WATER QUALITY AND SOURCE WATER PROTECTION: ISSUES AND STRATEGIES IN THE KETTLE RIVER WATERSHED

DISCUSSION PAPER FOUR – JULY 24, 2014

Regional District of Kootenay Boundary

Kettle River Watershed Management Plan

The Kettle River Starts Here

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Cover Photo: "Spring Run-Off, Mt. Cochrane" – Courtesy Stacy Metcalf [26]

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1 Introduction

The Regional District of Kootenay Boundary is developing a watershed management plan for the Kettle River in Canada. This plan will consider issues and develop strategies and actions related to water quantity, water quality, and aquatic ecosystems, across the Kettle River watershed.

The Watershed Management Plan is supported by a Stakeholder Advisory Group (Advisory Group) representing a broad range of interests from across the Boundary and beyond. In the spring and summer of 2014, we are sharing the ideas that are being considered for the Kettle River Watershed Management Plan, with the intent that community members participate in the conversation.

The purpose of this discussion paper is to outline issues, strategies and actions related to water quality and drinking water source protection. The paper builds on ideas discussed in previous papers, in particular "Discussion Paper 1: A Vision for the Kettle River Watershed" [43] and "Discussion Paper 2: Working together - Growing our capacity for watershed stewardship in the Kettle River" [46]. Water quality is also tightly linked to issues of water supply and conservation (Discussion Paper 3 [16]) and riparian, wetland and upland functions (Discussion Paper 5, forthcoming).

The strategies and actions discussed in this paper have been reviewed by the Stakeholder Advisory Group and are the basis for further discussion by the community before we finalize the draft Kettle River Watershed Management Plan.

2 Water Quality & Source Water Protection Issues

2.1 Introduction to Water Quality

As identified in the results of a Boundary-wide survey [45], residents of the Kettle River Watershed have expressed a number of concerns about water quality and the safety and security of their source waters. However, many respondents also noted they had very little information about water quality.

As one respondent declared, "Water is life"[45]. Clean, reliable water is seen as the foundation for living in this watershed. In the survey, the quality of water in the Kettle River and aquifers was a major concern for residents. The phrase 'water quality' was mentioned over 80 times by respondents, and related issues such as pollution, dirty runoff, and unclean water were noted hundreds of times.

Water quality is intuitively understood to mean the cleanliness and safety of water for drinking, recreation, and other purposes. In this sense, the quality of water can determine its use – drinking water may be used for irrigation but irrigation water may not be suitable for drinking [11].

Scientists also describe water quality in terms of its physical, chemical, and biological characteristics – quantities of fine sediments, dissolved substances, or pathogens. These characteristics determine the suitability of water for various human uses and the health of organisms in the environment.

Suitability is described by water quality guidelines and standards for uses such as drinking water, the protection of aquatic life, or contact recreation (swimming). Canada has established water quality guidelines that provide information on the levels of chemicals and other measurements that are not likely to be harmful for drinking water, aquatic animals, stock watering, or other uses such as irrigation or recreation [7,20].

Ideally, water bodies and aquifers are regularly sampled for major water quality parameters. Scientists can then calculate an 'index' that reports on how often these guidelines are exceeded. A water quality index has been developed in Canada to summarize water quality and communicate it to general users [6]. Using regular sampling at suitable locations, water quality is rated as poor, marginal, fair, good, or excellent.

Within each watershed, governments or local organizations can move beyond guidelines to develop site-specific water quality objectives to protect different uses of water. The following is a general process to determine water quality objectives:

1. Identify water quality-dependent uses and desired outcomes relevant to the overall watershed;
2. Divide the watershed and main rivers into sub-watersheds, aquifers and reaches (completed for the Kettle River in Phase 1);
3. Identify capacity and potential uses of water and outcomes for each reach and aquifer;
4. Evaluate available data and select measurable indicators for each use; and
5. Develop narrative and numerical objectives for each indicator using historical monitoring data and published water quality guidelines (completed for Christina Lake) [24,27].

In the Kettle River watershed, residents and stakeholders have placed the highest priorities on protection of the aquatic ecosystem, domestic/drinking water use and food production [16,44]. As aquatic ecosystem protection and drinking water uses are the most sensitive to water quality degradation, addressing water quality problems for these areas has an 'umbrella effect' in protecting other uses as well.

2.2 What we know

A great deal is known about the water quality in the lower portions of the Kettle River near the border with the United States and in the Grand Forks Aquifer. However, less information is available for water quality in the upper watershed, the tributaries and in other aquifers and water sources [37].

2.2.1 Surface water

Our understanding of water quality in the watershed is well served by regular monitoring at the Canada-B.C. sites, Christina Lake, and near the wastewater treatment plants. However, most of the data are concentrated in the lower third of the watershed. Less is known about water quality in tributaries, although there are data from the West Kettle River and other locations related to periods when mines were operating.

Most of the drinking water supply in the Kettle River watershed is now from groundwater, but several water suppliers still rely on surface water sources (i.e. Big White, Christina Lake). In addition, there are numerous licensed (and unlicensed) individual domestic surface water intakes outside of community watersheds.

Some protection for source waters is intended to be provided by designation as a community watershed. However, the effectiveness of this designation has been questioned by a recent special investigation of the B.C. Forest Practices Board [14], which found issues with sediment pollution caused by roads and bridges.

Surface water is generally more at risk from sediment and pathogens than groundwater, so surface water sources require assessment, protection, and sometimes filtration before treatment that takes into consideration the issues affecting the source water. Sediment often carries other pollutants (nutrients, heavy metals, and bacteria), and makes it harder to treat drinking water from surface sources.

In the Canadian portion of the watershed, surface water quality is sampled every two weeks near Midway and Carson (upstream of Grand Forks) by the Canada-B.C. water quality monitoring program [10]. The most recent B.C. Ministry of Environment report (2009) concluded that water quality was similar at both sites and was “generally good,” although some years were in only fair condition.

Measurements that have exceeded guidelines include temperature, dissolved fluoride, and a number of metal concentrations such as aluminum, cadmium, chromium, and iron. There are *increasing* trends at one or both sampling sites for turbidity (muddiness), total hardness, phosphorus, molybdenum, dissolved chloride, dissolved fluoride, and fecal coliforms. *Decreasing* trends were found at one or both sites for total colour, specific conductivity, and several metals (notably aluminum, chromium, copper, iron, lead, manganese, nickel, and zinc).

Between 2000 and 2008, counts of fecal coliform bacteria increased significantly at the Kettle River water quality monitoring sites, particularly at the Midway water quality station. Fecal coliform counts were above water quality guidelines for drinking water during spring freshet in 2006 and 2007 [10].

The overall chemical composition of water bodies in the region is largely determined by geochemical influence on groundwater and weathering of minerals, with some inputs from atmospheric deposition and human activities [19].

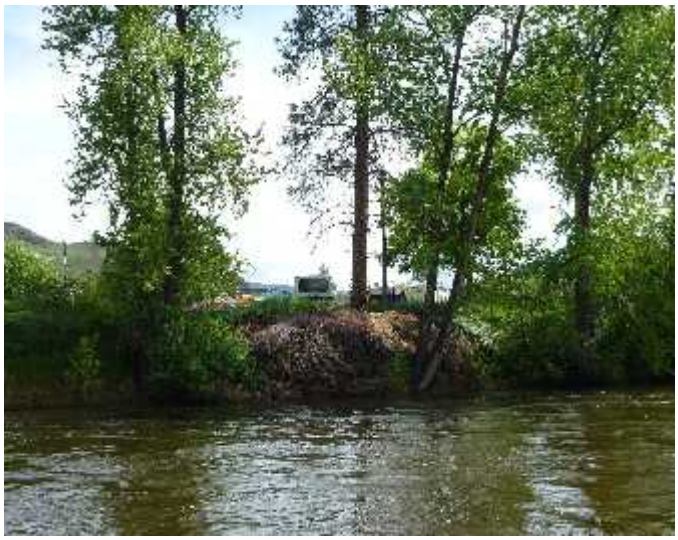

Figure 1. Dumping of landscaping materials can pollute waterways (Graham Watt)

In Washington State, water quality in the Kettle River is sampled at various locations in tributaries and major water bodies, with a long-term station at Barstow (downstream of the border crossing near Christina Lake) [42]. Washington State Department of Ecology has noted water quality at Barstow is of 'moderate concern,' with moderate scores regularly recorded for oxygen, suspended solids, temperature, total phosphorus, and turbidity, and poor scores sometimes recorded for temperature, suspended solids, and turbidity. Additionally, Curlew Lake (north of Republic) has repeatedly been listed as impaired and requiring action to reduce phosphorus [41].

Water quality in Christina Lake is regularly monitored by the provincial government and the Christina Lake Stewardship Society because of its value for aquatic life, community primary drinking water source, and recreation. Site-specific Water Quality Objectives (WQO) have been set to guide management [37].

The most recent published report (2006 data) found that the WQO in Christina Lake were met 97% of the time, with minor departures from objectives for dissolved oxygen and Secchi depth [34]. The water quality rating score was 85%, giving a water quality ranking of "good." Water quality objectives are reported on at the Christina Lake Stewardship Society Annual Watershed Review.

2.2.2 Aquatic ecosystems issues

Water quality issues vary widely between different regions and water bodies and change over time. For instance, increased nutrients such as phosphorus and nitrates in Prairie and Midwest landscapes cause eutrophication and toxic algae blooms in inland waters and oceanic dead zones in the Gulf of Mexico [1]. On the other hand, a lack of nutrients caused by reservoir development in the Kootenay River watershed has led to targeted lake fertilization to increase fisheries productivity [4].

Within the Kettle River watershed, major water quality issues affecting aquatic ecosystems and fish are temperature and sediment / particulate matter, with some concern over bioaccumulation of metals.

High temperatures (19-25 °C) are sub-lethal to lethal for salmonids such as rainbow trout (*Oncorhynchus mykiss*) [12], and occur regularly in the Kettle River in late summer. While higher water temperatures occur in later summer during low flow, water temperature is mostly related to air temperature, not flow volume [12]. When water is warm and moving slowly, dissolved oxygen also becomes low, further impacting fish health. Low dissolved oxygen levels have been noted at Barstow, but are not recorded regularly at Midway and Carson water quality stations. The effects of global warming on summer water temperatures, habitat quality, fires, and other pressures are expected to further stress trout and overall aquatic ecosystem health [23,36].

Sediment is a naturally-occurring material broken down by erosion from ice, wind, or water. It ranges in particle size from less than a micrometre for clay mud to greater than 256 mm for boulders [38]. Fine sediment (clay, silt, and fine sand) can be carried easily in stream currents as suspended sediment. It can be measured by filtering water or estimated by examining the scatter of light, or cloudiness, in water (turbidity).

Sediment is a good indicator of watershed health as it responds to changes in land management and disturbance. It is also associated with other water quality issues such as heavy metals and pathogens, and strategies to reduce erosion would help improve many other aspects of surface water quality. There was a small but statistically significant increase in fine sediment (turbidity) between 1990 and 2008 at the Canada-B.C. water quality monitoring station at Midway [10].

Increases in suspended sediment can degrade fish spawning areas and directly harm fish, mussels, and aquatic invertebrates. Spawning gravels can become clogged with silt, reducing oxygen and clean water flow for developing eggs. Fine sediment can also irritate fish gills and cause mussels to stop feeding.

Water quality issues such as metals are often associated with sediment during spring freshet, and have been assumed to be unavailable for uptake by aquatic life [10]. However, questions remain about the effects of sediment and metals on filter feeders like mussels and other invertebrates, and further testing of metals in mussel and fish tissue has been recommended following evidence of uranium and metal bioaccumulation in mussels at sites along the main stem of the Kettle River [17,18].

Larger sand, gravel, cobble and boulders that are moved during higher flows are called ‘bedload’. Bedload moves slowly through river systems, often taking decades to move from landslides through river valleys. Increased bedload can raise the elevation of the river bed (aggradation), fill in deep pools

needed by fish. It also leads to widening and braiding of the river channel, causing more loss of property and roads along the river as well as increased sediment, a vicious cycle.

There are no measurements of coarse sediments in the Kettle and Granby rivers, but recent observations of erosion, braiding and widening channels on the Kettle and Granby Rivers suggest increasing bedload and aggradation [29]. Further studies will be required to examine the sources of sediment and geomorphological effects in the rivers.

2.2.3 Groundwater

Relative to other watersheds in southern B.C., groundwater makes up a significant proportion of agricultural and domestic water use in the Kettle River watershed. The Phase 1 Report found over 1,400 local wells in the provincial well database [3,37]. However, as registration is voluntary the number of active, abandoned, and closed wells is certainly much higher. About half of the known wells are in the Grand Forks area.

There are 15 mapped aquifers in the watershed, all associated with the valley bottoms where industrial and agricultural activities and communities are concentrated. Shallow sand and gravel aquifers such as those in Grand Forks, Midway and Beaverdell are particularly at risk from contamination by intensive agriculture or poorly managed septic systems [47,48].

Most of the mapped aquifers are in sand and gravel deposits and are ranked as having moderate to high productivity and moderate to high vulnerability to contamination from surface activities. The demand on these aquifers is either low or moderate, except the Grand Forks aquifer where demand is high. Because of this high vulnerability and demand, the Grand Forks aquifer has been studied in detail over the past 20 years [48]. Little is known about aquifers in other parts of the watershed.

Nitrate has been the contaminant of greatest interest both because of potential human health effects, and because it is mobile in groundwater and therefore an indicator of the potential presence of other contaminants that originate on the surface. Residents of Grand Forks and the surrounding rural areas have been concerned about nitrate since testing in the 1980's showed high levels (above the 10 mg/L drinking water quality guideline) in the Nursery and east Carson Road areas.

Recent studies revealed that nitrate levels are decreasing in Grand Forks municipal wells and do not pose a health risk [8]. Similarly, in the rural area surrounding Grand Forks, nitrate levels are stable or gradually declining, according to a 2011 study by the Province of B.C. [32].

Continuing the ambient groundwater quality network as well as testing of additional private wells would be valuable to detect future changes in nitrate concentrations and other contaminants [37]. Information on other contaminants and pathogens is not sufficient to draw spatial patterns or trends, and there is no available information on levels of pesticides in higher intensity agricultural areas.

2.3 Source water protection overview

Source water protection is the management of aquifers and watersheds for the protection of drinking water supplies and other human uses [28,33]. It is the first step in the 'multi-barrier' approach to drinking water management that helps ensure high quality water that is free of disease-causing organisms and chemicals known to cause health problems, and is aesthetically acceptable [13].

Many parties are responsible for the protection of surface and ground water quality in B.C., including the provincial government, regional health authorities, local government, water suppliers, and individual well and land owners. Description of all of the components of source water protection are beyond the scope of this document, but can be found in provincial and federal guidance documents [13,33,35].

Source water protection is ideally nested within watershed management planning because achieving water protection outcomes aligns well with many other watershed management initiatives. For example, Simms and others [33] identify seven aspects of source water protection that inform and depend on watershed management:

- *Surface and groundwater protection* includes tools and plans that decrease contamination risks, improve water quality and safeguard water quantity;
- *Drinking water and wastewater management* includes treatment of raw water to drinking water standards and releasing wastewater (including stormwater) at an acceptable quality;
- *Wetland and aquatic ecosystem protection* includes conserving and restoring wetlands and riparian areas to filter reduce sedimentation, filter contaminants, and provide source protection services;
- *Point source pollution management* includes prevention of pollution from point locations (such as outfalls) using approvals, reporting requirements and zoning by-laws;
- *Land use planning* addresses links between land use practices and contamination or insufficient supply using zoning, development permit areas and regional growth plans;
- *Management of land use impacts* from various resource management and industrial activities includes environmental assessments, land reclamation/restoration and approvals; and

- *Land stewardship* includes conservation, protection and restoration of lands in support of water quality and healthy ecosystems through protected area designations, conservation easements, and incentive programs for voluntary actions.

Under the B.C. *Drinking Water Protection Act* [30], a water source and system assessment may be required by a drinking water protection officer [15]. This assessment typically inventories risks to water sources from land uses and activities, the state of the water supply system, monitoring requirements, and current and future threats.

If this assessment finds issues with the water system, a drinking water protection officer may order a water supplier to complete an Assessment Response Plan to respond to identified threats. These may include: increasing public engagement and awareness; preparing and distributing guides to best management and conservation practices; infrastructure improvements; and land use regulations [15].

The B.C. Ministry of Health considers wells to be at risk if they are located in **g**round **w**ater that is **u**nder the **d**irect **i**nfluence of surface water (GWUDI), meaning hydraulically connected to nearby surface waters and susceptible to contamination by pathogens [5]. A multi-stage screening, assessment, and monitoring procedure allows the drinking water officer to determine if the **g**round water source is **a**t **r**isk of containing **p**athogens (GARP), which may lead to the water supplier being required to treat the water, relocate the well, or take other action.

Through land use planning, local governments have a major role to play in protecting groundwater quality on private lands [21]. For instance, restricting residential development in rural areas can reduce the risk of contamination by septic systems, and controlling industrial and intensive agricultural activity over groundwater recharge areas can limit contamination by chemicals, pathogens, and excess nutrients.

However, it may be more difficult for local government to control risks to groundwater quality due to management practices within different land use zones or on public land. This is because responsibilities for regulating various land management *practices* affecting water quality resemble a patchwork quilt of laws and regulations across multiple agencies in different levels of government. It is therefore especially important for source water protection planning to incorporate the range of resource management activities in a given watershed as part of a comprehensive watershed management plan.

> *"Abandoned wells can provide a direct conduit into the aquifer for any contaminants that may be present at the wellhead. If abandoned wells are left without being deactivated or closed, they may become… forgotten over time* (Wei and others [48] – p. 65)

There are several ways landowners can protect groundwater and surface water sources. For instance, reducing fertilizer

use, conserving water, managing manure properly and building soil health can reduce leaching of chemicals and nutrients. Following septic system regulations, siting wells properly and ensuring proper closure can also reduce the chance of contamination.

Healthy riparian vegetation buffers, wetlands and related upland areas are also very important in filtering polluted runoff and protecting water bodies from erosion and sediment [2,9]. Maintaining and restoring riparian vegetation depends on the active participation of landowners, farmers, industry, and all levels of government, which will be addressed further in Discussion Paper 5.

For several years (prior to 2010) the Grand Forks Aquifer Protection Society led efforts to study the Grand Forks Aquifer and implement aquifer protection and management actions. Stakeholders have indicated an interest in reconvening the Aquifer Protection Society to undertake aquifer management actions as part of implementing the Kettle River Watershed Management Plan.

3 PROTECTING AND IMPROVING WATER QUALITY

3.1 Outcomes

In Discussion Paper 1 [43], the Advisory Group proposed goals relating to water quality and source water protection based on input from community members: "Excellent water quality (supporting healthy aquatic ecosystems)," "Safe and secure drinking water," and "Adequate water quality to support current and future uses." Achieving these goals will require commitment to two broad water quality outcomes, **no further degradation** and **continual improvement.**

The first broad outcome is no further degradation of water quality. This means that communities must do everything they can to stop increasing impacts from point-source and non-point source pollution[1] on drinking water sources, fish and aquatic life, and enjoyment and other uses of water bodies in the Kettle River watershed.

The Advisory Group understands that making informed decisions about water quality requires relevant, up-to-date information supported by a long-term monitoring system. Therefore, they recommend improving knowledge about water quality conditions in the watershed, developing and implementing water quality objectives [27], and reducing pollution by adopting beneficial management practices and continuing to improve industrial and wastewater practices.

Where monitoring shows that these water quality objectives are not being met, the provincial and federal governments need to work more closely with sectors whose practices affect water quality, providing a strong regulatory 'backstop' to hold significant polluters responsible for both point-source and nonpoint-source pollution. Where policy changes and budget restrictions have decreased the effectiveness of regulation to the point that streams are becoming degraded (see Pynn [31] or

Outcomes

- Water quality is rated good or better for all index parameters
- Surface and groundwater sources are drinkable with minimal source treatment for surface water and no source treatment required for groundwater
- No further impacts on drinking water sources, fish and aquatic life, or recreational enjoyment of water

[1] Point source pollution comes from a discrete location such as a wastewater outfall. Non-point source pollution comes from many diffuse sources and enters water bodies via runoff and infiltration or atmospheric deposition [40].

WCEL [22]), authorities must re-examine policy priorities and evaluate and address gaps in compliance and enforcement.

The second broad outcome is **continuous improvement** of water quality beyond regulatory requirements and water quality objectives. This means that facilities, organizations and individuals voluntarily decrease pollution by, for instance, optimizing industrial processes, replacing or augmenting wastewater discharges with alternative treatments, improving agricultural management practices, or reducing or eliminating domestic or aesthetic pesticide use. To increase the adoption of these voluntary practices, stewardship organizations and government agencies need to work together to recognize leadership, identify and remove barriers to behaviour change, increase awareness, and provide meaningful, targeted incentives designed to achieve the desired objectives [25,39].

3.2 Strategies, management directions, and actions

This section summarizes the strategies, management directions and actions related to water quality and source water protection being considered by the Stakeholder Advisory Group. Strategies and Management Directions were first outlined in Discussion Paper 1 [43]. Here they are expanded on with additional strategies and actions to be undertaken by specific agencies or organizations, within stated timelines over the first phase of implementation (2014-2017).[2]

Strategy 1. Increase community understanding, support and capacity for stewardship of the Kettle River Watershed.[3]

Direction 1.1. Improve understanding of watershed function, integrity, resilience, and sustainability. Fill gaps in understanding through scientific studies and ongoing monitoring.

Action 1.1.1 Design and implement a synoptic water quality assessment[4] to characterize current conditions along the main stem of the West Kettle, Kettle, and Granby Rivers (provincial government; by 2017).

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[2] The *Implementation Team* was identified in Discussion Paper 2 [46] as the partnership of RDKB, other government agencies, local organizations and individuals who lead the first phase of implementation. It is expected to evolve into a more formal organization or partnership following a governance study by the implementation team. The Implementation team is expected to lead in the monitoring, reporting, and/or coordination of work by the various agencies and groups involved.

[3] Strategies and directions are repeated in all discussion papers but only the actions that are directly related to water quality and source water protection are presented; the final draft plan will compile and arrange all actions by strategy and theme.

[4] Synoptic water quality assessments 'follow' the water downstream from headwaters to outlet, sampling water quality at the confluence of major tributaries to characterize changes.

Action 1.1.2 Design and implement a medium-term (3-5 year) water quality monitoring network to collect and update water quality data: a) downstream of Grand Forks at the former Gilpin water quality station; key tributary locations (lower Boundary Creek, lower Granby River); and in sites downstream of proposed new forest harvest, mining and road-building activities. (Provincial government, water suppliers, implementation team; by 2017).

Action 1.1.3 Continue the sampling and reporting program for the ambient groundwater quality network and consider expanding sampling and reporting to other aquifer locations (i.e. Midway, Beaverdell), including additional parameters (key pesticides) (provincial government; ongoing).

Action 1.1.4 Develop an accessible database to compile and share (voluntarily) well-testing data from private, municipal and industrial sources and report changes in supply and quality to all stakeholders (provincial government, Interior Health Authority, water suppliers; by 2017).

Action 1.1.5 Share results of water quality monitoring in the watershed information system and regularly through awareness and outreach programs (Implementation Team; ongoing)

Direction 1.2. Build public and institutional support for improved watershed management, including the development, implementation, and continued support of policies and regulations that safeguard watershed health.

Action 1.2.1 Establish site-specific water quality objectives for surface and ground water purposes including drinking water and the protection of aquatic life (Provincial government with support from implementation team; by 2016 for sites with available long-term data, by 2020 for additional sites).

Action 1.2.2 Assess and improve the consistency, alignment and application of policies and regulations for protecting water quality and source waters in, for instance, resource management, health, and local government jurisdictions (Provincial and federal government, with lobbying and monitoring by local government and non-governmental organizations; ongoing)

Action 1.2.3 Give consideration to source water protection and water quality protection in local government planning documents (RDKB, municipalities, with support of Implementation Team; ongoing).

Action 1.2.4 Manage the permitting, licensing and approval processes (including groundwater) to support water quality objectives (Provincial government; ongoing)

Action 1.2.5 Adjust permitting, approvals, and land use by-laws to support the remediation of areas were water quality is not meeting objectives (provincial and local governments; ongoing).

Direction 1.3. Improve capacity for watershed stewardship

Action 1.3.1 Create a water supply working group to pool expertise and other resources and meet semi-annually (Implementation Team, municipalities, water purveyors; 2014)

- Provide regular (i.e. annual) opportunities for water suppliers and community representatives to discuss source water protection and water supply management, share learning and resources, and report on links with watershed management (Implementation Team, water suppliers, Interior Health Authority)
- Re-establish the Grand Forks Aquifer Protection Society to continue studies on the Grand Forks Aquifer and implement site-specific aquifer management actions (City of Grand Forks, Grand Forks Irrigation District, SION Improvement District, Covert Irrigation District, RDKB and Interior Health Authority; by 2015)

Action 1.3.2 Align and target stewardship and funding programs to address and support continuous improvement in key water quality concerns (i.e. sediment, pathogens) (Implementation team, stewardship organizations, provincial government; ongoing).

Action 1.3.3 Work with local conservation groups to establish a formal 'Streamkeepers' group or similar organization for ongoing water quality monitoring, wetland/riparian restoration and other stewardship activities (stewardship groups, fish and wildlife groups, Boundary Habitat Stewards; 2015)

Action 1.3.4 Design and implement an extension program for specific groups at risk of affecting or being affected by water quality issues (well owners, septic system owners) (Interior Health Authority, Environmental Farm Plan, BCWWA, Implementation Team; by 2015).

Strategy 2. Improve the quality, reliability and security of water supplies through sustainable management of water resources

Direction 2.1. Improve water quality in relation to point-source pollution

Action 2.1.1 Identify, implement and report on water quality improvements for stormwater, wastewater, and other discharge sites (municipalities [water treatment facilities], dischargers; ongoing)

Action 2.1.2 Consider strategies for augmenting or replacing wastewater treatment outfalls with alternative land-based treatment (treatment wetlands, irrigation of biomass plantings)[5] to

[5] http://publications.gc.ca/collections/collection_2012/rncan-nrcan/Fo147-1-11-2012-eng.pdf

reduce nutrient loads entering water bodies during low flows (municipalities, implementation team; by 2017).

Direction 2.2. Improve water quality related to non-point source pollution

Action 2.2.1 Continue risk screening and assessment activities in collaboration with local water suppliers and watershed partnerships (Interior Health Authority, Implementation Team; ongoing)

Action 2.2.2 Develop aquifer management or source water protection plans for areas where risk assessment determines current or future threats to surface water or groundwater resources (provincial government, water suppliers, local government)

- Identify and use codes of practice, incentives for best management practices, and other tools for groundwater protection

Strategy 3. Improve watershed health and function in the Kettle River Watershed

Direction 3.1. Maintain or increase the extent and cover of permanent vegetation, including forests, in uplands, stream corridors and on floodplains

Action 3.1.1 Implement or extend incentives for retaining or increasing native tree, shrub and grassland cover (provincial government, implementation team; by 2015)

Action 3.1.2 Design and implement urban & rural tree programs to increase tree cover (local municipalities, RDKB; by 2017)

Direction 3.2. Protect soil and improve soil health to improve water retention and decrease erosion

Action 3.2.1 Implement and align agricultural stewardship incentives for grazing, nutrient management, crop management & soil conservation (provincial government, implementation team; ongoing)

Direction 3.3. Maintain or increase the areal extent and function of wetlands and riparian areas across the watershed[6]

Outcomes for Strategy 3

- No further increase in nutrient, turbidity, or sediment loads measured in the Kettle River at water quality monitoring sites
- Increase cover of native trees, shrubs, and functionally equivalent vegetation in riparian areas and floodplains by 25% by 2025
- Implement a zero net deforestation status by 2020, including roads

[6]Actions for Strategies 3.3 and 3.4 to be developed in Discussion Paper 5

Direction 3.4. Encourage shoreline and bank protection measures that protect aquatic and riparian habitat and water quality functions

Strategy 4. Maintain or enhance recreational, cultural and amenity values

Direction 4.1. Maintain a healthy sport fishery through habitat protection and restoration, continued stocking of recreational lakes and the protection of native fish populations in tributaries and rivers

Action 4.1.1 Identify the source, transport and fate of sediment currently affecting fish habitat and investigate the aggradation (widening) of the Kettle and Granby Rivers (Provincial government, university researchers, implementation team; by 2017).

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