

reactivate previously discontinued Water Survey of Canada gauges. This approach requires less work as rating curves are already established and historical data already exists. There may also be a need to install new hydrometric stations in un-gauged creeks/streams which has already been discussed for each specific water region.

9.6 Reporting System to Track Surface and Groundwater Use

The MOE/RDN need to establish an electronic tracking system to collect actual measured surface water and groundwater use information. As was shown for the Nanaimo River surface water budget assessment, using the licensed allocation values to complete the water budget calculation is misleading and may incorrectly indicate the level of stress on the river. Groundwater extraction volumes for large users also need to be tracked in a consistent manner. The RDN water service data is in a relatively good condition, however; data for large municipal users or private utilities was not always available. The Water Use Reporting Tracker web application previously developed by Vancouver Island University, or currently being developed by the Okanagan Water Basin should be considered for this purpose.

10.0 Recommended RDN Action Plan

10.1 Provincial and/or Local (RDN) Regulatory Guidance

Provincial regulatory change is underway with the BC Water Act modernization process (<http://livingwatersmart.ca/water-act/groundwater.html>) initiated in about 2005. However, after about 6 years of public consultation, MOE officials have indicated that another 4-5 years may be needed before formal legislation is established (Ted White, February 2012). The RDN simply cannot afford to wait for provincial guidance in this matter, as some of the mapped aquifers are already showing signs of stress. Increased demand for water supply resulting from population growth and coupled with climate change predictions that will likely cause a long-term reduction in aquifer recharge, has the potential for negative impact to all aquifers within the RDN.

Surface water and groundwater protection initiatives are most often driven by regulation, policies or guidelines. Although people generally want to do what is right for the environment, the tendency is always to do the minimum requirement at the minimum expense.

The stated purpose of the Drinking Water and Watershed Protection Program is to learn more about water within the RDN, use this information to make better land use decisions, and help communities protect the environment. In order to continue to move the watershed protection and management forward, a series of guidelines will need to be developed to ensure that high quality surface water and groundwater information is collected in a suitable electronic format. Once the Waterline Geodatabase has been transferred to the RDN and a user interface constructed, the final electronic format will be determined.

10.2 Community Engagement

Community engagement is the foundation for successful water and watershed management. As part of the Drinking Water and Watershed Protection Program the RDN initiated team Water Smart in partnership with Town of Qualicum Beach, Fairwinds Community & Resort, City of

Nanaimo, City of Parksville and District of Lantzville. The proactive approach taken by the RDN and its partners in this regard is to be commended. The RDN website is a very useful resource providing the public with useful information regarding groundwater and surface water in a user friendly and easily read format. Once the final geodatabase is complete, Waterline recommends that community sessions be held where the groundwater and surface water information is openly shared and discussed with the public.

10.3 Near-Term Priorities

10.3.1 Geodatabase and User Interface

Waterline constructed a geodatabase to facilitate surface and groundwater budget assessments for each defined water region as part of the Phase One Water Budget Assessment Project. The finalized geodatabase, along with datasets are also intended to serve as a data repository for use by the RDN to store and update future water and environmental related information. It is important to have these data available electronically as the RDN moves toward fully integrated watershed planning.

The geodatabase structure developed by Waterline is intended for sole use by the RDN. It should be treated like any other software program and should not be distributed to a third party in its raw or original form. The intent is for the database to be managed and updated by/for the RDN so that high quality, up-to-date water maps and data tables can be maintained and made publically available via a web-based, secure user interface. The centralized geodatabase concept works best if the RDN is in charge of maintaining and updating the system and have control over editing and data processing.

Making the information publically available will allow water managers and practitioners to have current and consistent data future water and environmental-related projects within the RDN. It is anticipated that the web-based user interface would initially be similar to the RDN Water Map where key reports and maps are made available on-line. As the web interface is further developed, it should be possible for users to upload electronic groundwater and surface water data on-line. The data could include monthly/annual water use, water levels, water chemistry, aquifer properties interpreted from pumping test analysis, cross-sections, time-series data (MOE Hydrographs and selected water chemistry parameters), hyperlinks to raw data (BC Wells Database, WSC Time series data, VIAH water chemistry, etc...), and a geo-referenced copy of any final reports. The RDN will likely need to develop guidelines, policies, and templates for data collection and submission as part of their planning and watershed management initiatives.

Although the Phase One Water Budget is focussed on surface water and groundwater, the database can (and should) be expanded to accommodate other forms of environmental and infrastructure data (E.g.: fisheries, geotechnical, air, soil, LIDAR, land use, etc.). Waterline does not recommend separating the water-related datasets from other RDN datasets. As was demonstrated by the Waterline's work, having multi-disciplinary data allows scientists and engineers to consider human-environment interactions, and provides a basis for assessing cause and effect response in surface water or groundwater/aquifer systems.

The hope is that every water study or related environmental study that is completed within the RDN will allow for the advancement of knowledge regarding water management and protection. This of course is the primary objective of the Drinking Water and Watershed Protection Program. The database system will allow for the filling of data gaps mentioned previously, and also provide a basis for the RDN and its partners to initiate more detailed assessments required for accurate water budgeting and watershed management.

10.4 Medium-Term Priorities

10.4.1 Focus on Areas of High Stress

Major watersheds exhibiting moderately high to high apparent stress include the following:

- French Creek,
- Nanoose Creek,
- Chase River, and
- The Nanaimo River.

Mapped aquifers exhibiting moderately high to high apparent stress include the following:

- Quadra Sand Aquifer 421 located in WR1 (BQ) adjacent to Nile Creek;
- Haslam Formation Bedrock Aquifer 220 which extends across 3 regions including WR1 (BQ), WR2 (LQ), and WR3 (FC);
- Vashon (Kame) Aquifer 663 at the top of Whisky Creek in WR2 (LQ);
- Quadra Sand Aquifer 217 extending from WR2 (LQ) to WR3 (FC);
- Quadra Sand Aquifer 216 in WR3 (FC) and extending into WR4 (ER);
- Buttle Lake Group Bedrock Aquifer 210 in upper Nanoose Creek;
- Benson Formation bedrock Aquifer 218 located on the Nanoose Peninsula;
- Quadra Sand Aquifer 215 beneath the District of Lantzville;
- Vancouver Group and Nanaimo Group bedrock aquifer 211 located at Benson Meadows;
- Upper Cassidy (Capilano) Aquifer 161;
- Nanaimo Group bedrock Aquifer 162 located in the Cedar-Yellow Point Area; and
- Quadra Sand Aquifer 163 located in an isolated pocket in the Cedar area.

Waterline recommends that the RDN select one or two water regions to complete Tier 1 or 2 Water Budget assessments (OMNR 2011). This allows RDN to develop a complete template for future water planning in all water regions across the RDN. It may make sense to select area in Nanaimo Lowland so that numerical modelling being completed by the Geological Survey of Canada can be used to further refine aquifer water budget estimates. Given the stress assessment for both surface and groundwater, the French Creek Water Region may be a suitable candidate for a pilot study.

10.5 Long-Term Priorities

10.5.1 Other Important Data Sources

There are other important sources of geological, geotechnical and environmental data that would be useful to have compiled in the Geodatabase. These include, but are not limited to: septic suitability studies; geotechnical investigations; fisheries in stream flow suitability surveys, water quality reports and contaminant/environmental investigations.

10.5.2 Remote Sensing Data (Land Cover & LAI)

The significant recharge area map needs to be further updated by further processing of the NRCAN Remote sensing data. The present Phase one Water Budget study is only accurate to 1 km² due to the limitation of the surface water model and computation time. These data should be verified in the field to confirm the assessment provided as part of the Waterline study. Some of the areas identified may occur on private land and any protection measured developed by the RDN need to take these and other issues into consideration. It is also possible to further refine the data to a 10 m² grid accuracy which would improve the maps provided in this report.

10.5.3 LIDAR Data

All Waterline geodata was referenced to 1:20,000 elevation trim data which has an accuracy of +/- 10 m. Although it may be sufficient for regional mapping scale to develop conceptual level assessments, it may not be sufficiently detailed for Tier 1, 2 or 3 assessments (OMNR 2011). For instance, development of geomodels near the coast and assessment of the potential for salt water intrusion risk may not be possible to ensure protection and management strategies can be developed. Competing LIDAR surveys over the entire RDN could help resolve this issue. Although not currently a priority, Waterline recommends that the RDN consider running LIDAR so that all data contained in the geodatabase can be referenced to a more accurate datum.

11.0 CLOSURE

Surface and groundwater are renewable resources but a balance must be struck between water needed to maintain healthy ecosystems and the demand for water by humans. Although the Phase One Water Budget project sets the framework for assessing water availability versus water demand, considerable gaps exist in the data which need to be filled to provide a more accurate picture of current and future water conditions. The objective in water management is to achieve "sustainability" of water resources. This is simply not possible in the absence of proper monitoring data.

The BC Water Act Modernization process appears to be focussed on public consultation and attempting to address the issue of water rights which has caused considerable delay in developing legislation. No matter who owns the rights to the water, sustainable management practices need to be implemented as water supply wells continue to be drilled and aquifers exploited as the demand for water continually rises.

Approaches to water management are relatively well understood and not unique to the province British Columbia. Developing guidelines that lead to improved knowledge of surface water and groundwater systems within each water region has been done by other jurisdiction across