Okanagan-Similkameen.

Tamera Services Ltd. 2002. Report concerning relations between local governments and First Nation governments. Submitted to the Provincial/Territorial Senior Officials of Local Government Committee by Alberta Municipal Affairs, in Cooperation with British Columbia's Ministry of Community, Aboriginal and Women's Services and Manitoba Intergovernmental Affairs.

van der Gulik, T., Neilsen, D., Fretwell, R., and A. Petersen. 2012. Agricultural Water Demand Model: Report for the Similkameen Watershed. Funded by Canada-British Columbia Water Supply Extension Program, April 2012.

Washington State Department of Ecology (DOE) and U.S. Environmental Protection Agency (EPA). 2004. Lower Similkameen River Arsenic Total Maximum Daily Load. Publication Number 03-10-074. Olympia WA.

Wells, M. 2004. Structuring collaboration amongst BC First Nations and local governments: Learning from Katzie First Nation and neighbouring local governments. MA dissertation, University of British Columbia, Vancouver.

Westland Resource Group Inc. March 2007. Cowichan Basin Water Management Plan. Prepared for the Cowichan Valley Regional District, Ministry of Environment, Fisheries and Oceans Canada, Catalyst Paper, Cowichan Tribes, and the Pacific Salmon Commission.

Wildstone Engineering Ltd. 2001. Lower Similkameen River watershed overview fisheries habitat assessment and restoration plan. Prepared for The Similkameen River Planning Committee.

Wittneben, U. 1986. Soils of the Okanagan Similkameen Valleys. Report No. 52, British Columbia Soil Survey. B.C. Ministry of Environment Technical Report 18. March 1986. 229 p.