

1.0 INTRODUCTION

1.1 Background and Scope

The Regional District of Nanaimo (RDN) is located on the east coast of Vancouver Island and extends from about Cedar in the south to Deep Bay in the north (Figure 1). The RDN is divided into seven water regions, one of which includes Gabriola, Mudge, and DeCourcy Islands which is the subject of another study. The enclosed document focuses on the development of a water budget for the six regions located on Vancouver Island defined by watershed drainage rather than political boundaries.

The Vancouver Island portion of the RDN includes City of Nanaimo which has a population of approximately 80,000 people. Several towns, districts, and smaller unincorporated communities with the RDN have an aggregate population of approximately 25,000 people. The total population of the RDN is estimated to be approximately 146,574 (RDN, 2011). Most of the residents live and work within the Nanaimo Area Lowlands, typically at elevations less than 250 metres above sea level (mASL). The uplands are primarily private forest land with active logging operations.

The RDN is a rapidly growing area where the land base is primarily rural, with several expanding urban areas. Projections indicate that the population in the RDN will increase 49% by the year 2031 (HB Lanarc, 2010). During this time, climate change is predicted to cause irregular weather patterns that include longer, hotter and drier summers. Present data indicates that water levels may already be dropping in some water supply aquifers, causing reduced flows in rivers and associated ecosystem impacts (HB Lanarc, 2010). As a result, the RDN has initiated a Drinking Water and Watershed Protection Program (DWWP) in an attempt to ensure sufficient, safe and sustainable supply of water exists for present and future residents (RDN Website: www.rdn.ca).

The RDN's DWWP program has a mandate to protect drinking water and watershed health by developing an understanding of local water resources and using this information to make informed land use decisions and to promote community stewardship. To accomplish the DWWP mandate, it is important to understand how much water is available within the six water regions and mapped aquifers identified over the Vancouver Island portion of the RDN. There is also a need to understand the current and future demand for water, how land use and climate change will impact water resources and the general health of watersheds within the RDN.

In February 2012, Waterline Resources Inc. (Waterline) was retained to complete the Phase 1 Water Budget study for Vancouver Island. Kerr Wood Leidal and Associates Limited (KWL) have been sub-contracted to Waterline to assess surface water for this project. A water budget assessment is an attempt to consider all the inputs and outputs from the surface water and groundwater systems to assess if water is being used sustainably, or being overused. As all water inputs to both surface and groundwater systems within the RDN comes from precipitation, either as rain or from the mountain snowpack, climate data is very important to complete accurate water budget estimates. The interaction between different systems, i.e. exchanges between aquifers and rivers, and both natural and anthropogenic discharges from the system must be understood to facilitate a preliminary water budget. The enclosed report summarizes the results and conclusions of the Waterline study.

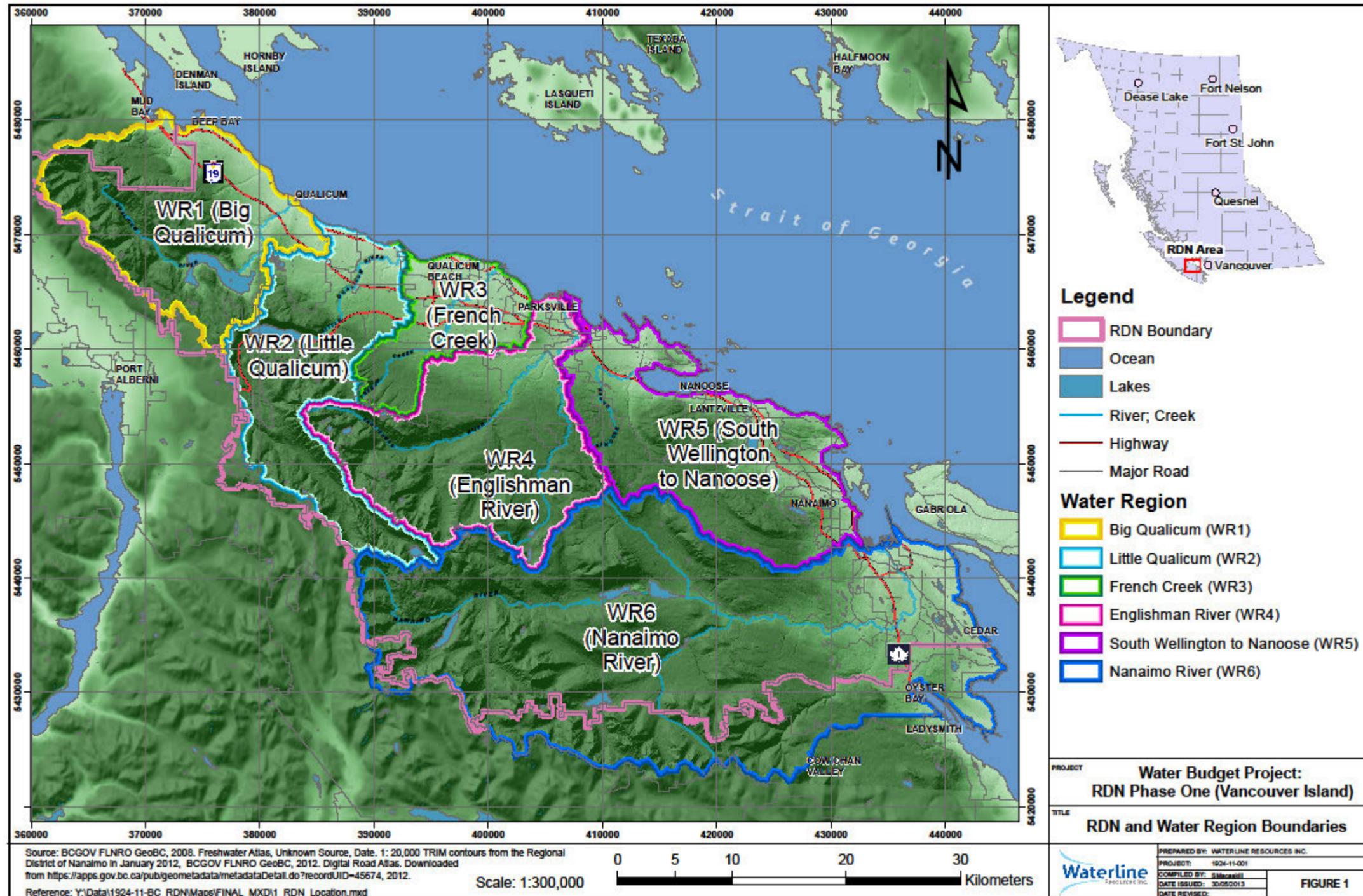


Figure 1: RDN and Water Region Boundaries

1.2 Study Objectives and Goals

The primary objective of the RDN Phase 1 Water Budget Project was to develop a better understanding of the interactions between rivers/creeks, lakes, and groundwater aquifers across the RDN. In order to meet the objective of the study, compilation of available hydrology¹ and hydrogeology² information into a comprehensive electronic geodatabase was completed by Waterline. The electronic information was then used to develop an up-to-date conceptual model of each region to assess water movement and exchange between various watershed elements including rivers and creeks, lakes, and aquifers. An important aspect of the study was to assess environmental controls on surface water and groundwater availability such as climate, topography, soil/geology, land cover, aquifer geometry, etc. and how they affect the water balance in each region.

As part of the water budget assessment, the determination of the availability of water needed to maintain natural ecosystems and community water supplies was also required. The study aimed to develop an understanding of the current water demands, the stresses placed on rivers/creeks and aquifers by human activities, as well as long-term effects of changing climate conditions. The ultimate goal of the project was to determine the sustainability of current and possibly future water use practices in each water region and to identify uncertainties and data gaps in the analysis. Recommendations are also included to improve input parameters for water budget estimates and to develop surface water and groundwater monitoring strategies that will help ensure sustainability of water resources for future generations.

1.3 Scale of Assessment - Conceptual Water Budget

In order to complete the RDN's Phase 1 Water Budget project, Waterline followed the approach previously applied by the Ontario Ministry of Natural Resource (OMNR) for water budget assessment in that province which requires increasing level of complexity with each tier of assessment (OMNR, 2011). The following lists the approach and the level of analysis required at each Tier level:

1. Conceptual Water Budget (RDN Project):
 - Characterization and visualization;
 - Watershed or Water Region Scale.
2. Tier 1 Water Budget RDN Project (Partially):
 - GIS-based Water Budget
 - Supply, Demand, Stress Assessment (RDN Project but preliminary)
 - Subwatershed Scale
3. Tier 2 Water Budget:
 - 3D GW Flow or continuous SW Flow Model;
 - Subwatershed scale
4. Tier 3 Water Budget:
 - 3D GW Flow or continuous SW Flow Model;
 - Water Quantity Risk Assessment;
 - Local scale (well capture, GW protection zones).

¹ The study of surface water

² The study of subsurface water or groundwater

It must be cautioned that the RDN Water Budget project is a regional study intended as a high level water budget assessment for many of the watersheds and aquifers within the six water regions on Vancouver Island. As a result, calculations presented herein are conceptual in nature and only serve to provide an assessment of the linkages between various water resource elements. Local issues may not be fully addressed at the current scale of assessment. However, these will be considered in the future as the RDN progresses through each Tier level (OMNR 2011) from the water region scale (100's of watersheds), to individual watersheds, and finally to the subwatershed scale where more detailed and complex water budget calculations can be completed.

Although water budget and stress calculations presented herein may appear quantitative, they should only be considered as qualitative. The water budget estimates provide a relative comparison from region to region or aquifer to aquifer, rather than actual values of water availability or water use which are needed for quantitative land use planning and design.

1.4 Report Terminology and References

Wherever possible, Waterline has attempted to use non-technical language in the enclosed report. However, where this may not have been possible, a footnote has been added to the bottom of the page to further describe the term and a glossary of terms provided in Appendix A. Data and references provided by the RDN and used in the water budget analysis are summarized in the bibliography provided in Appendix B.

2.0 METHODOLOGY AND APPROACH TO WATER BUDGET STUDY

2.1 ARC-GIS Geodatabase Development

The first task for the RDN Phase One Water Budget project was to assemble existing surface water and groundwater data previously collected across the RDN into a single, centralized Geodatabase. The data was compiled in a consistent format that would allow the Waterline team to complete water budget assessments. The intent was to develop a "living system" whereby the state of knowledge on surface and groundwater systems within the RDN could be expanded with every new study. With this tool, data and water management guidelines may be developed to elevate the accuracy of water budget estimates that will ultimately be used for making land use decisions.

Numerous groundwater-related studies have been completed in each region in relation to the existing well fields and mapped aquifers in the region. However, the data existed in various formats (mostly paper) and needed to be synthesized and integrated into a consistent electronic format by Waterline so that surface and subsurface information could be considered concurrently as part of the Phase One Water Budget Project. Files were reviewed by Waterline and data extracted as required for use in the analysis (E.g.: aquifer transmissivity/storativity values (Carmichael 2012), water levels, information on groundwater flow, etc.). As a result, individual sources of data could not all be referenced in the body of this report but are listed in the attached bibliography provided in Appendix B.

The bibliography provides a complete list of reports and files on individual projects completed by the RDN, consultants, land developers, and commercial operations over many years. The