Regional District of Central Kootenay

Regional Water Landscape Inventory and Discussion

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Executive Summary

Global awareness of climate change and its impacts is increasing. Scientific experts in the field of climate change continue to deliver the same message; we need to think globally and act locally in order to mitigate the impacts, prepare for the impending changes, and to create a sustainable focus for future work. With the climate change action charter, water smart initiatives, and strategic planning, the BC Provincial government is establishing itself as a world leader in mitigating and preparing for climate change impacts.

On a regional level we are experiencing accelerated climate change in the Columbia Basin with increased summer and winter temperatures, an increase in runoff events, and up to a 47% reduction in some snow packs. Scientific studies report that this area will experience some of the most pronounced climate changes globally which will have significant impacts on water availability in the region. There now exists an opportunity to accept the challenge of mitigating and preparing for climate change by building on the leadership direction set by the Provincial government. Recognizing that climate change is linked to ecosystem functions and that how we manage water resources from both a watershed and user perspective will have significant impacts, through partnerships with external stakeholders the RDCK can work towards affecting positive change to ensure the long-term vitality and sustainability of the region.

As a first step, a spatial water landscape inventory has been completed which includes the following: all water systems within the RDCK, 3rd order watersheds and volume of water licensed per watershed, existing water licenses and points of diversion, licensed water sources that have water allocation restrictions, water license applications that are currently in progress, identification of aquifers and classification, identification of known groundwater wells, identification of current and historical snowfall levels, identification of areas experiencing increased level of development pressure, identification of water systems in relation to slide hazards, flooding and erosion areas, and floodplain boundaries, identification of mountain pine beetle infestation and severity, and identification of watershed and fisheries constraints issues. Although this report makes no conclusions from the information that has been assembled, it becomes apparent that there is a need to continue on to develop a Regional Water Plan to ensure the vitality and sustainability of the area. This plan cannot be created and implemented without the leadership of the RDCK Directors.

It is important to note that the RDCK has little or no jurisdiction over a number of factors that affect watersheds and water supplies, including surface water allocation (licensing), forestry, roads and highways, recreation, mining, and pollution control. Management of these activities are spread across a number of agencies and ministries, often resulting in a disconnect between the authorities. Climate specialists, local water managers, hydrologists, regional and municipal governments, community members, environmental interests, and others must be participants in the dialogue and decision making processes about water systems management and addressing climate change impacts. Future discussions need to explore the options that exist and what further information is

required; the existing institutional, political, or practical barriers present, and include consideration of pressures derived from sources other than climate change.

Continuing the development of the Regional Water Plan can provide a framework in which to coordinate existing land use policies, whether done as a component of a locality's comprehensive OCP or zoning plan, and to coordinate multi-jurisdictional planning efforts. Many agencies already have the pieces that can form the foundation for a Regional Water Plan; the plan itself can tie together local efforts. To that end, any future actions proposed should occur in partnership with other government agencies, the private sector and volunteers. As previously reported, responsibilities for watersheds and safe drinking water supplies are shared among many players, and cooperation among all parties is needed. By thinking outside the box and developing shared leadership, improved approaches to water supply systems management can be realized.

Although many recommendations have been made at the end of this report, the next step is to create a work plan and schedule to take the document to the next level. This is an exciting opportunity for the Regional District to become a leader in the area of water use management.

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1.0 Introduction

"We never know the worth of water till the well is dry."
(Thomas Fuller; Gnomologia, 1732)

Each and every generation are dealt their share of challenges. This generation is becoming aware that the globe is facing significant environmental change and there is a need for leadership to ensure that we are prepared for the coming challenges. This paper deals specifically with water and the opportunities that are available to the leaders of our region to ensure that future water supplies are secure.

The broad scope and complexity of water issues facing BC and the Central Kootenay Region require that a strategic, coordinated approach be taken to begin to understand the issues so they may be responded to timely and effectively. Key overarching concerns affecting water supply systems include: land use planning, full-cost accounting and life cycle assessment, growth and development pressures, and emerging climate change impacts. This paper will guide the reader through a discussion of some of the existing and future threats and impacts on water systems and will present a regional spatial water landscape inventory that can be used to inform decision making.

Time, resources and budget constraints have limited the scope of this project. This working document addresses a broad, high-level assessment of the RDCK relationship to water issues and outlines options available to address concerns. The intent of this project is to provide a detailed but not exhaustive spatial inventory of water systems in the RDCK, identify areas experiencing growth and development, delineate where water supplies are being drawn from along with any associated allocation restrictions, and to highlight emerging climate change impacts. The parallels between the spatial information and the elements of concern are presented in a framework that will inform readers of the priority issues. A technical evaluation of specific concerns is not a component of this document.

This working inventory and discussion paper represents the first phase of a project to develop a Regional Water Plan in a watershed management context. A Regional Water Plan would address the current issues identified in this phase one report and provide the context for how the RDCK can deal with existing water systems and what to do in the future to meet domestic water demands without compromising the economic, social, and environmental vitality of the region. Success of this project and future phases of it depends on buy-in and participation from internal RDCK stakeholders including elected officials, member municipalities, and departmental staff. Key external stakeholder groups including Interior Health Authority, Ministry of Environment, Columbia Basin Trust, NGOs, and the City of Nelson were consulted and assisted in shaping this document. Full public consultation was not undertaken during the report development period, however, requirements for consultative processes related to proposed initiatives and strategies for later implementation and development of a Regional Water Plan are encouraged.

1.1 Current BC Water Policy Direction

In June, 2008 the BC government released the *Living Water Smart* plan, the government's vision for sustainable water stewardship. It provides a set of goals to keep BC's water healthy and secure for the future. Within this plan, the provincial government commits to new actions and targets to protect BC's water. Actions and targets set to achieve this vision include:

- Keeping water in mind when we develop our communities, protecting sources of drinking water and strengthening flood protection to adapt to climate change.
- Ensuring wetlands and waterways will be protected and rehabilitated and land activities will not negatively impact our water.
- Modernizing BC's Water Laws to ensure adequate streamflows, ecosystem health, more community involvement, and protection of groundwater.
- Setting strong water efficiency targets and working with all sectors to reduce water consumption.
- Improving science and information so British Columbians can better prepare for the impacts of climate change (Ministry of Environment, 2008).

The following report considers the perspectives and direction outlined in the *Living Water Smart* plan and builds upon it. Affecting positive change is dependent upon there being a collective effort to work together to protect water sources, manage water demands, and modernize water systems and infrastructure (Ministry of Environment, 2008).

1.2 Organization of the Report

Following this introduction in **Section 1**, this report includes a discussion of six key areas impacting the effective management of water supply systems in the RDCK. A high-level discourse is provided, followed by the regional context perspective in **Section 2**. **Section 3** introduces a spatial inventory of the water landscape and provides a discussion on how understanding a watershed and using maps and models can be used to prioritize protection and inform decision making to improve water systems management. An evaluative matrix framework is presented as a tool to link the spatial inventory and elements of concern facing the region. **Section 4** outlines the next steps in building on this inventory and report to develop a Regional Water Plan in a watershed management context.

2.0 Existing and Future Impacts on Water Systems

Based on the spatial data inventory and analysis (presented in Section 3), and a focused discussion with internal and external stakeholders to the RDCK, this discussion paper is organized around six key areas of concern affecting or that may impact effective water management in the region. These include:

1. Climate change
2. Ecosystem Services and Natural Capital
3. Water use Management – Full-cost Accounting & Demand-side Management
4. Planning and Development
5. Watershed Management Planning
6. Building Partnerships

For each issue a general explanation and discussion is provided. This is not an exhaustive list, but rather an introduction to some of the matters that warrant consideration.

2.1 Climate change

"Adapting to climate change and reducing our impact on the environment will be a condition for receiving provincial infrastructure funding."
(Living Water Smart Plan, 2008; BC Government Position)

Peer reviewed research has resulted at last in a consensus on the fact that climate change is happening and that human activity is driving a good measure of the warming we are experiencing. Residents of BC are experiencing different weather conditions than in the past. We are seeing higher summer and winter temperatures, declining mountain snowpack, reduced snowfall, long, dry summers, and heavy sudden rains. Changes in natural systems including melting glaciers, lower summer streamflow, more frequent and intense wildfires, and outbreaks of pests such as the mountain pine beetle are being realized. The climate of the RDCK and the entire Canadian Columbia Basin has been and will continue to change in ways that will alter the way people will live and derive their livelihood (Pacific Climate Impacts Consortium, 2006).

It is expected that BC will face longer, drier summers, followed by warm wet winters with more intense rainfall events. That means a decrease in snow pack and less storage for the extended summer months, when the demand for water is the greatest. Further, there will be less chance for groundwater to replenish in the winter, as intense rainstorms run off the surface of the earth and don't recharge groundwater like slow steady rain does. Compounding this issue is the fact that land use changes on top of aquifers compact the soil, making it more difficult for rain to penetrate (Schreier, 2008).

Today, BC residents are already seeing changes in water quantity and timing, including: reductions in summer flow and water supply, increases in drought frequency and severity, changes in hydrologic extremes and groundwater supplies, and varying flood risks (Hamlet, Alan F., Mote, Philip W., & Lettenmaier, Dennis P., 2004). Increasing water temperatures, changes in sediment loadings and nutrient loadings (up or down) are also being reported. Further changes in land cover via disturbance including: an increase in forest fires, insects, disease, and invasive species are also becoming the norm.

For example, very small changes in temperature affect the water-ice interface which impacts soil temperature and moisture retention which in turn affects the timing and extent of water supply. Changes in the dynamics of the water-ice interface will have significant impacts, specifically in Canada where this inter-face defines many ecological conditions.

As climate change continues to impact how much water we have in the West, ignoring the link between the two is no longer a viable option. Climate experts conclude that even before climate change finishes shrinking the glaciers, global warming will impact snowpack. Land, water and climate are expressions of one another. In managing one, we are in effect directing the other.

Regional Context.

The warming that has occurred in the Canadian portion of the Columbia River Basin over the last century has occurred in the last 30-50 years (Pacific Climate Impacts Consortium, 2006). Winter minimum temperatures are increasing the most. In this pattern, the Basin is warming faster because the night time low temperatures are increasing more than daytime highs. Although Summers are becoming slightly warmer, winters are becoming a lot warmer. The warming process is expected to accelerate, due to the accumulation of carbon dioxide in the atmosphere and because of feedback mechanisms from changes that have already occurred in this region.

We are seeing changing streamflow patterns with earlier spring peak flows and lower summer flows. Researchers have reported that annual mean streamflows are decreasing while the spring runoff (known as freshet), is occurring 20 days earlier in the spring. A warmer climate and lower summer precipitation results in long periods of low flow and lower flows at the end of the summer. Through late fall and early winter, warmer air temperatures are resulting in more precipitation falling as rain instead of snow, leading to increased streamflow in winter. For example, at the end of the summer in 2003, the streamflow in the Slocan River was at the lowest it had been in many decades while the Kootenay River had the lowest July flows ever recorded. These conditions were evaluated to be the result of low snow packs from the preceding winter, hot and dry conditions during summer and a delay in the offset of fall precipitation. The evidence suggests that the amount of water flowing in the region's streams and rivers has been changing. Historical streamflow records show a general trend towards earlier and larger spring freshet and smaller summer flows (Pacific Climate Impacts Consortium, 2006).

High resolution modeling projections of snowpack on April 1st throughout the Columbia River system indicates that snowpack will decrease by 3.6% by the 2020s and 11.5% by the 2040s (Pacific Climate Impacts Consortium, 2006). Larger percentage decreases in lower elevation areas are expected. Climate change impact studies further indicate that earlier runoff, lower precipitation with warmer, wetter winters and longer, hotter and drier summers will be the norm in the future.

In 2006, a regional assessment report commissioned by the Columbia Basin Trust and undertaken by the Pacific Climate Impacts Consortium presented information and results on the physical impacts of climate change in this region. Projections throughout this report were based on coarse resolution Global Climate Models (GCMs). Local topography effects were addressed by empirical downscaling from GCMs or by using Regional Climate Model projections available from the Canadian Centre for Climate Modelling and Analysis. Further, historical trends and future projections for selected hydrological parameters were based on the Variable Infiltration Capacity (VIC) hydrological and energy balance model from the University of Washington's Climate Impacts Group. Although some differentiation can be estimated over the spatial extent, the key findings from this assessment are as follows:

Temperature

- A small increase in the average temperature may cause significant changes in runoff by increasing the frequency of melt events.
- Most of the warming in the Columbia River Basin has occurred in the last thirty years, which is consistent with global trends.
- Temperature increased more in winter than in other seasons, with minimum winter temperatures in the Basin an average of 3 degrees C per century warmer.
- Annual mean temperatures are likely to continue to increase by 2.4 to 3.1 degrees C by the middle of this century. Increases are expected to be larger in winter minimum and summer maximum temperatures than other seasons.
- Small differences in average annual temperature do matter – a global 4 degrees C rise in average temperature approximately 18,000 to 10,000 years ago resulted in the ice sheets melting in the area that covered the majority of North America (Walker & Pellatt, 2003).

Precipitation

- Annual precipitation in the Basin increased by 3% per decade over the last century. An additional increase of +1 to 6% by the middle of this century is projected based on Global Climate Models.
- Snowpack on April 1 has decreased by 20-40% since 1950 in some locations.
- Snowfall is expected to continue to decrease, especially at low elevations and in the late fall and early spring when warming will shift temperatures above freezing more frequently.
- Snowpack is expected to continue to decline, primarily due to warming, and snowmelt will continue to happen earlier in the spring (Pacific Climate Impacts Consortium, 2006).

Seasonal climate

- The effect of warmer temperatures is to shift the timing of the runoff freshet to earlier in the spring, thereby depleting the storage that would normally be available during the later summer season.
- Summers are projected to warm by more than the average annual warming, with higher maximum temperatures and 5 to 16% less rain projected.

- Winters are projected to warm, with more precipitation and an increase in the portion of precipitation in the form of rainfall instead of snowfall, specifically at lower elevations.

Glaciers

- Satellite data show that there have been decreases of 10% in the extent of snow cover globally since the late 1960s. There is a statistically significant correlation between decreases in snow cover and increases in Northern Hemisphere land temperatures.
- Glacier retreat has occurred throughout the region. An average of 16% of ice cover (area) was lost in the Columbia Basin between 1986 and 2000, with the Slocan losing 47% of their total ice area.
- Continued warming will cause glaciers in the Basin to continue to retreat, resulting in potential impacts on hydrology. Initially, rapid melting of glaciers increases summer streamflow. Once glacial retreat stabilizes or glaciers are gone, streamflows will dramatically decrease.
- Glaciers are sensitive indicators of climate change.

Streamflow & Storage

- Streamflow study during the summer of 2003 in the Kootenays (Land and Water BC, 2003) found that the Slocan River experienced the lowest flow levels since 1968; and the Kootenay River discharge in July 2003 was the lowest ever recorded. These circumstances were attributed to low snow packs from the previous winter, hot and very dry conditions in summer, and a delay in the onset of fall precipitation (Pacific Climate Impacts Consortium, 2006);
- The changes in water storage capacity of watershed basins and timing of the runoff have serious implications for the competing interests of water resources. These changes are expected to increase in the coming decades (Pacific Climate Impacts Consortium, 2006).

Regionally, taking action to reduce greenhouse gas emissions is one way of tackling climate change. Although this will help to slow the process, it will not stop it. Anticipating what the effects of climate change will be on the region's watersheds and water sources, and developing the means to deal with them is paramount. Some approaches to adaptation and mitigation planning that are available to decision makers include:

- Anticipate changes and accept that the future climate will be substantially different than the past;
- Undertake scenario based planning to evaluate options rather than using historic records;
- Expect surprises and plan for flexibility and robustness in the face of uncertain changes rather than counting on one approach;
- Plan for the long haul. Where possible, make adaptive responses and agreements.

2.2 Ecosystem Services and Natural Capital

"By 2012, water laws will improve the protection of ecological values, provide for more community involvement, and provide incentives to be water efficient.

Legislation will recognize water flow requirements for ecosystems and species."
(Living Water Smart Plan, 2008; BC Government Position)

Ecosystem services are those services provided by the natural environment that benefit human society (i.e. wetlands filter contaminated water, insects and wind pollinate crops, photosynthesis produces plants for food, plants clean and provide clean air, trees control local climate, etc.). Historically, these services go unseen and underappreciated. They have often been taken for granted and have been treated as infinite. As a result, they have been subject to frequent and persistent degradation in a quintessential "Tragedy of the Commons" scenario. However, as the natural environment is increasingly taxed by the pressures presented by human activity, the importance of ecosystem services needs to be re-evaluated for its overall importance to the proper management of safe water.

The traditional approach to managing water systems has usually followed a supply-demand approach. The more water a community required, the more infrastructure that was constructed to accommodate the community's growing needs. However, today's water managers are beginning to recognize the importance of a soft approach to managing water (to be expanded upon in section 2.4).

Ecosystem services provide a number of benefits when it comes to providing safe, reliable water. Ecosystem services include the ability of forest cover to lower evaporation rates as well as reduce the velocity of surface water runoff. Forest cover can also reduces the amount of suspended particles in water, thereby reducing turbidity levels and the associated health risks. Table 1 illustrates examples of the types of goods and services provided by different types of natural capital.

Table 1. *Examples of Ecosystem Services by Ecosystem*[1]

Ecosystem	Goods and Services Provided
Forests	Carbon storage and sequestration, soil formation, waste treatment, biological control, cultural, air quality, stormwater control, recreation, raw material (timber), genetic resources
Grasslands, rangelands	Carbon storage and sequestration, water regulation, erosion control, soil formation, waste treatment, pollination, biological control, food production
Wetlands	Disturbance regulation, water supply and treatment, food production, recreation, cultural, habitat/refuge, total ecosystem
Lakes, rivers, riparian zones	Water supply, waste treatment, food production,

[1] Adapted from Amanda Sauer (2002), *The Values of Conservation Easements* discussion paper, World Resources Institute, presented by West Hill Foundation for Nature, December 1, 2002.

	recreation, total ecosystem
Croplands	Food production, habitat/refuge, scenic
Undeveloped Lands	Scenic

Placing a monetary value on ecosystem services can be complicated. The ability to duplicate what nature does for society is both challenging and costly. A perfect example is the ability of wetlands and estuaries to mitigate the impacts of high water events. In 2005, Hurricane Katrina caused $110 billion dollars worth of damage to the USA by breaking through levies and initiating massive amounts of damage and suffering (Hurricane Katrina Relief, 2008). Before the engineered physical flood controls were constructed, much of the affected land-water interface was comprised of tidal estuaries[2]. Nature controlled high water levels. Over time, levies were built to hold back flood waters, which allowed society to build into areas that previously served to mitigate the impacts of fluctuating water levels. Once these areas were taken away, the constructed control measures were expected to do the work previously done by nature. In the end, the engineered levies could not match the performance of the estuaries. If the original ecosystems had been maintained instead of being developed, the impacts of Katrina (i.e. costs to repair damage to infrastructure, human suffering, etc.) would have been greatly reduced.

In most cases, ecosystem services are far too complex for human intelligence to replicate. Attempting to understand the minute details associated with ecosystem service functions and mechanics should only be carried out with the utmost caution. Whenever ecosystem services are attempted to be replicated or reproduced, the precautionary principle ought to be incorporated. For instance, in 2001 the City of New York contemplated the high value of ecosystem services and decided to invest up-front in nature's services and the robust land-based ecosystems, wetlands and waterways. The City determined that it was economical to finance $1.8 billion dollars to private landowners to protect 80,000 acres of land in local watersheds. The move was made to protect the City's drinking water. The alternative was to spend $8 billion dollars to build a new water filtration plant. Not only did the City save in capital costs, but also $300,000 a year in operations (Olewiler, 2004).

Ecosystem services need to be valued. However, they must not be allocated a monetary value. Due to the overwhelming complexity of the issue, placing a dollar value on these

[2] An estuary is a partially enclosed body of water along the coast where freshwater from rivers and streams meet and mix with salt water from the ocean. Estuaries and the lands surrounding them are places of transition from land to sea, and although influenced by the tides, they are protected from the full force of ocean waves, winds, and storms by such landforms as barrier islands or peninsulas. Estuarine environments are among the most productive on earth, creating more organic matter each year than comparably sized areas of forest, grassland, or agricultural land. They are fascinating and highly productive ecosystems distinct from all other places on earth. Most estuaries are at risk due to human activities, both past and present and the increasing concentration of people in coastal areas is upsetting the natural balance of estuarine ecosystems and threatening their integrity (http://www.epa.gov/nep/about1.htm).

assets could actually undermine the overall benefits received by society. Consider, for example, the dollar value of a tree. A forester might value the tree according the market value of the timber alone. A landscape architect might value the tree according to the purchase price and cost to install. An artist might consider that tree priceless. Placing a direct dollar figure on ecosystem services should be avoided.

Regional Context.

From a regional government perspective, placing a figure on the maintenance and acquisition of variables that provide ecosystem services should be considered as part of a shift towards full cost accounting. While it may be challenging to place a dollar value on the service provided, it is less complicated to place a value on the maintenance, restoration, and enhancement of natural systems. These include introducing watershed protection measures; maximizing overall percent forest cover, retaining soil and minimizing runoff, restoration works, wetlands conservation, and reclamation. While it may not be feasible to identify a monetary value associated with these items, the payoff will prove to be invaluable.

Another consideration would be to introduce regulations and bylaws that enhance those ecosystems that provide services. For example, according to existing legislation in new development must ensure 30 m setbacks from fish-bearing streams and 15 m from non-fish-bearing streams. Both of these setback figures are, by and large, arbitrary. The effectiveness of these distances for protecting water quality is largely unsupported. The science now exists to support a more significant minimum distance, one that will protect riparian quality and, thus, the overall quality of the water in a system. 100 m setbacks are being increasingly seen as a much more progressive figure to incorporate. Regions in North America recommending or making use of 100 m setbacks for various development projects include: the Montana Alberta tie project, which encompasses 130km of intact prairie lands in the Milk River Ridge region of southwestern Alberta (AMEC Earth and Environmental, 2006); the Regional Municipality of Halton, Ontario (Conservation Halton, 2005), and areas in Carolinian Canada[3]; Canada's southernmost region which is home to 25% of Canada's population (Carolinian Canada, 2008). Bylaws requiring that any new development ensures minimum 100 m setbacks from streams could be an effective tool for protecting ecosystem services.

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[3] Carolinian Canada is the southernmost region of Canada and contains more rare and endangered species of plants and animals than any other part of Canada. Over 125 species have been declared at risk and over 400 others are considered rare. Forest cover has been reduced from 80% to 11% and in some places is less than 3%. Wetlands once covered 28% of the land but now are reduced to 5%. Fragmentation of remaining habitats into very small remnants is a further threat. The Carolinian zone occupies only one percent of Canada's land area, but is home to 25% of its people. Not surprising that the Carolinian zone is Ontario's most threatened ecological region, and one of Canada's most threatened (http://www.carolinian.org/ConservationPrograms_BigPicture.htm).

2.3 Water Use Management - Full-cost Accounting and Metering

"Government will develop new protocols for capital planning that will look at the life-cycle costs and benefits of buildings, goods and services."
(Living Water Smart Plan, 2008; BC Government Position)

"By 2020, water use in B.C. will be 22 percent more efficient."
(Living Water Smart Plan, 2008; BC Government Position)

Throughout BC, water rates do not appropriately reflect the true costs of water service provision. Several research papers reviewed recognize that the price of water in BC is inexpensive and results in increased quantity demanded since users have little financial incentive to practice efficient water use or to give much thought and consideration to where their drinking water comes from and whether or not it is safe (Brandes & Brooks, 2006; Brandes & Ferguson, 2004; Boyd, 2003; Davies & Mazumder, 2003; Weisenberger, 2004) This under pricing perpetuates a common misconception that "fresh water is in abundance" (De Villiers, 2003). Maintaining artificially low rates means water purveyors rarely have the means to train operators or make necessary upgrades to water treatment and distribution systems. Reserve funds are then not available for system expansion or water main breaks.

Full-cost accounting is one mechanism available to water systems to help them ensure delivery of safe drinking water (Office of the Provincial Health Officer, 2007). Full-cost accounting means projecting all costs for the life of the water system, including small parts that require annual replacement and the regular maintenance and replacement of water mains, storage reservoirs, or concrete structures. To accommodate for monitoring, maintenance programs and system upgrades on a 20 to 100 year interval, water supply system operators have to ensure that financial capacity is built into their system assessment and assessment response plans (Office of the Provincial Health Officer, 2007). Not doing so and operating with unrealistically low water rates has the potential to result in water system degradation and risks to public health.

One measure commonly employed to support full-cost accounting practices is metering. Metering of residential, commercial, industrial and agricultural connections is an effective strategy for reducing overall water consumption. Meters make consumers more aware of the amount of water used for daily activities, and can reduce consumption. Many communities have opted for metering as a conservation program to defer the cost of tapping new sources and expensive infrastructure upgrades such as Prince George, Port Alberni and Vernon. Meters used in conjunction with pricing strategies that benefit efficient and conservative use such as volume based pricing are highly effective in placing value on water as a resource (Brandes & Brooks, 2006; Ells, 2005). The technology exists for these practices but in many cases is hindered due to lack of education and municipal bylaws and regulations. For many communities changing public perception of water as an unlimited resource will require innovation and demand management principles (Ells, 2005; Brandes & Ferguson, 2004).

To facilitate in these efforts, local government owned water systems can apply for grant funding for water system improvements through the Canada-British Columbia Infrastructure Program. Further, public water supply systems owned by regional districts, private utilities, and municipalities are fiscally responsible to the provincial government. As a result, some assurances are realized in that these water purveyors are overseeing budgets in a fashion that should ensure both short and long-term requirements are considered. It is in the best interest of a water supplier to guarantee an appropriate revenue stream. Alternatively, volunteer owned and operated water supply systems are not governed by any legal accountability mechanisms.

Best Practices in BC.

- The Comox-Strathcona Regional District went to metering in 1995 at a cost of $300,000. The district noted a decrease in maximum demand from 45 litres/second to 23 l/s after meter installation, representing a 50% savings in use.
- The regional district of North Okanagan (RDNO) has a bylaw requiring meter installation in all new construction that has been in place for the past 12 years.
- In 1999, the Regional District of Okanagan passed a low flow fixture bylaw that requires all new residential construction to install low flow plumbing fixtures such as 6 litre/flush toilets, low flow shower heads and aerators for other faucet heads.
- The city of Vernon uses a combination pricing structure. For consumption up to 40 cubic meters per quarter (~ three months) consumers are charged a flat rate of $33 dollars. Consumption above 40 cubic meters, from 41 to 300 cubic meters a volume based pricing structure is used charging $0.34 per cubic meter/quarter. Above 300 cubic meters consumers are charged $0.56 per cubic meter/quarter.
- In 2008 the Regional District of Nanaimo adopted a new water user fee rate structure for the seven water systems it serves. The new rate structure is the same for all seven water systems, is based on the average cost to produce water for consumers, and is structured to encourage water conservation. The average minimum daily rate for water has been decreased to reward the low water consumer, while an additional consumption category has been introduced for high water users.

2.4 Water Use Management – Demand-side Management and 'soft path'

"Reducing the demand for water is our best source of new water."
(Oliver Brandes, The POLIS Project on Ecological Governance, 2005)

"Fifty percent of new municipal water needs will be acquired through conservation by 2020. Government will look at new ways to help promising water conservation technology succeed."
(Living Water Smart Plan, 2008; BC Government Position)

One in four Canadian municipalities has experienced water shortages in recent years (Boyd, 2004) and Canadians are second only to the United States of America in per capita water use (Brandes & Brooks, 2006). In Canada, a yearly average of 13% of municipal water is unaccounted for (Canadian Water and Wastewater Association, 2006). Ensuring that there is an adequate provision of water to meet human needs is a current sustainability challenge.

Water management in Canada has long been characterized by a supply-side paradigm. The goal of this approach is to secure an adequate water supply to meet current and future demand. Experts in the field of water resource management, academic researchers, policy makers, and water conservation officials contend this is not a sustainable management practice. An alternative to this exists, which requires a shift in governance.

Alternative Governance System

Governance can be defined as the way any organization, public or private, small or large, distributes power and authority through its information, decision-making and resource allocation instruments (Doppelt, 2003). A body's governance system plays a vital role in shaping the way its members view the world, interact with each other and the external environment, and perform their tasks (Doppelt, 2003).

A viable alternative governance option to the traditional supply-side management used in the RDCK is demand-side management and soft path planning. Demand-side management (DSM) aims to influence the efficiency and timing of water use through a variety of measures including: use of low flow fixtures and appliances, reuse of wastewater, education, drip irrigation, repairs to leaks and cracks in pipelines, and volume-based pricing (water meters required) (Maas, 2003). Study results indicate that low flow water saving devices such as toilets; showerheads, faucets and washing machines use at least half as much water as conventional products. Low flow retrofit programs are also effective for reducing municipal water consumption as shown by the city of Barrie, Ontario. Other practices such as grey water reuse and recycling as well as rainwater harvesting are common in many countries of the world except North America. Decisions made operating under this approach first consider opportunities to lower demand before costly supply infrastructure are built.

DSM tools can be applied to RDCK communities in two main ways: by providing the means for reducing demand, and by creating the policy instruments to motivate these means (Maas, 2003). Means include: changing the water use behaviour of individuals and institutions, and making physical changes to increase efficiency. Policy instruments fall into three realms: education, economic incentives, and regulatory mechanisms (Maas, 2003). Using the demand-side management approach, water resources can effectively be managed to ensure the economic, social, and environmental concerns, known as the three pillars of sustainability, are addressed.

Improved efficiency can reduce the demand for water and save money (Brandes & Brooks, 2005). Demand-side management principles are now being utilized to varying degrees across Canada in a number of municipalities. As they become more engrained and part of everyday life, a more holistic approach to water management can evolve, known as the soft path[4].

Tools and Strategies

There are 4 principles that distinguish soft path from conventional planning and management. They include:

- Treat water as a service rather than an end in itself.
- Make ecological sustainability a fundamental criterion.
- Match the quality of water delivered to that needed by the end-user.
- Plan from the future back to the present (Brandes & Brooks, 2005).

A service.

The soft path management approach does not view water as a final product. Alternatively, water is viewed as a means to complete specific tasks, including but not limited to: sanitation, aesthetically pleasing yards, and agricultural production. In order to meet these needs, water managers look to alternatives to water-based services, rather than supplying more water. The goal for example, becomes one of removing wastes and growing food, rather than flushing toilets and irrigating croplands (Brandes & Brooks, 2005).

When water is regarded as a service, mangers and planners do not focus solely on historically proven technologies and infrastructure. They also encourage education and social marketing, local reuse and recycling, urban re-design to support conservation, and different ways to address farm management (Brandes & Brooks, 2005). Altering behaviour and practices provides a means to reduce water use while still meeting service needs.

However, consideration of the inherent challenges and resources required to make such a societal shift cannot be ignored and require further study. Critics contend that efficiency energy programs do not necessarily correlate with a decline in society's overall energy consumption and that increased efficiency will result in more, not less, energy or water use (Tanton, 2008). Additional types of barriers that may inhibit this shift include: attitudinal and perceptional, organizational and administrative, resource-related and financial, data availability, and existing policy and regulatory frameworks. Overcoming the drawbacks of demand-side and soft path approaches will require planning and collaborative teamwork among all stakeholders to promote change.

Ecological Sustainability.

Environmental considerations are accounted for at the beginning of the planning process, with the intent to limit the amount of water withdrawn from natural sources and to establish conditions on the quality of water returned to nature. Ecosystems are understood to be legitimate users of fresh water and regarded as the foundation of many

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[4] The soft path for water concept is adapted from the energy field. Amory Lovins created the term "soft energy path" in a 1976 Foreign Affairs article, and eventually developed a planning approach that carefully calculated requirements for energy services with great emphasis on economic efficiency, environmental protection, and democratic management (Brandes & Brooks, 2005).

aspects of our economy (Brandes & Brooks, 2005). This consideration ensures that water is valued for itself, and not just as a commodity to be used for human benefit.

Quality as well as Quantity.

Water quality requirements vary with end-use activity. For example, we do not desire animal waste in our drinking water, yet it is sought after for our gardens and farms. The fact remains that in the majority of Canada, including the RDCK, we do all our irrigation with drinking water. In reality, high quality water is primarily needed only for drinking and some specific industrial and medical tasks. Low quality water can be used for irrigation, in oil production, and for cooling tasks at generating stations and industrial plants. Under the guide of soft path principles, water service delivery needs are designed to match the quality of water supplied to the quality required by the end-use (Brandes & Brooks, 2005). The goal is to develop cascade water systems, where wastewater from one use becomes the input for another use. For example, water from a washing machine later becomes sustenance to a garden.

Moving to a demand-side and soft path management approach to water resources is dependent on changing patterns of water use. There are many tools and strategies available to communities in adopting this alternative governance system. Socio-political strategies include; a comprehensive education program, mandatory water-use permits, introducing landscaping ordinances, water restrictions, turf limitation by-laws, appliance standards, and enhanced plumbing requirements for all new structures (Brandes & Brooks, 2005). Economic tools that could be employed include; tax credits for reduced use, rebates for efficient technologies (i.e. drip irrigation, showers, faucets, appliances), high-consumption fines and penalties, and varied pricing structures to accommodate for seasonal rates, daily peak-hour rates, marginal cost pricing, and increasing block rates. Effective operational structures include; metering, water audits, dual flush toilets, landscape efficiency, rain sensors, pressure reduction, and recycling and reuse (i.e. grey water for toilets and irrigation, treatment and reclamation of wastewater for reuse).

Regional Context.

In the RDCK, a migration from supply-side management to demand-side management and soft path planning will take leadership and education. Comprehensive planning, critical analysis, public consultation, and strategic implementation will be required. To develop a soft path approach, the RDCK can begin by involving as many stakeholders as possible in decision making. Through meaningful public participation and educational campaigns, the region can learn to manage water supply systems in a manner that respects guiding sustainability principles.

2.5 Planning & Development Services

"Community development strategies will be created to recognize the importance of riparian zones in adapting to climate change."
(Living Water Smart Plan, 2008; BC Government Position)

Focused discussions with internal and external Planners to the RDCK identified a number of roles planning and development services plays in the administration of and impacts on water systems. Results of these meetings within the contextual discussion of climate change and water resources management are presented below.

Planning practice on adaptation to climate change impacts is still in its infancy. Planners need to look for new approaches to respond in partnership and collaboration with developers and the wider community to ensure that decision making is cognitive of the uncertainty surrounding climate change impacts on water supplies. Where climate change mitigation strategies have focused on the reduction of carbon emissions, climate change adaptation will largely be focused on water. With potential for water resource depletion caused by decreased precipitation and loss of glacial cover, there will be increased demands put on groundwater, water source management, and water source protection. Planners play a pivotal role in facilitating the dialogue needed to build relationships amongst the various jurisdictions with responsibilities around our drinking water resources. It will be important to determine what the supply and demand on our water systems will be, so that collaborative action can be taken on future planning for this vital resource.

The role of planning and development services in the administration of a water strategy is critical. Spatial or land use planning has important implications for the quality and quantity of water available to meet future needs. There are several themes around water that are important considerations for land use decision making. Some of these which are outlined below include:

- Water Quality
- Stream Impacts from Site Design to Construction
- Water Supply Management
- Infrastructure Costs and Maintenance

Water Quality

There are several tools available to local governments under the Local Government Act to protect the quality of water available to residents and property owners.
At a higher level, Official Community Plans can identify areas of high value or risk for water quality and can delineate guidelines for the protection of water resources through the establishment of Development Permit Areas (DPAs). To date, the only Official Community Plan in the RDCK that has included water protection guidelines is that of the East Shore of Kootenay Lake or Electoral Area A. The Draft Official Community Plan for Slocan Lake North or the northern portion of Electoral Area H also provides such guidelines for streamside and foreshore protection. DPAs are a regulatory tool that can be used to protect the natural environment, and provides some flexibility in how a local government intends to protect natural resources. DPAs for streamside and foreshore protection can require appropriate setbacks (as presented in Section 2.2) for development and construction and can also require maintenance or re-establishment of vegetation to filter contaminants and reduce erosion along streams and lakes.

Another regulatory tool that has been underutilized in the Regional District is that of the Subdivision Bylaw which can stipulate 'potable' water requirements as a condition of

Subdivision or Multi-family Development approvals. To date, the Regional District requires that applicants submit proof of adequate water supply but has no requirements on the quality of water supply. In addition, the Subdivision Bylaw can stipulate thresholds and appropriate requirements for connecting to available water infrastructure already in place or the creation of new community water systems. Currently there is no regulation in place that requires properties within a community water service area to participate in that service. This can be problematic if the cost of extending water lines bypasses property owners that do not pay for the extended service. In addition, the creation of additional wells or stress on water resources in a community water service area can make the system more vulnerable to contamination and water shortages, since point source pollutants may enter the system from privately maintained well sites and the lack of control over use and quantity of use of private well sites.

A Subdivision Servicing Bylaw can also be used to regulate the disposal of waste water and sewage to ensure adequate treatment and to encourage the placement of septic and sewerage systems a set recommended distance from drinking water sources or soils that place groundwater sources at risk.

Stream Impacts from Site Design to Construction

The RDCK has traditionally not been actively involved in site design requirements or approvals. Stricter control or involvement in site specific developments, such as those associated with subdivisions or multi-family housing, commercial and industrial developments would be of great benefit toward mitigating some of the non-point source and point source impacts that development can have on area streams and lakes, as well as groundwater resources.

Zoning Bylaws typically stipulate the permitted site coverage for a lot, which includes the area of a lot allowed to be covered by structures, buildings, driveways, parking areas and outside storage. Site coverage allowances in the Regional District generally vary from 30 to 50 percent. Site coverage regulations do not control site drainage or landscaping, both of which can have detrimental impacts on storm water drainage and erosion during and after construction activity. This type of activity could be addressed in the Subdivision Bylaw. For example, requirements for the design of water and drainage flow and for catchment areas for storm water drainage might be considered as part of the design requirements for larger subdivision proposals.

Promoting the clustering of development or housing is another method of reducing rural sprawl and increasing the availability and retention of green space. This can assist in protecting ecologically significant landscapes, while simultaneously providing greater public or common amenity to developments and increasing their livability.

Another method of site control used to protect or conserve water resources is to mandate the use of landscape buffers from streams and water bodies that act as filters for erosion and sediment run-off during storm events. This also assists in filtering pollutants and sewage if old septic systems fail. Shoreline that has already been degraded or manipulated should be restored in the area within the setback distance, preferably with deep rooted native plants for bank stability and habitat creation. Vegetated shorelines allows for greater protection of a property from erosion and flood events. Tree cutting bylaws are another tool that can be used to minimize erosion and protect bank stability in areas that have steep slopes or demonstrate risk. This type of regulatory bylaw can be of duel benefit for protecting mountain streams and springs from adverse harm from erosion and disturbance of the hydrological regime. In some local governments, such as the Regional District of Nanaimo, there is policy direction that developments result in no net loss, or that development impacts be balanced with protection of green space to protect watershed functions (Lanarc, 2007).

The RDCK can also work cooperatively during development approvals in encouraging the adoption of green design principles for construction of docks, marinas, boat slips and other structures traditionally built in or adjacent to water bodies. Policy direction can be adopted in Official Community Plans or as part of the approval process for building permits. 'Living by Water' (Living by Water, 2002) is an educational and voluntary program that can be used with waterfront property owners to reduce their impacts on water through innovative design and protection of green space along waterfront properties.

Water Supply Management

Many communities in BC are close to exceeding their capacity to provide clean and adequate water supplies to residents, as was demonstrated in Tofino (2006) on Vancouver Island and many parts of the Okanagan. It is becoming increasingly important to be able to determine and understand the sustainable watershed capacity of an area rather than continually expand services and allow for unchecked growth.

In the Central Kootenay area, water licenses are issued with little regard to cumulative impacts on a watershed level as provincial licensing has traditionally occurred on a stream by stream basis. For larger lakes, such as the Kootenay, Arrow and Slocan, they are categorized as undetermined sources and thus licenses for large volumes of water can be issued without regard and consideration to cumulative impacts on water supply or hydrological cycles associated with these larger bodies of water. In addition, many water licenses on smaller streams and creeks are shared by property owners or used without permits which does not allow for accurate record keeping on which water bodies may or may not be at risk or over-subscribed.

Due to inadequate information, development and planning decisions can be made in isolation of an adequate supply of safe drinking water. Consideration of water supplies for irrigation and fire protection purposes can also be overlooked. With an increase in non-resident property ownership, seasonal strain on water resources is another growing issue, where water resources are being used primarily during the summer months when water supply is lowest.

Green development focuses on building design and materials that lessen the impact on the area in which development occurs. Under the new Greening requirements in the Building Code (to come into effect on September 5, 2008), the Province is making it easier for property owners and builders to be innovative in cutting costs and energy needs in new construction and renovations. Green developments can integrate landscaping and design elements that improve drainage and reduce the need for irrigation. Nature-scaping or the use of native plant species, enviro-grasses, and xeri-scaping are all types of landscaping tools that can be utilized to conserve water resources. All of these tools can be promoted through voluntary incentives, such as streamlined approvals or reductions in permit costs.

Infrastructure Costs and Maintenance

The cost of maintaining infrastructure for community water systems exponentially increases with low density and low population numbers, due to the amount of water lines required and the implications to tax payers for the maintenance of such services over dispersed areas. Small water systems are often at risk over time for not being able to afford upgrading to provincial standards, in addition to routine maintenance by qualified technicians. In many cases, small water systems are created to allow for higher returns for investors and the creation of pockets of density in rural areas. Often maintained by strata corporations and councils, or by the developers, these systems over time can suffer neglect as those trained to maintain the systems move on to pursue other properties or no longer have the ability to maintain the systems. This practice is one reason why there are numerous systems currently under 'Boil Water' or 'Water Quality Advisory' notices in the region.

Current zoning and rural land use bylaws in the Regional District promote the creation of community water systems as a means to achieve higher density for subdivision or strata creation. However, there is no threshold stated to make these systems self-sufficient and it is widely understood that many developers pursue the option with the intent that the Regional District will eventually take over the systems that are created. In addition to new systems being created, there are a multitude of older systems that require significant upgrades to meet current safe drinking water standards. In many cases, before the creation of new community water systems, options for consolidation and improvement of existing systems should be explored. Greater cooperation between Engineering Services and Planning is required to coordinate such options. In addition, parameters to cluster development into existing and new village sites could reduce the costs of infrastructure improvements and expansion where appropriate. How people are distributed within a community, not the total size or average density of a community dictates the cost of related servicing and infrastructure. Rural sprawl costs on average 60% more than moderately dense, clustered developments in the same area (Litman, 2004).

The creation of community water systems can play an important role in dictating settlement patterns and the location of higher density development. In the RDCK, the creation of improvement districts or service areas have assisted in achieving higher density in the rural areas surrounding member municipalities, however they have also enabled developments to occur in areas that are more appropriate for individual on-site service (water licenses and wells) delivery due to cost implications. Public costs tend to be low in areas where most residents provide their own water and sewage, and service standards are relatively low. However, where urban boundaries start to expand into rural fringe areas resulting in sprawl, residents accustomed to urban quality services move into low density locations expecting the same level of service despite the increased costs (Litman, 2004). In a Regional District this puts increased pressure on member municipalities to expand their services or to expand their boundaries to accommodate this growth.

In the RDCK there is a high percentage of non-resident property ownership. Non-resident property ownership can result in ‘dark’ communities or areas where few to no residences are occupied for all or some of the year. The costs to maintain infrastructure increases in areas where it is not used year-round; as issues such as the calcification of water lines and freezing of pipes, sewage lying stagnant, and other seasonal use concerns becomes the burden of the local government or other tax payers to cover. For this reason, many local governments are asking developers to cover the costs of infrastructure maintenance upfront and no longer subsidizing these developments over the long term. The issue of non-resident ownership also has impacts on the ability to obtain government grants, since non-residents rarely show up on the census data used to calculate expenditures by the province. Tools, such as Official Community Plans, Subdivision Bylaws and a Regional Growth Strategy can be used to better manage growth and rural sprawl and can assist in directing settlement patterns to reduce infrastructure and servicing costs while maintaining the rural nature of our communities.

Regional Context.

Data from the Ministry of Environment indicates that many of the surface water sources are over-prescribed or at capacity in the RDCK. With the uncertainty surrounding the impacts of climate change on water supply, the management of surface water resources becomes paramount. With more frequent and more intense storm events, periods of drought and extreme heat and increased risk of forest fire, surface water resources will be put at greater risk and demand. It will become clear that development and subdivision approvals can not be considered in isolation of ensuring an adequate water supply for both domestic and agricultural use and for fire protection. In addition, the District will need to cooperate with the Ministry of Environment to ensure that unrecorded sources of water are not exploited without knowledge of the cumulative impacts of licensing on these larger water bodies. It should become standard practice in the review of development proposals that surface water sources are reviewed to ensure that they have adequate capacity to serve the needs of residents and other licensees.

Groundwater resources may also become less reliable as the population in the region puts additional stress on these relatively unknown sources of water supply. Aquifers and springs are difficult to map and assess for capacity and may be slow to replenish supply if demands are too great. Currently, the RDCK Subdivision and Zoning Bylaws tend toward reliance on individual surface and groundwater sources for smaller development proposals due to cost efficiencies for the applicants. Groundwater resources can be easily contaminated with higher density development in their service areas. With climate change impacts, groundwater and surface water resources may disappear during periods of drought, or be contaminated with silt and other sediments during storm events. It will be of critical importance to better manage and direct development in areas where water resources are not deemed to be at high risk, or where water resources are considered adequate to provide the flexibility needed in the face of current and future uncertainty. Management or direction in this regard, should be pursued at a regional scale and could be addressed as part of a Regional Growth Strategy or through Smart Planning (formerly known as Integrated Community Sustainability Planning).

2.6 Watershed Management Planning

"Government will support communities to do watershed management planning in priority areas."
(Living Water Smart Plan, 2008; BC Government Position)

Changing land use resulting from urban, agricultural and industrial development is altering use patterns and impacting water resources. Climate change will intensify these stresses as it alters the intensity and distribution of rainfall and affects temperature. Ensuring the viability of our watersheds is vital to the future of heath and the security of our environment and economy.

Watershed management involves an effort to coordinate and integrate natural resource based programs, tools, resources and needs of multiple stakeholder groups within a watershed to conserve, maintain, protect and restore habitat and water quality (Department of Conservation and Recreation, 2003). A watershed management plan is a detailed vision and strategy, usually at the watershed level, to achieve watershed management. Often initiated by local governments in conjunction with other local planning efforts, watershed management planning identifies specific actions to restore habitat and water quality, lands for conservation and development, and ways to reduce non-point sources of pollution (Department of Conservation and Recreation, 2003).

Local governments throughout BC are actively pursuing these types of endeavours. For example, the Capital Regional District (CRD) recently announced that it is purchasing a total of 9,723 hectares of land from TimberWest Forest Corporation to protect the future of the region's drinking water supply. With this purchase the CRD will manage nearly 20,000 hectares of land dedicated to the protection of the region's water supply. The purchase also allows the CRD to avoid substantial future capital costs of more than $150 million associated with the construction and operation of a new water treatment facility (Capital Regional District, 2008a).

Managing water at the watershed scale is paramount in protecting ecosystem health and reducing the costs of providing municipal and industrial water needs. Water does not adhere to political boundaries and must be managed within an integrated watershed context. In many areas, water quality or scarcity is leading to competing interests for water resources. This is increasingly becoming a limiting factor to sustainable growth and prosperity. When watersheds are at capacity to assimilate the various human impacts, a failure to balance water demands and risks results in poor allocation of water. In turn, this reduces our ability to optimize benefits from the resource.

Watershed management planning involves consideration of air, land and water living organisms, including humans, as well as the interactions among them to achieve specified and integrated outcomes. At the core, a watershed management approach to community planning is focused on the protection of people and property from natural hazards, the preservation and conservation of self-sustaining ecosystems, continuation and growth of resource based economic activity, and the provision of an affordable, sustainable, and maintainable infrastructure (GVRD, 2002). Decision making needed to achieve this approach is dependent upon inclusion of the following:

- Incorporates science-based, local and cultural knowledge about the physical, biological and human processes and their relationships.
- Relies on the precautionary principle to growth management and daily human activity decisions which affect environmental health, ecosystems and resource production capability.
- Demonstrates an understanding of achievable and effective outcomes as acknowledged by setting effective realistic and reasonable goals referenced by specified timelines.
- Careful and thorough assessments of the distribution of costs and benefits of planning and regulatory goals, objectives, policies and programs.
- Encourages fair and equitable use of regulatory, voluntary, incentive and public investment approaches to the achievement of public and private interests.

Regional Context.

The identification and prioritization of watersheds (and/or aquifers) is the first step in considering the development of a watershed management plan. Watershed boundaries in the RDCK and the total volume of water licensed per watershed are delineated in the maps in Appendix A. The process for prioritization for protection and management should take an approach that combines watershed significance with 'at risk' factors, whereby watersheds could be evaluated against the following criteria:

- Size, rate and type of land use change / development pressure;
- High risk of surface or groundwater contamination / existing or future hazardous land uses;
- Source of water for local food production;
- Overlaps or contains significant aquifer recharge areas;
- Significant fisheries and or wildlife values;
- Area under jurisdiction or influence of the RDCK;
- Drinking water source;
- Funding availability to support development of a watershed management plan (Lanarc, 2007).

The prioritization process should also consider both the ‘relative importance’ of the resource being affected, and the ‘severity and consequences’ of the impact. Those regions with both high importance and current or potential high impact would become the first priorities for watershed management plans (Lanarc, 2007). Engaging with experts and officials with local knowledge of the region to work together in prioritizing watersheds or parts of watersheds is important to ensure a sound knowledge-based process prevails and also encourages buy-in from all the players. This could be achieved by hosting an interdisciplinary roundtable session where participants would indentify the watersheds with high value natural resources, potential changes in land use or development that may affect these resources, and the relative scope of the perceived risks. High risk areas may be an entire watershed, a drainage basin, or encompass numerous watershed areas (De Loë, 2008).

2.7 Building Partnerships

“Government will work with other provinces to share ideas and resources to improve water conservation and collectively help communities adapt to climate change.”
(Living Water Smart Plan, 2008; BC Government Position)

Creating an action based Regional Water Plan requires the support and cooperation of various public and private partners. Most communities’ source areas lie partially, if not entirely, outside of their jurisdiction and, in other cases, cross multiple jurisdictions. Few water suppliers and agencies have the authority to control activities on land in their source area, but most have the ability to plan and partner with other agencies, communities, and stakeholders who can directly influence land use and land management activities. Source water protection can be achievable and effective when you influence others to act on your behalf, utilize existing initiatives and frameworks, and find common goals with others to build partnerships (Ernst, 2004).

Further, communicating and sharing ideas and experiences in the management, protection and restoration of watersheds from around Canada and abroad can help us to improve the way we deal with water. Incorporating and making effective use of scientific findings when developing water management decisions is paramount. It is important to note that a substantial amount of scientific information about rural watersheds is present in various NGO and government reports. Drawing on this information and building upon it can be a positive first step in conducting a comprehensive evaluation of all relevant information compiled about individual watersheds.

Regional Context.

The RDCK has little or no jurisdiction over a number of factors that affect watersheds and water supplies, including surface water allocation (licensing), forestry, roads and highways, recreation, mining, and pollution control. Management of these activities are spread across a number of agencies and ministries, often resulting in a disconnect between the authorities.

Climate specialists, local water managers, hydrologists, regional and municipal governments, community members, environmental interests, economic sectors including forestry, agriculture, power producers and tourism, and social sector representatives from public safety, health and education must be participants in the dialogue and decision making processes about water systems management and addressing climate change impacts and other challenges and impacts to water resources. At the outset, discussions need to explore the options that exist, what further information is required; the existing institutional, political, or practical barriers present, and include consideration of pressures derived from sources other than climate change.

Regional water planning can provide a framework in which to coordinate existing land use policies, whether done as a component of a locality's comprehensive OCP or zoning plan, and to coordinate multi-jurisdictional planning efforts. Many agencies already have the pieces that can form the foundation for a Regional Water Plan; the plan itself can tie together local efforts.

To be effective, any future actions proposed should occur in partnership with other government agencies, the private sector and volunteers. As previously reported, responsibilities for watersheds and safe drinking water supplies are shared among many players, and cooperation among all parties is needed. By thinking outside the box and developing shared leadership, improved approaches to water supply systems management can be realized.

3.0 Inventory of Maps and Data

3.1 Understand your Watershed

A watershed is the area of land that drains rainfall, snowmelt, sediment and dissolved materials to a particular water body, such as a stream, river, lake, reservoir or marine harbour (Capital Regional District, 2008). Watershed boundaries can be delineated on topographical maps by linking all the surrounding high points in the land, as shown in Figure 1. The dotted lines represent the watershed boundaries or 'divides'. All watersheds, regardless of size, consist of the basin within these boundaries and the surface water bodies. The physical characteristics of a watershed including the geology, soil, vegetation, slope, and human land uses influence the quality and quantity of the water that flows through it (Capital Regional District, 2008).

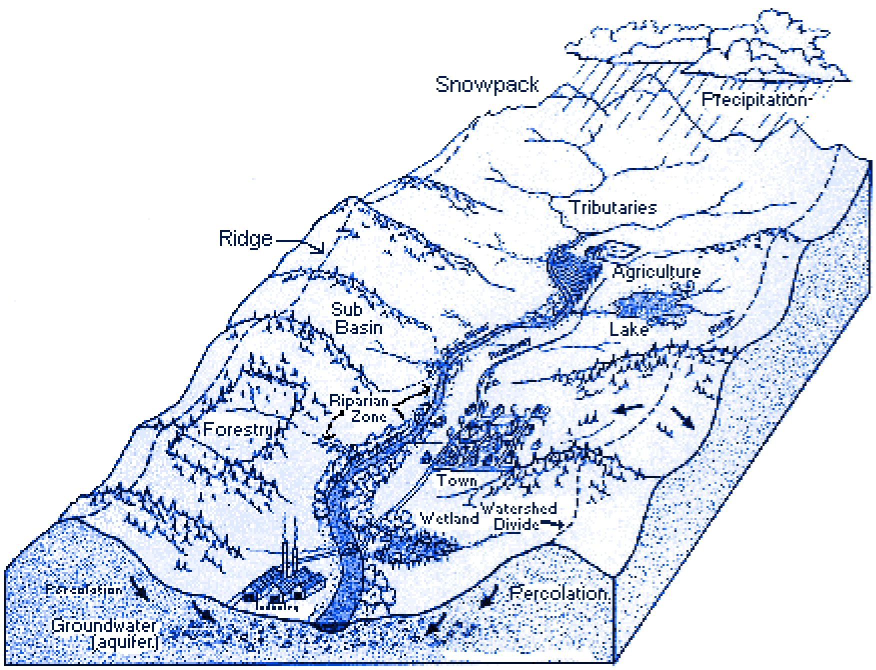

Figure 1.
Watershed Basics[5]

The first step in understanding a watershed is to compile existing information in order to determine the current and likely future threats to drinking water (Ernst, 2004). This understanding involves the collection and analysis of scientific data about source lands, land ownership, growth and development patterns, and the health of watershed lands. Water quality data is typically collected by more than one agency or NGO and analyses can be conducted to differing standards at the local, provincial, or federal level. Bringing

[5] From Capital Regional District, 2008, http://www.crd.bc.ca/watersheds/protection/watershed-basics/index.htm. Produced by Lane Council of Governments.

these varied sources of information together into one source water assessment for the region is needed.

Appropriate water quality monitoring is also an important aspect in understanding watershed health and tracking the impacts of changing land use on water quality (Ernst, 2004). Monitoring is a technical process that provides an indicator of watershed health, where land use is impacting water quality, and where conservation, restoration, or best practices are effectively mitigating those impacts (Ernst, 2004). Monitoring should include:

- Sampling on all primary tributaries in the watershed;
- Sampling at targeted sites to test the impacts of specific land use activities;
- Physical, chemical, and biological sampling methods;
- Monitoring during both wet and dry weather.

A monitoring program is most useful when implemented across all jurisdictions in the watershed in an effort to establish a baseline of past and current watershed health.

Data collected from different agencies could be consolidated and analyzed as a single resource. Working with existing data that is physically and readily accessible to the public, elected officials, and other stakeholders can facilitate in the creation of a shared understanding of current and future threats to water resources and can further lead to a shared commitment to action.

For the purpose of this project, no monitoring or sampling was conducted in any of the regional watersheds. Due to the time and resource constraints of this assignment, only a cursory spatial inventory of the water landscape has been completed. These data, analysis, and set of maps will serve as a sound foundation for future project phases and will help to inform decision making. The mapping products have been created based on the integration of a number of resources from the following agencies:

- Ministry of Forests and Range
- Columbia Basin Trust
- Regional District of Central Kootenay
- Interior Health Authority
- Ministry of Environment – Water Stewardship Division
- Ministry of Environment – Environmental Protection Division
- Natural Resources Canada
- Integrated Land Management Bureau
- Canadian Columbia River Intertribal Fisheries Commission

3.2 Baseline Maps and Models

Building an inventory of existing conditions, resources and impairments, as well as the relative conditions of each is a necessary first step in developing a Regional Water Plan in a watershed management context. Once created, an inventory of available data and data needs can help to identify watershed plan priorities. The inventory can be used to identify areas that require restoration or protection. It can also be a tool for evaluating costs and potential benefits of different watershed protection strategies.

The spatial inventory (Appendix A) compiled by RDCK staff includes the following data and maps:

1. Regional map of all water systems; highlighting RDCK and non-RDCK ownership;
2. Regional map of systems requesting RDCK ownership;

Requests to assume responsibility of water system
Armstrong Bay Improvement District
BC Hydro – Burton
BC Hydro – Edgewood
BC Hydro – Fauquier
BC Hydro – West Robson
Bourke Creek Improvement District
Davidoff Rentals, Well & Pumping System
Kingsgate Water Supply System
Orde Creek Improvement District
Playmor Utility Company
Poplar Ridge Water Users Society
Ridgewood Road Water Service (Shannon's Mobile Home Park)
Robson-Raspberry Improvement District
Rykerts Irrigation District
Woodbury Village Services Society
Woodland Heights
Wynndel Irrigation District

3. Regional map identifying major, community and 3rd order watersheds;
4. Regional map identifying 3rd order watersheds and total volume of water licensed per watershed;
5. Regional map of all existing water licenses and Points of Diversion;
6. Regional map identifying licensed water sources that have water allocation restrictions;
7. Regional map of water license applications in process;
8. Regional map of aquifers, aquifer classification and street addressing overlay;
9. Regional map of known groundwater wells, aquifers and aquifer classification;
10. Regional map identifying current and historical snowfall levels;
11. Regional map identifying areas that are experiencing increasing levels of development pressure;
12. Regional map highlighting location of water systems in relation to slide hazard areas, Non-standard flooding and erosion areas, and floodplain boundaries;
13. Regional map delineating extent of mountain pine beetle infestation and severity;
14. Regional map identifying watersheds with fisheries constraints issues (based on the *Columbia Basin Water Conservation Tools Project* prepared for the Canadian Columbia River Intertribal Fisheries Commission. Hard copy maps are not included in this inventory.)

GIS mapping analysis facilitates the creation of ranking systems and operational models that rank water systems or a given region based on a set of characteristics. As reported, the inventory (see Appendix A) and analysis completed in this phase of the project is limited. Further research, study and analysis needs to be undertaken to ensure that enough scientific information is available to support informed decision making. Details of additional work required are outlined in Section 4.

3.2 Evaluative Matrix

A matrix has been developed (Table 2) to serve as an evaluative tool for decision makers. This tool provides a framework for taking the mapped information (Appendix A) and evaluating it against the impacts and threats reported to begin the process of identifying problems that need attention and matters that will influence what will need to be considered in the future.

As an evaluation guide, the criteria elements have been defined and listed in addition to RDCK water systems and those requesting assistance from the RDCK. The matrix allows users to see the integration of the whole picture; the spatial landscape alongside the relevant issues, and facilitates the evaluation and ranking of each system against a set of stated parameters. Utilizing such a framework can result in better and informed scientific based decision making.

Table 2. *Evaluative Matrix**
(* Evaluation not complete for each system; table to be used as a guideline)

RDCK Water System	Parameters / Elements											
	Zoning / Land use Planning	Facing Development Pressure – system adjacent to high subdivision area	Water source has allocation restrictions	Adjacent to existing water supply system or Municipality	Within slide hazard area	Within Alluvial Fan (NSFEA)	Close proximity to Very Severe, Severe, or Moderate Pine Beetle activity (2007)	Aquifer presence and aquifer classification	Conservation measures in place (i.e. metering, restrictions)	On boil water notice / advisory (as of January 3, 2008)	Watershed flagged as having fishery constraints issue	Capacity to expand and bring in surrounding areas
Arrow Creek	Yes					Partial			No			
Denver Siding	No	Yes				No			No	Boil Water Notice		
Duhamel	Yes					Partial			No			
Erickson	Yes					Partial			No			Yes
Lister	Yes					No			No	Boil Water Notice		
Lucas Road	Yes					No			No			Potential to amalgamate with Castlegar
MacDonald Creek	No	Yes				Partial			No			Potential to amalgamate with Kaslo WS
Riondel	No					Partial			No			
Sanca Park	No	Yes				Yes			No	Boil Water Notice		
South Slocan	No					No	Moderate		No	Boil Water Notice		
Ymir	Yes					Partial			No	Boil Water Notice		
Systems requesting assistance												
Armstrong Bay Improvement District	No					No				Boil Water Notice		
BC Hydro – Burton / Edgewood / Fauquier / West Robson	Yes / Yes / Yes / ?					No / Yes / Partial / ?						
Bourke Creek Improvement District	Yes	Yes		Yes – Clayton Creek, Sitkum Creek		Partial	Moderate, Severe			Boil Water Notice		
Davidoff Rentals, Well & Pumping System												
Kingsgate Water Supply System												

Orde Creek Improvement District	Yes	Yes				No				Boil Water Notice		
Playmor Utility Company	Partial – S ½ only	Yes				No						
Poplar Ridge Water Users Society	No					No						
Ridgewood Road Water Service (Shannon's Mobile Home Park	Yes	Yes				No	Moderate					
Robson-Raspberry Improvement District	Yes	Yes				Partial				Boil Water Notice		
Rykerts Irrigation District	Yes					No				Boil Water Notice		
Woodbury Village Services Society	No					No						
Woodland Heights	Yes					No						
Wynndel Irrigation District	Yes					Partial						

4.0 Next steps

This paper has revealed a number of challenges and potential impacts to water supply systems requiring attention in order to achieve the sustainable management of water service areas in the RDCK. Though current and future economic, environmental, and social problems exist, there is now an opportunity to move towards a more sustainable approach for water service delivery and management. A baseline and cursory inventory of the regional water landscape has been completed. Further spatial research and GIS analysis is needed to support scientific based decision making. Increasing communication, collaborating with other agencies, building partnerships, and thinking watershed-wide are required if we are to affect positive change. A change strategy would engage all stakeholders in developing shared and integrated approaches and actions to deal with the challenges we face.

4.1 Future Considerations

4.1.1 Short Term.

Until a comprehensive Regional Water Plan for priority areas has been completed, the RDCK is not in a position to take on any new water systems given the current level of personnel and resources. A work plan and project schedule should be developed with external stakeholders engaged to support the project. The Columbia Basin Trust has indicated that they may be in a position to support further development of the Regional Water Plan.

A resource planning document will be developed in parallel with this document to ensure that the acquisition of additional water systems into the RDCK is supported by proper resources. Both the Regional Water Plan and the Resource Planning Document are important to ensure the long term vitality and sustainability of RDCK owned water systems.

The work plan and project schedule will be presented and included during budget discussions. A working Regional Water Plan can be developed by the end of 2009 with Board and external stakeholder support.

4.1.2 Long Term.

It is important to recognize that the purpose of this planning process was originally grounded in the acquisition of additional water systems requesting RDCK assistance. In the past the systems that the RDCK has assisted did not have a plan for long term vitality or sustainability, creating many challenges for the Regional District. The challenges that some systems are now facing are bringing to light the need to have a Regional Water Plan that is founded in the watershed. In that context it is important to acknowledge the benefits of partnering with external stakeholders. Opportunities to partner with Columbia Basin Trust and draw on Learning Network for *Communities Adapting to Climate*

Change[6] members to continue this process should be explored. The following aspects should be addressed in this planning process as it evolves:

- Build partnerships via facilitated discussions with key stakeholders including researchers, decision makers and practitioners (Interior Health Authority, Ministry of Environment, Integrated Land Management Bureau, Selkirk College Geospatial Centre, Department of Fisheries and Oceans, Small Water Users Association, Columbia Basin Trust, RDCK Engineering and Environmental Services staff, and water stewardship NGO representatives) with a shared commitment to improving water management.
- Improve awareness of our valuable water resources by coordinating efforts and activities with School Districts, and support community stewardship groups that are already running information programs, to make best use of available expertise and resources.
- Develop a strategy that identifies the potential impacts of climate change on aquifers and water service areas in the region.
- Work to better understand the risks and adaptive capacity of human systems to climate change impacts.
- Encourage a shift to and support watershed and basin-wide thinking. Environmental elements and impacts in RDCK are connected and decisions and actions taken have impacts throughout the entire watershed.
- Build on existing knowledge about current and future supply limits; anticipated demands through population and economic growth, ecological limits, and financial impacts of water shortages on the social and economic well-being of a region.
- Establish thresholds and undertake further study into identifying the carrying capacity of an area.
- Embed performance planning and adaptive management into future work by clearly defining performance targets and a commitment to achieving these. Monitor and report on these commitments and successes from the regional to the site level.
- Expand and refine parameters in the Evaluative Matrix as changing conditions and information warrant.
- Adapt to evolving conditions and make adjustments in response to experiences. This process facilitates continual learning.

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[6] A Columbia Basin Trust program, Communities Adapting to Climate Change is an initiative that aims to help Basin communities increase their resiliency to climate change at the local level. It will do this by identifying the range of potential impacts, assessing local vulnerabilities and sensitivities, and developing adaptation strategies for addressing climate change impacts (http://www.cbt.org/climatechange/adaptation.asp).

4.2 Additional or New Data Collection

As the process evolves there will be a need to partner with external stakeholders and collect additional data and information. Some possible gaps in the information are as follows:

1. Incorporate new scientific information and external study findings to refine and improve upon the analysis of critical areas that are at risk to climate change.
2. Analyze the timing, frequency, and intensity of past summer rainfall and winter snow events to explore the relationship with increases in wildfire, drought and precipitation.
3. Develop climate projections and scenarios (seasonal, annual) for temperature; precipitation; snowpack; snowline; intensity and frequency of extreme weather events (i.e. heat, precipitation, wind, storms, soil moisture, relative humidity, role of El Nino/ el Nina/ multi-decadal pacific oscillation).
4. In consultation with appropriate agencies, identify potential aquifer recharge areas, discharge areas (including springs) and evaluate against water systems spatial data to support future interpretation of relationships between surface water basins and aquifer recharge rates.
5. Extend and enhance GIS analysis to further identify varying degrees of water allocation and use conflicts within watersheds.
6. Data on streamflow levels, groundwater resources, and water use levels by various end users.
7. Map and model the quantity and quality of at-risk surface and groundwater resources and provide results in a form that is accessible to regional, local, and community members.
8. Acquire spatial extent and evolving projections of Mountain Pine Beetle infestation in the region.
9. Further historic data (seasonal, annual) in temperature, precipitation, snowpack and wind.
10. Identify demographic trends and projections and explore geographical relationships between water sources and water demand.
11. Develop potential future scenarios for future human water use.
12. Obtain regional information on the state of conservation measures such as pricing, reuse and recycling.
13. Local species inventory (flora and fauna).
14. In-stream flow and temperature requirements for local fish populations.
15. Long term energy price forecasts.
16. Projections on future fire frequency, length and timing of fire season.
17. Prepare tables/graphs from existing data to show trends.
18. Identify data gaps and set priorities for acquiring additional data.

Glossary

Adaptation - Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Capacity building - In the context of *climate change*, capacity building is a process of developing the technical skills and institutional capability in developing countries and Economies in transition to enable them to participate in all aspects of adaptation to, mitigation of, and research on climate change

Climate baseline – Average climate during a historical reference period, usually a 30-year period.

Climate change - Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may result from natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that United Nations Framework Convention on Climate Change, in its Article 1, defines "climate change" as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". *United Nations Framework Convention on Climate Change* thus makes a distinction between "climate change" attributable to human activities altering the atmospheric composition, and "climate variability" attributable to natural causes.

Divide - marks the high point of land that separate one watershed from another.

Mitigation - An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases. Refers to actions that will reduce the sources or enhance the sinks of greenhouse gases emissions.

Mitigative capacity - The social, political, and economic structures and conditions that are required for effective mitigation.

Natural capital – The stock of natural resources, environmental and ecosystem resources, and land. It is capital in the sense that these resources are assets that yield goods and services over time. Protection and enhancement of natural capital will improve water quality and decrease water treatment costs, increase recreational opportunities, mitigate flooding, decrease net greenhouse gas emissions, lower dredging costs of waterways, improve air quality, provide habitat, sustain food production and produce many more tangible and intangible benefits to society (http://www.ducks.ca/aboutduc/news/archives/pdf/ncapital.pdf).

Resilience – The amount of change a system can undergo without changing state. It refers to biophysical and socio-economic abilities to recover from and/or adjust to the impacts of climate change. For example, mature forests are most likely to be able to withstand the additional stress brought by climate change.

Sequestration - The process of increasing the carbon content of a carbon *reservoir* other than the atmosphere. Biological approaches to sequestration include direct removal of carbon dioxide from the atmosphere through land-use change, afforestation, reforestation, and practices that enhance soil carbon in agriculture. Physical approaches include separation and disposal of carbon dioxide from flue gases or from processing fossil fuels to produce hydrogen- (H_2) and carbon dioxide-rich fractions and long-term storage underground in depleted oil and gas reservoirs, coal seams, and saline aquifers.

Snowfall – represents the amount of precipitation falling as snow

Snowpack – the amount of snow that accumulates on the ground

Socio-economic potential - The socio-economic potential represents the level of GHG mitigation that would be approached by overcoming social and cultural obstacles to the use of technologies that are cost-effective. See also economic potential, market potential, and technology potential.

Watershed – A watershed is the area of land that drains rainfall, snowmelt, sediment and dissolved materials to a particular water body, such as a stream, river, lake, reservoir or marine harbour. Watershed boundaries can be drawn on topographical maps by linking all the surrounding high points in the land. All watersheds, regardless of size, consist of the basin within these boundaries and the surface water body (or bodies). The physical characteristics of a watershed – the geology, soil, vegetation and slope, as well as human land uses – influence the quality and quantity of the water that flows through it.

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Appendix A – Water Landscape Inventory Maps

See PDF Maps.